**INDUSTRY 4.0**

**Introductory thoughts on the current situation**

The joint future programme-platform of the German Government and representatives of the industrial sector – Industry 4.0 (in German – Industrie 4.0) consists in comprehensive and systematic digital networking of the creation, logistics and use of products or services. It is often regarded as an impetus which will start the fourth industrial revolution.[1] For conventional automation in analogous world, machines are programmed to take over single functions by responding to certain signals. The scenarios of the Industry 4.0 platform comprise entire systems. These systems largely function independently both in responding to impulses, planning the following process stages and generation of the respective automation programmes and monitoring of the processes generated. The man-machine interaction points have changed in principle in that respect. The actual and digital, i.e. virtual world are increasingly merged. This creates a multi-level and intertwined data set which according to the estimates doubles in volume every two years and contains trillions of units (Big Data).[2]

New knowledge is acquired nowadays more than ever as a result of intense research. Quite innovative products are developed through digital technologies on the basis of research results. Research and development activities are the pillars supporting Industry 4.0. However, this concept does not include just new tangible products that are constantly developed further, such as high technology production equipment and consumer goods, the created value of which increasingly consists of semiconductors and software – although we could assume that judging by the name – but Industry 4.0 covers also the creation of intangible products. These are services which arise from the data of networked production processes and on the basis of which technical innovations are implemented.

After the financial crisis which started to roll from the U.S. subprime mortgage crisis which reached its maximum level in 2008 and led to the crisis of banks and the still continuing crisis of national debts and the euro, the global economic growth has not fully recovered yet. But due to the technological revolution set in motion by the Industry 4.0 platform, a modest but – as it seems – fundamental recovery of economic activities can be observed in many industrial countries.Most raw materials available are used by the industrial sector. Together with the private sector, the industry uses also most of the primary and electrical energy. Considering that natural resources, such as oil, natural gas and several metals are continuously decreasing, the digitally controlled value creation chains and the resulting more efficient control of industrial production processes may create a significant basis for sustainable economic growth.

Logistics, networking of the creation and use of products or services is developing further and will soon comprise all levels of national economy. It will increasingly concern also households in the future. Not only national governments and their economic systems have to be ready for such challenging changes but the whole identity of the society will start changing in the future. This is evident already now in the clearly perceptible changes in the habits, interests and world outlook of young generations.

Industry 4.0 will launch a fundamental transformation of the employment world. Increasingly more labour is replaced by intelligent algorithms and robots. This concerns not only unqualified labour but also people with knowledge-based education and training, such as skilled workers, bank clerks, lawyers, even the work of physicians will undergo fundamental changes. On the other hand, increasingly more staff qualified in software and communication technology will be needed, also in the area of systems engineering. Professions with new duties will appear, such as data scientists who filter the information required for the established objectives from unstructured data sets.

In the future, employment will be considerably less than now related to specific hours and places. Flexible performance of duties, such as working from home or through the web (crowdworking) are increasingly common.

Employees have to adopt a different way of thinking and learn to integrate themselves in modern production processes. For instance, an employee may need to become a part of a network of intelligent robots (APAS – automated production assistants) which has recorded important information on the work duty and constantly supports human labour by communicating important information (cyber- physical system).

As the general trend is to develop and test new products in a computer and to simulate at first virtually the processes required for their production, the employees sought should above all be able to use the respective computer software. They have to be able to understand complicated data sets and effectively process them. The other required characteristics are independent and pro-active thinking and adaptability, accuracy, creativeness, sense of responsibility, also the ability and readiness for cooperation. For those who do not have the characteristics described or have no ability to acquire them, it will be more difficult to find jobs in the future or they will have to cope with less paid jobs. With increasing digitalisation, jobs with simple manual activities or routine work are less needed. Machines will take care of such jobs. Steam engine and mechanical looms taken into use in the 18th century led to the first industrial revolution, the implications of which, such as increasing unemployment, salary dumping and uprisings of workers should be certainly prevented. It is absolutely necessary to provide preventive support from the state to create sufficient opportunities for the acquisition of high-quality training and retraining and further training. A situation where *summa summarum* more jobs will disappear than are created should be prevented.

Digital networking is a supranational phenomenon, therefore countries have to prepare their national economy for fundamental changes. As innovation both in the area of production processes and products will have an increasingly critical role in raising the productivity and also international competitiveness of countries, the capacity for innovation and also for

[1] The sequence of technological revolutions was 1. steam engine, 2. electrification and conveyor, 3. computer.
[2] $10^{18}$ = exabytes; see the additional information below.

their fast implementation should be strengthened. What would be the use if the enterprises of a country were successful in the development of innovative processes or products but enterprises of other countries in international competition were implementing faster new ideas that can be easily integrated in systems? Therefore it is important for the enterprises of each country to fight for a head start in the acquisition of new knowledge, to create a comprehensive innovative and technological basis and that way to stay always ahead of the competition. In order to achieve that it will be useful to have cooperation with recognised experts in the IT field who have already achieved something in their speciality. Also start-up businesses should be used as their often extraordinary wealth of ideas can be used by combining them with existing knowledge and experience. This will provide an opportunity for comprehensive development also to large companies. Therefore mutual assistance in many respects could be beneficial to all parties.

As the data communication between networked machines and digitalised supply chains is increasing on the internet, there will be a high risk of data theft and cyber attacks through viruses and Trojans. Such malware as Stuxnet, Duqu and Flame have targeted digital control systems and may make the infected computers suitable for espionage, and it may be possible to find secret patented structures and new product components in the computers or even subject them to external control. Effective encryption technologies are needed more than ever today. Security and constant monitoring of data flows should be regarded as tasks of primary importance for the applications of the Industry 4.0 platform. This is very important, for instance, when machinery and equipment are connected over state borders for remote maintenance or data analysis through the internet. Ensuring the security of data will be a special challenge when communicating through global platforms, such as the providers of cloud services of large U.S. corporations.

For unobstructed conduction of research and development activities through cross-border cooperation it will be necessary to establish generally accepted patent and copyright rules for the protection of the results developed. Here a fair balance should be found above all between the interests of the owner of the above-mentioned rights and the consumer. Also the issue of responsibility should be clarified for cases when, for instance, systems have autonomous communication and request production information on the basis of the respective algorithms and when its acquisition thus becomes legally binding. The whole legal regulation has to be closely related to practice and cover all economic sectors.[3]

Also consumer protection should be ensured in fighting against espionage, sabotage and other criminal acts and bearing in mind the absolute necessity to counter both domestic and international cyber crime with full severity.

As a response to the creation of the Industry 4.0 platform, the U.S. corporations Cisco, IBM and General Electric created their own platform **I**ndustrial **I**nternet **C**onsortium (IIC). By now, more than 140 companies have joined it, including German enterprises, such as Bosch, Siemens and SAP. The platform members have cooperation by performing practical tests. According to the members this is not a competition between standards but diversity of research projects.

All enterprises starting from global players to small businesses have to respond to the challenges of the Industry 4.0 platform. Otherwise they will risk losing touch with networked value creation chains and therefore losing also an access to flows of information and goods which raise efficiency and reduce costs. The current niche policies will no longer exist in the future. On the other hand, involvement of all small and medium-sized businesses will be inevitable in the future to ensure fully networked processes and eventually also the success of the Industry 4.0 platform. Such enterprises face a specific problem, however – they are not able to finance the headquarters of the staff who would only work with duties arising from digitalisation. They have to use the assistance of centres of excellence or search for cooperation in that field. If such a path is chosen, it is important to achieve independence of the business. At any rate, access of third persons to specific information of the company should be prevented.

The impetus of technological development has an impact on virtually all economic sectors.[4] Even agriculture has to subject to these challenges. By 2050, the population of the world is expected to be nine billion. Ways and means will have to be found for adequate and healthy feeding of all people, in order to increase crop yields and crop quality in a sustainable manner and to reduce losses in harvesting. Only advanced agriculture can ensure the supply with food through innovative technologies in the required quantity and without setting human health at risk.

Considering the improvement of the quality of a few products, the prices have decreased in relative terms – despite the increase in prices in figures. This generally applies to the production of machinery and equipment, and products of the automotive and electronics industry and other industrial sectors, and also services, such as communication, traffic, entertainment, intermediation, consultation, maintenance.

Industry 4.0 means that industrial countries have entered a new era which is characterised by an endless flood of innovation to raise the productivity of products and services. The impact of this on economy as a whole is considerably different from the earlier implications of steady development, which were expressed in price indices and moderate GDP growth indicators. Almost all areas of the economy are influenced by this. This also applies to the business sector, particularly the banking sector. Thus, among other things, we have to start thinking how to adjust the objective of monetary policy to the new trend.

The European Central Bank (ECP) was established in 1998. The objective of the bank is to ensure the stability of the price level. It has not been defined more specifically in the statute. As prices are expressed in figures and combined into indices from the aspects of general economy, the Governing Council of the ECP specified the operative target figure through the

[3] According to its purpose, in close cooperation with industry, such as the digital alliance Bitkom of the Allianz für Cybersicherheit (Alliance for Cyber Security).

[4] For instance, clinical studies in health care are performed with telemedical monitoring of patients in which the blood parameters, body temperature, heart rate, etc. of patients are automatically sent to the doctor through mobile communication service. A network-based analysis platform makes it possible for the doctor's office to check in real time whether the patient has taken the right dose of medication.

harmonised consumer price index. It was certainly clear to the Governing Council members that there is nothing absolute in the economy and that statistics and any results calculated on their basis cannot serve as a basis for exact conclusions on the actual situation. Therefore they did not set a definite index value as the target but agreed on a range of "zero to two per cent". Thus a price increase from two percent to zero was deemed to comply with the verbally defined objective.

During the year of economic recession 2003 the Governing Council of ECP changed the range of this objective to become "below two per cent but close to it". Thus the targeted range was contracted and raised higher from the zero level.

Although the price developments at that time were similar to those of today at first glance, their main reasons were and are quite different. In 2003 the economic situation was determined by economic cycles, i.e. more short-effects of factors. Short-term deviations should be in principle countered with the specific countermeasures created for that purpose.

It is actually unfair to adjust the unachieved objectives in such a situation according to the actual development in economic policy. This would be the same as hiding unachieved environmental objectives by the adjustment of standards afterwards. It would have been politically appropriate to take measures to achieve the objective, not to adjust the objective in the framework conditions of that time. But it is generally not the task of monetary policy to pursue countercyclical policy but to take care of the stabilisation of the value of money, considering taxation policy.

Industry 4.0 has altered the framework conditions of functioning of macroeconomics. Also monetary policy has to be adjusted accordingly. The issue is whether the change in the target of monetary policy made in 2003 applies also today. Industry 4.0 considerably modifies both the current and future developments in prices. This means that the continuing digitalisation of the economy and the resulting progress in productivity will increasingly compensate the factors influencing price increases in the future. Consequently, the very vaguely formulated maximum price level "below two per cent but close to it" should be adjusted also in the future to the development trends described.

In August, 2015

Manfred O. E. Hennies
Kiel/Warder
Germany

Matti Raudjärv
Tallinn/Pirita-Kose and Pärnu
Estonia