Working on the robot society

Visions and insights from science on the relationship between technology and employment – Executive summary

Rinie van Est & Linda Kool (eds.)

Rathenau Instituut

The Rathenau Instituut promotes the formation of political and public opinion on science and technology. To this end, the institute studies the organization and development of science systems, publishes about social impact of new technologies, and organizes debates on issues and dilemmas in science and technology.

Working on the robot society

Visions and insights from science on the relationship between technology and employment – Executive summary

Editors:
Rinie van Est en Linda Kool

Authors:
Rinie van Est, Ira van Keulen, Linda Kool, Arnoud van Waes and Frans Brom
(Rathenau Instituut)
Frans van der Zee and Govert Gijsbers (TNO)
Jan Korsten, Harry Lintsen and Johan Schot (Stichting Historie der Techniek)

This is the executive summary of the Dutch report *Werken aan de robotsamenleving: visies en inzichten uit de wetenschap over de relatie technologie en werkgelegenheid*, which was published by the Rathenau Instituut in June 2015.The fully translated report *Working on the robot society: visions and insights from science on the relationship between technology and employment* will be made available on the website of the Rathenau Instituut (www.rathenau.nl) in September 2015.

Introduction

The international debate about robotization and the potential impact on employment has become fiercer in recent years. On the one hand, there are concerns about technological unemployment and job polarization (erosion of employment in middle class jobs which require midlevel skills). Others see chiefly opportunities and argue that in the past, innovation has always sparked more economic growth, prosperity, and welfare; and smart machines will do so again. The Standing Committee for Social Affairs and Employment (SAE) of the House of Representatives of the Dutch Parliament has asked the Rathenau Instituut to conduct research on the latest scientific findings concerning the impact of technological developments on employment and thereby provide a shared fund of knowledge for the coming societal and political debate.

The Standing Committee for SAE has formulated the following central question: what current scientific knowledge is available on the impact of technological developments on employment? The associated secondary questions concern the availability of relevant and current scientific knowledge regarding the following aspects:

1. The impact of technological developments (mechanization, automation, etc.) on employment in the past.
2. The potential impact of technological developments on future employment.
3. Scope for responding, through policy, to future effects on employment, for example by means of training.

The relationship between technological development and employment is very complex. Scientific research on these questions is being carried out in very different fields, from the perspective of various scientific disciplines and levels of aggregation. This report outlines the main findings from science, with the aim of allowing a sound and well informed political debate.

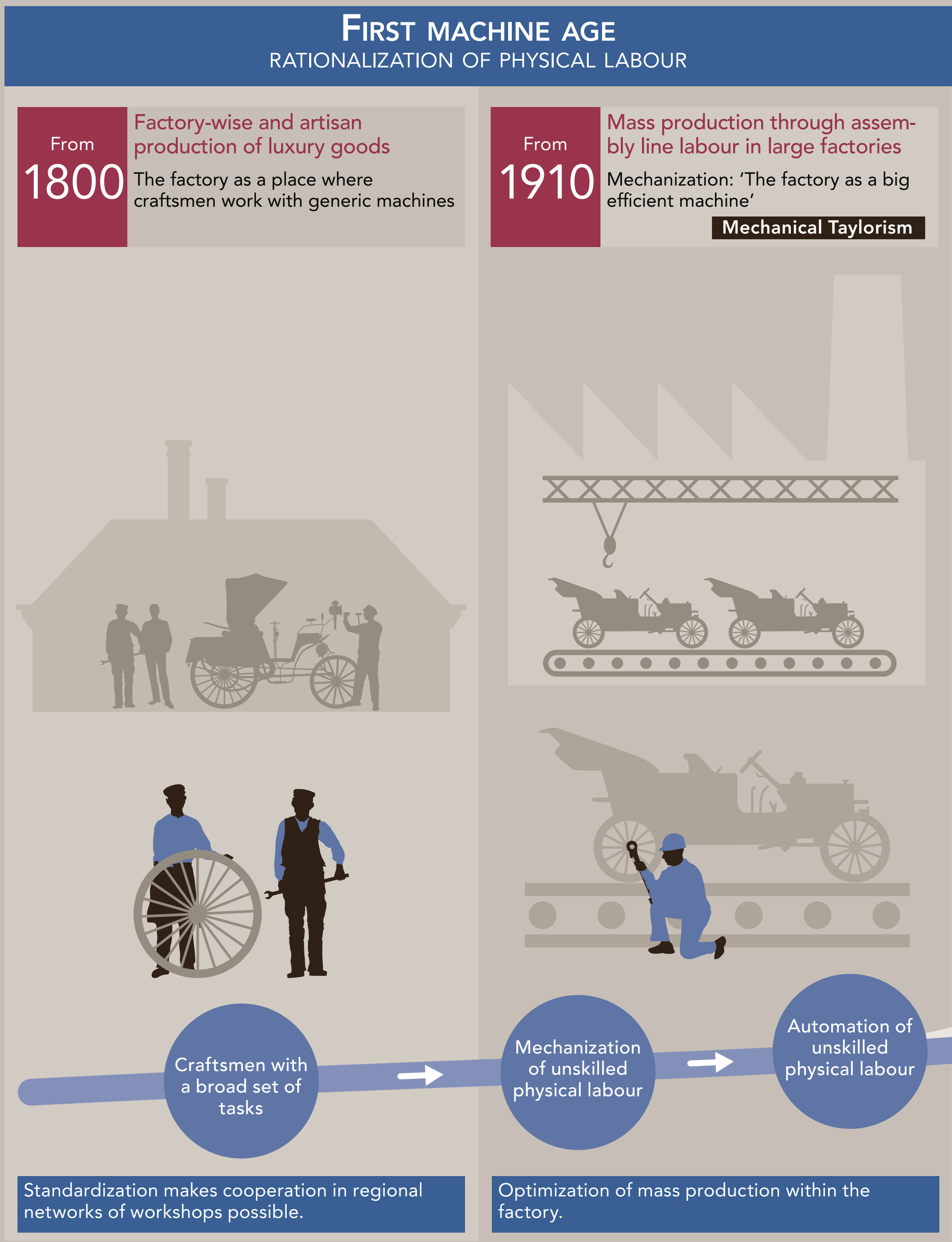
The study comprises a review of the literature, media analysis of the policy options, and interviews with scientific experts. The aim of the interviews is to verify whether relevant literature has been included in the review, and to evaluate the literature found in terms of its scientific value and to explore policy options. Further reflection on and analysis of these policy options are needed to come up with specific policy recommendations.

The past: long-term

Second machine age and the robot internet

Historians of technology often mention three industrial revolutions: the introduction of steam, electricity, and information technology (IT). The distinction

Figure 1 Overview of organisational characteristics during the first and second machine age



SECOND MACHINE AGE

RATIONALIZATION OF COGNITIVE LABOUR

From **1980**

Computer enables automation of services

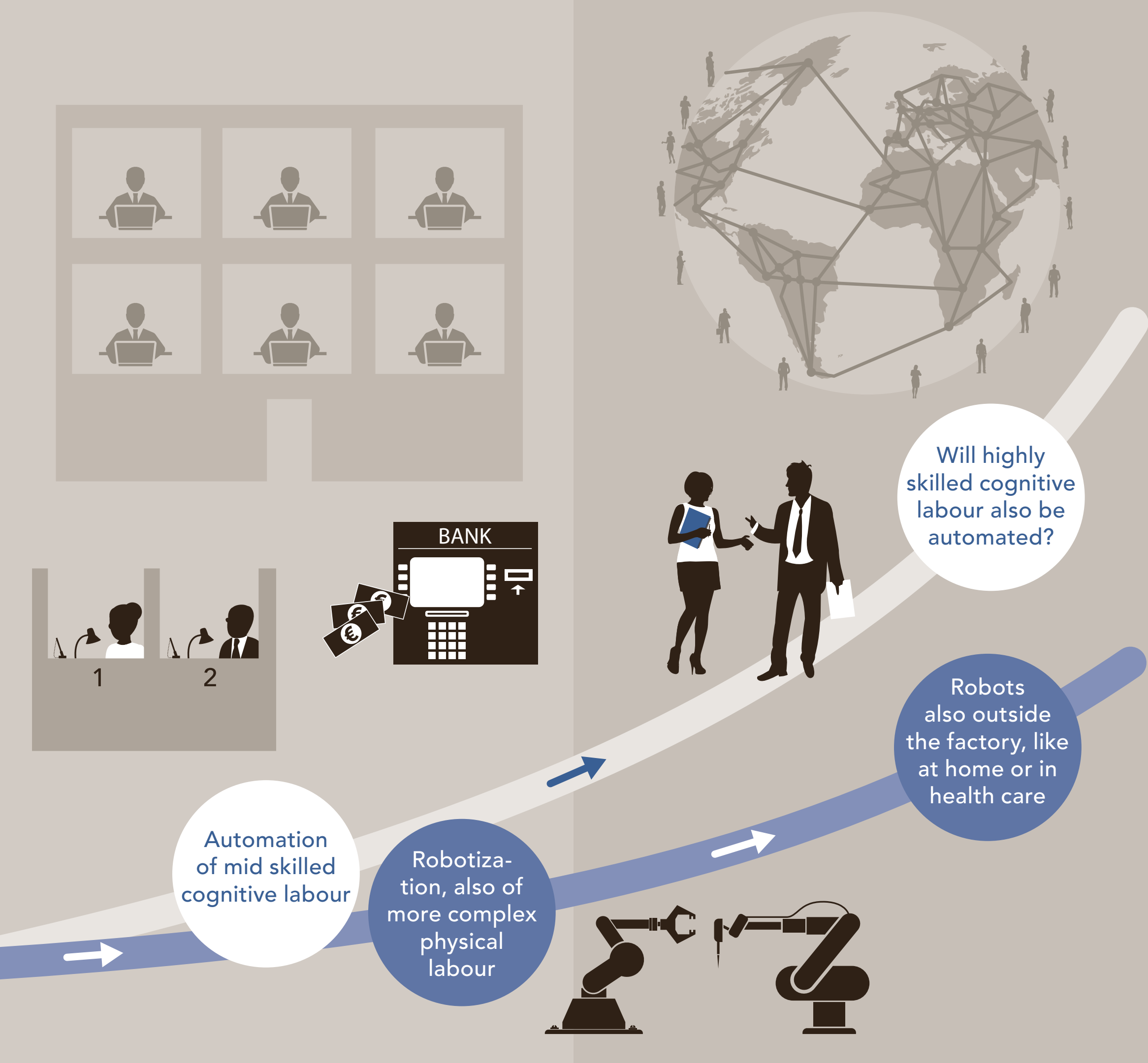
Digitization of physical and cognitive labour: integration of digital and human labour

Digital Taylorism

From **1995**

Internet boosts internationalization and platformization of labour

Digitization value chains: 'The world as one big efficient (smart) machine'



Optimization of global production chains through regional outsourcing and offshoring of unskilled labour to lower income countries.

Optimization of global value chains through offshoring of un-, medium and high skilled labour, reshoring highly automated production, and on-demand crowd sourcing of cognitive labour.

between the first and second machine age is also important in the debate about technology and work. The first machine age covers the first and second industrial revolution. That age involved machines that provide muscle power. The third industrial revolution – the IT revolution – is the second machine age, in which machines also supply thinking power. In thinking about the relationship between technology and employment, we should therefore consider the technical characteristics of the current IT revolution. This entails not only physical robots but also technologies such as 'softbots,' artificial intelligence, sensor networks, and data analytics. It involves the advent of the 'Internet of Robotic Things', or the robot internet. In this way the internet is being expanded with senses (sensors) and hands and feet (actuators), and, as a result of machine learning and artificial intelligence, the internet is also becoming 'smart'. The management and analysis of large volumes of data is of key importance in this regard. Machines from the first and second machine age provide scope for taking over both physical and cognitive work from humans. Whether or not such scope can be utilized depends, however, on how production and work are organized.

From mechanical to digital Taylorism

The continuous search for new forms of organization is usually driven by rationalization, or the quest for greater efficiency and control, including control over the worker (see figure 1). In the first machine age, starting in 1910 the traditional factory was redesigned into 'a big efficient machine' on the basis of (mechanical) Taylorism. This was done by splitting work processes into simple tasks, thus allowing certain physical tasks to be mechanized and later automated.

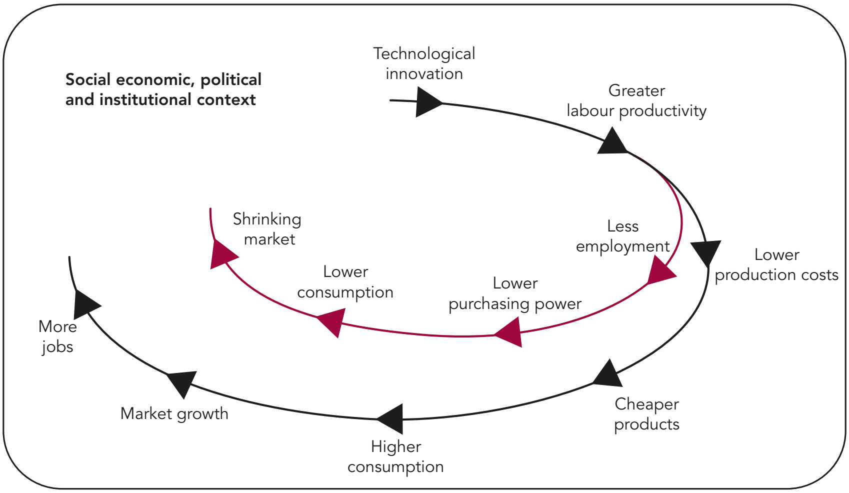
In the second machine age, and through the advent of IT, the services sector since the early 1980s came under the influence of (digital) Taylorism . Where mechanical Taylorism allows the automation of physical work, digital Taylorism allows the automation of cognitive work. As a result, it has become possible to outsource, offshore, or automate not only physical but also cognitive tasks. Thinking about new and more efficient ways of organizing things has received fresh impetus since 1995, owing to the arrival of the internet. The internet boosts the internationalization, flexibilization, and 'platformization' of work. We can see the advent of the virtual network organization which seeks to optimize on-demand access to paid and unpaid work. This body of ideas underpins, for example, the way in which Uber uses drivers.

Lessons from the Netherlands' past

In the past, the Netherlands has been able to benefit from the three industrial revolutions described. However, that required foresight and an active adaptation process that often did not take place without setbacks. The government has always played an important part in the introduction of new technologies by creating the right conditions. Firstly, this entails fostering innovation by investing in physical and knowledge infrastructure (such as knowledge institutes and training). The construction of a good transport system (canals, railways, and paved roads) in the first half of the nineteenth century paved the way for the use of coal and steam engines, and thus the growth of, for example, the textile industry in Twente (in the eastern part of The Netherlands) in the second half of the nineteenth century. Extending the electricity grid to the entire Netherlands meant that, in particular, small and medium-sized enterprises could benefit from the potential of the second industrial revolution. Secondly, the government played a key role in regulating new practices, preventing excesses, and sharing prosperity. Examples include social legislation, such as Van Houten's Child Labour Act of 1874, the first Compulsory Education Act of 1901, and the Social Assistance Act enacted in the 1960s.

The past: recent

Figure 2 Visions on technology and labour: more or less jobs.



Rathenau Instituut

Two opposing visions

The debate about the relationship between technology and employment is characterized by two opposing visions. According to one vision, innovation leads to economic growth, jobs growth, and an acceptable distribution of prosperity. In this way, technological innovation leads to greater labour productivity and cheaper products, which in turn bring about higher consumption, and thus market growth and more jobs and prosperity. According to the alternate vision, increasing labour productivity through innovation (via labour-saving technology) conversely leads to less employment, and thereby to lower purchasing power and consumption, and thus to shrinking profits and markets, and declining prosperity. The assumptions behind the two visions outlined in figure 2 raise the following secondary questions: within science, what is known about the relationship between the IT revolution and productivity, between IT and the loss and creation of jobs, and about how IT influences our prosperity?

Impact of IT on productivity

The relationship between economic growth and productivity growth, on the one hand, and the role of IT, on the other, is complex. With science focusing increasingly on measuring the contribution of IT to productivity and productivity growth, it has become clear that over the past twenty years, IT has made an important contribution to productivity growth. With regard to automation and robotization and their impact on jobs and economic growth, there has traditionally been a consensus among economists that technological growth in the very short term comes at the expense of jobs, but that this provides new jobs relatively swiftly, within one or two years.

This occurs via 'second-order effects' in which savings achieved by productivity growth flow back into the economy. This consensus has started crumbling since 2010, among not only criticasters such as Brynjolfsson & McAfee but also well-known economists such as Krugman and Summers. This crumbling consensus is based not only on facts – scientific observations concerning employment creation in the short, medium and longer term – but also on changing perspectives on the underlying economic dynamics (see for example various 'diagnoses' of current economic problems by Gordon, Brynjolfsson & McAfee, Cowan, Krugman, Summers, and Rifkin).

IT and the loss/creation of jobs

Since the 1980s, automation has led to job polarization: demand for medium-skilled work has declined, whereas demand for chiefly highly skilled and low-skilled work is rising. In previous technological revolutions, mainly low-skilled, physical work was affected by mechanization and automation. Now, IT is taking over cognitive routine work such as administrative work, the performance of calculations, bookkeeping, the monitoring of processes, or the assessment of products. This is also a consequence of digital Taylorism: the rethinking of work processes and being able to split work into subtasks that can be outsourced, offshored, or automated. Globalization – which also is enabled by IT – therefore also plays a part in the polarization of jobs. Offshoring can be seen as a first step in the codification and automation of tasks. If you can codify work (capture it in rules, such as a telemarketer's script in a call centre), you can readily relocate and automate it. It is now becoming clear that both highly skilled and low-skilled work is no longer 'immune' from automation: all levels of education and training may be affected by automation.

IT and prosperity

IT has differing effects on different occupations and types of job: it is mainly favourable for highly skilled people, and relatively neutral for low-skilled people who perform location-bound work, and exerts pressure principally on middle-class jobs in both industry and the service sector. Where IT allows offshoring, wages come under pressure as a result of growing competition with low-wage countries. Globally, we can see the emergence of a new form of technology-driven accumulation which, prompted by debate about the Uber taxi service, has now come to be known as 'platform capitalism'. Flexibilization and platformization of work are also prompting a debate about the impact of IT on the quality of work and job security. The differences between permanent jobs with high salaries and temporary jobs with lower wages are persistent. In the Netherlands, most people work in paid employment, but the number of workers on flexible contracts and self-employed people is growing. Self-employed people are much more diverse than flexible workers in paid employment. Highly skilled self-employed people are often 'happy workers': quality of work is high and they are often more satisfied with their work. Lower skilled self-employed people and those forced to be self-employed are much less satisfied. For the self-employed, the work-home balance is often a problem, as are insecurity about the future, the sometimes low number of work providers, and the high degree of underinsurance for unemployment, occupational disability, and pension accrual. Both groups of flexible workers enjoy less protection than workers on fixed contracts, which is prompting a debate about how the disparities in protection between both groups (permanent and flexible) can be reduced.

Prognoses for the near future

The second research question is as follows: what are the possible effects of technological developments on future employment? The future is fundamentally unknown because it has yet to be made. It is therefore unsurprising that there are different visions and speculations about the future. In the current debate, attention focuses mainly on the extent to which robots and computers will lead to more or fewer jobs. This debate has been stoked by the investigators Frey & Osborne, who predict that in the next twenty years nearly half the current number of jobs in the US may be taken over by computers or robots. To ensure a good debate, it is important also to consider, alongside IT as a means of automating jobs, the role of IT in the creation of new jobs. Attention also needs to be paid to the economic, social, ethical and legal aspects involved in how IT influences work, how IT changes the organization of work, and finally the influence of IT on prosperity or, more accurately, the influence of IT on our capabilities for acquiring income and assets. These four issues still come up very little in public debate.

All these matters require consideration in order to gain a better understanding of the multi-layered and diverse influence of the IT revolution on work. IT allows the automation of existing jobs, but also affects in a complex fashion the way in which work practices and global value chains take shape. An example is the advent of platforms (such as Airbnb or Uber) that have been made possible by IT and which save capital and labour. IT also exerts a global, transformational impact: for instance, the breakthrough of the internet in the mid-nineties, the lowering of the costs of doing business internationally, and the formation of global value chains. For the coming years the further servitization of the manufacturing industry is being envisaged. This means that the service component of products is expected to increase. The challenge is for policy and politics to capitalize in a timely, intelligent manner on this whole IT-related set of developments. An understanding of prospects for action requires insights into how economic, social, ethical and legal aspects (may) help shape the relationship between IT and labour in the near future.

Policy options

The robot society as a positive prospect

There is a growing feeling that our technological society is again entering a new phase. We are currently confronted in all kinds of ways with new technological possibilities: from artificial intelligence and robots in healthcare to self-driving vehicles, sensor networks, big data, 3D printing, drones, and more. This broad development is captured in terms such as the Internet of Things and the Internet of Robotic Things. The big question now is how do we, as a society, handle this new phase of the IT revolution? History offers an answer to this question: technology does not just happen to us, but takes shape in all kinds of social practices.

The Dutch response to the industrial revolution at the time was the formation of an industrial society, which was made possible by the appropriate technological and knowledge infrastructure, as well as by all kinds of social legislation. The Dutch response to the advent of the computer was the information society. During the recession of the 1970s, concerns grew about the loss of jobs as a result of automation. Those concerns prompted public debate and further research. A committee led by Professor G.W. Rathenau was established, among other things, to study the social consequences of microelectronics. In retrospect, that period of unrest, debate, and research has been crucial in creating awareness of the social importance of the IT revolution that had entered a new phase: a transition from the large mainframe computer to the small personal computer. The debate that started with the question of what small computers would mean for labour broadened into the question of how the computer society should look like. The mobilizing concept of the information society thus arose, which was deliberately used throughout Dutch society to free up money and energy for the application of computers.

The response to the advent of robotics and the robot internet may thus be something like the 'robot society'. The robot society is expressly enclosed in inverted commas because it is a concept that has yet to be fulfilled; it is, as it were, a mobilizing prospect. It is important that the Netherlands as a whole – from citizens, politicians, teachers and entrepreneurs to people in the manufacturing and creative industries and the services sector – becomes acquainted with the new technological options and visions in the field of IT, to enable us to appropriate these opportunities based on our own wishes and concerns. In many areas of society, active policy is required to shape a 'robot society' so that it can be a positive prospect for all Dutch people. In this context, three aspects deserve full attention: socially responsible innovation, training, and prosperity.

Socially responsible innovation

The historical perspective in this report shows that early investment in physical infrastructure and the building up of an adequate knowledge infrastructure are essential to reap the rewards of new, emerging general purpose technologies. Every age imposes its own demands on this. For example, during the first industrial revolution, the Dutch government, in collaboration with market players, invested heavily in transport systems, such as paved roads, canals, and railways, despite the poor state of the national public finances. In the second half of the nineteenth century, this facilitated, for instance, the modernization of the textile industry in Twente. The associated knowledge infrastructure also blossomed: engineering educational programmes and the national engineers' association were established. The creation of a sound electricity grid was crucial in the second industrial revolution. Private entrepreneurs and municipalities initially played a part in this, followed by the provincial and national authorities.

In the information age, computers in the 1950s were initially used for such things as administrative automation at insurers. The first professional associations in the sphere of automation also arose during that period. During the 1970s and 1980s, when the personal computer came into the picture, knowledge infrastructure entailed, for example, the setting-up of computer service centres, new professional associations, and the development of digital skills in the population through the promotion of computer use at home. The 1990s and the beginning of this century saw the advent of fast internet connections.
Now, too, the question is about what role the government can play in boosting economic growth by encouraging technological development. Embracing the information revolution seems to be an important tool for the future because it contributes to productivity growth, even though the direction and choice of investments is a matter of debate. The following questions arise and will require further research in the future. Is the Netherlands investing enough in new technology? Why would more investment be desirable? How can digital start-ups be supported? What obstacles are there to the changes needed – and what part do our institutions (laws, rules, and application) play in this? How can public investment in technology and innovation contribute sustainably to a prosperous Netherlands?

Internationally, renewed attention for the manufacturing industry is currently perceptible, as illustrated by the Dutch *Smart Industry* intiative and German developments concerning the Industry 4.0 concept. The German discourse radiates a lot of positive energy, but it is also driven by anxiety that Germany is losing its global leadership in high-tech manufacturing to countries such as

China and India. The traditional geographical distinction between low-value manufacturing there and high-value innovation here has become much less obvious. The smart factory has become the primary place where innovation on production processes and products takes place. The question for the future is thus where this smart factory will be located.[1] The clustering of innovative activities in certain regions is already apparent. More and more countries are actively striving to be or become an attractive location for enterprises and personnel.

In addition, more and more money is made from services linked to products. The digitization of industrial manufacturing processes and products is becoming increasingly dependent on close cooperation between industry and service providers, for example between the industrial and internet cultures. This means that more attention needs to be paid to encouraging cooperation between the industrial and services sector, and to the importance of innovation within the services sector.

Education and training

In the past, heavy investment in education has always made it possible to train people better and to meet changes in demand for skills (owing to the advent of technology). The 'race' between technology and education was won by education. Job polarization has become evident since the advent of the second machine age: middle-class jobs are under pressure. Looking ahead, it is expected that automation may affect all educational levels, in various ways. Even now, training and investment in education are cited as important policy tools for ensuring that people have the right skills for the work of the future. At the same time, it is uncertain what exactly that work – and the associated skills – will look like.

Investment in retraining and upskilling is needed to help surplus workers, including those with mid skilled jobs, find new work, and to shift the mid skilled segment as far as possible into the higher skilled segment. However, this is a slow and potential painful process for the groups affected. In the Netherlands, this process takes place chiefly via the influx of young people into the labour market. To match supply and demand as closely as possible, interaction between enterprises and education is important, for example in terms of involving enterprises in designing curricula, and in strategic relations between enterprises and educational establishments. New online matching services, such as LinkedIn, can play a part in bringing about a better, faster match between demand and supply. In addition, the emergence of Massive Open Online Courses (MOOCs) may help make higher education more accessible.

---

1 Where production ends up also has a geopolitical dimension: the battle between countries and regions for where the advantages and disadvantages of the IT revolution end up. This is prompting questions about Europe's role: should the EU, for example, be more active in providing European alternatives to American or Chinese IT solutions?

Investment in primary and secondary education is also important to equip children with skills for the future. This involves various generic skills: skills in which people differ from computers (working with new information, creativity, communication) or skills associated with flexibilization and a digitizing environment, such as metacognitive skills (e.g. learning how to learn), entrepreneurship, and e-skills (learning programming, 3D printing, etc.).

Prosperity

IT and automation have had an adverse impact on middle-class jobs. With broad application of the technologies of the second machine age, there is a real chance that inequality will grow in the future. That prompts the question of what we can do to ensure that the benefits of digitization are shared as widely as possible.

The government can, for example, create opportunities by encouraging more people to earn a living in the digital economy. Access to the internet is not sufficient for the effective use of ICT services, or for ensuring the ability to produce digital goods and services and thereby earn a living. This requires investing in digital skills. The development of inclusive technology also plays a part in this. This involves, among other things, technology for people with a disability and inclusive innovation: innovation for the benefit of principally poor population groups, and prioritizing the user and ease of use.

It is also important that the government offers protection. How can, for example, the interests of workers who have to contend with automation or platformization be safeguarded? This involves such things as a safe working environment, a safe number of working hours (to prevent excessive stress and exploitation), questions about adequate incomes to live on, and ensuring upskilling, as well as the safeguarding of privacy. Under a permanent employment contract, matters of this kind are generally well regulated. In the case of on-demand crowdsourcing of work, which generally does not involve an employer-employee relationship, but rather a client-contractor relationship, that is not the case. What rights, not only for low-skilled but also for high-skilled cognitive work, must be safeguarded? Is new social policy needed? Can workers' rights be designed and integrated into platforms?

Related to this is the policy option of regulating platforms – and thus newly emerging monopolies. Regulation is often still lacking at the present time. A debate has started in Europe on this, and the European Commission considers that regulation is needed to promote competition and prevent the development of monopolies. At the same time, it should be pointed out that these new business models also offer important opportunities for innovation and economic growth. It is therefore important to strike a good balance on this.

Who was Rathenau?

The Rathenau Instituut is named after Professor G.W. Rathenau (1911-1989), who was successively professor of experimental physics at the University of Amsterdam, director of the Philips Physics Laboratory in Eindhoven, and a member of the Scientific Advisory Council on Government Policy. He achieved national fame as chairman of the commission formed in 1978 to investigate the societal implications of micro-electronics. One of the commission's recommendations was that there should be ongoing and systematic monitoring of the societal significance of all technological advances. Rathenau's activities led to the foundation of the Netherlands Organization for Technology Assessment (NOTA) in 1986. On 2 June 1994, this organization was renamed 'the Rathenau Instituut'.