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Foreword



Brigitte Zypries,
Federal Minister for
Economic Affairs and Energy

Digitalisation is a major theme of Germany's G20 Presidency, the motto of which is "Shaping an Interconnected World", and is a key factor for strong, sustainable, balanced and inclusive global economic growth. I have invited the G20 digitalisation ministers and digital industry to discuss how digitalisation can be successfully shaped. This is the first such meeting in the history of the G20.

Prior to the Digital Ministers Meeting, the Federal Ministry for Economic Affairs and Energy hosted the conference "Digitising Manufacturing in the G20 – Initiatives, Best Practices and Policy Approaches" in Berlin in March 2017. Issues related to the digitalisation of industry were discussed at high-level panels and in numerous workshops. The discussions provided us with key findings and pointers for the G20 process.

Digitalised industry – Industrie 4.0, as we call it in Germany – has the potential to foster the global economy via more efficient and sustainable production. New value chains are emerging, and the definition of different sectors is changing. New business models and technologies like artificial intelligence and additive manufacturing are driving the process.

The G20 countries have differing industrial structures, and the economic strengths, corporate cultures and traditions vary from country to country. For this reason, each country has to identify and utilise its specific strengths in the digitalisation process. At the same time, it is necessary to strengthen international cooperation in the field of Industry 4.0, for example with regard to standardisation, access to test beds, or support for small and medium-sized enterprises. The future of the economies in the G20 depends on how they master the transition to digital production.

The digital transformation is a task for the whole of society and a global development. If we are to make full use of the potential of a globally connected world economy, we will need to cooperate across borders. We will need to work together to boost confidence in the digital economy. We will need common standards. And we, the G20 countries, will need to keep calling for open markets for goods, services and investment. They have brought enormous benefits all round the world. Our aim is to shape fair globalisation. To do this, we need to have key policy principles and common rules.

A global shift towards digitising manufacturing

Germany took over the G20 Presidency in December 2016. Digitalisation is a core focus, as it is a key requirement for strong, sustainable, balanced and inclusive global growth. The G20 Digital Ministers came together for the first time in April 2017 to discuss “Digitalisation: Policies for a Digital Future”. In this context the German Federal Ministry for Economic Affairs and Energy hosted the conference **“Digitising Manufacturing in the G20 – Initiatives, Best Practices and Policy Approaches”** in Berlin in March 2017. Around 500 representatives of government, business and civil society from the G20 countries joined the conference.

In the light of the status quo, reflecting the challenges and accepting a different level of digitisation of the respective manufacturing sectors within the G20, the conference had the following objectives:

- Bringing together experts from enterprises, science and political decision makers from G20 countries in the field of digitising manufacturing.
- Fostering a common understanding of key areas and the status quo regarding the challenges and opportunities in the field of digitising manufacturing.
- Recommending action for the regulatory framework, cyber security, enabling of business models, artificial intelligence, standardisation and digital skills.
- This brochure gives an overview of the discussions and the main findings at the conference. It describes some initial conclusions and different perspectives in the high-level panels. This is followed by summaries of the 13 interactive panels which covered various topics, ranging from standardisation, testbeds and regulatory challenges to the future of work, training and skills as well as data security, artificial intelligence and the impact on developing countries.

Digitising manufacturing, Industrial Internet and Industry 4.0 all refer to an intelligent and flexible production system. This will fundamentally transform value-creation processes. The key element is a combination of production methods with state-of-the-art information and communication technology. Production and logistics processes are integrated intelligently across company boundaries to make manufacturing more efficient and flexible. Networking the companies in the supply chain makes it possible to optimise not

only individual production steps, but the entire value chain. Production processes can be controlled across company boundaries, and resources and energy can be saved. All in all the competitiveness of the industrial sector can be strengthened.

Digitising manufacturing offers enormous potential for the industrial sector in the G20 as millions of jobs depend directly and indirectly on the manufacturing industries. The industrial sector accounts for a significant part of the GDP of the G20 members. As there is a strong impact of digital technologies on industry, many G20 states have launched their own initiatives – in Germany it is called “Plattform Industrie 4.0”.

Digitalisation will give rise to new business models and new prospects, but also entails certain challenges. There is a broad consensus that stakeholders from industry, science, politics, labour representatives and society need to work together to master the challenges and to reap the benefits of the fourth industrial revolution. The dialogue in the G20 is of key importance and can support the process of deepening a global understanding and exchanging best practices.

Key recommendations and areas of action identified during the conference:

- Encourage the creation or further development of national initiatives involving relevant stakeholders on digitising manufacturing and support learning partnerships between them. These initiatives can contribute to the digitalisation of economies and facilitate international cooperation.
- Sharing best practices is essential to facilitate digital transformation on a global level and to increase transparency about the ongoing activities in the G20 countries.
- To follow the path to digital transformation and recognise and grasp the opportunities presented by Industry 4.0 SMEs need particular support. Centres of excellence, digital hubs (for start-ups) and clusters should be encouraged in order to inform and support them, as well as to explore synergies with various partners, including large companies.

- For SMEs, easy access to testbeds is necessary and there is a need for testing facilities set up by various international partners.
- The development of international standards should be industry- and market-led, based on principles of openness and transparency. Consensus-based standardisation and consortia/de-facto standardisation should be included.
- Work within international forums and consortia should be intensified in order to ensure interoperability in Industry 4.0.
- Companies should be helped to identify IoT risks, to consider a consistent, effective and resilient design to protect security-/safety-critical assets and maintain a safe and secure state, and to dispatch and share information.
- Digital skills and competencies are driving forces for innovation and competitiveness in G20 and partner countries' economies. Digital literacy and digital skills should be elements of all forms of education and professional training throughout people's lives. Starting from early education to vocational and university education to life-long learning – the acquisition of digital skills is essential in all these periods, especially in the transition from job to job.
- Governments now have a window of opportunity, and should create an environment for innovation which includes incentives for investments in new technologies.
- Incentives for international research collaboration and new business-to-business connections should be fostered.

Global aspects of digitalisation – summary of the three main panels



FLTR: Melinda Crane, Mauro Fenzi, Susanto Irwan, Dr. Jan Michael Mrosik, Karthikeyan Natarajan, Prof. Stephan Reimelt

Factories of the Future – from global value chains to interconnected global value networks (Panel I)

The first panel brought together business leaders from various G20 countries who are implementing their vision for the emergent digitised industry. The goal was to present concrete examples within the production context and to discuss the implications of digitalisation that can already be seen and that are expected in the future. Topics like changing business models, business cooperation and changing value networks and digital ecosystems were touched on, as were education, skills and corporate responsibilities.

“Everything is changing very fast,” Mauro Fenzi, CEO of the Italian multinational manufacturer Comau, summarised the status quo of the transformation. Businesses are affected by digitalisation, challenging their business models and customer relations, their workers and necessary skill sets and their integration into global value networks. The manufacturing sector is already marked by huge investments in new technologies, robotics and automated machines, for example. Companies need to rethink their strategies in general. Mauro Fenzi outlined this by stating “If you do not digitalise your company, it is hard to digitalise your business model.”

Data has become an important commodity, giving platforms which provide solutions to use it an increasing relevance and increased visibility. “It is a platform game”, said Prof. Stephan Reimelt, former CEO of GE (General Electric) in Germany and Austria. As a multinational enterprise, GE is setting up an ecosystem based on data-driven platform solutions. These platforms help manufacturing companies to deal with and benefit from the massive data output being generated from the connection of “things” such as machines, computers and products. The increasing access to information, growing transparency and fast availability of products through the digital transformation allows more focus to be placed on the individual customer. “Many companies are starting to bring some of the manufacturing process into the shops,” said Mauro Fenzi, pointing out the new approach to integrate the customer into the production process. Karthikeyan Natarajan, Senior Vice President and Global Head of Engineering, IoT & Enterprise Mobility, at the Indian enterprise Tech Mahindra adds to this: “What we are doing is mapping our customers’ journey to find out where they see themselves in five years. Many of them go beyond selling products to delivering services and product as a service models” Tech Mahindra’s goal would not just be to develop the most sophisticated technology but “to make the customer’s transformation towards digitalization, services and business models happen” by providing the necessary infrastructure, applications solutions, and global scale.

With the growing speed of the change of individual consumer demands comes the challenge to innovate much faster. Start-ups have a competitive advantage in this respect as they are more flexible. This allows them to try new ideas, to fail and reinvent their business models. Susanto Irwan, founder of Sensify Security and on the panel as a representative of the Silicon Valley start-up scene, said: “Start-ups are not typically tied to a strict agenda of a larger corporation. They are hyperfocused on innovating fast, failing fast, continuing to iterate and execute. Speed and agility are the core tenants of a startup to enable to succeed and deliver results.”

The larger multinational companies are trying to integrate more of a start-up culture into their own operations in order to speed up innovations and survive on increasingly competitive markets and with more demanding customers. “You need innovations and ideas from outside and that can be possible through mergers and acquisitions” said Dr. Jan Michael Mrosik, CEO of the Digital Factory Division of Siemens. Also, as a second way of keeping innovations high within Siemens, Mrosik introduced the newly founded

company next47: “This company bundles Siemens’ start-up related activities. It works highly autonomously with start-ups worldwide in order to identify new ideas, projects, technologies and inspiring people from various disciplines and backgrounds.” As another global enterprise, Karthikeyan Natarajan of Tech Mahindra introduced their strategy: “We are defining and mapping our offerings to the run, change, and grow goals of our customers. We help them run better, change faster, and grow greater by leveraging digital engineering and the power of digital platforms. We want to equip our customers to operate like start-ups.”

Industry 4.0 not only changes business models and the way we do business, but also the way industry is working. In future, robots and human beings will be working closely together in hybrid systems. “It seems that the workers are not in the middle of the game, but they need to be” said Comau CEO Mauro Fenzi. “Digital human manufacturing”, as Fenzi calls it, is focusing on the worker perspective and supporting them in this massive transformation. Education and training needs to prepare people as well as possible for the changing working environment in Industry 4.0.



Karthikeyan Natarajan speaking, Prof. Stephan Reimelt behind

The manufacturing industry needs to adapt to the platform economy, developing its own platforms to collect all the necessary data along the value chain and to work efficiently with Big Data. Companies need to become faster and foster innovations holistically. Education and training needs to evolve to better prepare people for the changing working environment that Industry 4.0 presents. The German dual education system, which combines apprenticeships in a company and vocational education at vocational school in one course, can be a good model for other countries too.

Susanto Irwan Center, Prof. Stephan Reimelt behind

Panellists

Mauro Fenzi

CEO, Comau S.p.A. |

Susanto Irwan

Founder, Sensify Security |

Dr. Jan Michael Mrosik

CEO Digital Factory Division, Siemens |

Karthikeyan Natarajan

Senior Vice President, Global Head of Engineering Practice, Tech Mahindra;
Co-Chair, Engineering Council,
NASSCOM (India) |

Prof. Stephan Reimelt

former CEO of GE (General Electric) in Germany and Austria |



Shaping the future of industry together – how Industry 4.0 initiatives can enhance progress in digital production processes (Panel II)

Countries worldwide are trying to strengthen their manufacturing industries by setting up programmes, networks and initiatives. Representatives from eight national initiatives and the EU discussed the national focus that they have initiated in order to foster the development of Industry 4.0 in their country and where they see the potential for international cooperation. The discussion revealed that opportunities to develop new expertise and smart solutions within a globally interconnected system stand side by side with concerns about not being able to keep pace with the rapid developments in today's world.

The panelists basically agreed on two observations describing the global phenomenon of digital production:

The transformation process takes different forms but the challenges are similar: While Spain's focus lies on extending its IT competencies, as the Spanish representative Mario Buisán indicated during his description of the Spanish initiative Industria conectada 4.0, Germany and Italy are banking on their strengths in the automation and manufacturing sector. Mexico needs to redefine its industrial sector due to its changing role in the supply chain. All the initiatives' representatives have common concerns regarding cyber security, changing work force requirements, regulatory frameworks and standards.

- *The transformation stresses the need for and benefits of new multilateral cooperation:* Many initiatives for example set up networking opportunities and foster an exchange of best practices, including with international partners. "We still have a lot to learn and therefore we need this international exchange more than ever," says Prof. Dong Sub Kim, Head, Institute for Future Industry Strategy, Ulsan National Institute of Science and Technology, 4th Industrial Revolution Forum (Korea). This approach is in line with European activities as outlined by Khalil Rouhana, Deputy Director-General and Director for Digital Industry, DG Connect from the European Commission: "We encourage the EU Member States to start their own initiatives adapting the EU approach to national and regional specificities. We bring them also together to share experiences and collaborate even further when action at EU-level is needed and adds significant value."

Triggering investments from small and medium enterprises (SMEs) in particular for their digital future is the first success factor the groups brought up in the discussion. The supply chain in most countries mostly consists of SMEs, so they have to be ready for digitalised production. To help them getting to that stage is a big challenge, as Benjamin Gallezot, Deputy Director-General for Enterprise at the French Ministry for the Economy and Finance; Industrie du Futur (France) acknowledged. He was joined by Mario Buisán: "We have to convince SMEs of what is at stake because their own survival as companies may depend on it."

FLTR: Melinda Crane, Mario Buisán, Prof. Bronwyn Fox, Benjamin Gallezot, Prof. Henning Kagermann, Prof. Dong Sub Kim, Yutaka Manchu, Ricardo Del Olmo, Khalil Rouhana





Prof. Henning Kagermann speaking, left Benjamin Gallezot, right Prof. Dong Sub Kim

Panelists

Mario Buisán

Director General of Industry and SMEs, Ministry of Economy, Industry and Competitiveness; Industria conectada 4.0 (Spain)

Prof. Bronwyn Fox

Director of the Manufacturing Futures Research Institute, Swinburne University of Technology; Exemplars of Initiatives from the Prime Minister's Industry 4.0 Taskforce (Australia)

Benjamin Gallezo

Deputy Director-General for Enterprise at the French Ministry for the Economy and Finance; Industrie du Futur (France)

Prof. Henning Kagermann

President acatech – National Academy of Science and Engineering; Global Representative und Advisor, Plattform Industrie 4.0 (Germany)

Prof. Dong Sub Kim

Head, Institute for Future Industry Strategy, Ulsan National Institute of Science and Technology; 4th Industrial Revolution Forum (Korea)

Yutaka Manchu

Deputy Secretary-General, Robot Revolution Initiative (Japan)

Ricardo Del Olmo

Head of the Government Procurement Unit; Roadmap Industry 4.0 (Mexico)

Khalil Rouhana

Deputy Director-General, DG Connect, European Commission (EU)

“It’s important to share best practices, but it is also important to share lessons learned as well,” Prof. Bronwyn Fox, Director of the Manufacturing Futures Research Institute, Swinburne University of Technology; Exemplars of Initiatives from the Prime Minister’s Industry 4.0 Taskforce (Australia), pointed out. Setting up cross-sectoral and cross-country business alliances, digital innovation hubs, research and cluster networks are among national support strategies.

Another focus was set on common standards. “Interoperability is our number one goal. Since one worldwide standard is not realistic, open standards are key,” said Prof. Dr. Henning Kagermann, President, acatech – National Academy of Science and Engineering; Global Representative und Advisor, Plattform Industrie 4.0 (Germany). Interoperable standards are pivotal to the ability to set up global value chains in the future. Joint efforts to harmonise various approaches on standardisation will create benefits for a global economy. Yutaka Manchu, Deputy Secretary-General, Robot Revolution Initiative (Japan) refers to the existing reference architectures including the RAMI (the German Reference Architecture Model for Industrie 4.0) and IIRA (Industrial Internet Reference Architecture) are already mapped in a metalevel reference architecture as “Unified Reference Model – Map and Methodology (URM-MM)” introduced in IEC/SEG 7.

A crucial task the panelists identified was the need to prepare and train the workforce with regard to the changing skill requirements. Of special importance are investments in educating and training existing personnel, thus enabling them to take part in the transformational process. Prof. Dong Sub Kim, for example, suggests pooling strengths and resources internationally by sharing training and awareness tools between countries.



Speaking Mario Buisán, followed by Prof. Bronwyn Fox, Benjamin Gallezot



FLTR: Melinda Crane, Sharan Burrow, Philippe Darmayan, Bahadır Kaleağası, Robert Koopman, Vasily Osmakov, Marcos de Souza, Subra Suresh

Game changer digitalisation? (Panel III)

The World Economic Forum (WEF) is monitoring the global impacts of digitalisation, which is changing interactions between people. It has issued various reports on this topic. The discussion in this panel was launched with an overview of trends that are highlighted in the Forum's Global Risk Report.

Global income and wealth disparities are substantially restricting life chances

- An increasing polarisation of societies with a growing tendency towards advancing cultural and national concerns within international and domestic politics
- Mutual accountability is decreasing, giving room for new international security threats and a decreasing commitment to international cooperation
- Risks concerning global issues like climate change have increased at an unprecedented rate

The Forum has elaborated four contrasting production scenarios showing what consequences today's actions can have on the world of tomorrow.

Disrupted: Production transformed

A technologically driven society defines a radically new production paradigm. Economic growth is ensured by continuous technical innovations and reskilling of the workforce to enable them to use the technologies.

Deterred: Production undercut

The focus on real time connectivity causes a loss of security and privacy for the individual. A societal clash characterised by cyber conflicts and growing disparities is attributable to an economic model that mostly benefits corporations.

Damaged: Production stratified

Populism and protectionism have led to the end of a multilaterally oriented world. A phase of deglobalisation is initiated by governments reverting to patterns of economic statism. Income disparities lead to a societal cleavage that is difficult to overcome.

Devolved: Production redirected

Social priorities are rearranged in reaction to the inability of governments to achieve an equitable distribution of wealth where production is digitised. The new economy is driven by localisation movements, customisation in pursuit of the circular economy, and a "human at the centre of everything approach" by companies.



Sharon Burrow speaking

There was a consensus in the panel that digitalisation is one of the major drivers of change and that it has the potential to redefine opportunities while setting out a new direction of social wellbeing.

The Panel brought together renowned experts combining various perspectives – the economy, education, research and politics.

Philippe Darmayan, President of the French company ArcelorMittal, explained, that we have not only a revolution in production, but also a revolution in consumption and a revolution in the way people want to work. Success for the digital economy depends on the integration of the human

identity within technological innovations, but also on creating a society that is inclusive. Eventually societies will judge the change not only by economic but also by the social and ecological benefits it creates. This shows that the transformation in production systems is triggered by advanced technologies but does not stop at the factory door.

Besides a change in values, the panelists agreed that global production – especially global value networks and value creation patterns – will dramatically change. Countries like Russia, Turkey and Brazil have mostly been integrated in value creation chains as suppliers so far. The pressure of upskilling the workforce will cause a challenge for these countries. Vasily Osmakov, Deputy Minister of Industry and Trade of the Russian Federation, said “The biggest problem for us is the transformation for the industrial workers because in Industry 4.0 every worker has to be an engineer.” The skills and qualifications of the current workforce and succeeding generations are key elements to ensure inclusive growth, and to provide fair opportunities for people. Sharon Burrow, Secretary General of the International Trade Union Confederation (ITUC), reaffirmed that right now the low skilled labour force is increasingly marginalised. She sees the need to develop education programmes that are jointly set up with companies and workers to meet the needs of both sides. How to do this appropriately is a question that also occupies Prof. Subra Suresh, President of Carnegie Mellon University. Questions like: What is the minimum body of knowledge one needs in order to be a part of the workforce in a digitalised economy? How can you make education deeper and broader at the same time? The discussion revealed that universal solutions do not exist, but initial ideas that have proven to be successful include fostering a culture of lifelong learning and setting up local innovation ecosystems. Reorganisation of government actions and civil society structures towards a more problem-oriented approach can support this change and ensure that all relevant perspectives are considered when devising new policies.

Societies now stand at a tipping point as to which way they will go. Questions around inclusive growth are more relevant than ever. Discussions on possible adaptations and frameworks have just started in most societies and the list of questions to solve is still longer than the list of answers.

Panellists

Sharan Burrow

Secretary General, International Trade Union Confederation (ITUC) |

Philippe Darmayan

President, ArcelorMittal France; President, Industrie du Futur |

Bahadır Kaleağası

Secretary General Turkish Industry and Business Association (TÜSİAD) |

Robert Koopman

Chief Economist, WTO |

Vasily Osmakov

Deputy Minister of Industry and Trade of the Russian Federation |

Marcos de Souza

Secretary of Innovation, Ministry of Industry, Brazil |

Subra Suresh

President of Carnegie Mellon University |

Interactive Panels

In addition to the global aspects of digitalisation discussed by the high level panels, the conference focused on specific topics through interactive panels. In total more than 50 international experts discussed the different topics in 13 interactive panel sessions.

Many panels were chaired by Germany with a co-chair from one of the other G20 countries to feed different perspectives into the discussion.

(1) Global Industry 4.0 Standards: challenges and opportunities

Reinhold Pichler

GERMANY | Standardization Council I 40

Jörg Diederichs

CHINA | Huawei

Thomas Hahn

GERMANY | SIEMENS AG

Prof. Fumihiko Kimura

JAPAN | University of Tokyo

Patrick Lamboley

FRANCE | Schneider Electric

Enrico Scarrone

ITALY | Telekom Italia/ETSI

Dr. Wei Sha

CHINA | China Electronic Standardization Institute

“Reference architecture models help to come to a common understanding and to identify needs for standardisation.”

Thomas Hahn

Entire value chains will be digitalised, integrated and connected from product design up to on-site customer service. Interoperability is a must and interoperability needs standards. The aim of the session was to discuss how international standardisation could be strengthened. One further aspect was the need for reference architecture models such as RAMI.

Summary

All discussants stressed the need for global standardisation. Standardisation should be driven by industry and done in international standardisation committees, whether in regard to consensus-based standards like ISO and IEC or de-facto standards, for example OPC Foundation, IETF, W3C, eCl@ss, etc. In the future, existing standards must remain in force in order to digitalise the installed industrial base. About 80 percent of required standards are already on the books and can be used. Reference architecture models for Industry 4.0 can be used to identify what standards are required in Industry 4.0 production.

In the opinion of the plenary session it will not be necessary to define one unique reference architecture model that will substitute all the different existing models. But to achieve a common understanding, it is at least the aim to define a kind of “general” model.

The need for fast standardisation procedures was discussed as time-to-market becomes shorter and the digital transformation is moving fast. Standardisation needs to become more agile and flexible. Test labs are a means to test and evaluate proposed standards.

FLTR: Dr. Wei Sha, Jörg Diederichs, Thomas Hahn, Prof. Fumihiko Kimura, Patrick Lamboley, Reinhold Pichler (not in picture: Enrico Scarrone)



(2) Cooperation in a new dimension: the international testbed network

Thomas Hahn

GERMANY | SIEMENS AG |

Dr. Andreas Bihlmaier

GERMANY | Startup robodev |

Tom Egan

UK | Leadership Group Catapult |

Prof. Bronwyn Fox

AUSTRALIA | Swinburne University |

Prof. Egbert-Jan Sol

NETHERLANDS | EFFRA / Smart Industry NL |

Richard Soley

USA | IIC |

Jean Sreng

FRANCE | CEA |



Thomas Hahn

“Without a doubt, the digital transformation of industry demands cooperation. Cooperation at all levels – between companies, industries and institutions. And cooperation across national borders and across the respective emerging digital platforms.”

Thomas Hahn

The digital transformation, Industry 4.0 and Industrial Internet are sounding the bell for a paradigm change. Experts expect digitalisation to become the most important driver for the manufacturing industry.

The aim of the session was to discuss best practices, especially how best practices can be harvested from testbed projects and how to share the efforts. It was discussed what lessons could be learned internationally and how governments could strengthen test cases running inside test labs and facilitate international collaboration.

“It’s not only about introducing new technologies and testing them, half of it is about educating people.”

Egbert-Jan Sol

Summary

Testbeds are a proven method to accelerate knowledge transfer and increase the development of new technologies and business models. They foster collaboration and networks between companies, research institutions and other stakeholders.

All companies and especially SMEs need test environments to make “risk reduced” testing before new technologies are used operationally. This opportunity is especially important for SMEs before investment decisions are taken.

The role of regional test labs and focused hubs was stressed. As a conclusion, the panelists agreed upon the value of an international network of testbeds to accelerate the development of digital technologies, interoperability and related standards. Governments can facilitate the process by funding programmes for projects or infrastructures.

Digital transformation creates a need to upskill people. Testbeds or learning factories can contribute to training and educating employees.

Last but not least testbeds should focus on the development of requirements for standards to ease the adoption of digitalisation and to the testing of standards before they go public.

(3) Regulatory challenges of Industry 4.0

Dr. Alexander Duisberg

GERMANY | Bird & Bird LLP |

Mike Bilton

CANADA | Mould Makers Association |

Dr. Jesse Jijun Luo

CHINA | Huawei |

Kiyoshi Mori

JAPAN | Ministry of Economy, Trade and Industry |

Khalil Rouhana

FRANCE | DG Connect / European Commission |

This workshop examined the regulatory challenges associated with Industry 4.0 including access to data, data ownership, data privacy and liability of autonomous systems. Panelists discussed possible ways forward.

Summary

Data ownership and access to data are being debated around the world. It was agreed that data should flow freely across borders as this is a key element to stimulate the world economy, both for developed and developing countries. Regarding data, there has to be an international regulatory level playing field. An international information exchange on the level and content of data regulation should be established. This process requires openness, digital trust, international consensus and cooperation. Cyber security is of utmost importance to unlock and safeguard innovation. To secure data privacy, anonymisation of data is crucial. Regulation must not hamper investments and innovation. Regulation, if needed, should be set up in such a way as to promote private-sector activities. OECD and other relevant international organisations are expected to enhance their tasks to measure various issues relating to digital economy and digital trade. The public sector should encourage start-ups and encourage big companies to continuously create better ways of providing internet services which are more compatible with various social issues, including privacy issues, both in B2C and B2B.

FLTR: Dr. Jesse Luo, Mike Bilton, Kiyoshi Mori, Khalil Rouhana, Dr. Alexander Duisberg



(4) Smart Cities: digitalisation put into practice

Iris Plöger

GERMANY | BDI – Bundesverband der Deutschen Industrie

Jaime Reyes Robles

MEXICO | Staat Jalisco

Prof. Dieter Spath

GERMANY | Fraunhofer IAO / acatech

Dr. Eberhard Veit

GERMANY | Festo & 4.0-VEIT

Luis Ignacio Vicente del Olmo

SPAIN | Telefonica

Smart cities bring together a variety of digital solutions and create a digital ecosystem of their own. This panel flagged up opportunities and challenges of smart cities.

Summary

The Mexican state of Jalisco and its capital Guadalajara served as an example: In Jalisco, the government has created co-working spaces to bring together SMEs and larger companies together to foster innovations and found start-

ups. Also, the government has established the concept of a digital university without classrooms, buildings and professors but with digitised contents.

Besides co-working spaces and education a city not only needs the hardware but also must identify itself with the process. As every city is different, every city needs an individual plan on its way to become smart. Governments cannot influence most of their city's areas as they are mostly in private hands. Thus, cities need to establish funding schemes and public-private partnerships and should stimulate private investments. Generally, they should start becoming smart in parts of the city, test different approaches and learn from them in order not to waste money.

As further enablers, the panelists pointed out the importance of availability of energy, mobility, an open government strategy and data. Data could be used much better to develop smart cities if laws and regulations were not that strict. The relevant data e.g. to smartly manage traffic in a city exists but is not useable in Germany due to strict laws. However, the sharing and smart using of data is important for smart cities. When looking at data, the topic of cyber security, which is closely interlinked with open data usage, also arises. If the data is safe and secure, a more open culture of sharing and using data could be emerging.

“The more cyber security the more e-commerce we will have.”

Jaime Reyes Robles, Minister of Innovation, Science and Technology, Government of Jalisco, Mexico

Prof. Dieter Spath



“We have to develop a culture to handle open data but also to find a solution to fight cyber crime and data misuse.”

Prof. Dieter Spath, Präsident acatech und Leiter Fraunhofer IAO

“In bigger cities the radius of action is much better than in smaller cities.”

Prof. Dieter Spath, Präsident acatech und Leiter Fraunhofer IAO

(5) Pathways to the future of production

Kamau Gachigi

KENYA | Gearbox |

Dr. Reinhold Achatz

GERMANY | ThyssenKrupp |

Konrad Klingenburg

GERMANY | IG Metall |

Jennifer Morgan

NETHERLANDS | Greenpeace |

Marcos de Souza

BRAZIL | Ministry of Industry, Foreign Trade and Services – Brazil |



Konrad Klingenburg

“We have to teach the teachers in order to keep up with the speed of development.”

Konrad Klingenburg

The discussion about “Pathways to the Future of Production” is guided by two key assumptions: The need for (1) major drivers which transform production systems and (2) strategies which prepare leaders and employees for the transition into new production systems.

Summary

Digitalisation is a challenge for industries, for employers and employees, and society. Advanced and innovative technology is only one part of the transformation of production systems. Besides the focus on products and processes, especially in industry, there should also be a focus on organisations and human potential. Existing skills should be interlinked and embedded in the new needs of the digitalised market. Therefore a new ecosystem needs to be created to generate

“When we think about transforming the production system, what should be in our minds are the planetary boundaries. The timeframe we are talking about to transform our production system is very short, or else it will be very costly.”

Jennifer Morgan

Marcos de Souza



innovative hubs as well as values for society to cohere around. Governments and industries in developing countries must handle many more challenges, such as lower education levels or less developed innovation ecosystems. Moreover, Industry 4.0 implies a huge potential for disruption of supply chains around the world, impacting in many ways on developing countries. The opportunities for developing countries are their ability to attract investment from multinational corporations, as well as the low entry barriers for new companies. Another important driver for transforming production systems is the interaction between Industry 4.0 and climate change. Advanced technologies have to be used to find new ways of producing without negatively impacting the environment.

The main pillars for a successful transition into new production systems are value chains, technologies, infrastructure, education and soft skills. Therefore, investments in innovative education systems and teachers are indispensable. Furthermore, society needs to understand that education does not last forever, and that people need continuous learning – life-long learning and on-the-job learning. At the same time leaders have to adapt programmes to the new skills needed, offer them to their employees, and support them. This leads to enormous educational challenges for governments as well as for industries. A possible solution to this challenge is a dual education system which connects academic knowledge and on the job training.

“We have to acknowledge how challenging it is for policy makers in developing countries to foster innovation due to differing starting points and conditions.”

Marcos de Souza, Secretary of Innovation,
Ministry of Industry, Brazil

(6) The future of work and skills in digitalisation

Sharan Burrow

AUSTRALIA | International Trade Union Confederation (ITUC) |

Heidi Cigan

EUROPE | DG Connect, European Commission |

Anja Demont

GERMANY | Fraunhofer IPA |

Markus Lorenz

GERMANY | Boston Consulting Group |

Konrad Klingenburg

GERMANY | IG Metall, Trade Union |

The key question of this session was which skills are needed in a digital manufacturing environment and how training of the employees can be transformed.



FLTR: Konrad Klingenburg, Markus Lorenz, Heidi Cigan

Konrad Klingenburg speaking, Dr. Reinhold Achatz



Summary

Digitalisation challenges the whole of society and the education system. Digital change and digitised industries need employment protection as a framework for new digital skills and life-long learning. We must avoid a digital divide and enable participation: educate “new digital natives” and (re-)train the employed workers.

The panelists agreed that there is a need to focus on the human being and their experiences. It is a duty not only for government but also for industry to find solutions for bringing together new topics (like engineering and IT), to find solutions for training older employees (50+) and to integrate the young generation. Furthermore, new job profiles like “Data Scientist” must be designed and the education system (based on a dual-mode education) needs to be revised. Training for the future could start in primary schools with the introduction of some basic knowledge of technology and engineering topics.

For the employees, it is necessary to understand that digitising the work generates a lot of opportunities due to new technology. On the other hand, they must accept that there is a request for life-long learning also with a focus on soft skills. Government and industry have to make sure that minimum wage and social security aspects are recognised, safeguarding a standard of living e.g. also for digital co-workers.

Government and industry must avoid a digital divide and enable participation: educate “new digital natives” and (re-) train the employed workers. Although there are and will be different education systems and skills levels within the G20 members, sharing of experiences and best practices of the digital transformation could help to implement global standards. True partnerships between employer and employee could be a key aspect for a successful transformation of the workforce and its environment. Focusing on the opportunities without denying the challenges of digitisation should help to motivated the workforces independent of sector or country.”

“Industrie 4.0 is not only a technical discussion, it’s about people.”

Konrad Klingenburg, representative of IG Metall in Berlin

(7) Infrastructure: optical communication in space

Dr. Gerd Kraft

GERMANY | DLR |

Prof. Volker Liebig

GERMANY | DLR

Massimiliano Ladovaz

ITALY | ESA |

The goal of this panel was to illustrate earth observation from space as a powerful tool for today's digital society: 80% of all data is related to geographical information.

Summary

Covering all regions of the world, satellite-based observation provides a fundamental understanding of our globe's topography. With its high precision, the detailed survey is a key-enabler for the digital revolution of both society and industry in the G20: digital and precision farming to enhance efficiency in food production, maritime surveillance and analysis of tectonics to predict earthquakes all rely fundamentally on geographical data from space.

To provide (near to) real-time access to space-based information, laser communication provides the technological backbone to handle the peta-byte of data produced in modern satellite programs. With the highest data rates and the ability to provide secure communication via quantum cryptography, optical technologies can ensure integrated connectivity to all regions of the globe in the upcoming 5G communication era.

“Optical technology is a key enabler for secure communication using quantum cryptography.”

Massimiliano Ladovaz



Dr. Gerd Kraft

The G20 should facilitate the development and implementation of laser-based communication in space within the following field of actions:

- a. Standardisation:** Recent development of communication technologies are hindered by a lack unified standards and communication protocols within the G20.
- b. Implementation:** With mature laser communication in space the implementation of digital business concepts based on “data from space” should be fostered within the G20.
- c. Fundamental research:** Dedicated R&D programmes to facilitate the development of quantum cryptography as a backbone for secure communication in the digital society should be promoted.

(8) Artificial intelligence for Industry 4.0

Prof. Wolfgang Wahlster

GERMANY | DFKI |

Prof. Sahin Albayrak

TURKEY | GT-ARC |

Dr. Philippe Beaudoin

CANADA | Element AI |

Dr. Satoshi Sekiguchi

JAPAN | AIST

Prof. Paolo Traverso

ITALY | FBK-ICT IRST |



Prof. Paolo Traverso

Artificial intelligence (AI) is moving at an incredible pace. It is a key enabler for the next generation of smart manufacturing in Industry 4.0. It can lead to interference in traditional workflows, supply chains, value creation and business models in manufacturing and works towards empowering and expanding workforce expertise. This workshop aimed to take a closer look at the impact of artificial intelligence and how research and innovation can be promoted.

“Machine Intelligence is a complement to human intelligence. We need collaborative cooperation between robots and human competences and creativity.”

Prof. Paolo Traverso

Summary

Adapting best practices in AI for internet services to manufacturing will pave the way for synergistic collaboration between humans and robots in urban smart factories for mass customisation. Common standards and a free flow of industrial data in a secure and safe environment within the G20 countries are a prerequisite for AI applications in Industry 4.0.

The G20 countries should support coordinated research, development and deployment activities on AI for the fourth industrial revolution, in particular in the following priority areas:

1. Hybrid teams of human workers and collaborative robots in smart factories and deep learning for state-based and predictive maintenance of networked production machines and for understanding human behaviours of shop floor workers; intelligent industrial assistance systems for human workers: proactive and situation-aware online help and training on the shop floor

2. Semantic technologies for worldwide interoperability of machine-to-machine-communication in smart factories and logistics to enable real-time production planning & scheduling for multiagent systems and dynamic plan revision

3. Trusted industrial data exchange hubs and machine learning for industrial process mining and active digital product memories and digital twins for intelligent asset tracking and production cockpits; long-term autonomy and self-learning as well as self-healing capabilities of industrial components

4. Security technologies for intelligent intrusion detection and penetration testing for smart factories.

Prof. Wolfgang Wahlster; background FLTR: Prof. Sahin Albayrak, Prof. Paolo Traverso

“Artificial Intelligence is a key enabler for the implementation of Industrie 4.0 and will lead to disruptions in production processes and business models.”

Prof. Wolfgang Wahlster



(9) Impact of digitising on developing and emerging countries

Andreas Beckermann

GERMANY | BMZ |

Augusto Luis Alcorta

PERU | UNIDO |

Mohammed Almajed

SAUDI ARABIA | Taqnia Digital Manufacturing |

Katja Dombrowski

GERMANY | Development Magazine |

Prof. Carl Benedikt Frey

UK | University of Oxford |

Dr. Alexander Werbik

GERMANY | acatech

“It’s good to be prepared for the transformation, but it will not be coming overnight.”

Prof. Carl Benedikt Frey, University of Oxford

This panel aimed to provide insights into the challenges of digitalisation for developing and emerging countries and to find evidence of the effects.

Summary

In 2050, four out of five children will be born in Africa. This development clearly marks where the future markets will be – in today’s developing and emerging countries. Today’s developments in digitised manufacturing will have major impacts on the developing and emerging world. In particular, these are the Internet of Things with massive Big Data and ongoing automation, the impacts of digitised manufacturing like 3D printing on global value chains, and the technology-enabled platforms. The challenges for developing and emerging countries regarding digitised manufacturing will be the proper set-up of infrastructure, technology and knowledge transfer from developed countries, skills development and disruptive adaptations in academic education as well as the expected **polarisation of the labour market** due to an increase in automation.

Some effects of the transformation of labour markets due to technological and societal developments can already be seen today when comparing emerging and developed countries. Today more jobs are being created in automation in China than in Germany or France. Thus, on the one hand,

there is an opportunity for developing countries to accelerate the transformation of industry due to digitalisation. On the other hand, there will be an increasing pressure on low and medium-skilled manufacturing jobs, while new job developments will arise primarily in high-skilled industry sectors and urban areas. For some years, there will be still a market for low-skilled workers as it might not be competitive for all products to replace cheap labor through robots, but in the end, the costs for robots and other types of automation and digitalization will go down dramatically.

The educational systems in developing countries are yet not good enough for the transformation, and the skill sector is not well developed. Besides this, the social security networks in developing and emerging countries are often not well developed, thus leaving those behind who might have to change their job through automation. The discussion in developed countries, whether an unconditioned minimum income could constitute a social safety net for those who lose their jobs is less applicable to developing countries as their governments don’t have the budget to cope with the costs of such a system.

(10) Industrial Cyber Security: global defence strategies

Dr. Wolfgang Klasen

GERMANY | SIEMENS AG |

Takashi Amano

JAPAN | TOSHIBA |

Guy ALee

USA | Intel / IIC |

Stantchev Pentcho

FRANCE | Schneider Electric |

I Nyoman Supriyatna

INDONESIA | National Standardization Agency
of the Republic of Indonesia |

Takashi Wada

JAPAN | Information-technology Promotion
Agency (IPA) |

The discussion on this panel was about the industrial security situation today and how stakeholders can improve overall cyber security for their business. Global standardisation concerning cyber security was also on the agenda of the panel.

Summary

The Industrial Internet of Things (IIoT) / Industry 4.0 will lead to an increasing connectedness of industries, plants, machines, humans, products and other devices. A tremendous amount of data will be generated. With the rise of connected devices and generated data, security and safety risks will increase. Hence, industrial cyber security is a key enabler for IIoT / Industry 4.0.

To ensure industrial cyber security different initiatives like the Industrial Internet Consortium (IIC) from the USA, France's Fédération des Industries Electriques, Electroniques et de Communication (FIEEC), Indonesia's Badan Standardisasi Nasional, Japan's Information-Technology Promotion Agency and Germany's Plattform Industrie 4.0 provide recommendations for companies on how to ensure industrial cyber security. A joint Japanese-German position paper recommends companies to (i) establish a basic policy considering the IoT characteristics, (ii) identify IoT risks (iii) consider a consistent, effective and resilient design to protect security-/safety-critical assets, (iv) consider processes, technical and network-based countermeasures and (v) maintain a safe and secure state, dispatch and share information and consider business continuity.

However, becoming part of interlinked value chains requires a company to do both: meet certain security requirements and prove the trustworthiness of the security of products and processes. In that regard standardisation procedures, certification and self-declaration will play an important role – not only at the national but also at international level. Some international cooperation aiming at achieving standardised procedures at ISO / IEC level is already in place like the one between Plattform Industrie 4.0 and Robot Revolution Initiative, Plattform Industrie 4.0 and IIC and German ZVEI and French FIEEC. It is expected that on the one hand further international cooperation will emerge and on the other hand different national standardisation approaches will converge.

(11) Upgrading SMEs for digitised value chains

Prof. Egon Müller

GERMANY | Kompetenzzentrum Mittelstand
4.0 Chemnitz

Benjamin Gallezot

FRANCE | DGE, Ministry of Economy

Prof. Dagmar Gesmann-Nuissl

GERMANY | Kompetenzzentrum Mittelstand
4.0 Chemnitz

Dr. Max Lemke

EUROPE | DG Connect, European Commission

Prof. Margherita Peruzzini

ITALY | University of Modena and Reggio Emilia



FLTR: Prof. Dagmar Gesmann-Nuissl, Benjamin Gallezot, Dr. Max Lemke, Prof. Margherita Peruzzini, Prof. Egon Müller

“We need to work for SME’s on the ground to master their digital transformation. This is the primary objective of the European Network of Digital Innovation Hubs.”

Dr. Max Lemke, DG Connect, European Commission

Margherita Peruzzini



“Best way to motivate SMEs is to show results and facts to them. That is what Universities and Research Centers can do to bring them closer to new methods, tools and technologies.”

Prof. Margherita Peruzzini, University of Modena and Reggio Emilia

This panel discussed the importance of small and medium-sized enterprises (SMEs) in an Industry 4.0 ecosystem.

Summary

Excellence in SMEs is the backbone of industry throughout most of the G20. Due to their indispensable connectional role in the value creation process, Industry 4.0 solutions must become widely adopted in these companies to achieve the vision of a new economic era. Therefore, not only does

this mutual interest need to be worked out and emphasised, but also specific measures have to be defined and taken to foster a sustainable development which considers the individual means and goals of the partners involved.

Due to a lack of resources and competences, the digital transformation is a huge challenge for SMEs. To manage these challenges there is a need for awareness to open their processes, to design new business models and to train their employees. This requires sustainable standards in the field of machine-to-machine communication, industrial cyber security systems and best-practice exchange between the companies.

A specific challenge is financing the transformation process as the investment in machines and education is expensive and banks are not easily convinced to finance such investments. Furthermore, SMEs need to find ways to get new ideas (inside or outside the company) and integrate innovation into the organisational context.

SMEs can be successful in a digitised economy thanks to their flexibility, digital business models and willingness to embrace change. They depend on external networks and integration into new value networks to benefit from digital development in different areas, as they do not have experts in every field in their own organisation. They need support with financing their digital change, a powerful digital infrastructure, as they are often located outside the big cities, as well as a stable legal framework regarding standardisation, cyber security and education.

(12) A shift towards sustainability: How can Industry 4.0 promote the circular economy?

Prof. Günther Bachmann

GERMANY | Sustainable Development Council |

Philipp Buddemeier

GERMANY | Accenture |

Jorge Ceballos

ARGENTINA | pre-Industrie 4.0 |

Dr. Jens-Christian Holst

GERMANY | SIEMENS AG |

A circular economy is a regenerative system in which resource input and waste, emissions, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling. The aim of this panel was to explore how Industry 4.0 technologies can unlock their potential for the circular economy and how this can be supported through the right policy mechanisms.

Summary

Excessive use of resources is not a single-country problem. The panel discussion focused on a holistic approach to overcome uncontrolled growth at the expense of nature. Industry 4.0 technology enables enterprises to save resources in the production of goods and services. For instance, transparency along the value-adding chain helps to reduce

resources and energy by up to 90%. Regarding the circular economy, the new technology is a driver for working with new materials and design of products based on new production processes. In summary, it can be said, that for enterprises and societies, digitalising 4.0-wise drives pretty much all aspects of future creation of wealth.

Even though there is a large potential in the circular economy and digitalisation (up to 100 trillion in the next 10 years, WEF 2016: <https://www.weforum.org/press/2016/01/100-trillion-by-2025-the-digital-dividend-for-society-and-business/>), there are still barriers impeding sustainable growth: 1) from the investment perspective there is hesitation to replace existing machines, 2) there is still no positive business case, due to the fact that most of the costs of waste are not included in the sales price, and 3) a circular economy ecosystem is missing.

Panelists assumed there is a big potential to support the Sustainable Development Goals (SDGs). The circular economy offers a tremendous opportunity to enable resilient economic welfare, by keeping within the boundaries of one planet.

“If you have to bring your children to school with a mask, you cannot talk about ‘economic growth’!”

Dr. Jens-Christian Holst

“We have to embrace circular economy to stay alive and Industry 4.0 give us the tools to achieve it.”

Jorge Ceballos

Philipp Buddemeier



(13) Data Sovereignty in Global Value Networks

Prof. Boris Otto

GERMANY | Fraunhofer ISST |

Prof. Michael ten Hompel

GERMANY | Fraunhofer IML/ISST |

Ulrich Graf

CHINA/GERMANY | Huawei |

Prof. Jun Ni

USA | University of Michigan |

Prof. David Romero

MEXICO | Tecnológico de Monterrey /
Intelligent Manufacturing Systems |

Prof. Nishioka Yasuyuki

JAPAN | Industrial Value Chain Initiative |



FLTR: Prof. Boris Otto, Prof. Nishioka Yasuyuki, Prof. David Romero, Ulrich Graf, Prof. Jun Ni (Prof. ten Hompel not in picture)



Prof. Boris Otto

“A global approach must take national and regional requirements into account. However, data does not stop at country borders, thus, we need an international standard as a widely supported consensus for data sovereignty.”

Prof. Boris Otto

The panel discussed the need for international efforts to achieve data sovereignty. Data flows do not stop at country boundaries, thus, (different) national regulations must be taken into account, but should not hinder a global standard. In addition, an industrial code of conduct could work alongside widely supported practical approaches like the Industrial Data Space.

Summary

The panel pointed out that in future digitised companies will increasingly collaborate within global value networks and will therefore share data and information. In this process, the data and information have to be categorised by the participating companies into at least three categories: (1) free data, which e.g. could be found also on the company's

website, (2) internal data which cover the expertise of the company owning the data but have to be shared with a partner to enhance the efficiency and the effectiveness of the value chain, and (3) confidential data, which has to be kept confidential by the owner. To allow for this data sovereignty, companies have to “dare to share” the category 2 data and keep control over it. Data sovereignty is the capability of a natural person or corporate entity of exclusive self-determination with regard to its economic data assets. That means e.g. to control who and how often/long someone has access to which data and information.

Annex: National initiatives presenting themselves during the conference

Germany



GTAI | www.gtai.de |



Labs Network Industrie 4.0 |



Standardization Council 4.0 |

<https://sci40.com> |



Kompetenzzentrum Berlin |

<https://gemeinsam-digital.de> |



Industrial Data Space |

www.industrialdataspace.org |



Plattform Industrie 4.0 |

www.plattform-industrie40.de |

European Union



Digitising European Industry |

<http://ec.europa.eu/digital-agenda/en/digitising-european-industry> |

UK



High Value Manufacturing Catapult |

<https://hvm.catapult.org.uk/>

Italy



Piano Industria 4.0 / Fabbrica intelligente |

www.sviluppoeconomico.gov.it/index.php/it/industria40

www.fabbricaintelligente.it

Japan



ロボット革命イニシアティブ協議会
Robot Revolution Initiative

Robots Revolution Initiative (RRI) |

<https://www.jmfrri.gr.jp/english/>

China



Alliance of Industrial Internet |

<http://english.gov.cn/2016special/madeinchina2025/>

Spain



Industria conectada 4.0 |

www.industriaconectada40.gob.es

