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Machinery. Technology. Social Well – being

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Abstract

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The article discusses the importance and the impact of the scale of hi – tech innovation in economy on social welfare. The author gives examples of industrial policies in the different countries. The author gives a detailed description of technological structures with chronological and institutional perspectives. The article also gives the definition of chronological order. The author comes to conclusion that the machinery is the basis of technological development. The paper analyzes the technological development of the Russian economy. The author concludes that the technological development of the Russian economy should be gradual, based on engineering production. The author substantiates the social and economic importance of Russian engineering. To this end, statistical data on the number of the working population employed in this industry, their level of qualification and the number of enterprises of mechanical engineering. In conclusion, the author notes the existing relationship between the technological development of the economy and social welfare.

Keywords: Technological development; social well – being; technological structures; modernization; R&D expenditures; machinery; high technology products.

1. Introduction: Technology and Society Development

The relationship between technological development and society is bi-directional. Our economic needs, cultural and individual values, organisational structures and educational practices – all have influence on how we develop and utilise new technologies. There is the growing urgency to understand the impact and changes that technologies bring to our lifestyles, their threats, opportunities, and their inherent dynamism alike [1]. For the purpose of sustainable growth it is important to understand the problems that we are facing today and it's equally important to understand what possibilities will open for us in the future.

For example, technological advances such as automobiles, airplanes, radio, television, cellular phones, computers, modems, and fax machines have brought major advances and changes to the world.

Indeed, the 20-th century technologies have completely – and irreversibly – changed the way people meet, interact, learn, work, play, travel, worship, and do business.

The technological development needs a platform for its implementation in societies' economies. In this case, this platform is machine-building in particular and the entire industrial production sector as a whole. The development of manufacturing facilities is now a priority in both developed and developing countries.

After all, the current global economic crisis has resulted in the growing interest in the production capacity growth, the implementation of industries-related policies (Table 1) and the enhancement in the integration between science and production [2].

Table 1. Examples of industrial policy initiatives.

Country	Initiatives
Brazil	Plano Brazil Major
China	Plan for National Strategic Emerging Industries
Russia	Federal Law "Industrial policy in the Russian Federation"
India	National Manufacturing Policy
Japan	Industrial Structure Vision
Netherlands	Top Sectors Policy
UK	Plan for Growth and Industrial Strategy
US	American Recovery and Reinvestment Act and National Innovation Strategy

In order to overcome the economic crisis and improve the social welfare it is necessary to develop industrial production, in other words, to ensure economic growth by means of real production. This will result in technological development of the entire economic system. If society does not adapt to new technologies, it will soon fall behind other societies that are nimbler. Productivity and well-being depend on utilization of the correct tools required to accomplish what we wish to be done. A society can increase its productivity briefly without renewing the technologies it uses, but in the longer term this won't be possible.

Society however inevitably slows down the diffusion of new technologies because the laws, practices, education and values adapt to the existing mainstream technologies. New technologies face a hurdle and society can do much to speed up and steer emerging technologies especially in countries that are among the first to adapt and support new technologies. Later the inertia becomes greater [1].

In other words, it all means that technological development can lead to the growth in knowledge and information and, thus, to uncovering the means to create better technologies, which in turn will lead to greater competitiveness of the economy.

That is why, to date, the technological development of the economy determines the level of competitiveness of the country, provides economic and geopolitical security of the state, and also determines the level of welfare of the population.

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2. The technological structure of the economy

Technological structure is directly related to the technological modernization of the economy. The concept of the "technological wave" was introduced by Russian economists D. S. Lvov and S. Y. Glazyev. By definition of S. Y. Glazyev the "technological wave is a macroeconomic reproduction circuit, covering all stages of resource recycling and the appropriate type of non-productive consumption. As a part of a technological wave the primary production resource obtaining is carried out passing all stages of processing and production of a set of end products that conform to the appropriate type of public consumption" [3]. There are five technological ways mentioned in the economy-related literature. Tables 2 and 3 illustrate a detailed description of the institutional structure and chronological characteristic of technological waves.

Table 2. Chronology and characteristic of the technological waves.

Dominant Features	**The number of a technological wave**				
The period of domination	**I** (1770-1830)	**II** (1830-1880)	**III** (1880-1930)	**IV** (1930-1970)	**V** (1970-2010)
Technology leaders	Britain, France and Belgium.	Britain, France, Belgium, Germany, the United States.	Germany, USA, UK, France, Belgium, Switzerland, the Netherlands.	US, Western Europe and Japan.	USA, Japan.
The developed countries	The German government, the Netherlands.	Italy, the Netherlands, Switzerland, Austria-Hungary.	Italy, Denmark, Austria-Hungary, Canada, Japan, Spain, Russia, Sweden	USSR, Newly industrialized economies (NIEs).	NIEs, Brazil, Russia.
Key factor	Textile machinery.	The steam engine machines.	The electric motor, steel.	The internal combustion engine, petrochemicals.	Microelectronic components.
The core technological structure	The textile industry, textile machinery, production of cast iron, iron processing, construction of canals, water engine.	The steam engine, railway construction, transport, mechanical engineering, coal, iron and steel machine tool industry.	Electrical engineering, heavy engineering, production and distribution of steel, power lines, inorganic chemistry.	Automotive, non-ferrous metallurgy, production of durable goods, synthetic materials, organic chemistry, production and refining of oil.	The core technological structure
The emerging new mode core	Steam engines and machinery.	Steel, power heavy engineering, inorganic chemistry.	Automotive, organic chemistry, manufacturing and oil refining, nonferrous metallurgy, road construction.	Radars, pipelines, aviation precious stones and diamonds, gas production and processing.	The emerging new mode core
The advantages of this technological structure compared with the previous	Mechanization and concentration of production in factories.	Growth reduction and concentration of production through the use of the steam engine.	Increased production flexibility through the use of motor standardization of production, urbanization.	Mass production and repetition work.	The advantages of this technological structure compared with the previous

Table 3. The institutional structure of technological waves.

Socio-economic characteristics of waves	**The number of a technological wave**				
	I (1770-1830)	**II** (1830-1880)	**III** (1880-1930)	**IV** (1930-1970)	**V** (1970-2010)
Modes of economic regulation in the leading countries	The destruction of the feudal monopolies, restriction of trade unions, free trade	Freedom of trade, restriction of government intervention, the emergence of sectoral trade unions. Formation of social legislation.	Expansion of state regulatory institutions. State ownership of natural monopolies, the main types of infrastructure.	Development of the public institutions of social security, the military-industrial complex. Keynes's state regulation of the economy.	State regulation of strategic types of information and communication infrastructures, changes in the regulation of financial institutions and capital markets while reducing the role of the state in the economy. The decline of the trade union movement.
International modes of economic regulation	British dominance in international trade finance.	Political, financial and commercial dominance of the UK. Freedom of international trade.	Imperialism and colonization. The end of the British rule.	The economic and military dominance of the US and the USSR.	International modes of economic regulation
Key economic institutions	The competition of individual entrepreneurs and small firms, their union in the partnership, to ensure co-operation of individual capital	The concentration of production in large organizations. The development of joint stock companies, providing capital concentration on the principles of limited liability.	Merging firms, the concentration of production in the cartels and trusts. The dominance of monopolies and oligopolies. The concentration of financial capital in the banking system. Department of Property Management.	Transnational Corporation, an oligopoly in the global market. Vertical integration and concentration of production. Divisional hierarchical control and domination of the technostructure in organizations.	Key economic institutions
Organization of innovative activity in the leading countries	The organization of scientific research in the national academies and scientific societies, local scientific and engineering societies. Individual engineering and inventive entrepreneurship and partnership. Professional training of staff, and with a margin on the job.	Formation of research institutes. Accelerated professional development; education and its internationalization. Formation of national and international systems of intellectual property protection.	Create in-house research, departments. The use of scientists and engineers with a university degree in manufacturing. National institutes and laboratories. Universal primary education.	Specialized research and development departments in most companies. State subsidies for military research and development activities. State involvement in the sphere of civil R & D. The development of secondary, higher and vocational education. Technology transfer through licensing and investment by transnational corporations	Organization of innovative activity in the leading countries

Tables 2 and 3 illustrate that the fifth wave is primarily financial and technological, the main elements of which are money and information. During this wave the acquired data made it possible to make money, which in turn, led to the emergence of companies whose operations are fully associated with the Internet activities.

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Today, the fifth technological wave is in its maturity phase, allowing for faster development of priority trends for the sixth technological wave. The sixth technological wave implies changes in priorities, a shift from consuming to producing economy. Development of production (mechanical engineering) will entail a change in the financial sector. The achievement of a qualitative transition to the sixth technological wave requires transition from short to long-term investments. The management will change too. The fifth technological wave is governed by vertically integrated structures, the sixth one will involve a horizontal space-time distribution, i. e. network-based management.

The sixth technological wave is characterized by the orientation towards the development of the following areas:

- biotechnology;
- nanotechnology;
- genetic Engineering Technology;
- membrane and quantum technologies;
- photonics;
- micromechanics;
- thermonuclear, renewable energy and others.

The totality of the achievements in these areas should lead to the creation of, for example, quantum computers and artificial intelligence to provide access to a new level in the system of government, society and the economy [4]. The years 2020 – 2025 are expected to face the new scientific, technical and technological revolution, which will be based on the developments synthesizing achievements in biotechnology, nano-technology, genetic engineering, membrane and quantum technologies, photonics, micromechanics, fusion energy.

The sixth technological wave is a matter of complex economic development, industrial safety and the international status of the country as well as its achievement of the high level of well-being of its citizens. For engineering the sixth technological wave involves close cooperation between science and the accelerated development of industries compared to the whole economy, as well as the synthesis of robotics technology, nano- and biotechnology, microelectronics, and so on.

At the current pace of technological and economic development in the industrialized countries, the 6th technological wave can start its propagation phase in 2015 – 2020, and the phase of maturity will occur in the 2040s. In Russia, the 6th technological wave has not been formed as such. The share of the technologies of 5th wave is about 5 – 8 % (and it's only in the military-industrial complex and the aerospace industry), the 4th – about 32 – 34 %, the third – more than 50 % [5]. Considering the present level of technological development of Russia it will take over 20 – 30 years of continuous reform and modernization in both industry and the forms of its control (public, market, institutional) to reach the sixth technological wave. At the same time, in our opinion, Russia should go through all the stages of technological development. The transition from the fourth way right to the sixth one, thus skipping the fifth technological wave, does not make sense. The development should be gradual and phased.

The concept of technological waves emerged on the basis of the teachings of N. D. Kondratieff's economic cycles. According to the scientists, the end of the fifth wave would come in 2011 – 2013 marking the onset of the economic crisis.

The calculations carried out about a hundred years ago proved to be accurate. Thus, we can conclude that the world is on the threshold of the sixth technological wave, which is characterized by the proliferation of nanotechnology, biotechnology, investments in human capital, education of the new level, the advent of new natural resources management. The center of the sixth wave is engineering.

3. Engineering as a basis for the technological development of the economy and the Russian population well-being level growth

The situation in engineering is a primary determiner of the technological level of economic development. The profit gained from the industry every 8 – 10 years promotes the modernization of the entire industrialized world. The industry products, due to their high quality and competitiveness, have a huge share in the total exports of the country and high market attractiveness. However, in Russia the share of mechanical engineering products account for only 10 – 20 % of the total country's exports, whereas in Japan, it is 64 %, in the USA and Germany – 48 %, in Canada – 42 %, Sweden – 44 % [6].

It should also be understood that all the innovative products are manufactured with the help of machines and equipment supplied by machine-building sector. The machine-building sector has a key role in the dissemination of advanced machines and technologies in other industries according to the fact that machine-building complex includes more than twenty sub-sectors (aeronautics, machine tools manufacture, handling equipment, etc.). The level of the industry development depends on the material consumption, energy intensity of gross domestic product, productivity, safety and national defense. So, in terms of economic security, the engineering share in a country's GDP should be at least 30 %. Within the structure of industrial production in Russia the share of mechanical engineering amounts to less than 15 – 20 %, whereas in developed countries this share reaches 35 – 50 % [6].

This situation undermines the stability of the Russian economy during the crisis and increases its dependence on western manufacturers. The depreciation of fixed assets in the whole Russian machine building is 65 – 75 % [7]. This significantly reduces the level of competitiveness of domestic enterprises. In the current state the Russian machine-building enterprises can carry out the production of competitive products only for a relatively narrow segment of the market, mainly of certain types of weapons and military equipment. According to the international experts, only about 50 Russian machine-building companies can compete in the respective segments of the global market.

The share of high technology products in the Russian engineering industry is about 2,6 %. In the shipbuilding industry and especially in military shipbuilding the share of high-tech products is slightly higher and amounts to an estimated 10 % [7]. In the machine tools and instruments sphere this share does not exceed 2,8 – 3,7 % [8]. There is still a long way before the real technical re-equipment of the domestic industry is accomplished. Today the share of purchased domestic manufacturing equipment is set at 10 %. Between now and 2020, the Russian government plans to increase this figure to 60 % [8]. To date, the domestic high-tech exports is only 1,2 % of China's exports, 3,7 % of the US exports, 4,3 % of Japan's exports [7]. According to the World Bank the volume of Russian exports of high-tech products is lower than Thailand's 6 times and 10 times lower than that of Switzerland.

The share of high-tech products in the export of Russian industrial goods has dropped and is around 2 % in recent years [7]. The total share of high-tech products in exports of South – East Asian countries

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is tens of times as much and is growing rapidly. These countries are a serious competitions not only for Russia but also for many major world exporters. As a result, there is a substitution of high-tech with low-tech exports, mainly raw materials.

Russia has only about 0,3 % – 0,5 % share in the global high-tech products market while the US has 36 %, Japan – 30 %, Germany – 17 % [8]. The current leaders in the field of mechanical engineering, chemical weapons are countries such as the US, Germany and China.

The social significance of engineering is determined by the fact that this sector has about 7,5 thousand large and medium-sized enterprises and organizations, as well as about 30 thousand small ones accounting for about 40 % of the number of the companies on independent balance throughout the domestic industry. The number of the employed workers in the engineering industry is about 4 million people, more than a third of all workers in the industry of the Russian Federation [7]. The skill level of the domestic engineering industry workers largely determines the human resources industry in Russia, and the level of technological development of the industry determines the whole process of further development of the state. Moreover, due to the degradation and shaut downs in mechanical engineering, ferrous and nonferrous metallurgy, mining, oil extraction and so on will follow suit [5].

Thus, the role and importance of engineering in social and economic development of the country can not be overemphasized. The industry trends complicating the positive development of the Russian machine-building are as fllows [7]:

- depreciation of fixed assets (65 – 75 %);
- the technological gap between Russia and advanced countries;
- the absence of developed legal framework in the field of industrial policy and pricing for the products of engineering industry;
- the imperfection of the tax system in stimulating domestic producers to provide tax breaks and preferences;
- the growth of tariffs of natural monopolies (electricity, heating, etc.).

The development of Russian machine-building is complicated by general economic conditions that hinder the growth of business activities and competitiveness of the products and, accordingly, the growth of domestic demand for domestic manufacturers of goods, which is met by imports. To date, the global market of Russia serves only as a net importer of machinery products. The volume of imports of the industry in 2012 was $ 15 billion, exports – only $ 2 billion in 2000 – 2008 (before the crisis), the import growth rate reached 25 % annually. The main trading partner of Russia is the European Union which account for 90 % of imports of engineering [9].

The role of engineering in the politics and economy of Russia determines the central position of the machine-building complex in the process of modernization of the national economic system. The factors of engineering growth are private enterprise, competition, guaranteed property rights and access to domestic and international markets, technology and scientific research as well as the state regulation of development of mechanical engineering. It is the role of government and the extent of its impact on the industry in particular and the economy in general that cause controversy. The influence of the state on the economy during the current geopolitical situation has been increasing.

4. Conclusion: Main source of welfare

Machine is central mode of production in large-scale industry and its technological improvement - the starting point of economic development. Thus, the level of citizens welfare depends on the technological development of the country. This is confirmed by empirical and statistical data. With technological development and automated production per person accounted for informational and organizational and managerial functions. And the transition as the main source of wealth and development to scientific knowledge. As a result, the development of human capital is the basis for good economic growth, to increase the well-being, development of the industry. So, we would like to emphasize once again that everything is interconnected in the modern economy. The development of one industry can give an impetus to development of the whole industry, which in turn will revive the financial sector, the labor market and contribute to the growth of the well-being of the population.

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