MEGATRENDS

Edited by Gergely Baksay – György Matolcsy – Barnabás Virág
Published by the Magyar Nemzeti Bank, 2025

transformed into the teaching material of the course titled

Sustainability Management

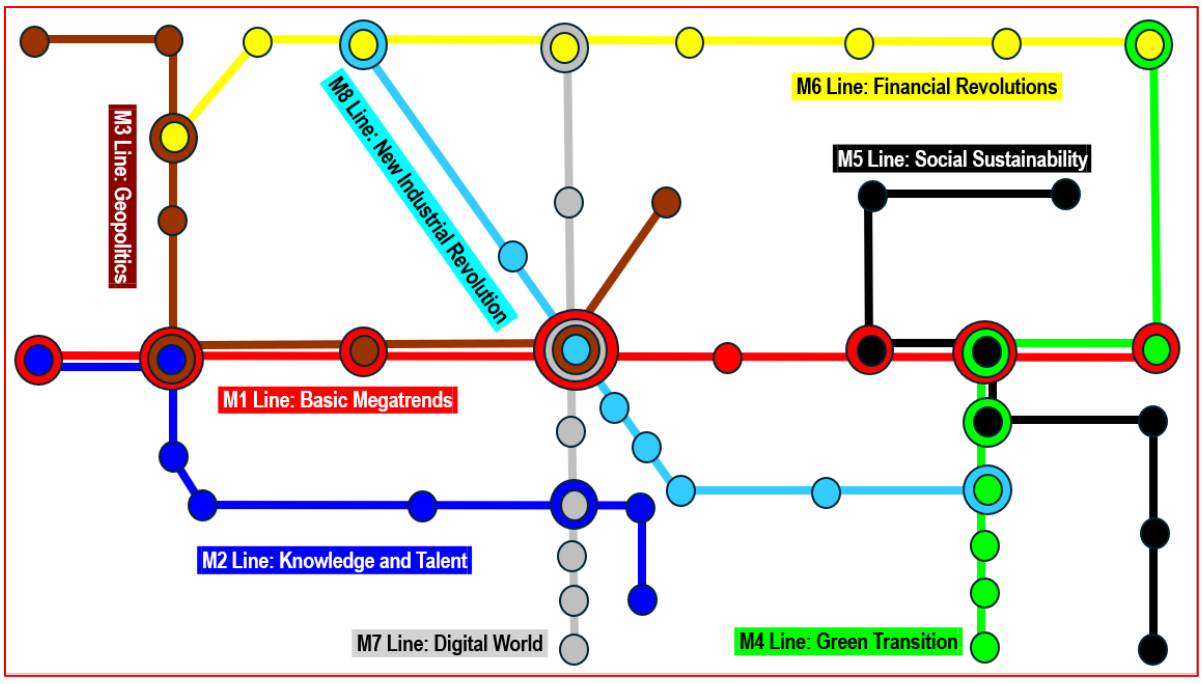
in the Master Program of

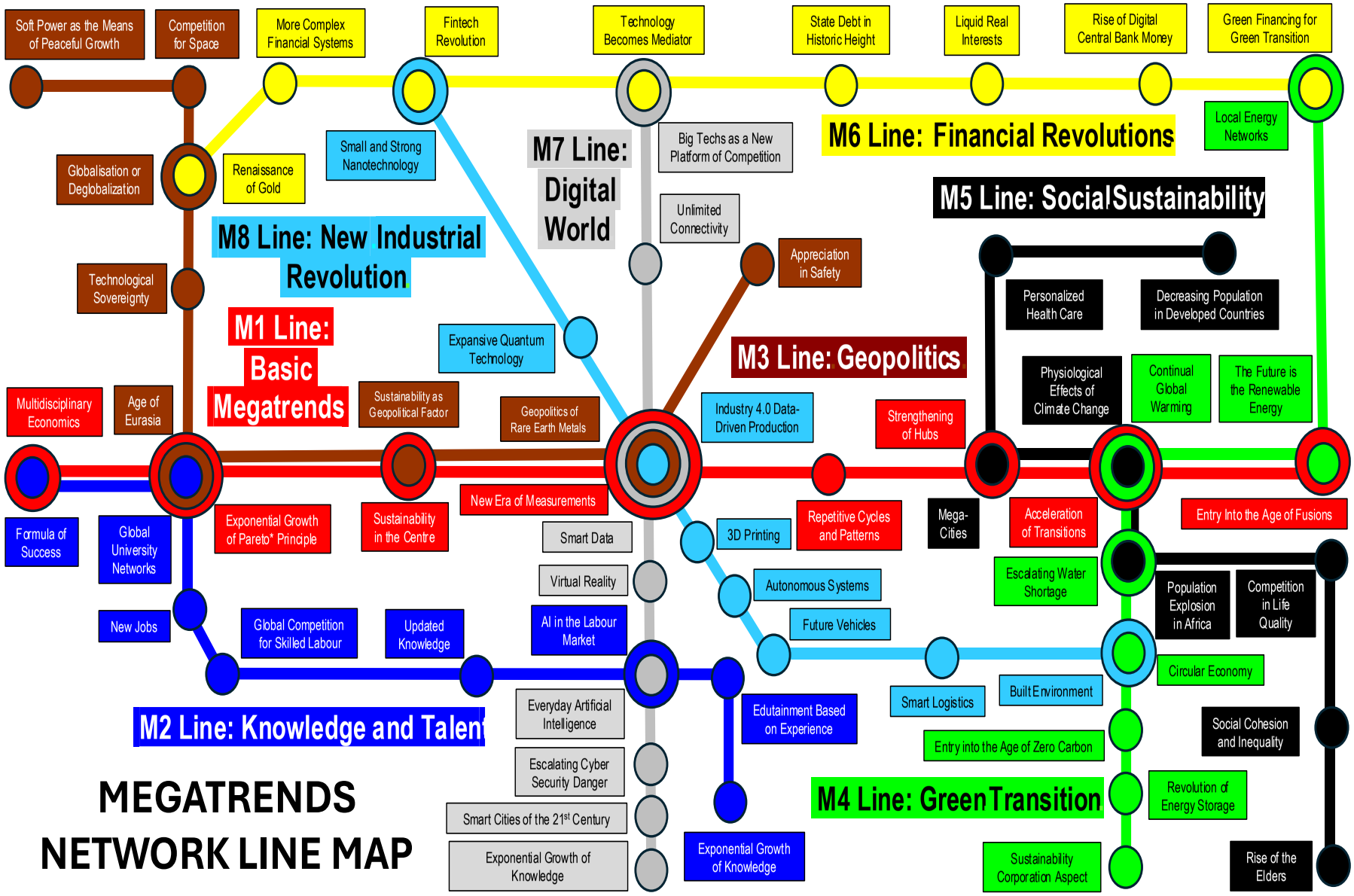
Regional and Environmental Economics

John von Neumann University
Kecskemét
2025

We invite the students to travel across an imaginary underground network titled MEGATRENDS consisting of 8 lines with 8 stops each.

The future will be won by those who best understand the megatrends shaping it today. Our goal is to introduce students to these megatrends in areas such as technology, finance, geopolitics, and demography. In an era of major transitions, only those who operate on the principle of sustainability can succeed. This textbook highlights the most important changes affecting our world and presents them to students in an orderly manner, in 8 groups (i.e. underground lines), in a total of 64 chapters (i.e. underground stations). Knowledge of these megatrends helps to become a winner of the changes not only at the national economic, regional or corporate level, but also at the individual level.




Soft Power as the Means of Peaceful Growth
Competition for Space
More Complex Financial Systems
Fintech Revolution
Technology Becomes Mediator
State Debt in Historic Height
Liquid Real Interests
Rise of Digital Central Bank Money
Green Financing for Green Transition
Local Energy Networks
M6 Line: Financial Revolutions
M5 Line: SocialSustainability
Globalisation or Deglobalization
Renaissance of Gold
Small and Strong Nanotechnology
M7 Line: Digital World
Big Techs as a New Platform of Competition
Unlimited Connectivity
M8 Line: New Industrial Revolution
Technological Sovereignty
Appreciation in Safety
Personalized Health Care
Decreasing Population in Developed Countries
M1 Line: Basic Megatrends
Expansive Quantum Technology
M3 Line: Geopolitics
Physiological Effects of Climate Change
Continual Global Warming
The Future is the Renewable Energy
Multidisciplinary Economics
Age of Eurasia
Sustainability as Geopolitical Factor
Geopolitics of Rare Earth Metals
Industry 4.0 Data-Driven Production
Strengthening of Hubs
Formula of Success
Global University Networks
Exponential Growth of Pareto* Principle
Sustainability in the Centre
New Era of Measurements
Smart Data
3D Printing
Repetitive Cycles and Patterns
Mega-Cities
Acceleration of Transitions
Entry Into the Age of Fusions
Virtual Reality
Autonomous Systems
Escalating Water Shortage
Population Explosion in Africa
Competition in Life Quality
New Jobs
Global Competition for Skilled Labour
Updated Knowledge
AI in the Labour Market
Future Vehicles
Circular Economy
Built Environment
Smart Logistics
Edutainment Based on Experience
Everyday Artificial Intelligence
M2 Line: Knowledge and Talen
Social Cohesion and Inequality
Entry into the Age of Zero Carbon
Escalating Cyber Security Danger
Revolution of Energy Storage
M4 Line: Green Transition
Smart Cities of the 21st Century
Exponential Growth of Knowledge
Exponential Growth of Knowledge
Sustainability Corporation Aspect
Rise of the Elders
MEGATRENDS
NETWORK LINE MAP

M1 Line: Basic Megatrends

TERMINAL: 1.1. Multidisciplinary Economics

György Matolcsy - Gergely Baksay - Emese Kreiszné Hudák

CHANGE here to

M2 Line: Knowledge and Talent 2.1. Formula of Success

Knowledge crosses disciplinary boundaries, so cross-cutting issues increasingly need to be approached in a multidisciplinary way. Since economics interacts with almost all aspects of life, it is increasingly necessary for economics to draw on the knowledge and methods of other disciplines in its renewal.

Multidisciplinarity means the involvement of two or more disciplines in a single activity, i.e. working together. A multidisciplinary approach is particularly well suited to solving complex problems. Consider that in the 1940s, the creation of the atomic bomb required the collaboration of physics, chemistry and engineering. Nanotechnology, the industrial revolution of our time, combines physics and chemistry, but its practical applications also benefit medicine, pharmaceuticals, automotive engineering and computing.

The growing importance of multidisciplinarity is illustrated by the increasing number of Nobel Prizes awarded in the last decades to different scientific disciplines for the results achieved through cooperation between the areas. In 2002, Daniel Kahneman was awarded the Nobel Prize in Economics as a psychologist for his work integrating psychological research into economics. In his research, he has shown that, contrary to an important tenet of neoclassical economics, people do not always make rational decisions. Among other things, this is because our decisions are influenced by the framing of the question, and we react much more intensely to losses than to gains of the same magnitude.

Economics has never been far from multidisciplinarity, since its roots go back partly to the social sciences and partly to mathematics. But now economics needs a major transformation. Mainstream economics was in crisis in the wake of the global recession of 2008-2009, as its theories could neither explain nor predict economic events. In addition, climate change, high global debt levels, demographic change and the explosion of technology are creating a new environment in which old rules are being transformed and new laws are being put into play. The renewal of economics can only be achieved by focusing on sustainability. It must also draw more than ever on the knowledge and methods of other disciplines, such as psychology, physics and systems theory. Moreover, economics must take greater account than ever of the implications of geography and geopolitics. We must also take account of the fact that data is emerging as a new factor of production, which is distributed much more evenly than other resources and which does not or even multiply as it is used. The economy interacts with all aspects of life, so economics must also take account of all dimensions of life.

Notes:

It is essential for the renewal of economics to integrate the results and new vision of other disciplines.

Mainstream economics found itself in crisis in the wake of the 2008-2009 global recession, as its theories could neither explain nor predict adverse economic events.

List of sources used

M1 Line: Basic Megatrends

1.2. Exponential Growth of the Pareto Principle

György Matolcsy - Gergely Baksay - Emese Kreiszné Hudák

CHANGE here to

M2 Line: Knowledge and Talent | 2.2. Global University Networks

M3 Line: Geopolitics | 3.5. Age of Eurasia

One of today's biggest challenges is the scarcity of available physical and material resources. The key to success is to apply the Pareto rule. The Pareto rule is that a small fraction of resources is the key to success. By finding the part of our inputs that has the greatest impact, we can increase our efficiency and effectiveness.

The Pareto Principle looks for ways to use resources efficiently, and states that in many cases, most of the consequences come from a fraction of the inputs, i.e. the resources used do not lead to results in a linear fashion. The foundations of the Pareto rule were laid by the Italian economist Vilfredo Pareto in the late 19th century. Pareto examined the distribution of wealth in different countries and found that 20 percent of the population owned 80 percent of the wealth. Pareto's findings led Richard Koch, an American economist, to point out the disparities between resources and outcomes. Koch showed that in many cases, 20 percent of the causes are responsible for 80 percent of the consequences. This means that only one-fifth of our activities can produce four-fifths of our results.

Pareto ratios can be found in many areas of life, such as in sales or quality control processes, in nature and in information technology. Koch shows that up to 116 percent of a company's profits can come from around 20 percent of its customers, while the majority of customers can even make a loss. In the early, when Microsoft sought to improve the reliability and privacy of its software, it found that about 80 percent of

Windows and Office system failures and crashes were caused by only 20 percent of all detected bugs.6 Moreover, more than 50 percent of the detected bugs were caused by only 1 percent of the defective code. Today, the Pareto ratio can also be seen in the distribution of critical raw materials: 80 percent of the world's lithium crystals are linked to just 5 companies.

Nowadays, as the world accelerates, so too can the Pareto ratio, in which the spread of the internet plays a significant role. There is a crucial 20 percent of the 20 percent that produces 64 percent of the results (or another 80 of the 80 percent), and if we keep going, we can end up with only 1 percent of our resources producing about half of our results.

Always and everywhere, it is worth looking for Pareto ratios and making decisions about the use of resources based on them. The modern world has become obsessed with the principle of proportionality, i.e. less is more: investing time, energy or other resources beyond a certain amount does not add proportionately more to the result and may even lose what has been achieved. Because not only our time and material resources are limited, but increasingly our natural resources are too, we must always consider what is the 20 percent of the effort that will produce 80 percent of the results, or better still, what is the 1 percent that will produce 50 percent of the substantive impact.

Notes:

An example of the Pareto Principle prevailing in the Hungarian economy is the approximately 1100 innovation-driven companies accounting for only 0.3 percent of the total number of Hungarian companies but contributing 23 percent of the total GDP growth in recent years.

Individuals and the effectiveness of communities can be significantly improved by identifying and exploiting the 1 and 20 percentages that are the keys to success.

List of sources used

M1 Line: Basic Megatrends

1.3. Sustainability in the Centre

György Matolcsy - Gergely Baksay - Emese Kreiszné Hudák

CHANGE here to

M3 Line: Geopolitics 3.6. Sustainability as Geopolitical Factor

The world's population is consuming available resources at an exponential rate, while failing to ensure their sustainability. In the future, we must find a development path considers the environmental, economic and social aspects of sustainability.

Economic growth in recent centuries has been based on the increasing use of available resources. An expanding population has increased its material well-being through ever-increasing energy and raw material inputs. Today, however, the limits of this growth model are clearly exposed. Economic growth requires more and more debt, environmentally damaging activities contribute to global warming and modern social and economic conditions have led to a historically unprecedented situation where population in many countries is gradually declining (while elsewhere it is hardly sustainable, rising in an explosive way).

Achieving environmental sustainability is one of the greatest challenges of the decades ahead: the economic development of our time is being achieved at the expense of nature, as we continue to use more than the available natural resources. This is captured numerically by the Global Day of Overconsumption, which in 2024 fell on 1st August: this is the day when consumption exceeds the level of natural resources that the Earth can regenerate in a year. In the last 5 months of 2024 we used the resources (land, water, forest) borrowed from the next generation.

Sustainability must also be applied to finance. The world is in a debt trap that threatens the path to a sustainable future for future generations. The world's public debt has tripled since the mid-1970s. According to the IMF, the world's total debt stock was 237 percent of GDP in 2023, with public debt at 94 percent of GDP and private debt at 143 percent of GDP.

In addition to environmental and financial sustainability, demographic trends are also a major concern. Currently, developed countries in particular, but also developing economies over time, are facing the challenges of population decline and ageing. This poses both an economic challenge in of a shrinking workforce and rising public expenditure, and a social challenge in terms of, inter alia, loneliness and social services.

In order to our development in a sustainable way, we need a sustainability turnaround in every aspect of life, which must first take place in our thinking. The vision must be followed by the right objectives, with a roadmap and milestones to be achieved. This is not just a theoretical requirement, but also a human and family responsibility to leave our grandchildren a world as beautiful and liveable as the one

we inherited from our grandparents.

Notes

The ecological footprint is a measure of the demand of human activity on natural resources. At the current rate of consumption, the world's population consumes more than 1.7 Earths of resources year.

Through new visions for the future managed catchups can only be organised around the idea of sustainability.

List of sources used

M1 Line: Basic Megatrends

1.4. New Era of Measurement - Measurability

György Matolcsy - Gergely Baksay - Emese Kreiszné Hudák

CHANGE here to

M8 Line: New Industrial Revolution **8.3. Industry 4.0 Data-Driven Production**
M3 Line: Geopolitics **3.7. Geopolitics of Rare Earth Metals**
M7 Line: Digital World **7.6. Smart Data**

Today, the amount of data available to us is growing exponentially, expanding the possibilities for measurement in all walks of life. Data storage and processing is one of the biggest competitive advantages of the 21st century, and in this race, everyone is on an equal footing because data, unlike other resources, is evenly distributed around the world.

Measurement is as old as mankind. One might call it instinctive, the interest we have shown in knowing our environment since ancient times, but there are also practical reasons why we have needed to measure the water levels of rivers, to measure as accurately as possible the movements of the stars and the seasons. Later, it was on the basis of these measurements that all the scientific knowledge that makes our present technology and our way of life possible was based. But in recent decades, we have begun to measure more and more areas of life, so everything is transformed into data. Today, you can check your daily steps, your exercise habits, the latest weather or public health data with just one click. We can also measure the performance of national economies, the production time of parts and products, the skills of pupils in school competency tests and the results of sports competitions.

Measurement means even more when it is linked to a goal - it helps you achieve it. Measurement can two effects: on the one hand, positive feedback can accelerate progress in the right direction, and on the other hand negative feedback can encourage you to find the right way forward. With fewer resources but clear goals, we can achieve greater results than if we have an abundance of resources but no vision and no well-defined goal.

The expansion of measurement and measurability is made possible by the widespread use of the internet and digitalisation. Today, 5.4 billion people - two-thirds of the world's population - have access to the internet, a five-fold increase in less than two decades. Networked information and digitisation are transforming almost all activities into data. The speed at which data is being created is accelerating exponentially: 90 percent of the world's data has been created in the last two years. Data is the new oil of the digital age, as important a resource in the 21st century as oil used to be in the 20th. Both are the engines of economic growth, but both require processing and refinement before they can be used. The speed at which data is being processed is also accelerating at an explosive rate. Quantum technology is exponentially increasing the computing power of computers, making it possible to process data in real time, even for large amounts of data. The winners in the race of the future will be the companies and economies that make the most efficient and effective use of this extraordinary resource. And everyone stands a chance, because unlike oil, data is essentially ubiquitous and using it does not reduce the amount available.

Notes

The data is the new oil, which is, however, more evenly distributed around the world.

What we measure becomes a goal, but measurement also helps us to achieve the goal.

List of sources used

M1 Line: Basic Megatrends

1.5. Repetitive Cycles and Patterns

György Matolcsy - Gergely Baksay - Emese Kreiszné Hudák

Historical events show recurring patterns and turns, or cycles, from time to time. For example, longer economic cycles are typically driven by technological breakthroughs and geo-political changes. Recognising them can help us to adapt to future challenges, but we must be aware that repetition is never exactly the same.

World economic history is made up of cycles that mirror each other's patterns. But what does the word cycle mean? A cycle is a series of events that follow one after the other in a particular order and are repeated regularly. History is characterised by both repetition and change, that is, events repeat themselves in a recurring but always different way.

Cycles of quite different lengths exist simultaneously, side by side. By looking at fluctuations in economic performance, we can identify short business cycles of a few years or 10-15 years, which we can often understand ourselves. In the first phase of a cycle, economic activity increases, then a peak is followed by an economic slowdown (recession), and after the trough, a new cycle begins with a recovery. In the second half of the 20th century, European economies experienced booms lasting average of 12 years and recessions lasting nearly 1.5 years. Economic downturns can be explained by a number of factors, including a sudden rise in the price of the raw materials used to produce goods and services, financial crises or shocks to asset prices. Longer cycles are associated with specific generations (e.g. baby boomers, generations X and Y).

Russian economist Kondratyev found even longer cycles as early as the 1920s. Examining data from France, Germany, England and the United States between 1780 and 1920, he found that several economic variables - prices, wages, coal production, coal consumption, and iron and lead production - follow long cycles of 40-60 years. According to Kondratyev, these cycles are linked to technological developments, revolutions, and even wars over markets and raw materials. He attaches particular importance to technological innovation: he observes that in the downturn phase, many new innovations are typically created, which in the following long boom lead to productivity gains by being incorporated into production processes.

Looking at the events of the 2020s, we see parallels with the 1970s and 1940s, suggesting cycles of 50 and 80 years. As in the 2020s, geopolitical crises in the 1970s preceded a surge in energy prices (then oil prices, now gas and electricity prices). In both periods, this was followed by a global wave of inflation, rising interest rates and interest expenditure. The 1940s are paralleled by the turbulent conflicts and even the possible transformation of the geopolitical world order. The 2020 decade therefore brings greater risks, but also greater opportunities.

Notes

Preparing for the challenges of the future preparation by recognising the patterns and drivers of recurring cycles in history.

Many similarities can be recognised from the 1940s to the 1970s and the 2020s.

List of sources used

M1 Line: Basic Megatrends

1.6. Strengthening of Hubs

György Matolcsy - Gergely Baksay - Emese Kreiszné Hudák

CHANGE here to

M5 Line: Social Sustainability | 3.6. Mega Cities

The future will bring the strengthening of centres in many areas. Population ageing, climate change, technological change, and the increasing importance of security will increase the need for public involvement. The role of central banks and technology companies with unprecedented levels of investment will also grow.

Several phenomena can be identified that are likely to increase the weight of public policies and budgets in the coming decades. Humanity is facing challenges that cannot be met as effectively at the individual level as in a coordinated way. These include an ageing and shrinking population, which will require a re-think of social care systems. These include the fight against climate change and the technological transition, the technical and business aspects of which are of course determined by the private sector, but which require budgetary resources and inevitably public regulation because of their extreme cost. Finally, the increasing importance of security and defence is a classic public policy area which also requires more resources and coordination than in the past.

The private sector is both decentralised and centralised. Giant corporations are emerging as powerful centres in the global economy. Large corporations existed in previous centuries, but today the most valuable firms, mainly in the technology sector, are at the heart of our daily lives. It is enough to think that our social interactions and communication are increasingly shifting to online platforms, and that when we travel we no longer pick up a traditional map but use online navigation to reach our

destinations. At the same time, decentralisation is also present in the way these companies operate. They are themselves making it possible for people and companies that were previously isolated in the world to interact with each other. On the face of it, these hundreds of billions of connections reinforce de-centralisation, but we must not forget that in practice most of this is done by the services of a few large companies.

Central banks are the strong centres of the global economy, and they have been hugely important in the downturns of 2008-2009 and the coronavirus epidemic. In recent years, an increasing number of central banks have taken into account the need to promote environmental sustainability in their operations, as climate change implications for price stability, financial stability and sustainable catching-up. In the period ahead, central banks can also play an active role in innovation. Most of the world's central banks are already exploring the possibility of introducing digital central bank money, which would combine the security of cash issued by central banks with the benefits of electronic payment instruments mediated by private actors.

Notes

The five biggest in the world technology companies have combined revenues that rival the performance of national economies: based on their combined revenues in 2020, the Big 5 tech companies would have ranked 18th among the world's economies.

In addition to strong centres, there are also signs of decentralisation. In geopolitics, several geopolitical centres are emerging from the unipolar world order.

List of sources used

M1 Line: Basic Megatrends
1.7. Acceleration of Transitions

György Matolcsy - Gergely Baksay - Emese Kreiszné Hudák

CHANGE here to
M5 Line: Social Sustainability **5.4. Physiological Effect of Climatic Change**
M4 Line: Green Transition **4.6. Continual Global Warming**

If we find it increasingly difficult to adapt to change, it is not by chance. By all standards, the transitions in our world have accelerated, not only in terms of technological progress but also in terms of socio-economic change, and this is increasingly pronounced in global warming. The challenge is also an opportunity: those who adapt faster to the transitions will win.

Changes in the world around us have gradually accelerated in recent centuries and decades. Human progress has never been static, but the pace of change has tended to follow a steady linear trend, which has accelerated exponentially since around the industrial revolution.

The acceleration of change is essentially the result of technological progress, but it is also felt in all areas of life. This is reflected in the extraordinary growth of the world population during the 20th century. While the world's population quadrupled in the 1000 years preceding the industrial revolution, the global population has increased eight-fold in the two centuries since, from a substantially higher level. The acceleration of change is a self-exciting process. Each change triggers others, which follow in increasing frequency and number.

The closer we look to the present, the faster the change. The time between technical revolutions is getting shorter and shorter, and the diffusion of new technologies is also getting shorter. We have witnessed in our lifetime: in the space of a few decades, we have witnessed the revolution in computers, the internet and then wireless technologies. While it took several decades, or even nearly a century, for fixed telephones to become widespread compared to the patenting of the telephone in 1876, it took around a decade for mobile phones and just a few years for smartphones.

In addition to technological progress, social and environmental change is also taking place at an extraordinary pace. The divided world after the Second World War seemed to have been reunited for a few decades, followed by a re-emergence of fissures. There are also changes that seem more dangerous, more preventable. One such is climate change, where warming can trigger environmental changes at an exponential rate, from which there is no return to the status quo ante.

The increasing frequency of change, i.e. the acceleration of the transition, enhances the role of adaptive capacity and forward thinking. The opportunities, but also the challenges and threats, are increasing exponentially. We see winners being born fast (none of the world's most valuable companies is older 50), but failures are also common. At both individual and collective (corporate, national) level, we need to

prepare for the accelerating pace of technological, economic, social and environmental change. The winners will be those who are quickest to adapt and who are able to build strategies to cope with them.

Notes

In the 21st century we have moved from a linear age to an exponential age.

The acceleration of transitions enhances the role of adaptability and forward thinking.

List of sources used

M1 Line: Basic Megatrends

TERMINAL 1.8. Entry into the Age of Fusions

György Matolcsy - Gergely Baksay - Emese Kreiszné Hudák

CHANGE here to

M4 Line: Green Transition 4.7. The Future is the Renewable Energy

It is true both globally and locally that we need to build our economic and technological development on the combination and fusion of factors that are seemingly remote from our traditions. The more advanced we are, the more difficult it is to surpass new achievements on our own. Collaborations are needed, exploiting the interaction and synergy of divergent skills and knowledge.

A merger means the joining together or fusion of two or more things. This fusion is not only the basis of development, but the biological basis of life itself. Fusion, of course, requires not only a mere interconnection, but also the harmony, the cooperation, of the interconnected elements. And in the long term, we observe that progress and development require increasingly complex relationships. For example, decades or centuries ago, scientific research or sport was much more an individual activity, but today, behind an apparent individual achievement, such as a Nobel Prize or an individual Olympic title, there is a whole team of people who bring knowledge from many different backgrounds to help achieve the goals. The many technological advances (telecommunications, transport) have also made possible collaborations that would have been unthinkable in the past because of the distance between the elements involved.

We find and need mergers in many areas of life. Fusions in gastronomy, music or other arts make us think and have fun, while technological connections drive our economy forward. Today we are innovations are increasingly crossing industry boundaries, making technological fusion inevitable. This typically involves the complementary combination of core technologies from different industries, based on mutual cooperation, which can ultimately create a whole new market or profession. Today, an average car can consist of up to 30,000 parts and 10,000 lines of software code, depending on the model and its complexity. A car manufacturer may have up to 40,000 direct suppliers who source the inputs for the part they are building from additional suppliers, so that parts from nearly 100 countries can be used to build a car. Just as mergers have the potential to improve efficiency, so too do technology mergers: the final result is much more than the sum of the parts.

Finally, a very concrete form of fusion could provide a solution to one of the greatest challenges facing humanity. Fusion energy can provide a virtually limitless source of energy without greenhouse gas emissions, making it the most economical form of energy production. The name is no coincidence, because here is also a fusion: nuclear fusion is the fusion of two nuclei (as opposed to the decay that occurs in nuclear power), which huge amounts of energy. Fusion power generation has not yet been implemented on an industrial scale, but research and testing of experimental reactors is well underway.

Notes

Fusions of gastronomy, music or other arts make us think and entertain, while technological connections drive our economy forward.

An average car is made up of nearly 30,000 parts, with parts coming from suppliers in around 100 countries around the world.

List of sources used

M2 Line: Knowledge and Talent

TERMINAL 2.1. Formula of Success

Péter Asztalos

CHANGE here to

M1 Line: Basic Megatrends | 1.1. Multidisciplinary Economics

The future of the rise of nations will be driven primarily by the proper exploitation of the capital-technology-knowledge-talent (CTKT) nexus. Those nations will rise that convert money into capital, invent new technologies, disseminate knowledge to a wide section of society and provide space for talent to flourish. In the future, however, the CTKT's internal power structure will be reversed.

A new ideal of long-term sustainability is at the heart of the first half of the 21st century. But the driving force of this era is no longer great geographical discoveries, but major technological breakthroughs. It is still determined by the same 4 factors, capital-technology-knowledge-talent (CTKT), which underpinned the most successful periods in economic history, but the internal order of factors has been reversed compared to the last 500 years. In the past, success was based on capital, which drove technology, knowledge and talent. In contrast, in the new era, it is now technology that is at the heart of the process, determining the evolution of the other three factors.

In the new sustainable economics, talent and creativity are becoming inevitable resources, as they represent the bottleneck of exponentially expanding resources. The material world of the future will be based on a spiritual resource, knowledge. Knowledge, when transferred, becomes information, while it expands exponentially when shared, i.e. consumed. This property of knowledge creates a general abundance that generates a continuous technological revolution. However, the revolution in knowledge cannot be infinite either - it is limited by the time and energy needed to acquire it. The role of talent, creativity and diligence is therefore crucial, as these factors determine the maximum amount of knowledge that can be used within the limited time available. All people and all nations possess these factors, yet they can translate them into economic development to varying degrees.

The geographical location of a country, the size of its population, the amount of raw materials available or the favourable climate are not sufficient for a country to be successful and sustainable in the long term, without a social approach and agricultural policy. We have seen many examples of this around the world. It is no coincidence that South Korea was able to host the Summer Olympics 35 years after its devastating internal war, nor that Singapore was able to become one of the most economically efficient countries in the world in terms of raw materials of all kinds. Many of the world's biggest companies started from a garage or a dorm room without any major financial or physical resources. These examples show the way forward for the world - including Hungary and the Hungarian people - in the 21st century. The key to success is CTKT, and the perseverance to dare to dream and to follow our own Hungarian path.

Notes

Many of the world's biggest companies started up on the basis of knowledge, without financial or physical resources

Compared to the last 500 years, the order of the CTKT Success Formula has been reversed and now it is Talent in the centre of processes: TCTK (Talent-Capital-Technology-Knowledge).

List of sources used

M2 Line: Knowledge and Talent

2.2. Global University Networks

Péter Savanya

CHANGE here to

M1 Line: Basic Megatrends **1.2. Exponential Growth of Pareto Principle**
M3 Line: Geopolitics **3.5. Age of Eurasia**

The single knowledge space created by globalisation encourages universities to consciously build global partnerships on an international scale. These networks are characterised both by competition for resources and scientific results and by cooperation and knowledge sharing.

One of the first of all aspects of globalisation was the flow of knowledge across countries and continents. Universities, whose Latin name (universitas) refers to the totality of human knowledge, have always been at the forefront of this. Today, the internationalisation of knowledge is at an all-time high, made possible by the development of telecommunications, the expansion of transport and the spread of international cooperation.

International relations between universities are based on both competition and cooperation. On the one hand, in the global knowledge landscape, there is international competition for leading scientists, top researchers and even promising research projects between knowledge institutions. On the other hand, even the largest universities are finding that working with others can achieve even more and the need to exploit synergies in an increasingly competitive international scientific environment. Experience shows that the creation of most of today's innovations culminates in the joint work of R&D teams from many separate organisations, based on a network of close collaborations. Building and managing these relationships is therefore key for all actors in scientific competition, including universities.

Accordingly, leading universities are creating global networks, which benefit the participating institutions on a reciprocal basis. Arizona State University (ASU), for example, currently works closely with 22 partner institutions worldwide, and METU (The Metropolitan University of Budapest) joined the ranks as a Hungarian partner university in 2024. ASU aims to expand its network to 65 universities by 2030, reaching more than half a million students globally. The education and mobility programme run by China's Fudan University is even broader, covering 130 universities in around 30 countries.

The intensive presence of higher education in virtual space facilitates collaboration but also raises the competition for students to a new level. This process has been greatly accelerated by the "online adaptation" to the COVID pandemic. Today, the world's leading universities offer a full range of undergraduate courses on an online platform, and some institutions offer complete accredited degree programmes. This model offers greater economies of scale and business efficiency, and additionally greater societal benefits, but still requires local partner organisations to operate within an institutional framework, which further increases the need for collaboration.

Notes

In the USA, according to calculation, 55% of those with a doctorate in engineering, mathematics and engineering research are foreign-born.

At Arizona State University, 45 percent of students study in online programmes. In the past 10 years, nearly 100,000 students have taken such courses.

List of sources used

M2 Line: Knowledge and Talent

2.3. New Jobs

Ágnes Nagy

The world of work has evolved with technological revolutions in the past, and this constant change will with us in the future. The majority of today's students will have jobs in the future that do not even exist today, but it seems certain that the ability to think creatively, to be technologically savvy and to be flexible will be valued.

The ever-changing world, industrial revolutions and technological change have shaped the world of work throughout history. These changes have led to the

disappearance or decline of some jobs, but also to the creation of many new jobs or the transformation of existing ones. Overall, previous waves of technological progress have led to increased prosperity, higher productivity and more jobs. The changes have also their difficulties, so it is important to prepare for transitions now. The extent of the impact of the current changes is and that it is estimated that 65% of children starting school today will have a job in the future that does not yet exist. And another projection from 2017 estimates that 85% of the jobs that will exist in 2030 do not yet exist today.

Technological progress, the green shift, changing supply chains and changing consumer habits are fundamental to the evolution of the world of work and the emergence of new occupations. Within technological development, the expansion of automation in both physical (robotisation) and mental (AI applications) jobs has a major impact. According to the WEF, 34% of all work processes in companies are currently carried out by automated machines, a proportion which companies expect to rise to 42% in the second half of the 2020s.The importance of well-being and well-being, physical and mental health and, in turn, the care economy, is also growing. The "hook" economy, which has become increasingly important over the last decade, is (gig economy) and hybrid working are expected to remain dominant.

Possible occupations of the future could include the AI ethics expert, the space tour guide, the ethical algorithm programmer, the prompt engineer, the digital detox therapist, the virtual reality developer and influencer, the human-machine manager, the smart city planner, or the environmental restoration strategist. The emergence of new occupations and the transformation of the world of work are creating new challenges for workers and employers alike, for which adequate preparation and continuous adaptation are essential. Creative thinking, technological skills, flexibility and continuous lifelong learning, among others, will be valued, but analytical thinking and cognitive skills will remain among the most important skills.

Notes

According to the WEF, currently in all company workflows 34 percent of the work is done by automated machines, a share that companies expect to rise to 42 percent in the second half of the 2020s.

It is estimated that more than two thirds of children starting school will be employed in a completely new job that does not exist today (WEF, 2016 and IFTF, 2017).

List of sources used

M2 Line: Knowledge and Talent

2.4. Global Competition for Skilled Labour

Péter Savanya

Knowledge is the most important resource of the 21st century. Although the proportion of people with tertiary education is rising rapidly globally, it is not keeping pace with the demands of technological and economic development. There is therefore competition for the most skilled workers, not only within countries but also between countries at global level.

In the 21st century, economic and technological development has reached a stage where knowledge is the most important resource. Only knowledge-based, innovative economies can develop in a sustainable way, while physical resources are limited. The most successful countries recognised this early on and have made every effort to increase the amount of skilled human capital at their disposal. This can be achieved by improving education systems and universities, and by attracting skilled labour from other countries.

The developed countries, especially the United States, have used both means, so in addition to an excellent university system, and in order to maintain it, they have tried to attract the best researchers from all over world. This process is known as the "brain drain". Developing countries have been less able to offer competitive working conditions to the best people and have focused on developing the university sector. This is how many Asian universities have risen to the top of the world, for example in China and Singapore. Once the economy had reached the right level, the flow of skilled professionals who had also been abroad began, as in China, among other countries.

Skilled workers in all countries face a significant wage premium compared to less skilled workers. On average in OECD countries, a worker with a tertiary education earns on average almost 56 percent more than a worker with a secondary education, while in Hungary the wage differential is close to 80 percent. The demand for highly skilled workers in the economy will continue to be a feature of the future, there is also a growing social demand for higher education. At the turn of the millennium, the number of people in higher education worldwide was around 100 million, rising to has risen to over 250 million by 2022. The World Bank forecasts that the number of tertiary graduates in the world could increase by one and a half times by the end of the decade compared to the early 2020s.

However, demand for highly skilled workers is expected to grow even faster than the number of graduates, which could lead to a new global competitive situation. Retaining workers from other countries will also be a challenge, as they are much less attached to their new environment than to their home country. People who move frequently but whose skills make it easy for them to find new work almost anywhere are also known as digital nomads. Some countries are trying to attract as many of as possible, example in Romania where there is a simplified way to obtain a visa.

Notes

The World Bank forecasts that the number of people in higher worldwide could increase by more than 50 percent in the 2020 decade.

It is estimated that around 169 million people work abroad globally.

List of sources used

M2 Line: Knowledge and Talent

2.5. Updated Knowledge

Péter Asztalos

The key question for education in the 21st century is whether we can make students love learning and, in doing so, encourage them to leave the school system and continue their education and development throughout their lives. In a global competitive environment, only those who are able to respond to challenges in a timely and appropriate way can succeed.

Whereas in the slow-changing world of past centuries the key to success was for workers to do well what they learned in school, in the fast-changing 21st century they have to do well what they have not learned yet. Thus, continuous development, self-education within an organised framework and self-taught learning are essential for success in the labour market.

Technological progress and the transformation of the concept of knowledge offer unprecedented opportunities for all. Today, anyone can listen to a course from the world's most powerful universities online, or find training in almost any specific subject, regardless of physical location. In the age of online knowledge transfer, the initial inequalities are diminishing, but the motivation and supportive environment are becoming more and more important. So, a large part of the world now has the opportunity to join the knowledge world, the question is who will take advantage of it.

Young people are increasingly pursuing career goals based on interpersonal relationships, mainly linked to the internet, for which the education system as it stands does not prepare them. However, these skills can be acquired through other channels and young people's attention can easily be diverted away from schools. If schools are to continue to be the main channel for learning and knowledge sharing, the curricula they teach, and the methods of knowledge transfer they use need to be significantly reviewed.

Employers now expect strong interpersonal (soft) skills in almost all jobs, so it is worth devoting special attention to developing these skills in public education. At the same time, new teaching methods should complement rather than replace classical methods, as both are needed for a well-functioning education system.

Improving the skills of workers, and unleashing their talents, has a major impact on productivity and thus on economic growth. The extent to which and how quickly countries can respond to the ever-changing challenges of the 21st century through their education systems is therefore key to their long-term success. Participation in lifelong learning will be essential for all. The Nordic countries are leading the way in this respect, with almost a third of the population already in continuous formal or informal education.

Notes

A key challenge for the education system in the 21st century is to sustain a love of learning and to develop the need for continuous self-improvement.

More than a fifth of the productivity gap between firms can be attributed to the skills of workers and management.

List of sources used

M2 Line: Knowledge and Talent

2.6. AI in the Labour Market

Péter Savanya

CHANGE here to

M7 Line: Digital World 7.4. Everyday Artificial Intelligence

Artificial intelligence (AI) will cause a major reshuffle in the labour market. Whereas previous industrial revolutions have tended to replace physical work, AI will affect intellectual jobs. AI is not expected to reduce the number of jobs, only transform them, but to exploit it requires the right digital skills.

The importance of artificial intelligence (AI) could be so great that it could define a new technological-industrial revolution. Among its many impacts, its impact on the labour market is often the subject of debate. The main question is whether AI will not eliminate countless jobs and thus increase unemployment. Based on past experience, this is not likely. Throughout human history, there have been continuous

technological developments that have helped people work, from the wheel to steam engines to computers. These have always transformed the labour market, with labour flowing from the agricultural economy first into industry and then from industry into the service sector, but the number of jobs has essentially always risen. Unemployment was not caused by technological progress but by temporary recessions in economic cycles.

It is estimated that nearly a quarter of jobs globally, more than 800 million jobs, will be transformed by AI-based technologies. However, the International Labour Organisation (ILO) also estimates that the impact of technological change will more intensely and more rapidly in developed economies, due to a higher share of data-driven, intellectual jobs. This does not mean, however, that technology will soon make white-collar jobs, which were previously considered quasi- classified, redundant in droves. According to ILO experts, the potential for automation to replace the added value of human labour affects just over 2 percent of jobs. By contrast, nearly half of the jobs affected by technological change are more likely to incorporate AI as a supportive, efficiency-enhancing tool, while in another third the expected impact on the workforce is difficult to predict in the present. Finally, as with previous technological developments, AI is also creating jobs - in some cases in jobs that we cannot even predict today.

However, in order to benefit from the efficiency gains of AI and to be able to take up new jobs, a higher level of technical skills than before is needed. In the future, the combination of digital skills - expertise - creativity in the labour market will become more valuable in the field of data-driven value creation. In addition, the digital sophistication and agility of national economies will play a crucial role in their competitiveness in the era of digital transformation that lies ahead, which is much more complex than before.

Notes

In the WEF's international survey of companies, nearly 25 percent of respondents said that the adaptation of AI technologies will have a displacing effect on the workforce in the next 5 years, while around 50 percent said it will create jobs (WEF 2023).

The ILO estimates that the technological transformation associated with the use of AI in developed economies will affect 30 percent of jobs in some form, compared to a quarter of jobs globally (ILO 2023).

List of sources used

M2 Line: Knowledge and Talent

2.7. Edutainment Based on Experience

Péter Savanya

Not only is the nature and complexity of modern knowledge constantly changing, but learning needs and habits are also changing, driven by digitalisation. The rise of the online space has brought profound changes in our daily lives and in the way we communicate - and education systems need to adapt to these processes.

In the knowledge economy, quality knowledge is both the key to individual prosperity and the basis for community achievements. Learning today should certainly not end with years of schooling. In practice, we need to acquire new skills and knowledge continuously, both as adults and as workers. The process of learning, of renewing knowledge, can only be truly effective if it is motivated from within. To do this, learning must be made attractive and, if possible, fun. This is precisely what so-called “edutainment”, a combination of education and entertainment, offers.

The concept of experiential learning is not new. The positive impact of the multifaceted involvement of the individual in the learning process (physical stimuli, emotions, social connections) on learning outcomes has long been recognised in educational science. Such forms of learning are increasingly coming to the fore because of the general phenomenon of a decline in active attention and concentration. Research has shown that in 20 years, the average adult's attention to a single screen of content has fallen by less than a third. This trend has been demonstrated by neuroscience research across generations. The phenomenon is linked to both the noisy information bubble created by smart personal devices connected to the Internet and the cultural transformation in which human thought patterns are increasingly determined by impulsive, fragmented communication of online audiovisual content consumption, as opposed to the reading and absorption-based thinking of earlier eras. Together, these changes are leading to a qualitative deterioration in the qualities of the basic human learning capacities (reflection, comprehension, memory), down to the brain level. Education systems need to find solutions and new methodologies to cope with these changes, particularly in public education, but also in higher education and in training to support lifelong learning.

In the future, the social demand for edutainment is expected to grow significantly, with the growing popularity of smart device-based language learning applications being a good example. Analysts are unanimous in predicting a dynamic global growth of up to 15% in the market for edutainment-based services by 2030, with next-generation technologies such as artificial intelligence or augmented reality (AR) playing a leading role. Good practices in the digital transformation of teaching and learning already exist, but methodologies are currently in the experimental phase. In the future, the integration of digital tools in education can be successful if the right approach is taken.

Notes

According to a US study, the average adult's attention span per screen of content was around 2.5 minutes 20 years ago, but today that window has shrunk to 47 seconds.

Market research until 2030 forecast annual growth of over 15 percent in global edutainment revenues.

List of sources used

M2 Line: Knowledge and Talent

TERMINAL 2.8. Exponential Growth of Knowledge

Péter Asztalos

Knowledge is the foundation of the new sustainable economics on which individuals and nations wishing to succeed in the 21st century must build their strategies. Knowledge is a special resource that grows exponentially as it is used.

Today, in many areas of everyday life, we can see that the most important value of the 21st century is information, and the processed form of this information is data, from which new knowledge can be created. The growing value of data and knowledge is fundamentally changing the way the world works, building a world based on data and knowledge. In many respects, knowledge has different properties from the material goods that previously determined the functioning of the economy. While the quantity of material goods decreases as they are used, knowledge is an economic resource that can expand expotentially as it is used and shared.

Knowledge is now available to almost everyone, with the tools in your pocket you can access almost any information about the world. The advent of the Internet has brought about changes in the way human knowledge is disseminated to the widest possible audience and thus in the way societies function, similar to the printing of books. It is now estimated that 330 million bytes of data are generated every day, and the amount of data being generated is growing exponentially as technologies are deployed. The future, and success, will therefore depend more on the ability to use the data that humanity has collected and how to create new value from a rapidly growing body of knowledge. Talent and hard work are in everyone, but they do not emerge in equal measure. This is why it is so important to create an inspiring and supportive environment, to recognise and nurture talent, and to recognise and reward hard work. Many of the students who go to school today will go on to work in professions that

do not even exist today. So, one of the most important qualities is to be open and to keep learning, to dare to rethink our daily lives and not to be afraid to change the things we can do better.

A nation can only be truly successful if it can bring out the potential in all its members. In the age of the internet, the ability to filter and interpret information and to think critically are essential skills. Teachers' task in the future will be not only to deliver the curriculum, but also to organise the information they learn, to connections, to develop critical thinking and the skills and love of learning that these require. Teachers can, with the right attention, identify the talents in children and use the right methods to encourage them. This is a broader understanding of giftedness than is currently the case, which requires a change of approach in education systems.

To achieve sustainable catching-up, Hungary also needs to shift to a knowledge- and technology-driven intensive growth model, with the availability of highly skilled workers in the economy being a key issue.

Notes

Web now has nearly 330 million terabytes of data that is generated every day.

All human knowledge is growing at an exponential rate, which will be accelerated by artificial intelligence.

List of sources used

M3 Line: Geopolitics

TERMINAL 3.1. Soft Power - the Means of Peaceful Growth

Nóra Anna Sándor

In international relations, not only hard power but also soft power is an important factor. By this we mean, first and foremost, the cultural and diplomatic means by which a country's views and ideology can spread peacefully. Traditionally, the United States has been the strongest in this respect, but in recent decades the influence of China, Korea and Japan has grown considerably.

The concept of soft power was introduced by Professor Joseph Nye, an expert on international relations, in the late 1980s. According to his definition, soft power is the ability of a state to influence international actors on a value basis, without force or coercion. Nye identified three main components of soft power: culture, political values and foreign policy. These have traditionally been by the United States and the

developed European countries, but have changed since the turn of the millennium. The influence of Asian countries is growing, not only through their economic weight but also through their cultural importance. The UK-based Brand Finance's Global Soft Power Index ranks the United States and the United Kingdom the top two, followed by China and Japan.

If a country can put its soft power tools at the service of economic growth, it is in a double win-win situation, as it not only makes its own values attractive, but also gains economic benefits. The film industry, pop music, TV series, gastronomy and even the beauty industry are all integral parts of the soft power toolbox, including the popularisation of culture, too. One of the most notorious examples is Hollywood, which has not only been providing material resources to the United States, but has also been broadcasting the country's core values around the world for nearly a century. In recent decades, however, similar film hubs have emerged in areas geographically and culturally distant from the United States. Already in the 1990s, South Korea's film industry has become successful, Bollywood in India has produced an extraordinary number of films and film production in China has also strengthened.

The "Korean wave" (hallyu) is a prime example of the power of soft power. the 1990s, Seoul has put popular culture (so-called K-content) at the service of economic growth: while in 1998 the equivalent of $14 million was allocated from the central budget to culture, in 2023 it will be $618 million. The success of the Korean Wave can also be seen in the growth of its fan base: from nearly 30 million fans worldwide in 2014, the phenomenon had 225 million by the end of 2023.

The size of a country's cultural institutional network and diplomatic network is also indicative of its soft power toolbox. In this respect, too, the competition between the great powers is close. By the end of 2023, the diplomatic network of the two great powers will have grown to 274-271 in favour of China.

Notes

Soft power refers to the ability of a state to influence the actors of national life on a value basis, without force or coercion.

The Global Soft Power Index ranks the United States and the United Kingdom in the top two for soft power, China and Japan in third and fourth place.

List of sources used

M3 Line: Geopolitics

3.2. Competition for Space

Nóra Anna Sándor

Five decades after the last Apollo mission, space and the Moon are once again at the centre of human attention and geopolitical competition. The competition, traditionally between the United States and Russia (the Soviet Union), has been joined over the decades by new players such as China, India, Japan, South Korea and the United Arab Emirates.

So far, the Soviet Union (1966), the United States (1966), China (2013), India (2023) and Japan (2024) have successfully landed on the Moon (so-called soft-landing, planned landing without injury). The United States is still the only country to have sent a man to the Moon (1969), but this could soon change as the race to reach the Moon and conquer space has gained momentum in recent years. The main goal of 21st century lunar missions is to put a man on Moon again after 1972, but there is also a growing demand for lunar bases, which could be used for space-based missions, including those to distant places such as Mars. They would also serve as a "boxing road". China and Russia agreed in 2021 to build a joint moon base, which could be completed between 2025 and 2035. In May 2024, Russia announced the construction of a nuclear power plant to provide energy for the moon base.

While the United States has set 2026 as target date for its astronauts to (re)land on the Moon as part of the Artemis III mission, Russia plans to send a first human to the satellite of our planet in 2029, China in 2030,5 and India in 2040.

Today's space objectives are more ambitious than in the Cold War era: the exploration and conquest of the Moon is now also important for resources such as water, sulphur, aluminium, iron, calcium, titanium, manganese, chromium and oxygen (the latter is not a gas but a solid, and the latter is in the form of oxide in a sheet of material called regolith, which covers the surface of the Moon. Surveys suggest that about 40-45% of the regolith covering the surface of the Moon contains oxygen bound as oxide in the form of minerals or glass, from which oxygen could be produced by electrolysis, but this is currently very energy intensive. On the other hand, controlling the space between the Earth and the Moon, creating lunar bases and launching satellites into orbit represents a huge military advantage. These factors justify states spending billions of dollars on space programmes. NASA announced in May 2024 that it plans to build a lunar railway that could greatly facilitate the transport of cargo across the sky to operate a deployed lunar base in the 2030s.

Hungary does not want to miss out on space exploration either: since 2021, Hungary has had a space strategy, which includes training astronauts. The aim of the Hungarian space strategy is for Hungary to become an active player in the global space value chain in the long term and, given its position, to play a leading regional role in certain areas of development

Notes

There may be enough oxygen in the form of oxides on our satellite planet to last for millennia.

It is thought that both sides of the Moon are frozen water-rich areas: it is estimated around 268 thousand billion litres (71 thousand billion gallons) of water may be hidden in glass beads on the Moon.

List of sources used

M3 Line: Geopolitics

3.3. Globalisation or Deglobalisation

Tamás Ginter

CHANGE here to

M6 Line: Financial Revolutions 6.8. Renaissance of Gold

After the rapid expansion of international trade and capital flows since the 1980s, the world economy has been characterised by a slowdown in globalisation since the 2008 financial crisis. This was initially based on private sector decisions but later became apparent in the economic policies and foreign trade conflicts of individual countries.

The period of hyper-globalisation since the 1980s (characterised by increasingly intense international trade, capital flows and political cooperation) came to an end with the 2008 financial crisis. Since then, international trade has remained stable, and the world economy has entered an era of slow globalisation ("Slowbalisation"). Although we have seen a stagnation, not a decline, in globalisation, successive crises in the 2020s foresee a more fragmented world economy. Brexit, the trade conflict between the United States and China in the mid-2010s, and the growing number of military confrontations (in particular the war in Ukraine) are all signs of this fragmentation.

In addition, the Covid epidemic has also highlighted the vulnerability of global demand, prompting large international companies to focus on the security rather than the efficiency of their supply chains. This has led to an increase in efforts to bring the location of production and consumption as close as possible to each other geographically (i.e. nearshoring); since the pandemic outbreak, the number of presentations on the results of the value chains has increased tenfold. They include expressions like onshoring, nearshoring, reshoring. On the other hand, the growing international tensions

have made the transformation of supply chains a tool for geopolitical advocacy. The trade competition between the United States and China, and the war in Ukraine, have led to demands at both state and corporate level to ensure that production and trade are primarily with politically allied countries and states (it is the so-called friendshoring).

At the same time, the construction of the global economy along international alliance interests again portrays a polarising world system. At the same time, a fragmented world economy is leading to severe losses of GDP globally: some projections suggest that these costs could be as high as 7% of GDP in the long term. In addition to economic damage, a fragmented world order could also adversely affect capital flows, international cooperation and the diffusion of certain technologies. The fragmentation of the world economy into blocks is projected to be most damaging for small open economies. The International Monetary Fund (IMF) has also spoken out against trade fragmentation, proposing to increase international trade and modernise cross-border payments.

Notes

Since the 2008 financial crisis world trade has not recovered and the trend towards deglobalisation will continue in the wake of the crisis of the 2020s

The world economy fragmentation can cost up to 7% of GDP.

List of sources used

M3 Line: Geopolitics

3.4. Technological Sovereignty

Patrik Tischler

Knowledge is power - and technology is the carrier of knowledge. That is why technological competition is also a struggle for supremacy and economic competitiveness among the countries of the world. In the recent past, a new dimension has been added to this: technological developments also strengthen the autonomy and sovereignty of the countries concerned.

The most sustainable driver of economic growth in the long term is efficiency improvements, and technological progress is the main source of these. In addition, economic growth can come from more labour input or more capital input, but the former is limited in developed countries due to population decline and the latter is

sometimes expensive due to falling interest rates. Technology can also be a factor in shaping history. The first industrial revolution made Britain not only the world's workshop but also its strongest power, and technological competition played a key role in the Cold War.

Today, technological development is more than just an aspect of economic competition, it is also an area of geopolitical struggle. It is therefore no coincidence that there has been serious global competition between the major powers, particularly between the US and China for the acquisition of technological competences, of which the semiconductor industry has become one of the most important areas. The technological ecosystem of our times would be unimaginable without the semiconductor industry, as the chips it supplies are the "soul" of all modern technologies, be they smartphones, artificial intelligence or satellites. The chip manufacturing process is extremely complex and requires large investments and a high level of technological sophistication, which is why the production chain, from the extraction of raw materials to the production lines, the chip to production involves many countries around the world and has so far required their cooperation.

The semiconductor industry's prominent economic role is demonstrated by the fact that its market size is growing dynamically year on year, reaching 544 billion US dollars in 2023 and is forecast reach 1137 billion US dollars by 2033, projecting an overall annual growth rate of more than 7 percent in the coming years. Despite the globalised supply chain, and in the wake of high investment costs, the chip industry has become highly geographically concentrated, with Asia and the Pacific holding more than half of the global semiconductor market, 52.8 percent. In contrast, North America is second with 22.7 percent of market, while Europe third with 15.8 percent and Latin America and the Middle East and Africa are marginal with 4.5 and 4.1 percent respectively.

Notes

In 2023, the global semiconductor market was worth a total of USD 544 billion; likely to rise to USD 1137 billion by 2033.

Asia and the Pacific the current leader in the semiconductor market, with a market share of 52.8 percent.

List of sources used

M3 Line: Geopolitics

3.5. Age of Eurasia

Nóra Anna Sándor

CHANGE here to

M1 Line: Basic Megatrends | **1.2. Exponential Growth of Pareto Principle**

M2 Line: Knowledge and Talent | **2.2. Global University Networks**

In recent decades, we have witnessed the rise of the Eurasian supercontinent, replacing the Atlantic era that lasted for 500 years. First Asian population growth and then economic development have shifted the centre of the world economy back to Eurasia.

Economic history is repeating itself: the centre of gravity of the world economy is returning to interior of Eurasia, where it been until the age of the great geographical discoveries. Until then, China had been the world's largest economy, but with European expansion and industrialisation, and the rise of America, the centre of gravity shifted westwards, towards the Atlantic. In the second half of the 20th century, the economic boom and population growth of first Japan and then the so-called 'small giants', and especially China, shifted the centre of gravity of the world economy back to Asia, a trend that could be further reinforced by the strengthening of the Indian economy. Asia now accounts for 54 percent of global GDP, up from 33 percent in the 1950s. The Eurasian supercontinent covers 36 percent of the world's total land area and 70 percent of the world's population.

Eurasia's economic recovery also strong geopolitical implications. The Eurasian states, China and the Global South are increasingly claiming their place on the international stage and are actively seeking to influence geopolitics and global economic processes through their initiatives. Asian countries have also made sweeping changes to their economic structures and aim to move up the global value chains and establish their technological sovereignty. More and more countries on the continent have become leaders and models for the world in certain areas.

The change in the economic structure model is also having tangible results in the technological field. According to the Critical Technology Tracker, by 2024, China will be a leader 37 of the 44 areas studied, including artificial intelligence, quantum computing, communications, critical raw materials extraction and processing, machine learning, drone technologies and even engine manufacturing. By 2024, CBDC will have reached the pilot phase in Eurasian countries such as China, Russia, India, Kazakhstan, Turkey and Saudi Arabia.

Recognizing the growing weight of the East and the coming of the age of Eurasia, and in order to strengthen knowledge sharing and dialogue with Eurasian countries, the Hungarian National Bank launched the Budapest Eurasia Forum in 2019, a series of events based on the idea of the emergence of a multipolar world order, including the rise of power centres. For years, the Budapest Eurasia Forum has provided an excellent platform for dialogue with the region, while strengthening Budapest's role as an intellectual

centre.

Notes

Eurasia accounts for 70% of the world's population.

Today Asia accounts for 54% of global GDP, compared to 33% in the 1950s, for example.

List of sources used

M3 Line: Geopolitics

3.6. Sustainability as Geopolitical Factor

Nóra Anna Sándor

CHANGE here to

M1 Line: Basic Megatrends | 1.3. Sustainability in the Centre

In the past, geopolitical changes were determined by the population, wealth, technology and military power of each country or region. In the 21st century, this will be complemented by sustainability, global warming will profoundly affect the future of our planet. As well as threats, there are opportunities for adaptation and the development of green technologies.

Climate change is one of the greatest challenges of our time and already one of the most important risk factors. According to the World Economic Forum (WEF), within 10 years, climate-related risks such as extreme weather events, water scarcity and biodiversity loss will be the most significant threat to the entire world. They are the most serious crises affecting the planet, which also entail geopolitical risks, for example through migration or conflicts over resources.

The balance of power between countries will be significantly affected by climate change and adaptation to it. Some countries will be affected by the adverse or even devastating effects of global warming, such as tidally vulnerable coastal areas and small island states, while others be less adversely affected, such as areas in colder climates. Changing temperatures will transform agricultural land, making new sea routes passable and other areas potentially impassable or even uninhabitable.

Some impacts of climate change are unavoidable, but others can be adapted to with the right tools, and the winners of the 21st century will be those who adapt successfully. To

mitigate the effects of climate change, a so-called green transition is needed, i.e. the use of less environmentally damaging technologies throughout the world. And whoever can provide them fastest and most cost-effectively stands to gain a lot from the deal. While the European Union has set itself the most stringent environmental targets, China is leading the way in the technologies needed to achieve them, such as solar panels and new energy vehicles (NEVs). According to the International Energy Agency, China accounts for more than 80 percent of global solar panel production.

The use of green technologies requires international cooperation. While the pace of globalisation in the world economy has slowed down considerably, or even come to a standstill, the fact that the raw materials for green technologies can only be mined in a small number of countries and that China is dominant in their processing, but that demand for the end products is also high in Western countries, and that the environment can only be effectively protected through global cooperation, is a factor in maintaining economic relations.

Notes

The effects of warming will hit Africa the hardest, with fastest growing population in the coming decades.

The World Economic Forum estimates that USD 125 thousand billion of financing would be needed by 2050 to achieve net zero emissions.

List of sources used

M3 Line: Geopolitics

3.7. Geopolitics of Rare Earth Metals

Nóra Anna Sándor

CHANGE here to

M1 Line: Basic Megatrends | **1.4. New Era of Measurements - Measurability**
M8 Line: New Industrial Revolution | **8.3. Industry 4.0 Data-Driven Production**
M7 Line: Digital World | **7.6. Smart Data**

Rare earths are an irreplaceable raw material in most modern technologies. Contrary to their name, their occurrence is not rare, but their mineable and economically exploitable reserves are. The reserves available deep underground are concentrated in a few countries, which could be bypassed in the

green technology transition.

Light sources, semiconductors, magnets, screens, catalysts - the uses of rare earth metals are already wide-ranging. But even more important are the tools essential for a sustainable economic transition, for example in the production of wind turbines, solar panels, electric vehicles and batteries. The rare earth group includes 17 chemical elements (lanthanides, scandium and yttrium), which should not be confused with other critical minerals also needed for the transition, such as lithium, silicon, cobalt and manganese.

The availability of rare earths on Earth is quite concentrated, which is an advantage for the countries concerned. China is a major player in rare earths, with an estimated 38 percent of the world's rare earth reserves (44 million tonnes) in Chinese soil. In addition to China, Vietnam, Brazil, Russia, India, Australia and the United States are also major players in terms of reserves. However, rare earth mining also has a very high environmental impact, with many deposits occurring in association with radioactive elements (uranium, thorium) that require special treatments and procedures.

Not only in terms of reserves, but also in terms of production and processing, China is the clear leader. 87 percent. Outside China, the United States (14 percent), Australia (6 percent), Myanmar (4 percent) and Thailand (2 percent) are the world's top producers of rare earths, but their combined share is nowhere near the Chinese figures. Their processing is a highly water- and energy-intensive process. China's superiority in rare earth mining and processing is related to this: in the 1980s, when the Asian giant opened its rare earth mines and sold large quantities of processed products on the world market, developed economies stopped producing more expensive products.

The role of rare earths could grow even further in the future. According to the International Energy Agency (IEA), demand for these materials could increase by a factor of seven by 2040, while demand for critical minerals could increase by a factor of forty times. Given the role of rare earths in high-tech, gaining control over the materials needed for the green transition and expanding links with countries rich in these minerals is now a driving force in geopolitics and geo-economics.

Notes

Demand for rare earths could increase sevenfold by 2040

China produces 87 percent of the total world production of processed rare earths.

List of sources used

M3 Line: Geopolitics

TERMINAL 3.8. Appreciation in Safety

Dávid Hory – Eszter Boros

As geopolitical conflicts in the world intensify, military and defence spending is rising globally. In the space of a decade and a half, the number of armed conflicts in the world has doubled, leading to an increase in expenditure of around one and a half times in several key countries.

The Ukrainian-Russian war has once again drawn attention to the fact that armed conflicts are still taking in the world, even in the context of closer economic cooperation. The number of such conflicts decreased slightly after the turn of the millennium but began to rise in 2010 and now stands at around 180 in the world. The tendency towards "blocking" in world trade is testing previously stable alliances, new crisis zones are emerging and the lines of force of old conflicts are being reorganised along new dynamics. But it is not only conflicts, but also successive global crises, uncontrolled migration, global warming and the increasing frequency of cyber-attacks that are intensifying the need for security.

Global defence spending has been on a rising trend over the past decade, both in response to the growing number of conflicts and to ensure security, reaching $2.24 trillion in 2023. The top ten countries with the largest military budgets are the United States, which alone accounts for more than a third of global defence spending. No other country can match the US global force projection capability, but maintaining this capability is becoming increasingly expensive, so Washington needs to set priorities.

In 2014, NATO member states agreed to increase their defence spending to 2 percent of their GDP. This is being driven by the shift of US attention to the Pacific and the war in Ukraine. China's defence spending has shown a steady, planned increase, holding steady in second place behind the US.

In the medium term, global defence spending is expected to increase: the European NATO allies are taking further steps towards strategic autonomy and closer cooperation. China is expected to further develop its military capabilities in the Pacific region, which will encourage other member states in the region to increase their defence spending. The higher inflation environment, the rapid development of technology, and the higher real costs of modern, complex military equipment also point towards an increase in defense spending. Besides the developments demanded by the conventional warfare, armed forces have to be prepared for the new forms of irregular warfare. Among these, the information and cyberspace, as well as the space race, hold enormous challenges, including the still difficult to assess prospects for the rapid development of artificial intelligence.

Notes

In 2023, the United States and China were responsible for almost half of the world's military expenditure (37 percent, and 12 percent respectively).

Since 1946, the number of armed conflicts in the world has been the highest in 2023.

List of sources used

M4 Line: Green Transition

TERMINAL 4.1. Sustainability Corporation Aspect

Donát Kim

In 2004, growing concerns about inequality and sustainability prompted the United Nations to publish the "Who Cares Wins" report, which drew attention to the fact that the financial performance of companies in the long term is strongly influenced by environmental, social and governance (ESG) considerations.

By publishing the document, the UN wanted to encourage investment in sustainability and promote mutual understanding between the stakeholders involved in companies (customers, employees and investors). This approach represented a major change from the approach that had been prevalent since the 1970s, as summarised by one of its fathers, Milton Friedman: *"Corporations have one social responsibility, namely, to increase their profits. "*

This “Friedmanite” thinking used to be the mainstream until the economic crisis of 2008, and focused exclusively on efficiency issues for companies, but after the recession, this view was also revised by company managers. This is partly based on the realisation that a focus on long-term sustainability increases shareholder value, and that business is not a zero-sum game. These ideas are not new, as many people associate Henry Ford with the observation that *"a poor business is one that only makes money."*

In order to consciously improve their ESG exposure, companies need to measure and collect data on its main components. And they can improve their competitiveness through data-driven decision-making. Green technology innovations help to strengthen resilience and increase their market participation. Finally, through cheaper financing they are able to gain access to capital, partly through the money and capital markets, and partly because state subsidies are also prioritising these companies. Public support for ESG aspects may also be desirable because they can promote the Sustainable Development Goals (SDGs) set by the UN.

Looking ahead, economic actors continue to see ESG challenges as a major risk over the next two years. The World Economic Forum's research identified five

environmental and two social risks out of top ten challenges over a ten-year horizon, overshadowing geopolitical and economic risks. This underlines that sustainability is not only in the interest of consumers, workers and citizens, but that business leaders must also take ESG priorities into account.

Notes

"Poor is the business that only makes money" (Henry Ford).

Of the top ten challenges, the World Economic Forum identified five environmental and two social risks.

List of sources used

M4 Line: Green Transition

4.2. Revolution of Energy Storage

András Zsolt Szabics

One of the biggest obstacles to the transition to renewable energy is the lack of continuous availability of its most typical sources (solar and wind). To ensure an uninterrupted energy supply, the energy produced must therefore be stored and made available to users at the right time. The development of energy storage is therefore one of the main prerequisites for the spread of green energy.

The International Energy Agency (IEA) estimates that the share of renewable energy in total energy supply must be raised to over 70 percent by 2050 if net zero emissions are to be achieved. Alongside the appreciation of renewable resources, the continued advance and development of energy storage methods is essential. without it, the balance of the electricity grid would be jeopardised and anomalies such as a persistently negative electricity price in an oversupplied market could arise. In practice, this means that electricity generators who cannot afford to shut down their plants when the market is experiencing surplus electricity or low consumption have to pay for the user to take over the electricity generated, questions about the return for renewable investors. The expected rise of energy storage technology is illustrated by the IEA's projection that by 2050, up to 4 TW of installed battery capacity could be built worldwide, compared to the current figure of only 0.05 TW.

The surge in storage capacity is supported by the very high level of innovation activity in the field, which is gradually reducing the unit costs of the different technologies, thus improving the payback period for the necessary investments. Solutions for bridging the

gap between energy production and consumption are available across a very broad spectrum. The most important are chemical (battery), mechanical (pumped storage power plant), thermal (concentrated solar power integrated into a compressed air model) and al- tentative (hydrogen) methods. The different technologies can be used depending on the time horizon for energy storage and the power capacity required. While chemical methods are feasible on a smaller scale, mechanical and thermal methods are more economically feasible for larger capacities of up to several hundred MW.

In addition to the lithium-ion batteries that are now considered conventional, liquid-flow batteries could gain ground in the future, with the big advantage that they do not require rare-earth metals (lithium, cobalt) and their performance does not decrease with use. The use of hydrogen for energy storage could be a similarly innovative and dominant technology in the future. Energy storage is particularly relevant for Hungary because of the country's significant battery manufacturing capacity and the dynamic growth of the renewable energy market.

Notes

The International Energy Agency (IEA) estimates that the share of renewable in total energy supply could rise to over 70 percent by 2050.

The IEA predicts that by 2050, up to over 4 TW of battery capacity could be built worldwide, compared to just 0.05 TW today.

List of sources used

M4 Line: Green Transition

4.3. Entry into the Age of Zero Carbon

Kata Molnár

The Net Zero target is a necessary and achievable milestone to avoid the worst consequences of climate change. Humanity must work together to reduce greenhouse gas emissions to ensure a liveable planet for ourselves and future generations.

Humanity's environmental footprint has increased dramatically in recent decades. Industrialisation, technological progress, global population and economic growth have contributed to the increase in greenhouse gas (GHG) emissions, which has led to an acceleration of climate change. The Net Zero (or Climate Neutrality) target, the cornerstone of the Paris Agreement, aims to reduce our global GHG emissions to zero, or zero emissions, of around 50 billion tonnes per year. If we do not change

our current practices, global temperatures will continue to rise, causing ecological, social and economic catastrophes.

By November 2023, 145 countries, responsible for 90 percent of global emissions, have announced or are considering net-zero emission targets. The scope, structure and transparency of these targets are not yet forming a clear and unified picture. What is needed is strong political will, short-term plans and mapping of implementation routes.

Hungary's GHG emissions in CO_2 equivalent were 64.2 million tonnes in 2021, and we have committed to achieving climate neutrality by 2050. Transport, energy and emissions from residential and other buildings are the main sources of greenhouse gas emissions account for 72% of the country's total emissions and are therefore a sector that we need to address as a priority. Of these emissions, 10 percent are tied to our natural carbon sinks (such as forests).

Climate neutrality is a realistic goal for Hungary by 2050. To reach the net zero target, Hungary would need to invest around €150-200 billion in green investments over the next 30 years. Although this is a very significant amount, the transition can bring both economic development and increased energy security through investment needs and the introduction of new technologies.

In addition to tightening regulations and policy measures, the identification, measurement and management of climate change and environmental risks is a key driver for achieving net-zero targets. Consumer pressure, particularly among the newer generations, can also have a strong impact on responsible and sustainable business. Innovative ideas, energy efficiency, increasing renewable energy sources or technologies to support carbon capture and storage are key to net-zero targets. This will require both natural (e.g. forests) and technological (e.g. 'air capture') solutions.

Notes

Until November 2023, the 145 countries responsible for 90 percent of global emissions have considered or are considering net zero emission targets.

Key role for the innovative ideas include energy efficiency, increasing renewable energy resources, or technologies supporting carbon capture and storage.

List of sources used

M4 Line: Green Transition

4.4. Circular Economy

András Zsolt Szabics

CHANGE here to

M8 Line: New Industrial Revolution 8.8. Built Environment

The transition to a circular economy is a prerequisite for environmental sustainability. This requires drastically reducing the amount of waste and reusing a large proportion of the remainder. We now have the tools to do this, and by making them cost-effective we can avoid irreversibly overburdening the Earth's ecosystem.

The linear economic model of our time is not sustainable. The "produce, use and throw away" approach is not compatible with the principle of sustainability and emission reduction targets in a context of exponential growth of the world economy. We need to return to the circular economy model, which focuses on the use of products rather than their consumption once with putting the emphasis on extending the life cycle of products as much as possible. This can be achieved in a number of ways, for example by switching to reusable, recyclable or repairable products, in some cases by renting rather than owning, or by sharing use with the community.

Intervention is also urgently needed because at current consumption levels, we are using an estimated 1.7 Earths of natural resources. The Earth's biocapacity is significantly exceeded by humanity's ecological footprint, which is depleting the Earth's resources to the point of threatening environmental sustainability and the living conditions of future generations.

Waste management is a key issue in the transition to a circular economy. The scale of the problem is illustrated by the fact that the largest of the garbage floating in the Earth's oceans is 1.6 million square kilometres, three times the size of France.3 A concerted effort is needed to reduce the amount of waste produced. On the other hand, we also need to recycle as much of the waste already generated as possible. The extreme or optimal form of the circular economy is the zero waste recycling system.4 Although this sounds radical today, it is in fact a return to the economic philosophy of the pre-modern industrial era, when essentially nothing was wasted, and durable and reusable equipment was used instead of temporary solutions (and packaging).

The scale of the challenges facing humanity is illustrated by the UN's projection, which modelled the expected amount of waste generated globally under different scenarios. If there is no change in the production and management of waste (the baseline), the 2.1 billion tonnes of municipal waste produced today could roughly double by 20505 because the rate of waste generation cannot decouple from economic growth. Only if the transition to a circular economy is achieved will we be able to keep the amount of new waste generated at current levels. This means, according to the UN, being able to collect 100 percent of municipal waste and achieve a recycling rate of 60 percent.

Notes

The Japanese industrial city of Kitakyushu has been able to cut municipal waste by almost half through a comprehensive programme

The largest of the islands of rubbish floating in the Earth's oceans is 1.6 million square kilometres three times the size of France.

List of sources used

M4 Line: Green Transition

4.5. Escalating Water Shortage

Kata Molnár

CHANGE here to

M5 Line: Social Sustainability 5.5. Population Explosion in Africa

Without water, there is no life, and this basic premise is now becoming crucial: humanity is facing an unprecedented water shortage. Global warming and desertification mean that access to fresh water will become a daily challenge in some regions, especially in warm climates. Hungary is also affected.

Access to water is a basic human need. This is why the first civilisations were built alongside large rivers (the Nile, the Tigris and Euphrates, the Yangtze), why small towns were built on the banks of water, and why, where water was not available, aqueducts were built with engineering ingenuity that was beyond their time.

As a result of global warming, the world's growing demand for water, and the undervaluation of water as a natural resource, water scarcity (and water quantity and quality problems in general), which used to be local, has become global. These challenges have already found their way into mass culture in the guise of science fiction (for example, in the Mad Max films and the film adaptation of the Dune novel cycle).

Water scarcity is not just an environmental issue. Global water demand doubled since the mid-20th century as population and economy have expanded, and now far exceeds available water resources. 25 countries, a quarter of the world's population, live in areas of extreme physical water scarcity, where at least 80 percent of available water resources are used. Globally, a 40 percent deficit in freshwater supply is projected by 2030, primarily in regions of high and extreme water stress. This poses an economic, food security and sustainability risk to 31 percent of global GDP by 2050. As water stress

(the ratio between water demand and renewable water resources) increases, so will competition for local water resources.

In addition to the limited and uneven distribution of readily available surface freshwater, the disruption of the world's natural water cycle, the average 30 percent water loss from the reservoirs, regulatory and institutional deficiencies are also responsible for the above-mentioned situation.

Hungary is often referred to as a water superpower, because of the vast reservoir of abyssal hot mineral waters under the whole Carpathian Basin; but the reality is 95 percent of its surface waters come from abroad. The annual internal renewable water resource per capita is 621 cubic metres, while a value below 1,000 cubic metres indicates a physical water shortage. The 2019 Hungarian water balance shows that our already high exposure is compounded by the fact that more water than arrives is leaving the Danube, Tisza and Drava River basins. Solutions can be found by increasing water efficiency, protecting aquatic ecosystems, integrated water management and the implementation of water conservation opportunities in the river basin, managing our main source of renewable water resources within the country, namely rainwater run-off, and recycling wastewater

Notes

Lack of basic drinking water and sanitation services (also known as economic water scarcity) affects one in four people.2

The hydrological James Bond ratio shows how limited the readily accessible surface freshwater supply is: only 0.007 percent of total water

List of sources used

M4 Line: Green Transition

4.6. Continual Global Warming

Balázs Lóránt

CHANGE here to

M5 Line: Social Sustainability **5.4. Physiological Effect of Climatic Change**
M1 Line: Basic Megatrends **1.7. Acceleration of Transition**

The global warming trend is now clear. Temperatures and extreme weather events have skyrocketed in recent times, causing huge human and financial

losses. This is a major challenge for Hungary and could become even greater in the future.

Global temperature rise and its effects are felt every day. Heat records are being broken, temperatures are getting milder and milder, while sea levels are rising. Warming was gradual in the 20th century and then accelerated after the turn of the millennium. As a result, the warmest 20 years in modern history were all after the turn of the millennium.

Climate change is profoundly transforming our environment and a myriad of negative impacts. Extreme weather events are on the increase, with heat waves, droughts, forest fires and floods hitting the planet. Global warming is also damaging biodiversity, land and water resources, as well as affecting people's well-being and health. Extreme weather events over the past 40 years, and heat waves have caused between 85 and 145 thousand deaths in Europe, more than 85 percent of which are attributable to heat waves. The most serious consequences include drought and water scarcity, which not only transforms farmland but also puts human lives at risk. Warming also has geopolitical effects: new areas become passable or inhabitable, while others are depopulated.

On top of this, global warming is also causing huge economic losses. It is estimated that between 1980 and 2022, extreme weather events will have cost EU countries around €650 billion in damages. One sixth of the damage over a period of more than 40 years will be incurred in 2021-22,2 which clearly shows the increasing risks. If global warming does not abate, the damage is likely to increase further, in particular in the form of increasingly extreme rainfall patterns, resulting floods and increasingly severe droughts. Even a slight increase in temperatures will cause a significant increase in these risks.

The current trend in the Earth's average temperature is therefore not sustainable. Humanity needs to do everything possible to ensure that the negative consequences already being felt do not worsen. Otherwise, we will find ourselves in a climate that humanity has never faced before.

Notes

The hottest 20 years in modern history were all after the millennium.

Extreme weather events over the past 40 years have caused the death of about 85-145 thousand people in Europe alone.

List of sources used

M4 Line: Green Transition

4.7. The Future is the Renewable Energy

Viktoria Deák

CHANGE here to

M1 Line: Basic Megatrends | 1.8. Entry into the Age of Fusions

One of the basic conditions for mitigating climate change is the use of energy sources with no or minimal greenhouse gas emissions. These include renewable energy sources such as solar, wind and hydro. In less than 30 years, two thirds of the energy used to meet climate targets would have to come from such sources.

Energy production, including energy for transport - mainly the burning of fossil fuels - accounts for about three quarters of global greenhouse gas emissions. In addition, events in recent years - the Covid19 epidemic, the Russian-Ukrainian war, increased inflation - have highlighted the downside of exposure to fossil fuels. Renewable energy sources, on the other hand, are locally available, have a much lower environmental impact and, as their name suggests, are permanently available and constantly renewing. The most common renewable energy sources are solar, wind and hydro, but geothermal energy and biomass are also increasingly being used.

The switch to green energy sources is helped by the fact that their economic returns have also steadily improved over the last decade, in line with the development of the technology used. These technological advances are a major contribution to climate targets: it is projected that 70 percent of the world's energy could come from renewable sources by 2050, if the net-zero target is met. Taking into account the projected doubling of the share of nuclear energy under this scenario, 90 percent of energy production could be non-fossil based in 30 years. This would be a complete reversal from the current situation, in which the share of fossil fuels, i.e. natural gas, oil and coal, is 78%. Without this change, it seems impossible to reduce greenhouse gas emissions, which are a major cause of climate change.

The vast majority of renewable energy production can be attributed to the rise of solar and wind power. This is due to easy access, lower costs and advanced technologies. Solar energy is also driving the greening of electricity generation in Hungary, with a projected doubling between 2022 and 2028 (4-8). In contrast, the IEA data estimates the growth rates of wind, biomass and geothermal energy to be low, based on currently available data and policies. This forecast also confirms that geothermal energy is under-utilised in our country, although its production potential is strong. However, the first steps have been taken and Hungary was in the list of geothermal electricity producing countries in 2018.

A surge in renewable energy production is necessary to combat climate change, but it is important that this increase is reflected in final energy use.

Notes

“The future is green energy, sustainability, renewable energy" (Arnold Schwarzenegger).

Energy in today's world plays a central role in almost all major challenges and opportunities.

List of sources used

M4 Line: Green Transition

TERMINAL 4.8. Local Energy Networks

András Zsolt Szabics

CHANGE here to

M6 Line: Financial Revolutions 6.1. Green Financing for Green Transition

The growth of renewable energy and storage capacity will allow for a gradual decentralisation of the energy network in the future. Green technologies can be easily combined with a local energy network that best meets local needs, which can reduce the energy dependence of countries without fossil fuels.

In the past, a country's energy system relied mainly on a centralised energy grid, with larger fossil-fuel power plants supplying the various players in the economy through a complex electricity network of up to several hundred thousand kilometres. This is expected to change fundamentally with the dynamic growth in the share of renewable energy sources and innovations in energy storage and other technologies that will allow the electricity needs of individual consumers or groups of consumers (small residential communities or industrial parks) to be met locally. This will allow better meeting individual needs while maintaining connection to the central grid, increase security of supply through the availability of multiple sources and, with the right solutions, be more cost-effective.

The decentralised model has a number of advantages over the centralised model. First and foremost, it is possible to integrate technologies that will reduce emissions, even very significantly. These are in particular renewable energy sources that may be able to meet temporary needs locally. This will be helped by the fact that the spread of smart devices and artificial intelligence will make energy demand and supply more predictable, and the expected development of energy storage will allow the system to tailored to local needs and, with sufficiently flexible planning, to meet changing demands more efficiently. Good example is the design of one of the world's largest

data centres in the north of Norway which is operated by taking into account the abundant hydro and wind energy available in the area. Since no large grid is needed, it is sufficient to build local connection points, so grid losses can be reduced. All these effects can combine to increase the security of supply in the system and make energy more affordable overall. Increasing domestic energy production and storage also increases a country's energy sovereignty, which is particularly important for fossil fuel-poor countries like Hungary.

An important aspect is that the range of technologies that can be integrated into the system is very long. Currently, the greatest demand for local generation, storage and use is for solar and wind power. In addition, there are high hopes, for example, for the local use of nuclear power, with small-scale modular nuclear reactors capable of generating electricity on a continuous and secure basis at local level. Hydrogen is another technology that can be used, and with the increasing use of renewable energy sources, hydrogen can be stored and used locally.

Notes

The involvement of smart devices and AI, energy demand and supply become more predictable, so that local network system that best fits your needs.

The growth of renewable energy and storage capacity will allow the energy grid to decentralisation in the future, with technologies that will reduce emissions and harmful materials can also be significantly reduced.

List of sources used

M5 Line: Social Sustainability

TERMINAL 5.1. Decreasing Population in Developed Countries

Péter Asztalos

The population of developed countries is projected to fall by 35% by the end of the century due to natural population decline, according to UN projections. Some of this decline could be replaced by migration, but this would have significant social and cultural consequences.

The world's population is expected to slow down in the coming decades, but the UN predicts that human population will increase by nearly a quarter by the end of the century. While between 1950 and 2025 the world's population will have more than tripled from 2.5 billion to 8.2 billion, by 2100 it is expected to have increased by a much smaller amount (24%). The current upward trend is expected to continue until the world's

population is projected to peak at 10.3 billion in 2084. After that, a slow decline is expected to begin.

However, the projected increase in the total population masks the fact that different demographic trends will be observed in different regions in the decades ahead. While the less developed countries - and especially Africa - will continue to experience dynamic population growth, the developed and many of the medium developed countries will face (further) population decline. If only natural population trends are considered - i.e. excluding international migration - the population of developed countries is expected to fall from 1.28 billion to 832 billion by the end of the century. This reduction of more than 450 million people would represent a loss of 35 percent of the population in developed countries. The UN estimates that the natural decline could be partly offset by the immigration of more than 200 million people and their subsequent children.

A lasting reversal of adverse demographic trends would require a further increase in life expectancy and a return a rising fertility trajectory. After a gradual decline, fertility rates in developed countries reached only 1.45 in 2024. The UN expects the downward trend to be reversed, but the fertility rate will still only rise to 1.60 by the end of the century. To maintain the population of societies, however, much larger increase would be needed to reach the desired 2.10. Life expectancy in developed countries is projected by the UN to rise from the current 80 years to 90 years by the end of the century, which could moderate the rate of population decline in the decades ahead.

Population trends in Hungary are similar to those in developed countries. The UN predicts that Hungary's population would fall from 9.6 million today to less than two-thirds by the end of the century without international migration if there is no significant change in population trends. Reversing the negative demographic trends in Hungary would require a reduction in deaths, an increase in births and a reversal of emigration.

Notes

The population in the developed countries is expected to increase, but without migration it will fall by 35 percent by 2100, while in Africa it will increase by 150 percent.

Only 45% of the world's countries have a fertility rate of 2.1 percent, which is necessary for a sustainable society.

List of sources used

M5 Line: Social Sustainability

5.2. Personalized Health Care

Ágnes Nagy

As science develops, the medicine of the future may increasingly move towards personalised medicine. Instead of standardised treatments, personalised medicine will allow for more targeted and effective treatment based on the genetic, medical and lifestyle characteristics of the individual, with a particular emphasis prevention and prognosis.

Advances in medical science, in particular genomics (the multidisciplinary science of genes and gene interactions), over the past decades have the potential to significantly transform the way we practice medicine today. In the future, personalised medicine could become increasingly dominant, replacing the 'standard' patient-centred approach of treating a 'typical' patient with a focus on a specific group of individuals, thus enabling prevention and treatment strategies to develop. There is no single definition of personalised medicine, but it generally refers to a model in which the right therapy is applied at the right time for the individual or preventive prevention is used to prevent disease.

Personalised health care is also referred to as 4P (P4) medicine, which is based on the principles of Predictive, Preventive, Personalised and Participatory. It focuses on proactivity rather than reactivity, thus emphasising prevention rather than treatment of disease, and in the case of illness, on the personalised rather than generalised treatment. In 4P medicine, the former doctor-patient relationship changes, with the patient acting as a client and becoming more actively involved in the maintenance of his or her health. It also involves collaboration between different medical teams rather than a single specialist.

4P medicine takes into account the patient's health and medical history, as well as their genetics, environment and lifestyle. By using complex data, doctors can identify the safest and most effective treatment options, discover new correlations and predict the chances of developing certain diseases or the lifestyle changes needed to avoid them. The method is therefore not limited to relieving the symptoms of a disease but also reveals its origin.

Personalised medicine is particularly in demand in certain areas (e.g. oncology) due to the significant side effects and ineffective drugs. New forms of medicine allow more accurate diagnosis and treatment without side effects, thus increasing the efficiency of healthcare and quality. In a peculiar way, the condition for personalisation is precisely the availability of large amounts of data on others, on similar cases, i.e. the new approach relies on Big Data and data analysis procedures. Furthermore, health will no longer be confined to hospitals and clinics, as there will be a greater focus on individual health promotion and quality of life, with the wellness sector playing increasingly important role. Personalised medicine could also further increase the uptake of telemedicine, which could also contribute to increasing the effectiveness of medical care and reducing costs at both individual and institutional level.

Notes

Personalised health care takes into account the patients' health and medical history, as well as their genetics, environment and lifestyle.

The principles of 4P health care include Predictive, Preventive, Personalised and Participatory.

List of sources used

M5 Line: Social Sustainability

5.3. Mega-Cities

Ágnes Nagy

CHANGE here to

M1 Line: Basic Megatrends **1.6. Strengthening of Hubs**

Modern urbanisation, which has begun in parallel with the world population growth and the industrial revolutions, is expected to accelerate further in the future. Today, more than half of the world's population lives in cities, and by 2050, 7 out of 10 people could be urban dwellers. The number and size of megacities could also continue to grow, particularly in Asia and Africa.

Cities are practically as old as history, with the first cities dating back to around 7500 BC. In the following millennia, the number, size and population of cities began to grow slowly but gradually, and urbanisation accelerated in the 18th century as a result of the industrial revolutions. The urban population was around 3 percent around 1800, and by 1950 it was around 30 percent; and today more than half of the world's population lives in cities. Urbanisation is set to accelerate further in the coming decades: by 2050, around 70 percent of the world's population could be urban dwellers, and by 2100, 85 percent.

One of the key factors in the expansion of urban populations is the continued growth and emergence of megacities - cities with populations of over 10 million. In 1950, only New York and Tokyo had populations of over 10 million, but now the number of megacities in the world ranges from 33 to 47, depending on the calculation. Tokyo is currently the largest city with over 37 million people. However, most of the most populous cities are located in the two most populous countries: Shanghai and Beijing in China, and Delhi and Mumbai in India. Other cities at the top of the list include Dhaka, Sao Paolo, Cairo, Mexico City and Osaka. In Europe, Paris (11.3 million people) and London (9.8 million people) are considered megacities.

The population of the largest 1000 cities is projected to grow by more than half a billion by 2050, half of which will be accounted for by population growth in megacities. The number of megacities could rise from around 40 today to nearly 70 by 2050. The fastest growth is expected in Africa, but megacities in Asia and Pacific will also expand and continue to be the largest. By 2050, Delhi is expected to be the world's largest megacity with nearly 47 million people. The source of urban population growth will be largely natural increase, but net immigration will also be a major factor, especially in Europe (Paris) and developed Asian cities (Tokyo).

Cities, especially large ones, are key drivers of long-term growth in countries, as more than 80 percent of global GDP is generated in cities. In the 21st century, cities are the most important source of growth in the world. Urbanisation on a large scale in the 21st century brings significant benefits for populations and countries, but also a number of challenges such as pollution, adequate housing, ageing populations in some regions, basic infrastructure, public transport, sufficient employment and conflict. Addressing these challenges effectively is key to long-term sustainability.

Notes

In today's world more half of its population lives in cities. By 2050, this ratio will be to about 70 percent, and by 2100, it could rise to 85.

There are 40 megacities in the world, and their number could grow to nearly 70 by 2050.

List of sources used

M5 Line: Social Sustainability

5.4. Physiological Effect of Climatic Change

Ágnes Nagy

CHANGE here to

M1 Line: Basic Megatrends **1.7. Acceleration of Transition**
M4 Line: Green Transition **4.7. Continual Global Warming**

In addition to the natural and physical environment, climate change also has a significant impact on the human body. Changes in climatic conditions directly and indirectly threaten and increase the risk of disease and death. Some 3.5 billion people live in an environment that is highly vulnerable to climate

change.

Climate change affects every aspect of health, from heat waves and windstorms to clean air, available food and livelihoods. It impacts not only on the human body, but also on health systems and social and economic processes. There are currently around 3.3 to 3.6 billion people living in environments that are highly vulnerable to climate change. However, exposure not equal: extreme weather-related mortality is 15 times higher in poorer countries than in less vulnerable regions.

The elderly, children, the sick, women, ethnic minorities and the poor are also more vulnerable. The significance of climate change is shown by the fact that the WHO estimates that between 2030 and 2050, 250,000 more deaths could occur each year from malnutrition, malaria, diarrhoea and heat stress alone. And the direct cost of damage to health is estimated to be between $2 and $4 billion per year by 2030.

Climate change affects health in many ways. Extreme weather events (mainly heat waves, but also storms and floods) can cause problems, illness and death directly, but climate change also threatens health indirectly. For example, increasing air pollution and pollen concentrations can lead to respiratory problems (asthma, allergies) and cardiovascular problems (hypertension, coronary heart disease). Heat can aggravate chronic diseases such as cardiovascular, respiratory and diabetes. Changes in temperature and precipitation can alter the distribution of insects and other species that can spread infectious diseases. The most common carriers of viruses and bacteria are mosquitoes, flies and ticks, which can cause diseases such as dengue fever, malaria and Lyme disease. Changes in the frequency and intensity of precipitation and rising sea temperatures can lead to more water-related diseases (typhoid, haemophilia, gastrointestinal problems) as pathogens multiply. Floods and droughts can also have an impact on food safety, as contaminated, contaminated food can cause illness (salmonella). In addition, the quality of foodstuffs may be affected, for example by a reduction in their nutrient content. In addition, extreme and volatile weather can also affect mental health and well-being: from stress and climate stress to clinical conditions (depression, PTSD), a range of mental health problems can develop.

Notes

About 3.5 billion people live in an environment that is highly vulnerable to climate change (IPCC).

Between 2030 and 2050, climate change could result in around 250,000 more deaths a year from malnutrition, malaria, diarrhoea and heat stress alone (WHO).

List of sources used

M5 Line: Social Sustainability
5.5. Population Explosion in Africa

Péter Asztalos

CHANGE here to
M4 Line: Green Transition 4.7. Escalating Water Shortage

Population growth in Africa is expected to continue to explode in the coming decades. At the same time, the quality of life on the continent could deteriorate significantly as a result of climate change. Together, these two factors could generate new and more significant waves of population migration in the near future.

In the decades ahead, world population growth will be driven mainly by population growth in Africa. While there were only 820 million people in Africa at the beginning of the millennium, by 2050 that number will exceed 2.5 billion. Historically, population growth has been seen as a great opportunity for economic prosperity, but also a source of danger if it is not achieved.

Successful periods of economic catching-up from Europe to East Asia have almost always coincided with a rise in population, mainly due to the large numbers of the younger generation entering the labour market. The economic growth surplus resulting from the size of the working age population is also known as the "demographic dividend". As the examples of China, South Korea and Japan show, with the right economic policies, the population explosion can be the engine of economic catching-up.

On the other hand, if the conditions are not right, population growth can create a negative spiral, leading to serious social problems. Many of the poorest countries have experienced significant population growth but have not managed to turn this into economic growth (examples this can be found in Asia and Africa).

The fact that climate change is expected to affect Africa more severely than any other region makes it more difficult to harness the positive effects of population growth. The World Bank estimates that in 2019, nearly 40 percent of sub-Saharan Africa's population, more than 420 million people, were living in extreme poverty, a situation that has been exacerbated by the Covid epidemic and the war in Ukraine since then. Climate change will exacerbate the situation. According to the latest IPCC report, warming will reduce food production, increase access to drinking water, increase inequality and poverty, reduce biodiversity and increase mortality. Without successful countervailing policies, this will stifle economic growth, reduce well-being and increase the risk of war.

If population growth cannot be used to accelerate economic growth, the population explosion and climate change could combine to trigger new waves of population migration. According to the latest Africa Climate Mobility Report, climate change is expected to cause 3-4 percent of Africa's population (70-100 million people) to leave their home countries by 2050. This represents a multiple increase compared to the

estimated 20 million people who have migrated so far.

Notes

Africa's population expected to grow by nearly 1 billion by 2050.

According to forecasts, 4 percent of Africans will be forced by their living conditions to leave their homes by mid-century, as a result of climate change.

List of sources used

M5 Line: Social Sustainability

5.6. Competition in Life Quality

Péter Asztalos

One of the critical resources of the 21st century will be a highly skilled workforce, for which there will be increasing global competition. Countries, cities and companies that can provide a good quality of life and social conditions will have an advantage in this competition.

In the future, there will be an increasing focus on raising individual and social well-being. The key player in an economic model based on knowledge and creativity is the worker, for whom there will be increasing competition both within and outside the labour market.

One of the key areas of competition for knowledge is quality of life, which involves many factors. The World Health Organisation has set out a coherent framework of key strategic directions for well-being societies, covering not only health care, but also the environmental protection, digital transformation, social protection and the issues of sustainable economic model, too. The social processes of the 21st century bring with them a number of major new challenges, and the development of individual and social well-being is therefore of increasing importance. For today's young people, for example, the future is unpredictable, and digital lifestyles, climate change and artificial intelligence are all factors whose impact we cannot yet measure. Loneliness is also a growing problem for societies: a UK study found that the cost of social isolation in the UK is more than 1% of annual GDP. Work-life balance is a different issue for younger generations, and companies need to find the balance that will enable them to work successfully with their employees in the long term. These factors all influence the choices individuals make and, as a whole, shape the fabric of society.

Surveys show that material well-being and individual subjective happiness increase linearly until the level of elementary well-being is reached but after this level reached, happiness does not increase and sometimes even decreases. The paradox discovered by Easterlin is another reason why it is important to measure development beyond maternal well-being. Of course, subjective happiness is difficult to compare between individuals, and even more so between countries and cultures. Even GDP, which is widely used in economics, has a number of methodological and comparability problems (e.g., "invisible" work at home, or quantification of digital services). These challenges are particularly true for indicators that seek to measure well-being or happiness. In recent years, the Magyar Nemzeti Bank has shaped the national and international debate on this issue with several publications, formulated the principles of a new sustainable economics (New Sustainable Economics Global Discussion Paper) and made concrete proposals for measuring sustainable growth (Sustainable GDP Global Discussion Paper).

Notes

More than half of young people is concerned about climate change

Between World War II and the change of (socialist) regime of East Central Europe, despite significant economic growth, subjective happiness index stagnated in the United States, Japan and France, too.

List of sources used

M5 Line: Social Sustainability

5.7. Social Cohesion and Inequality

Ágnes Nagy

Inequality is an inevitable feature of a market economy, but too much inequality can destroy social cohesion, lead to political polarisation and hold back economic growth. While global income inequality has declined in recent decades, in many cases inequality has increased within countries.

Inequality is a natural feature of the market economy, due to differences in endowment, effort, circumstances and luck. But too high a level of inequality can undermine social cohesion, lead to political polarisation and stifle economic growth. Unfortunately, countries around the world have also experienced the extreme equality ideals that can lead to even more serious economic and social damage. However, experience has shown that there is a level of inequality that still sufficiently egalitarian, but less divisive, that encourages enables social mobility and thus facilitates economic

and social development.

Inequality between countries has been declining since the 1980s, as some large, less developed countries (notably China and later India) have caught up with more developed countries through rapid economic growth. At the same time, inequality within countries - which people perceive in their daily lives - has risen in most economies, especially in developed ones. Among the latter, one of the largest increases in inequality has been in the United States, where the top 10 percent of society have on average 17 times as much income as those in the bottom 50 percent, while the gap in wealth held is extremely high, more than 235 times. The reasons for this include the unequal distribution of the benefits of technological progress and globalisation, as well as the shortcomings of redistributive and labour market policies. The increase in inequality is particularly evident at the extreme ends of the income distribution: in 2021, the richest 10 percent of the world's population held 52 percent of global income, while the poorest bottom half of the population held only 8.5 percent. The same is even more significant for wealth: 76 percent of global wealth was concentrated in the top 10 percent, while the bottom 50 percent held only 2 percent.

The growth of the middle class has contributed to the reduction in inequality between countries in the past and is expected continue, with the share of the global middle class rising from around 50 percent today to over 60 percent by 2030. However, some analysts suggest that inequality between countries will also rise again as middle-income countries catch up with high-income countries but move further away from poorer countries. As a result, overall global inequality could start to increase again in the late 2020s and early 2030s. Technological change, artificial intelligence, climate change could further widen existing disparities, so without countervailing policies inequality will remain high or increase.

Notes

71 percent of the world's population live in countries where inequality has risen in recent decades (UN).

The richest 10 percent of the world's population own 52 percent of global income and 76 percent of global wealth (WIR 2022).

List of sources used

M5 Line: Social Sustainability

TERMINAL 5.8. Rise of the Elders

Péter Asztalos

Over the next 25 years, the population aged 64 and over is expected to increase by 84 percent, bringing the total number of elderly people on Earth to nearly 1.6 billion. Increasing healthy life expectancy is therefore essential to ensure economic and social sustainability.

Between 2025 and 2050, the world's population aged 64 and over is expected to rise from 857 million to 1,578 million people, according to the latest UN population projections. However, this average increase of 84 percent will not be uniform across continents. While Europe is expected to see a 29 percent increase, Africa will see a rise in the number of older people of more than 150 percent (albeit from a much lower level in relative terms). More than 60 percent of people aged 64 and over (nearly 1 billion) are projected to live in Asia in 2050, while only 6 percent of older people will live in North America.

The old-age dependency ratio - the ratio of the elderly to the working-age population is projected by the UN to rise from 16% today to 26% in the next 25 years. The spatial distribution of the old-age dependency ratio will also show significant differences. While in Europe it will be 50 percent and in Asia 29 percent is expected to be 9 percent in 2050, to 9 percent in Africa.

Hungary's ageing trends are similar to those of developed countries. In 2025, there will be more than 2 million people aged 64 and over in Hungary, which is expected to rise to 2.4 million by 2050. At the same time, the working-age population (15-64 age group) will fall from 6.2 million to 5.1 million. As a result, the old-age dependency ratio in Hungary is expected to rise from 33 percent in 2025 to 47 percent by the middle of the century.

Population ageing will fundamentally reshape current social and economic trends. But the change will affect countries in different ways: while the decline of the working-age population will be a growing problem in developed countries, the biggest challenge for developing countries will be to improve their social care systems. However, the ageing of society, through changing needs and consumption patterns, will also bring new opportunities, the exploitation of which could be a breakthrough for many countries, including Hungary (e.g. health care, medical tourism).

Keeping the population healthy and achieving a healthy old age is a fundamental goal for all countries. but this will require an increase in expenditure. Experience shows that health depends primarily on the commitment of individuals, with the health care system responsible for only about 20 percent of the population's overall health.

Notes

By 2050, there are expected to be 1.6 billion elderly people on Earth, which 84 percent

higher than current levels.

Achieving healthy ageing is not only in the interest of individuals but also of society.

List of sources used

M6 Line: Financial Revolutions

TERMINAL 6.1. Green Financing for Green Transition

Szabolcs Párkányi

CHANGE here to

M4 Line: Green Transition 4.8. Local Energy Networks

Surely, everyone has heard the term "greenback" mentioned at least once, referring primarily to the distinctive colour of US dollar banknotes. But what if money were green not only in colour but also in the way it was used? What does green finance mean in practice and what is the role of central banks?

Financial instruments that finance projects or economic activities with a positive environmental impact are called green. Financing green activities is of particular importance for reducing environmental pressures and achieving climate objectives. Green investments are also helped by the fact that they may be cheaper to finance or face a lower tax burden than environmentally harmful activities.

The annual issuance of ESG bonds promoting environmental and social sustainability has increased nearly 100-fold over the period 2013-2023. 2023 is also a record year in other respects, with emerging market ESG bond issuance reaching $209 billion, up 45 percent from the previous year. Although the share of green bond financing continues to grow, it accounted for only 2.5 percent of the total bond market in 2023.

Just as the level of development of traditional financial markets varies, the uptake of green and sustainable financial instruments varies across economies. As a country highly exposed to the effects of climate change, promoting environmental sustainability is of particular importance for Hungary. Due to the size and level of development of the Hungarian financial sector, the green financial instruments market currently in an early stage of development, but this can also be seen as a window of opportunity.

As a central bank with a strong commitment to sustainability and a leading

international role, the MNB has put the promotion of green finance at the heart of its efforts. In particular, the MNB's Green Capital Allowance, which is unique at European level, has enabled it to promote green to make lending attractive to credit institutions and thus to their customers. Since its launch in 2020, the programme has to a dynamically growing green portfolio, which is supported by the programme's positive impact on the financial stability of the Bank. This is also reflected in the eightfold increase in portfolios that also participate in the program.

Notes

The MNB is a central bank with a strong commitment to sustainability and has a leading international role, too.

The annual issuance of ESG bonds, which promote environmental and social sustainability, has increased nearly 100-fold in the period 2013-2023.

List of sources used

M6 Line: Financial Revolutions

6.2. Rise of Digital Central Bank Money

Lóránt Kiss

What if we could combine the security of cash issued by central banks with the convenience and speed of electronic means of payment, usually mediated by private actors? This is where digital central bank money comes in and could transform the way we think about money in the next decade.

With the spread of digitalisation, we are increasingly using digital payment instruments, especially bill money, while the share of cash use is declining. However, alongside the benefits, there are also a number of challenges posed by digital payments. They are issued and intermediated between payers by private actors (banks, credit card networks, other payment service providers, cryptocurrency networks) and are inherently exposed to credit, market, liquidity and operational risks. In addition, as a result of the profiteering practices of private actors, some electronic payment solutions can be significant. In Europe, for example, the fees charged by card providers to merchants doubled between 2018 and 2022. All these risks have little or no impact on the money issued by the central bank.

The vast majority of the world's central banks are exploring the possibility of issuing digital currency, combining the security of cash with the convenience and speed of electronic payments mediated by private actors. This is the digital central bank

money (DJBP), which is being developed by 94% of central banks. DJBP would be by the central bank, similar to cash, would offer similar possibilities to commercial bank deposits and could be used digitally by the public on a large at a low cost. In addition, DJBP could create competition between banking system operators, allow price stability to be achieved and maintained more effectively, and provide greater protection against risks arising from the proliferation of digital (e.g. crypto) assets. Once DJBP is in place, market participants will be able to introduce new products and services, complementing the functions of DJBP.

Domestic – Hungarian - research is pioneering, with the MNB publishing a volume on its research on the instrument as early as 2021, and since then it has published numerous articles analysing different aspects of the instrument. In addition, research is also being conducted at a practical level, including the MNB Student Safe application. In addition, the MNB has participated and continues to participate as an observer in various international initiatives (e.g. mBridge, Dunbar). The domestic introduction of DJBP could contribute to preserving financial stability, strengthening the efficiency of monetary transmission and ensuring the maintenance of monetary policy sovereignty, while allowing domestic borrowers to obtain more favourable deposit and lending rates through stronger banking competition.

Notes

94% of central banks are considering plans for digital coins (BIS, 2024).

Digital central bank money can help to maintain the stability of the financial system and strengthen the efficiency of monetary transmission, while providing new, more efficient services.

List of sources used

M6 Line: Financial Revolutions

6.3. Liquide Real Interests

Norbert Szőcs

After the crisis that started in 2008, investors turned to less risky options. As a result, the countries and companies that were considered the safest borrowers were able to borrow cheaply in the previous decade. Although this megatrend appears to be reversing, the structural factors that have led to the current situation are still present.

In the 2010s, investors turned to lower-risk investment options despite lower returns.

Looking back, the main reason for this is that, after the 2008 financial crisis, confidence in riskier assets declined significantly and investments that appeared safer came under greater scrutiny.[1] Also as a consequence of the crisis, central banks and market supervisory authorities tightened risk-taking rules, which shifted the demand of financial institutions towards safer forms of investment. A more lasting, i.e. structural, effect was the increasing shift of the ageing societies of the most developed countries towards low-risk investments, even in the long term. Finally, a temporary effect was the purchase of government bonds by the central banks, which increased the overhang of these assets in two ways demand for these investments: on the one hand, the central banks bought them, and on the other hand, the amount of money the central banks paid for them was used to finance the economy.

These factors have led to a megatrend of real interest rates that have been on a downward trend and in negative territory for many years. In addition to real interest rates, nominal interest rates were also negative in some developed market countries. This meant that the lender agreed to get back a little less than the money he invested in the future. This was due to market uncertainty, which reinforced fears that the money invested or lent would not be returned at all in the future if it was invested in a riskier asset, but less frightening was the certainty of a small loss.

However, the downward trend in real interest rates now appears to be reversing. In the first half of 2024, however, inflation in many countries has already fallen close to the target, while interest rates have remained higher, meaning that positive real interest rates have returned. Looking ahead, it may be worth examining whether structural or cyclical factors are behind the trend reversal.

Emerging countries, like our country, are indirectly affected by the risk-aversion trap. There is a low share of low-risk assets in emerging economies, so if financial markets are imbalanced, there is a risk of capital flight. The outflow of money from emerging markets will flow into low-risk assets in developed markets, further increasing demand

Notes

In the 12 years following the global economic crisis, developed market bond yields fell by more than 300 basis points on the average.

The balance sheet total of developed market currencies has increased 8-10 times since the turn of the millennium, mainly due to asset purchase programmes.

List of sources used

M6 Line: Financial Revolutions

6.4. State Debts in Historic Heights

Péter Asztalos

As a result of the coronavirus epidemic, public debt across the world economy has risen to levels not seen since the Second World War, and in many places even exceeded them. Future reductions in debt ratios will be made more difficult by rising interest, defence and green transition costs and, in the longer term, population ageing.

World public debt has experienced six major upward cycles over the past 150 years or so, with the upward trend continuing today since the 1970s. In advanced economies, public debt is over 110 percent of GDP, meaning that it has quadrupled since the mid-1970s. An outstanding example is Japan, where public debt now exceeds 250 percent of GDP. In the United States, the debt-to-GDP ratio exceeded 100 in 2012 and will exceed 120 percent in 2023. In addition, in developing countries public debt has risen to its highest level ever, close to 70 percent. The rise in debt has been accelerated by the koruna crisis and the rise in energy prices, which have led to an increase in fiscal expenditure and a fall in revenues.

High debts are a bigger burden for countries than ever before. In the 2010s, yields were low worldwide, so even high debt had to pay only moderate interest rates. In contrast, the inflation and rising yields of recent years have significantly increased interest expenditure in most countries around the world. For example, in the United States, interest expenditure rose to 4.5 percent of GDP in 2023 from 3.8 percent in 2020, while in Italy interest expenditure rose to 3.8 percent of GDP in the same period from 3.4 percent previously. Of course, rising interest expenditure means that countries can either spend less on other things, such as education and investment, or can only maintain spending at the cost of even higher debt.

Reducing public debt would be beneficial in itself, but a number of factors make it difficult to achieve. In the short term, high public interest expenditure due to increased inflation and high debt levels pose a challenge for fiscal planning. In the medium term, rising defence spending due to increasing geopolitical conflicts in the world and the expenditure needed to finance the green transition investments will limit budgetary room for manoeuvre. the long term, ageing populations will challenge budgets, increasing pension and health care expenditure while reducing tax revenues.

The sustainability of public debt depends not only on its level, but also on the debt structure. Financing public debt in domestic currency and from domestic sources is more stable and carries lower risks than foreign debt. In Hungary, the decline in the foreign currency ratio of public debt and the reduction in domestic financing in the second half of the 2010s contributed to fiscal stability.

Notes

By the early 2020s, the public debt of developed countries will have risen to levels not seen since the Second World War, while that of the developing economies will have exceeded it.

World public debt is expected to rise further in the coming years.

List of sources used

M6 Line: Financial Revolutions

6.5. Technology Becomes Mediator

Péter Asztalos

CHANGE here to

M7 Line: Digital World 7.8. Big Techs as a New Platform of Competition

Technological progress is reducing the role of intermediaries. The peer-to-peer service model allows users to share anything directly, anytime, anywhere. This eliminates the role of intermediaries, which can lead to faster and more cost-effective services.

A peer-to-peer (P2P) service is a network structure in which computers (or other devices) communicate directly with each other without the need for a central server. P2P networks operate on the principle of de-centralisation, where all participants (peers) are equal and can be both providers and consumers (nodes). In peer-to-peer services, there is no need for a central server, as all participating machines communicate directly with each other. Each peer shares resources (such as bandwidth and storage), increasing the completeness and stability of the network. The network is composed of multiple nodes, which increases reliability because if one or more nodes fail, the network remains operational. The network can be easily expanded by adding new participants, as each new node increases the performance of the network.

P2P technology has a wide applications, as it can be used for file sharing or in chat and VoIP applications to allow conversations to take place directly between users. In the field of finance, it first in the world of cryptocurrencies, but blockchain technology, which is essentially a P2P network where transactions are recorded in a decentralised ledger, can also bring value to a number of areas of conservative finance. These can be new financial structures such as digital banknotes or tokenised assets,

contracts, shared databases and registers such as land registers.

In addition, the use of this technology may also raise challenges and security issues, as the decentralised structure makes it more difficult to apply security measures in a uniform way. P2P networks are often at the centre of legal disputes, particularly in the field of copyright protection

P2P technology also has great potential for Hungary, as it creates opportunities for the development of economic and social relations. By taking on the role of a facilitator, the technology provides a direct link between uploaders, which, in addition to providing more cost-effective solutions, can also help to strengthen communities. P2P systems enable users to share their resources, services and products directly, reducing the costs of intermediaries. This model could be important in an intensive growth model where fostering entrepreneurship and innovation is key to economic growth.

Notes

The size of the P2P payments market worldwide is set to explode, with more than five times the $2 trillion in 2022 expected to grow to $11-12 trillion in 10 years' time.

At present, we trust the most in specialised, licensed institutions to manage our finances, but with technological advances, this trust can become an integral part of systems and infrastructures.

List of sources used

M6 Line: Financial Revolutions

6.6. FinTech Revolution

Péter Asztalos

CHANGE here to

M8 Line: New Industrial Revolution 8.8. Small and Strong Nanotechnology

The FinTech sector is fundamentally changing the global financial market with its revolutionary solutions. Innovative FinTech companies are carving an ever-increasing slice of banking pie, forcing their traditional competitors to digitise. FinTech companies can continue to provide significant benefits by developing new business models and competitive advantages.

FinTech is the latest generation of digital finance that helps make financial services simpler, more cost-effective and faster. Over the past decade, the rapid evolution of the technology industry and FinTech companies with innovative solutions have revolutionised the business world. As a result, they have attracted more than $500 billion in funding and account for around 9 percent of the total value of financial services worldwide. FinTech and traditional financial firms may become partners rather than competitors and are expected to complement each other's services or to work together.

FinTech services are most likely to spread where traditional banking infrastructures are less developed, such as in South America, Africa and the Middle East. In other cases, too, technology development sometimes leaps and, crossing an intermediate level and allowing laggards to take the lead.

In addition to the rise of local FinTech companies, the role of multinational FinTech and BigTech companies in the financial services market could become increasingly important. Global BigTech companies with significant financial and technological resources are providing cross-sector solutions such as mobile payments, digital wallets or digital services for neo-banks, thus creating space for new markets to emerge. Recent difficulties, such as inflation, energy crises and geopolitical conflicts, have led to a drop in funding for FinTech companies. However, the future of FinTech remains promising, with the Boston Consulting Group (BCG) predicting that its uptake in financial services could grow up to six-fold by 2030.

Hungary is also part of this dynamic growth, as the number of FinTech companies operating in Hungary has doubled in just six years. These companies are making a major contribution to the recovery of the Hungarian economy and the development of digital finance. The growing presence of FinTech companies can increase competition, which can lead to the development of the financial sector as a whole. They can offer better services to customers while improving cost and operational efficiency. This could lead to increased resilience and financial stability, as well as improved competitiveness and support for economic growth. FinTech solutions deserve special attention regulators because of their long-term potential, as financial stability can only be preserved if regulators alert to the proliferation of new business models and service types.

Notes

It is estimated that by 2030, 13% of all banking revenues and 25% of banks' market value could be linked to FinTech.

The domestic financial-technology market is growing steadily. There are 212 FinTech companies operating in Hungary, with 80% of the market made up of micro and small companies.

List of sources used

M6 Line: Financial Revolutions

6.7. More Complex Financial Systems

Gábor Sztanó

Technological developments are making it easier and easier for individual users to get involved in the complex and global financial system, but it is also becoming more and more important to be vigilant and preventive to avoid excessive risks. Central banks and financial supervisors have an increasing role in regulating risks and the system as a whole.

Over the past decades, as countries have become more open to capital markets, international financial markets have become more complex and the network of financial links has become denser. At the same time, as the network has expanded, innovations in financial markets have created increasingly complex financial products. These are designed to manage risk as flexibly as possible, but their high degree of complexity makes it difficult to assess their riskiness.

Complex financial instruments, combined with cross-border investment activities, are turning the global financial system into a large and complex web. This increases the efficiency of markets and facilitates capital flows, while interconnectivity allows the most remote events to be felt immediately all over the world.

And as a result of the increase in complexity, it is difficult to predict the extent of the impact of individual events. This was reflected in the 2008 financial crisis, which was triggered in large part by the opacity of new products and the close interdependence of private institutions in the financial system. There has also been increasing concentration in some segments of the markets, reducing the balance of power between players. For example, the Norwegian sovereign wealth fund (worth USD 1,4 trillion) and the investment bank BlackRock (with USD 10 trillion in assets) own more than 2 % of financial assets. Overall, the global network, complexity and weight of some of these players increase the volatility of markets, which can be detrimental to long-term macroeconomic growth.

A key task for national central banks is to identify and manage risks in an increasingly complex financial system. In response, central bank regulations to strengthen bank capital, liquidity and funding are becoming more widespread around the world. The data services provided by individual market participants provide monetary authorities with essential information on transactions in the financial system, but they also provide a transparency across national borders. The task of studying and regulating complex financial systems is similar to the task of finding the most important facts, flows and patterns in today's vast information overload. A key element of this is to ensure that central banks have a better understanding of the latest money and capital market trends, thus supporting both the effective operation of monetary policy and financial consumer protection

Notes

The concentration is increasing: BlackRock alone holds nearly 2 percent of global financial assets (Source: BlackRock, FSB)

Daily turnover of exchange-traded derivatives has roughly six-fold increase in the last 20 years and exceeds 5 percent of global GDP (Source: BIS).

List of sources used

M6 Line: Financial Revolutions

TERMINAL 6.8. Renaissance of Gold

Róbert Baranyai

CHANGE here to

M3 Line: Geopolitics **3.3. Globalisation or Deglobalisation**

Gold has always occupied a prominent place in the millennia-long history of mankind, and its properties have made it the standard instrument and stable foundation of monetary systems for centuries. The uncertain economic and geopolitical developments have now led to a renewed appreciation of its role, resulting in an unprecedented gold boom in the world's central banks.

Throughout thousands of years of human history, gold has always held a special place in the history of mankind, associated with many concepts such as trust, wealth and fortune. Because of its properties, it has been the standard instrument and stable foundation of monetary systems for centuries, regardless of culture. Its significance has not diminished. Modern central banks primarily foreign exchange reserves for monetary policy, financial stability and transaction purposes, but gold is still typically on their balance sheets.

Although gold has had a variable share of central banks' asset portfolios over the decades, its role has recently been revalued, with some suggesting a renaissance.

Throughout time, there have always been nations that have pegged their currencies to gold or other precious metals. Between 1880 and 1914, under the classical gold standard system, many major economies pegged their currencies to gold. In the post-World War II Bretton Woods period, the United States guaranteed the convertibility of the dollar into gold and nations pegged their currencies to it. This system was suspended in 1971 because of the large dollar outflows, and countries then switched to floating their

currencies. After the Bretton Woods period, one of the main priorities of central banks became the accumulation of reserves in so-called hard currencies, which provide security and stability. The amount of gold in reserves declined steadily during this period, reaching a low of 850 million ounces of gold in the first quarter of 2009. The global financial crisis of 2008 proved to be a turning point in this respect, as in so many other respects.

Uncertain economic and geopolitical developments, coupled with an inflationary environment not seen for decades, have now reasserted the traditional role of gold as a safe haven, leading a long-unprecedented gold hoarding. The share of gold in the central bank's reserves has risen from 8-9% in 2015 to around 16% in the second quarter of 2024. Demand has doubled in the last two years, with world central banks buying more than 1,000 tonnes of gold a year. Emerging countries are also the main buyers of gold for investment purposes, notably China and India, where gold stocks have been running at 40-110 tonnes in recent quarters. Hungary, ahead of many countries, decided to significantly increase its gold reserves in 2018 and now has 110 tonnes of gold in stock.

Notes

The price of gold per ounce reached a historic high in October 2024, exceeding USD 2700.

According to the International Monetary Fund, by the second quarter of 2024, the world's central banks held nearly 1,050 million ounces of gold reserves, with a market value of nearly $2,400 billion.

List of sources used

M7 Line: Digital World

TERMINAL 7.1. At the Threshold of Technological Singularity

Ádám Nyikes

The performance of computers has been growing at an extraordinary rate for a long time, and at some point, this may cross a threshold where the rules and capabilities we have known before are suddenly radically changed. A future beyond the limits of human imagination could be revealed, where artificial intelligence and machine learning revolutionise the way, we live.

The concept of a technological singularity is based on the assumption that human technological development reaches a point of 'singularity', where the speed of change and the impact of new technologies become so great that they radically transform our world,

such as the spread of the internet and smart phones. The concept of a technological singularity was first proposed by János Neumann in the 1950s, but was popularised by Ray Kurzweil, who argued that the pace of technological progress will be so rapid that it will fundamentally transform human society.

Gordon Moore's law (1965) states that the computing stock roughly doubles every 18-24 months. The technological singularity has a special importance in Moore's Law according to which computer literacy, as technological progress, not only increases the performance of computers, but also has significant economic and social impacts. The development of new technologies can also accelerate the birth of new technologies, leading to a self-sustaining growth cycle. This is the point of singularity that can fundamentally change society. Of course, the nature of this change depends on us and on regulation. We must strive to ensure that the positive effects predominate, but adaptation will be necessary in any case (as it has been from urbanisation through the industrial revolutions).

Huang has observed that the performance of computer graphics processing units (GPUs) has been improving even faster since 2012 than Moore's law would suggest.2 This could have a significant impact on the timing of the singularity, as the rapid growth in GPU performance is critical to the development of artificial intelligence (AI) and deep learning models.

The exponential development of artificial intelligence is one of the key drivers that could lead to a technological singularity. This exponential development will allow AI to solve increasingly complex problems and have a growing impact on different areas of society, including medicine, economics and scientific research.

The technological singularity has huge economic potential, which is particularly important from the point of view of competitiveness in the global market, which is also relevant for Hungary. Countries that are able to adapt and take advantage of this development, and invest in the latest technologies such as artificial intelligence, will be able to move forward in industries and services that will define the economic structure of the future

Notes

In artificial intelligence, performance has increased 1000-fold in the last 10 years.

The exponential growth could lead to a point where AI and other technologies will be able to develop themselves further.

List of sources used

M7 Line: Digital World

7.2. Smart Cities in the 21st Century

Bence Muhari

The concept of "smart cities" and "smart states" is based on the use of information and communication technologies (ICT) to improve the efficiency of public services, the quality of life of citizens and sustainability. Using technology for the public good creates a better, more liveable and sustainable environment for all.

The world's population is gradually moving to cities: by 2050, 68% of the world's population is expected to live in cities.1 While developed regions are experiencing stagnation or even a decline in urban population, new megacities of more than 10 million people are developing in developing regions. This is often in a matter of decades, at an explosive pace by historical standards, and is prompting a rethinking of classical urban planning rules.

So-called smart city solutions, using cutting-edge technologies, are best suited to reconcile need for development, the changing needs of people living in cities and the basic requirements of sustainability in an economical and efficient way. Smart cities use the most advanced technologies to optimise many aspects of urban life, including transport, energy management, waste management, public safety and health services. In smart transport, the collection and analysis of real-time traffic data helps avoid traffic jams and increase the efficiency of public transport through traffic monitoring cameras and smart traffic lights. E.g. in Shanghai, at underground stations, they predict the crowdedness of each carriage of the following train, so passengers can choose which carriage they want to board. To improve energy efficiency, smart grids allow real-time monitoring of energy consumption and adaptation of energy production, reducing unnecessary energy use. Smart waste collection systems use sensors to track the flow of waste from tanks saturation and optimise collection routes, thus contributing to the management of waste in smart cities. By extending the concept, smart states can also improve the efficiency of services and government operations through the widespread use of digital governance and ICT.

Many countries around the world have already started to introduce and develop smart city concepts, with Singapore, Seoul, New York and some Chinese metropolises leading the way. While Stockholm stands out for its energy efficiency solutions, New York is working on systems to ease congested city traffic, such as smart parking. These cities are all examples of how modern technology can be used to improve urban life and create a sustainable future.

Notes

Smart cities can reduce water consumption by 20-30 percent, increase waste recycling by 10-20 percent and reduce greenhouse gas emissions by 10-15 percent.

By 2050, it is expected that 68 percent of the world population will live in cities.

List of sources used

M7 Line: Digital World

7.3. Escalating Cyber Security Danger

István Nicolaus Sándor

Cyber risk and cybercrime increasingly at the forefront of the challenges of the digital age, with a significant impact on our society, our economy and our daily lives. As the digital world more complex, vulnerabilities increase, presenting us with new challenges. The impact of cybercrime is already being felt and its long-term consequences could be even more profound.

Part of our daily and economic life now in the digital space, but this is followed not only by legal but also by illegal activities. Crime is increasingly taking place in cyber-space, which is no less dangerous than traditional forms of crime. Moreover, while in the everyday world it has become routine to protect our property and privacy, in the digital world this is not yet a matter of course. We put a security lock on the door of our home, but we think less about whether our online passwords are secure enough. Of course we don't invite a stranger knocking on door, but unfortunately, we often open a dangerous attachment in an email.

Cybercrime has grown to become an activity that causes significant damage on a global scale. The European Central Bank (ECB) estimates that the associated annual costs globally are in excess of $200 billion, and the total costs are likely to be much higher, at around 8 % of global GDP3. The most common form of crime is "social engineering", which uses psychological deception to extract confidential personal or corporate data from unsuspecting users. The rise of telecommunications, accelerated by the COVID-19 pandemic, has also created new cyber security challenges. Businesses are now struggling to secure a physically dispersed workforce, requiring increased investment in secure communications and remote access technology. to. This trend is likely to continue, permanently transforming the way we work and communicate.

Cyber-attacks can have a variety of effects. On the one hand, they increase vigilance and caution, which is beneficial in itself, but on the other hand, they reduce the use of digital platforms trust in the digital economy, which in turn hinders the growth of digital economies and the adoption of new technologies. Moreover, the expenditure required for digital security diverts resources away from other, more productive activities. This is why governments around the world are introducing tougher regulations and penalties in response to the cybercrime phenomenon. The European

General Data Protection Regulation (GDPR) and the California Consumer Privacy Act (CCPA) are examples of legislative efforts to protect consumer data and hold companies accountable for data breaches.

The development of new technologies such as artificial intelligence and quantum computing brings new opportunities and challenges. While these technologies have the potential to improve cyber security, they can also introduce new vulnerabilities that cyber criminals can exploit.

Notes

The European Central Bank (ECB) estimates that the annual costs related to cyber-risk globally are in excess of $200 billion.

We need to protect our digital security just as we protect our wealth and privacy in our daily lives.

List of sources used

M7 Line: Digital World

7.4. Everyday Artificial Intelligence

dr. Roland Bódi

CHANGE here to

M2 Line: Knowledge and Talent. 2.6. AI in the Labour Market

Artificial Intelligence (AI) has taken a new level in recent years and can have a more profound impact on our everyday lives than ever before. The proliferation of AI-based systems could fundamentally change the way we work, communicate, sleep and live our lives. It is our responsibility to reap the benefits and minimise the drawbacks of this.

Thanks to the exponential growth of data and the explosive development of computer science and data science, artificial intelligence (AI) solutions have been at the forefront of innovation in recent years. These systems automate our processes, discover the hidden relationships in our data and, while simplifying the human-machine interface, multiply productivity by analysing and exploiting vast amounts of data, enabling them to come up with new content in a fraction of the time it takes a human to do so - whether it's a movie script, the design of a previously unknown substance or the development of a new drug molecule with better efficacy than before. And the most

advanced multimodal AI systems go beyond this: they can combine multiple sources and different types of data (images, text, sound, sensor data) to complex results, such as interactive learning materials, personalised patient care and diagnostics, or even self-driving cars that respond more safely to their environment.

In addition to its technological, scientific and cultural impact, AI also has a significant potential economic and labour market impact. Automation and robotisation have already led to productivity gains, cost reductions and new business models in many industries, and the spread of AI solutions could accelerate this process even further. AI can also change the nature of human work. While some traditional jobs may disappear as a result of automation, and new jobs may emerge that would be difficult to invent with our current knowledge, generative AI is expected complement rather than replace most jobs.3 The labour market will expect workers in most sectors to be 'AI-ready' and 'AI-literate', and to ensure this, we need a knowledge-based transformation of our society.

Exploiting the new results of technological progress based on AI solutions is not only an opportunity for Hungary, but also a necessity: these innovations can help to maintain our country's competitiveness and increase our productivity. In addition to the development of individual skills, the exploitation of these achievements and the shaping of society's knowledge base will require the continuous renewal of the entire education system and businesses to adapt to innovative technological changes, and the targeted use of our national data assets, as well as better access to and use of our databases.

Notes

The application of artificial intelligence could lead to global GDP growth of up to 7 percent over the next ten years, according to current estimates, with an annual increase of $7 trillion.

Who is misses out of the AI revolution, is missed out of the future.

List of sources used

M7 Line: Digital World

7.5. Virtual Reality

Anna Bettina Danku

The metaverse marks the beginning of a new digital age, where the virtual and physical worlds are increasingly merging. New technologies such as augmented and virtual reality are transforming entertainment, work, education and financial habits. Part of the future will continue in this new digital ecosystem.

Our world today is expanding physically into space and virtually into the digital dimension. The rise of virtual reality and the emergence of the metaverse is ushering in a new era. Augmented Reality (AR) allows users to add digital elements to their real environment, offering new experiences and interactions. It is not yet possible to assess exactly how the digital and real worlds will evolve: in some areas they may complement each other, in others they may be built on top of each other. Currently, it is mostly found in entertainment and games, but its applications are expanding from medicine to finance. In healthcare, VR therapies and simulations are helping patients to heal and professionals to train, and VR solutions are also used for shopping in virtual reality and online shopping. A current example of this is the IKEA AR based pioneering mobile app PLACE, where shoppers can visualise and buy products from the store in their home environment using an online device. The virtual world can help make online education and online working, for example, more experiential, combining convenience of remote connectivity with closer interaction.

Augmented Reality offers a whole new creative medium in which the user experience shifts from observation to experience. Relationships between people may be transformed, digital identities and online presence will become increasingly important, raising new issues of privacy, cyber security, safety and ethics.

The emergence of the metaverse will bring significant changes to the digital world, requiring the regulatory side to take a number of measures to ensure that it operates properly and efficiently. Participation in the metaverse may require strict user identification and authentication procedures. This can help prevent the emergence of fake profiles, infringements and abuse. The metaverse could also create millions of new jobs worldwide. And augmented reality could become even more pervasive in the future, with the biggest changes in everyday life in virtual learning, entertainment and work in the years to come.

In Hungary several industries will change in an innovative way with the use of AR. The companies recognizing this in time can obtain competitive advantage. The market is still rather open, so even small “garage” companies can have the chance, like it had happened already in the early 1980s at the dawn of the information revolution.

Notes

The introduction of brain-computer interfaces (BCI) could further push the boundaries of metaverse, where people can control digital systems directly with their brains.

The virtual reality market was worth nearly $30 billion in 2023, and revenues could reach $80 billion by 2030.

List of sources used

M7 Line: Digital World

7.6. Smart Data

Dorina Bene

CHANGE here to

M8 Line: New Industrial Revolution | **8.3. Industry 4.0 Data-Driven Production**
M3 Line: Geopolitics | **3.7. Geopolitics of Rare Earth Metals**
M1 Line: Basic Megatrends | **1.6. New Era of Measurements - Measurability**

Smart data represents a new revolution in data management, where data are not only collected, but also intelligently processed. This technology allows us to extract immediately usable information from the data, which helps us to make faster, more effective and efficient decisions (or to increase automation).

What is data? Essentially anything that has a digital footprint. And if you have a digital record, it can be stored and analysed. As digitisation permeates our lives and the range of sensors that capture it expands, the amount of data increases exponentially. Data is a resource, but as long as it is stored it is an untapped potential. The real benefit we start analysing it - linking it to other data, aggregating it, looking for trends and patterns. Like raw materials in the ground, data needs to be cleaned and processed before it can be used. Computers have long helped the human mind to do this, but in the future, they will increasingly be able to do all the analytical work on their own - with less and less human intervention.

So-called smart data systems integrate data from different sources to provide a more comprehensive picture of the problem at hand, focusing on selecting relevant and accurate information and using only that which is truly useful and value. Smart data systems can process and analyse processes in real time, enabling immediate reaction and decision-making. Smart data often uses artificial intelligence (AI) and machine learning algorithms to analyse data and identify relationships that are difficult or impossible to detect manually.

There are many benefits to using smart data, such as making decisions based on accurate and reliable data, increasing efficiency and reducing the likelihood of errors. Significant cost savings can be achieved through optimised processes and more

efficient use of resources. In addition, smart data opens up new opportunities for innovation, enabling the development of new products and services.

Smart data systems operate with less infrastructure load, are more flexible and more accurate, faster response times. In the future, if all service providers use smart data, personalised and high-quality services will reach a new level.

Hungary can gain significant benefits from the use of smart data technologies, increasing its efficiency and competitiveness in many areas. In addition to companies, the use of smart data can also benefit agriculture, healthcare, urban infrastructure and education. The integration of smart data into different sectors in Hungary will not only increase economic development and competitiveness but will also contribute to a more sustainable and innovative future in the long term.

Notes

Intelligent data stored in an already cleaned structure, offer many new, faster ways to analyse.

Data scientists spend 80 percent of their time on cleaning, checking and preparing data.

List of sources used

M7 Line: Digital World

7.7. Unlimited Connectivity

Bence Muhari

The wireless connectivity of our digital devices, the Internet of Things (IoT), has the potential to transform many industries and our everyday lives. The IoT enables the collection of vast amounts of data in real time, which can be made available through technological innovations such as 5G or the intelligence the ability to analyse more and more autonomously.

The interconnectivity of our digital devices, the Internet of Things (IoT), has come a long way since a Pittsburgh researcher wanted to monitor the completion of a drinks vending machine in real time in 1982. In its current sense, the concept has been around since 1999 and has now spread to many sectors of the economy and become an integral part of our everyday lives through various technological innovations and advances in data transmission.

The fundamental role of IoT devices is to collect reliable and high-quality data from

the outside world using sensors. These sensors can collect a wide range of environmental, physical, biological and health data, which can be used to measure the environment in increasing detail as technology advances. However, the production of these precise instruments requires a high level of expertise, which initially entailed high costs, making distribution difficult. However, the cost of manufacturing sensors has fallen significantly in recent years, from an average price of $1.3 in 2004 to $0.38 in 2020, making technology more widely available.

The number of IoT devices is growing rapidly, surpassing non-IoT electronic devices in 2020 and is expected to triple by 2025.2 The number of connected devices was estimated at around 17 billion in early 2024, and could nearly double to 29 billion by 2030. Asia, and China in particular, is driving this growth. It is the country alone that has 5 billion devices, fuelled by intensive 5G network development, while the number of connected devices in North America and Europe also exceeds 3-3 billion.3 The uptake of personal and home devices - through fitness devices or ecosystem-based smart devices - has also accelerated. Other technologies offer a cost-effective solution for smart cities or economies of scale to cover large areas, complementing mobile networks or Wi-Fi, among others.

In our country, too, the use of IoT solutions is essential to improve our competitiveness. In manufacturing and production sectors, real-time monitoring and quality control can reduce production costs and improve operational efficiency. Hungary has a good industrial base, but to take advantage of this, it is crucial to use innovative technology in this area as well, to serve production by better measuring the quality of time, land and crops. In addition, the wider use of IoT can also help optimise transport in our cities, improve public safety, promote energy efficiency and protect our health.

Notes

The interconnection of digital devices generates an unprecedented amount of data, the analysis of which enables quick decisions and efficient operations.

In early 2024, around the number of connected IoT devices is estimated at 17 billion USD, almost doubling by 2030, reaching 29 billion.

List of sources used

M7 Line: Digital World

TERMINAL 7.8. Big Techs as a New Platform of Competition

Anna Bettina Danku

CHANGE here to

M6 Line: Financial Revolutions 6.6. FinTech Revolution

Platformisation is the engine of the digital economy. The "Big Five" giant platforms connect users around the world, making it easier to communicate, trade internationally and access services. On the other hand, their activities give them access to vast amounts of data and, in part, unprecedented influence. However, holding data can pose a number of challenges to the economy.

Platformisation is playing an increasing role in the digital economy. Services, products and communities are increasingly built on digital platforms. Platforms are digital infrastructures that enable service providers to meet user needs across an ecosystem in many areas of life, such as communication, shopping and finance. The first online platforms such as eBay and Amazon emerged with the development of the Internet. They enabled an informal relationship to be established between buyers and sellers. Then, the Web 2.0 revolution gave rise to platforms such as Facebook, YouTube and Twitter, which allowed users to not only consume and buy, but also to buy and sell. but also, content producers. The six largest American companies are all BigTech, of which the 5 largest technology giants dominate the market today.

These Big Tech companies operate global platforms that billions of users and wider access to services and information without geographical barriers. Digital infrastructure helps services grow quickly and efficiently as demand increases. This networking and scalability can be particularly important in fast-changing markets, where platforms can adapt flexibly to new demands. At the same time, rapid centralisation can lead to monopolization, i.e. increased or limited competition.

The proliferation and growth of platforms brings significant new challenges. These include consumer protection, privacy and cybersecurity concerns. Digital platforms require new regulations compared to traditional consumer protection rules. Data protection is of particular importance, as platforms store and process huge amounts of personal data, making data protection issues a serious concern and may have consequences. Cyber security is also a critical challenge, as platforms are popular targets for cyber-attacks. Regulating platforms on a global scale cannot be done at the national level and international cooperation is needed.

Platformisation continue in the future and may even bring many new business and operating models to banking. The concept of "Beyond Banking" allows financial institutions to build an infrastructure around themselves that goes beyond traditional banking activities while increasing customer loyalty.

Notes

Nowadays, the so-called. "the Big Five" technology giants like Apple, Amazon, a Google (Alphabet), Facebook (Meta), and Microsoft dominate the market.

Apple is the world's most valuable Big Tech company, with a market value of more than 3 trillion in 2024.

List of sources used

M8 Line: New Industrial Revolution.

TERMINAL 8.1. Small and Strong Nanotechnology.

Péter János Szabó – Kolos Molnár – Gergely Zaránd

CHANGE here to

M6 Line: Financial Revolutions 6.6. FinTech Revolution

With today's engineering technologies, it is possible to explore and manipulate the structure of matter at the nanometre scale, to produce nanostructured materials, nanoparticles with functionalities, and to use the nanostructures and materials produced in medicine, aerospace, quantum technology and food.

Nanomaterials are materials made up of extremely tiny particles, particles that are on the order of nanometres (parts per million). Today, nanomaterials and nanotechnology companies are present in all areas of our lives, dominating the health care industry, the food industry, electronics, energy storage and quantum technologies.

Nano sensors have applications in the military, environmental and health industries. Their extreme sensitivity is coupled with cost-effectiveness; the functionalisation and extreme sensitivity of nanomaterials allow allows the selective detection of only a few biomolecules or pollutants. In the healthcare industry, functionalised nanoscale sensors can be to target medicines or perform high-resolution diagnostics, detect the health of tumour or cells around implants. They can sense the level of biomolecules or pollution in a selective manner. hey can monitor the status of the cells, as a high-resolution diagnostic system, around tumour cells or implants and can transfer medicine on the cellular level.

Nanocomposites can be used to and design the structural properties, strength, load-

bearing capacity, thermal conductivity and resistance of materials. Nanofibers have a wide range of potential applications: they can be used as scaffolds for tissues, drug carriers, filters, energy storage and harvesting, sensors or as various functional textiles. During the pandemic, nanofiber face masks with high efficacy were also introduced to the market. The miniaturisation of computer processors has led to the development of nano electronic applications, which form the technological basis of today's superconducting quantum computers. Nanoscale memristor networks could revolutionise data storage by providing a new analogue artificial intelligence solution.

Nanomaterials are also increasingly being used in the food industry: nanotechnology can be used to create "smart" edible food packaging, to control food quality with nano sensors or to personalise the taste of food with nanostructured food. Intensive experiments are also under way in the field of food production, but the toxicity issue is complex and difficult to address because the biological effects of nanomaterials are component-dependent and unknown. Materials with at least one dimension on the nanometre scale also offer a promising future in energy storage and solar energy: carbon and oxide nanotubes and layered structures can be used for efficient energy storage, but also for low-cost, high-emission technologies and new nanomaterials that can be produced cheaply.
development is necessary.

Hungarian nano technology research is carried out in many research institutes and universities, among which the BME and the HUN-REN Energy Research Centre, where the most intensive nanotechnology research and development is carried out.

Notes

The size of the basic units that make up nanomaterials is the "nanometre", which is one millionth of a millimetre.

A special feature of nano-additives is that they can cause significant property improvements even when used in very small amounts (less than 1 percent).

List of sources used

M8 Line: New Industrial Revolution.

8.2. Expansive Quantum Technology.

László Bacsárdi – Sándor Imre – János Asbóth – Gergely Zarándi

Today we are living in the age of the quantum technology revolution. Quantum computing can increase computing power many times over, and quantum communication increases the security of our systems. In each of these areas, dynamic developments are taking place around the world, with Hungarian experts contributing.

In 2023, the value of research and development using quantum technology is estimated to be close to $40 billion. Quantum technology is the term used for solutions that operate at the atomic level. The advent of quantum computers has brought within reach efficient solutions to problems that cannot currently be solved by classical computers and can therefore provide innovative solutions in many areas (e.g. pharmaceuticals, logistics, finance).

Quantum computers based on superconducting, semiconducting and ultracold atomic devices on different physical architectures are being developed by a growing number of IT giants and are now available as subscription service.

From a technological perspective, quantum computing can help to reduce cybercrime, one of the biggest challenges of our time, by increasing the security of our systems through quantum key distribution (QKD). In this way, the secrecy of the operation of the systems is guaranteed by the laws of quantum physics, but of course the importance of human intervention remains. In addition to QKD devices quantum random number generators (QRNGs) are also available on the market, which also contribute to the operation of various encryption systems. Quantum superposition can also be used to significantly increase the sensitivity of various sensors, e.g. for accurate measurements of gravitational or magnetic fields, in geological, medical and other applications.

Hungary is also actively contributing to the development of quantum technologies. Under the coordination of the National Laboratory of Quantum Informatics, quantum informatics and quantum communication research is actively pursued at the Budapest University of Technology and Economics (BME Faculty of Science and BME Faculty of Electrical Engineering and Informatics), Eötvös Loránd University (ELTE Faculty of Informatics and ELTE Faculty of Science) and the HUN-REN Wigner Research Centre for Physics. 2023, the QCIHungary project, led by the Governmental Informatics Development Agency and involving BME, ELTE and HUN-REN Wigner, was launched to develop a national quantum communication infrastructure. Also in this year, the European OpenSuperQPlus project was launched, aiming at the development of a 1000 quantum-bit quantum computer, with the active participation of BME and HUN-REN Wigner.

Notes

With quantum computers, we can perform calculations in seconds that would take decades a conventional computer.

A quantum communication system developed at BME was used to set a national distance record in 2022.

List of sources used

M8 Line: New Industrial Revolution.

8.3. Industry 4.0 Data-Driven Production.

László Kovács – Márton Takács

CHANGE here to

M3 Line: Geopolitics | 3.7. Geopolitics of Rare Earth Metals
M1 Line: Basic Megatrends | 1.6. New Era of Measurements - Measurability
M7 Line: Digital World | 7.6. Smart Data

Industry 4.0, also known as the fourth industrial revolution, is a megatrend that is fundamentally changing the world of manufacturing. Data-driven manufacturing will enable companies to reach new levels efficiency, precision and competitiveness. But what does Industry 4.0 really mean and how will it affect Hungarian companies and industry?

The foundation of Industry 4.0 is real-time, relevant data, and a key element is the cyber-physical manufacturing system that combines physical manufacturing processes with digital technologies. This enables the monitoring and optimisation of manufacturing processes at a given moment, communication between machines and systems, and continuous analysis of data. As a result, production becomes not only more efficient but also more flexible and accurate.

By optimising manufacturing processes in real-time, you can maximise resource utilisation and reduce waste and energy consumption, resulting in long-term cost savings and greener operations.

Intelligent systems can anticipate maintenance needs, minimising. Predictive models based on artificial intelligence and real-time data can be used to predict at any moment the expected quality of the product in production or the remaining useful life of

the manufacturing tool.

The initial level in the practical implementation of digitalisation is the real-time collection and monitoring of production data, providing accurate production information to both management and customers. With complex Industry 4.0 systems, it is possible to make even products ordered online to be produced automatically, without the touch of human hands, while the degree of completion, quality and expected delivery time of the products can be monitored during the manufacturing process.

For Hungarian companies, the application of Industry 4.0 will increase competitiveness not only on the domestic market, but also on the international stage. Thanks to advanced technologies, Hungarian industry is able to keep pace with global trends and produce high-quality, competitive products.

In Hungary, too, more and more companies are adopting the technology of custom manufacturing, which allows them to produce tailor-made products that meet the needs of their customers. 3D printing one possible way of doing this. This not only increases customer satisfaction but also helps companies to strengthen their market position.

Industry 4.0 also plays an important role in education and research and development, as the acquisition and application of new technologies is essential for the future labour market. For Hungary, this is an opportunity that promotes innovation and economic growth, while contributing to sustainable development.

Although the full roll-out of Industry 4.0 solutions is far from complete, the 5th Industrial Revolution is already imminent. Within Industry 5.0, social values will come to the fore and human-centred manufacturing will become important again, based on the interaction between human intelligence and machine efficiency.

Notes

The market for Industry 4.0 solutions is growing dynamically at international level and is expected to exceed four times the 2024 value by 2032.

Due to the EU and Hungary with government support in Hungary, today there are 5 EDIH (European Digital Innovation Hub), which support the digitalisation of businesses

List of sources used

M8 Line: New Industrial Revolution.

8.4. 3D Printing.

Tibor Szalay – Tamás Markovits – János Slezák

The basic principle of additive machining - commonly known as 3D printing - is to build up the geometry of a computer model by stacking layers of material. In practice, it can be applied to a wide range of materials, including metal, polymer, ceramic and concrete. Additive manufacturing has the potential to revolutionise both the gastronomy and food industries in many ways.

In engineering, additive manufacturing, which emerged in the mid-1980s, has reached a level of maturity in the last 10-15 years where it is no longer used just for prototyping, but also for the production of parts and tools.

The manufacturing process involves slicing the computer-designed model to determine the layer cross-sections that the 3D printing machine will produce. There are many variations of the process, which is mainly used for polymers (plastics) and metals. A 3D workpiece is created by building layers on top of each other, which can be finalised by post-processing on the requirements.

The use of additive manufacturing is mainly appropriate for unique, customised, small batch, complex parts. Conventional manufacturing techniques are typically more cost-effective for medium and large series. 3D technology, on the other hand, allows custom manufacturing at a relatively low cost, ensuring that the design, rather than the technology, defines the product. is also more economical because, unlike traditional manufacturing, there are no individual tooling costs and the number of assembly, assembly, inspection and testing operations and the potential for errors is reduced. The fact that 3D printing makes it significantly cheaper and easier to produce samples and prototypes is a major driver of technological innovation. This makes it relatively easy for smaller companies with financial constraints to experiment with new solutions.

The use of 3D printing to create food can result in unique textures, shapes and flavours. The technique has from traditional extrusion methods, the main concept being that the composition, texture, colour and shape of the food produced can be flexibly changed, controlled and reproduced according to the needs of the user or customer. This allows the production of unique products, even in the food industry (e.g. our food products contain dozens of ingredients, making it a challenge to develop food printing tools to ensure coherent, popular and safe product, and to develop production platforms capable of producing as many different types as possible. This requires close cooperation between different engineering disciplines, gastronomy, nutrition and business professionals to ensure that printed food stands out on store shelves and on our tables, not only for its uniqueness but also for its healthiness and sustainability.

Notes

Additive manufacturing is a revolutionary tool for unique solutions.

3D market is expected to grow between 2021 and 2026 from $12 billion to $45 billion,

List of sources used

M8 Line: New Industrial Revolution.

8.5. Autonomous Systems.

Zsolt Szalay

Autonomous systems, i.e. artificial systems that can operate autonomously without human intervention, have emerged as a leap forward in technology in recent years. These systems include autonomous vehicles, drones, robots, manufacturing and power systems, with the potential to revolutionise entire industries.

One of the main drivers behind the rise of autonomous systems is the development of artificial intelligence and machine learning technologies, which have enabled machines to sense their environment, process vast amounts of data, make decisions and perform tasks with ever-increasing accuracy and efficiency. As a result, autonomous systems are now able to perform complex tasks that were previously only conceivable under human control, such as driving vehicles, monitoring infrastructure or performing precision surgery.

In the automotive industry, autonomous vehicles have received a lot of attention because of their potential to improve road safety, reduce traffic congestion and lower transport costs: the pilot programmes are already being tested in major cities around the world (e.g. San Francisco). Hungary is contributing to the future of safe public transport with a unique research and testing infrastructure through the ZalaZONE test track. As these systems continue to evolve and become more widespread, they are expected to revolutionise the way people commute, transport goods and travel long distances.

In addition to transport, autonomous systems are also impacting healthcare, agriculture, manufacturing and other sectors. In healthcare, robots and AI-enabled devices are being used to assist in surgeries, support medical diagnoses by analysing X-rays or lab results, and help nurses with their work, for example by dispensing and delivering medicines to patients. In agriculture, drones equipped with sensors and cameras help farmers crop health, optimise irrigation and increase yields. In product manufacturing, robots are used to automate repetitive tasks, increase efficiency and improve product quality.

Looking to the future, the impact of autonomous systems on society is expected to be very broad. While these technologies promise to increase productivity, efficiency and convenience, they also raise important ethical, legal and social questions, and we need to be prepared for the consequences of their introduction as autonomous systems become more integrated into our daily lives.

In summary, we can already conclude that the emergence of autonomous systems is reshaping industries, transforming the structure of the economy and forcing us to redefine our ideas about work.

Notes

The amount of data scanned by self-driving cars can be up to 10GB per minute.

The Hungarian ZalaZONE is one of the most modern test tracks self-driving cars.

List of sources used

M8 Line: New Industrial Revolution.

8.6. Future Vehicles.

Dániel Rohács – Máté Zöldy

Transport continued to develop throughout the 20th century, but the first half of the 21st century will see a paradigm shift, driven by the electrification of the sector and the growth of cognitive capabilities. The growth of electromobility opens the door to different alternatives in all transport sub-sectors.

The advance of e-mobility in passenger transport is very intense, but full take-up is not yet expected at current technology levels, urban use is the most likely to offer the potential for truly sustainable use of these vehicles, especially in shared fleets. Here, in addition to the distribution, the nature and size of the vehicles varies considerably. In addition to public transport, the use of electric scooters, e-bikes and electric scooters is rapidly expanding as an alternative to private car transport.

A more revolutionary change, not long ago in the realm of science fiction, would be the proliferation of small modern personal aircraft with 2-4 seats for use in cities. These are fully electric-powered, garbage aircrafts are capable of vertical take-off/landing, ideal for meeting mobility needs in or around cities. The aircraft will even be capable of fully autonomous operation, but to achieve this, the automotive industry will need to invest heavily in artificial intelligence (AI) and digital transformation.

Intensive electrification of transport is the solution for some mobility, but replacing oil-based energy sources is not feasible with current technology. In contrast to short-distance passenger transport, the needs of long-distance freight transport and large-scale agriculture cannot currently be met by electric drives. At the same time, alternatives to electric propulsion are being sought to replace diesel and petrol consumption (e.g. hydrogen propulsion). In air transport, electric propulsion can be complementary, providing extra thrust in the short term in a hybrid configuration, e.g. for take-off. A purely electric solution for longer flight distances is likely to be introduced only if significant progress is made in the development of energy storage batteries technology. The main energy source for waterborne transport is gas oil or fuel oil. The use of fuels with high sulphur content is also becoming more restrictive in this area. As alternative, wind energy is emerging as a historically known solution. The number of battery electric drives is slowly increasing, and hydrogen-based drives are also emerging.

Notes

In 2022, one in 10 new vehicles sold worldwide was electric and one in seven had a hybrid powertrain.

The most modern urban flying vehicles now have a range of 80 km and travel at speeds of up to 120 km/h.

List of sources used

M8 Line: New Industrial Revolution.

8.7. Smart Logistics.

Krisztián Bóna

Among the trends shaping the future of supply chains, the impact of digitalisation and automation should be highlighted. Developments in information technology and robotisation can be seen in all parts of the supply chains in the short term, while innovative solutions have also emerged that will determine the long-term operation of companies.

Without complex supply chains, it would be unthinkable to create value and serve the growing and ever-changing needs of customers. Challenges such as online marketplaces, dwindling resources, dynamically changing individual needs, mass, constant time pressure, environmental protection and new technologies are constantly shaping value chains. The number of actors is constantly increasing, as is their spatial extent, and cross-linkages are being between the chains, creating complex

networks are, with strong competition between them, forcing collaboration between actors. Consolidation solutions based on resource sharing and logistical innovations supporting the circular economy are playing an increasing role.

The development of information and communication technologies has opened up previously unimaginable opportunities in logistics. Data-driven supply chains are emerging. Digital transparency in value creation processes is becoming a reality, facilitating online process monitoring and the automatic management of logistics systems, enabling the use of digital twin technologies, i.e. the linking of the digital and physical worlds using virtual or augmented reality technologies. Thus, a logistics workflow in a value-creating system (e.g. a factory or a hospital) that exists in the physical sense will also exist in the digital sense, opening up new possibilities for optimising processes.

In the new generation of intralogistics systems, logistics equipment is no longer a stand-alone entity, but part of a complex cyber-physical system, where complex tasks can be performed in a collaborative way, connected to the Industrial Internet of Things (IIoT), even with decision intelligence. The components of such systems are logistics robots (AGV, AMR, UAV devices) with self-driving capabilities that can perform logistics tasks autonomously. Automation is also gaining ground in logistics networks. Autonomous freight vehicles are appearing on the roads, and autonomous vehicles using alternative (typically electric) means of propulsion are gradually replacing traditional freight vehicles not only for road transport but also for rail, water and air transport (e.g. The use of UAVs in last-mile logistics, mobile robots, or electric vans in city logistics). As a result, the determining factor in logistics systems will no longer be so much the physical capabilities of humans, but rather their knowledge.

Notes

The special logistics experts believe that the number of robots can be increased by three times in the next five years.

The size of drone logistics market is expected to reach USD 35 billion.

List of sources used

M8 Line: New Industrial Revolution.
TERMINAL 8.8. Built Environment.

Zsuzsa Szalay – Tamás Lovas – György Alföldi – Rózsa Szabolcs

CHANGE here to
M4 Line: Green Transition. 4.4. Circular Economy.

The built environment and the construction industry account for a significant share of global energy use and CO_2 emissions. Meeting climate targets can therefore only be achieved through the full decarbonisation of buildings and the construction industry, which also affects the process of building and building maintenance.

The green transition cannot be achieved without making our buildings more sustainable. This requires reducing the environmental impact of the construction process, as well as the emissions and energy demand during operation and maintenance. The former concerns mainly developing countries with rapidly expanding building stock, the latter developed countries with a large but ageing and energy-demanding building stock. The European Union has committed itself to a zero-emission target for the entire building stock by 2050. To achieve this, only new buildings will be zero-emission from 2030. Local emissions are not possible, and the energy demand must be met predominantly from renewable energy sources. Achieving these objectives is a major challenge from a social, technical and financial point of view.

Technological innovation needs to include new building materials, preferably based on natural materials. Innovative design, regulation and manufacturing tools based on new materials research should reduce emissions by applying the principles of the circular economy, promoting waste recycling and by developing detailed regulation of secondary construction materials (e.g. demolition of building, reuse of windows and doors, use of used tyres as bitumen additives).

Digitalisation, such as the use of building information modelling (BIM), significantly reduces design errors, increases efficiency and predictability, paving the way for process automation, parametric and genetic design, the use of artificial intelligence and robotisation in construction. The significance of digitalisation, beyond what is usual in paper-based design, is that the models and datasets created during the design process can be used the life cycle of the facility, from the decision-making process to implementation and operation. These digital construction site applications, integrated with robotisation or drone-assisted surveys, will significantly improve the efficiency of construction processes. This includes marking robots to assist with and semi-automated machine chains to support road construction. Compared to European countries, the efficiency and productivity of the domestic construction industry still needs to be improved, in particular, by improving the level of digitalisation, reducing the need for human resources and integrating organisational and management processes.

Notes

The built environment contribution to the global CO_2 emissions is 37 %

Such a large proportion as 7 % of the construction cost is caused by design errors. Building information modelling can also help with this.

List of sources used