

Научная статья

УДК 338.012 © Е. Г. Успен-  
ская

DOI: 10.24412/2225-8264-  
2025-1-910

**Keywords:** machine-  
tool industry, sustainable  
development, ESG,  
technological sovereignty

**Ключевые слова:** станко-  
строение, устойчивое разви-  
тие, ESG, технологический  
суверенитет

## SUSTAINABLE DEVELOPMENT OF THE RUSSIAN MACHINE-TOOL INDUSTRY AS A FACTOR IN ENSURING THE TECHNOLOGICAL SOVEREIGNTY OF THE COUNTRY

Elena G. Uspenskaia

Graduate student, Moscow State University of Technology «STANKIN»

**Abstract.** The article addresses the issue of integration of the provisions of the sustainable development into the machine tool-industry in order to achieve technological sovereignty of the Russian Federation. The theoretical foundations of the concept of sustainable development and ESG principles are discussed. The author analyzes the existing manifestations of sustainable development in mechanical engineering and develops possible ways to introduce sustainable development strategy into the machine-tool industry in Russia. Foreign expertise in implementing ESG principles in mechanical engineering is considered. In conclusion, the author evaluates the place of sustainable development in the development of the machine-tool industry and the achievement of technological sovereignty of the Russian Federation.

<sup>1</sup>Успенская Елена Григорьевна — аспирант кафедры финансового менеджмента, Московский государственный технологический университет «СТАНКИН» (Россия, Москва, Вадковский пер., д. 3А, стр. 1)  
E-mail: e-uspens@yandex.ru

## УСТОЙЧИВОЕ РАЗВИТИЕ РОССИЙСКОГО СТАНКОСТРОЕНИЯ КАК ФАКТОР ОБЕСПЕЧЕНИЯ ТЕХНОЛОГИЧЕСКОГО СУВЕРЕНИТЕТА СТРАНЫ

Успенская Е. Г.<sup>1</sup>

**Аннотация.** В статье рассматривается вопрос интеграции положений устойчивого развития в станкостроение в целях достижения технологического суверенитета Российской Федерации. Обсуждаются теоретические основы концепции устойчивого развития и принципы ESG. Автор анализирует существующие проявления устойчивого развития в машиностроении и разрабатывает возможные пути внедрения стратегии устойчивого развития в станкостроительную отрасль России. Рассмотрен зарубежный опыт внедрения принципов ESG в машиностроении. В заключении автор оценивает место устойчивого развития в развитии станкостроения и достижении технологического суверенитета Российской Федерации.

Поступила в редакцию:  
13.12.2024

## INTRODUCTION

Over the past 30 years, since the collapse of the USSR, the machine-tool industry of the Russian Federation has been stagnating. Soviet industry was the third in the world in terms of quality and volume of machine-building and engineering production after the USA and Japan. Still, at the current moment only autonomous islands of production remain.

Given the ongoing state policy in the field of machine-tool industry aimed at achieving the technological sovereignty of the Russian Federation, the need to implement the principles of sustainable development in the industry meets the modern requirements of Russian development.

The development of the green agenda in Russia can become an important component of building up the country's technological sovereignty, which is based on the ability to independently develop and apply technologies in order to reduce dependence on external factors. It is necessary to achieve environmental sustainability and strengthen its position in the global technological landscape.

## MAIN BODY

According to the most frequently cited definition of the concept of sustainable development also known as the Brundtland Report, sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own [1].

Sustainable development is a holistic approach to meet the needs of current and future generations without damaging or depleting the resources on which we depend. It is a question of finding a balance between environmental protection, economic development and social equity [2].

Environmental, social and governance (ESG) principles have shaped the industry from the beginning of prospecting to the production of assets. The goal of achieving net-zero emissions by 2050 (or earlier) is well established.

The attention paid to the social responsibility of machine-tool companies around the world continues to grow as the industry struggles with the consequences of extreme weather conditions on its sites, equipment, energy supplies and transport routes.

The following issues are covered by the industry's ESG agenda:

- E — Environment implies ecosystem services, air, noise, energy, climate change (carbon footprint and greenhouse gas emissions), hazardous substances;
- S — Social goes about human rights, land use, resettlement, vulnerable people, gender, work practices, health and safety of workers and the community, safety;
- G — Governance: legal compliance, ethics, anti-corruption and transparency [3].

These are all significant elements to take into account while having the ESG conversation. The industry must assess whether there are any dangers that might compromise its capacity to raise funds, secure licenses, work with local governments and regulatory bodies, and safeguard its assets from depreciation. As a result, it is feasible to lower carbon emissions, energy and water bills,

enhance operational effectiveness, fortify links between the community and government agencies, and oversee the closure's profitability.

Many companies in the sector are already actively working on their ESG program, identifying priorities and measuring performance. However, the real advantages appear when the state policies put the spotlight on the importance of ESG principles implementation.

Consumers want industrial companies to think not only about their growth, but also about the quality of life of workers, consumers and everyone involved in the production and development of their products and services.

ESG strategies have a direct impact on cost reduction. They make it possible to reduce operational expenses, such as raw material, water or electricity costs. Studies prove that companies that go further in their sustainable development strategies are the ones that achieve the best results in terms of resource efficiency and financial performance.

Cost reduction can be achieved through different solutions, such as: reduction of water consumption, reduction of energy consumption and switch to renewable energies, optimization of raw material consumption, waste reduction, production of recyclable or biodegradable products, reduction and recycling of waste produced and creation of partnerships for their treatment, improvement of logistics thanks to the optimization of routes.

ESG criteria can contribute to a holistic approach to risk management. As ESG integrates criteria relating to environmental management, working and safety conditions, respect for human rights, the fight against corruption and compliance with current laws and regulations, companies guarantee their compliance by avoiding fines and other penalties provided for and by ensuring the proper functioning of the entire organization.

On the other hand, investors are also more interested in integrating companies with sound ESG policies. Organizations that manage risks well are the ones that are most likely to attract major investors. Recent studies show that 89% of investors in the main global markets consider ESG as a criterion to be taken into account when evaluating an investment [4].

When it comes to sustainability issues, it is important to be proactive, because

The field of sustainability is expected to evolve in an accelerated manner over the next decade. This includes new laws and regulations, the stricter requirements of consumers and employees, as well as the expectations of investors.

According to Purvis B. and Robinson D., sustainable development of the machine-tool industry focuses on efficiency and conservation. This means that it is necessary to think about the entire life cycle of a product or service, rather than just the operating phase. By adopting a holistic approach that takes into account all aspects of sustainability, one can develop solutions that are not only functional but also protect and preserve our natural resources for future generations [5].

At the moment, machine learning and artificial intelligence (AI) technologies can play a key role in reducing the impact of industries on the planet. By identifying patterns and trends in the data, these technologies can help

industrial players better understand their environmental footprint and take steps to reduce it.

For instance, machine learning can be used to monitor production processes and identify areas where energy or resources are wasted. Artificial intelligence can also be used to develop new products and processes that are more environmentally friendly.

Society is making the end customer more and more responsible for sustainable development, which is important, but the role of industry is crucial. The customer may not be able to see the big picture, but the industry can. It is up to the industry to ensure that products and services are designed with sustainability in mind. This means that everything must be taken into account, from the supply of raw materials to the disposal of waste. Only by adopting a global approach can we find truly sustainable solutions.

In addition to helping companies be more sustainable, machine learning and AI can also be used to help consumers make more environmentally friendly choices. For example, by analyzing data on consumption habits, these technologies can identify opportunities for people to save energy or water. In the future, AI could even be used to develop personalized recommendations for a sustainable lifestyle based on an individual's lifestyle.

Moreover, machine learning and AI have the potential to transform the way companies operate and contribute to making the machine-tool industry more sustainable. As the Russian Federation moves towards a more environmentally friendly society, these technologies will become increasingly important to reduce the impact of industry on the planet.

It is important to note that industrial machining has always followed a form of sustainability. Machining high-quality products at competitive prices allows a manufacturer to make a profit and thus maintain its existence as a company [2].

Throughout history, manufacturers have been trying to find ways to increase the profitability and efficiency of their machining processes. These initiatives include the ongoing creation of sophisticated and accurate manufacturing equipment, the enhancement of cutting instruments, and the general streamlining of cutting procedures. The following are some of the most specialized techniques: digital machining, high-feed, high-speed, and high-performance machining.

The recent initiative called sustainable machining aims to reduce the consumption of raw materials, energy and waste production throughout the life cycle of products, at a level that is at least in balance with the regenerative capacity of our planet. Often, the general discussion about sustainability focuses on the major global environmental problems but neglects the basic elements of price, cost, customer satisfaction, process knowledge and reliability. When it comes to durability in machine-tool industry, real success starts with simple and straightforward steps and analyses.

Sustainable development is possible only through massive investments in the industry and state support from the federal government. Introducing sustainable development principles into the machine-tool industry is possible due to building up human resources, including

designers and engineers, production optimization and expansion of research developments in the field of cross-cutting technologies. Support measures should be aimed at the reconstruction of the engineering and specifically machine-tool industry of the Russian Federation. Moreover, it is crucial to take into account the importance of reverse engineering from China and Iran, since without this step it is impossible to recreate the industry, as continuity in design schools is disrupted.

Thus, sustainable development in relation to the machine tool industry should be understood differently — through technological sovereignty. Technological sovereignty is to be established via creation and localization of production facilities in Russia with the implementation of the following ESG principles:

1. Sustainable pricing. Every company is faced with the challenge of setting sustainable prices for its goods or services. The price should be high enough to cover costs and generate a profit, but low enough so as not to push customers to turn to the competition. An industrialist can set a higher price only if the customer perceives that the product brings sufficient value in relation to what he pays.

Moreover, if the pressure exerted by customers and competitors leads to setting a price too low, profit margins suffer. When the price is lower than the cost of producing the product, losses arise from it. If competitive pressures push the price down too much, those who design and machine the product must find ways to produce it cheaper, faster and more efficiently to reduce production costs and support a sustainable profit margin.

2. The invisible costs. The threshold at which costs stop and profits begin is unclear. This is due to the fact that the actual costs themselves are also not clearly defined. Hidden, ignored or unknown factors do not enter into account in the calculation of costs. Typical invisible costs are, for example, unplanned downtime, rejected machined parts and tool breakage. These costs are not considered representative or real. The behavior or mindset that leads to the invisibility of certain cost factors is not limited to the workshop staff; it can occur throughout the company.

To achieve a sustainable cost structure, it is necessary to make the invisible visible. The workshop staff must examine and evaluate the machining process as well as the structure and flow of the company's activities as a whole in order to uncover hidden costs.

3. Customer satisfaction. Customer satisfaction is a key element of economic sustainability. A customer wants to know when his order will arrive. The production time, in the mind of a customer, begins when he places an order. However, the overall manufacturing time is not exclusively the production time. If the machining of a part requires a delay of three weeks, but the administrative activities ultimately take an additional two weeks, the workshop must be honest with itself and with its customers by indicating a delay of five weeks. Suppliers to the machining industry, offer inventory management, tool identification and machine monitoring systems that allow operators to track customer orders. They thus optimize the workshop's ability to meet deadlines and satisfy customers.

4. Waste and measures. Efficient production minimizes the waste of time, energy and raw materials. The problems

associated with machining waste such as chips, cutting oils and cooling fluids are complex. Industrialists traditionally consider waste as an inevitable result of processes and believe that change is difficult to implement, therefore its result as marginal.

To effectively reduce waste and preserve resources, it is necessary to fully understand the characteristics of materials and machining processes. Understanding implies an accurate measurement of the parameters and production processes in order to determine exactly the actions implemented and the actual results. True accuracy avoids the use of rounded figures; these usually indicate incomplete knowledge of the current process and prevent a valid analysis of the results, when changes are made.

5. Salary and sustainability. If we analyze sustainability in correlation with global labor costs, then the assessment of labor productivity should exclude wage costs. Labor productivity is equal to the turnover of production minus the costs of purchased goods and services, divided by the number of employees, divided again by a unit of time.

This formula measures labor productivity regardless of its cost and allows interesting comparisons of labor productivity between countries or companies with different salary scales. The salary of a qualified operator from a Western country may be ten times higher than that of his counterpart from a low-wage country, but this difference does not reflect real productivity. It is thus possible that 10 operators from a low-wage country produce fewer parts, of lower quality, than a single Western operator.

High labor productivity indicates that production operators have a deep understanding of what they are doing and that they have extensive knowledge and skills. This allows them to work faster, to take full advantage of their skills and to increase their professional satisfaction. Unforeseen machining events are frustrating for a qualified operator. This happens frequently in the case of diversified small series productions, where the products and the batch size change very often. However, operations can quickly be adjusted by qualified and multidisciplinary operators to overcome bottlenecks and other disruptive events.

6. A reliable process. A sustainable machining process must be reliable, predictable and minimize energy losses. Indeed, an unreliable process leads to the need to re-machine or even scrap parts. This leads to waste of raw materials, energy and labor that have been used to produce the rejected work (Illustration 1).

Russian machining process should be optimized in such a way as to minimize the negative impact on the environment with the available resources, knowledge and expertise.

7. Reduction of energy consumption. Throughout history, the industry has found ways to achieve better results using less energy. For example, in the early 1980s, many workshops had machines with 70 kilowatts or more. Today, the 7 kilowatt milling machines demonstrate a productivity that can be higher than that of these ten times more powerful machines. A sustainable machining process minimizes the energy consumed per mm<sup>2</sup> or inch<sup>2</sup> of material removed. Reducing energy consumption automatically leads to a decrease in energy waste, which makes machining more environmentally friendly.

Since the Russian Federation does not have a unified sustainable development strategy, one can suggest 4 steps to integrate sustainable development into the machine-tool industry strategy of the Russian Federation:

1. Review and plan the industry strategy. The government should define an ESG strategy that is based on convictions that is distinctive, significant for their stakeholders, that resonates in the market and that is aligned with their objective.

2. Deploy the strategy to the point of impact. It is at the point of impact that the strategy becomes concrete, with objective indications on «what», «when», «how» and «how much» we want to achieve.

3. Implement disruptive strategic initiatives. It is essential to follow a structured approach to guarantee the success of disruptive improvements, maximize results and ensure their sustainability.

4. Monitoring results and implementing countermeasures. Sustainability reports must be a faithful mirror of the ongoing efforts to pursue priorities and achieve strategic objectives.

## CONCLUSION

The machine-tool industry has long been looking for economic sustainability by machining high-quality products at competitive prices that allow it to support and maintain its businesses. To achieve economic sustainability, Russian machine-tool industry is tackling issues that also allow it to take into account and reduce the impact of its activities on the environment and achieve sustainable development in the broadest sense of the term.

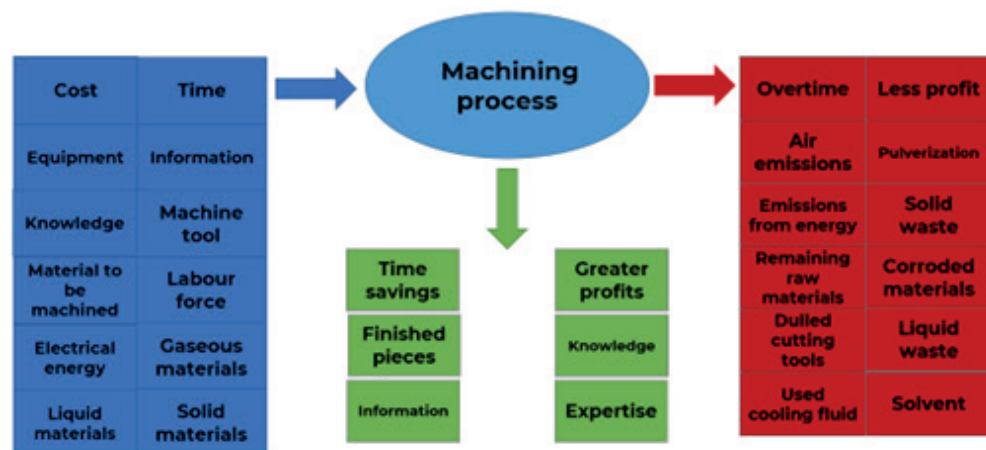


Illustration 1. Reliable and unreliable machining process

The organization and measurement of production factors and equipment is an important step for the elimination of waste and the establishment of sustainable machining processes. To know exactly at what level the losses of time and energy occur, operators must work

with precise figures and facts rather than speculations and estimates based on rounded figures.

It is possible to draw the conclusion that the presence of an advanced machine-tool industry is the mainstay of technological sovereignty of the Russian Federation.

#### **Список источников**

1. Кибл Б. Доклад Брундтланд: Наше общее будущее. 1988. С. 17–25.
2. Бюсси П. Устойчивое развитие для промышленности. URL: <https://www.easy-skill.com/fr/blog/defi-du-developpement-durable-pour-industrie>.
3. Как устойчивое развитие применяется к промышленности. URL: <https://www.industrieweb.fr/news/25858-comment-le-d%C3%A9veloppement-durable-s-applique-%C3%A0-l-industrie>.
4. Каково влияние ESG на промышленность? URL: <https://www.atpi.com/fr/quel-est-l'impact-de-lesg-sur-l'industrie>.
5. Первис Б., Робинсон Д. Три столпа устойчивости: в поисках концептуальных истоков. 2019. С. 681–695.

#### **References**

1. Keeble B. The Brundtland report: Our common future. 1988. P. 17–25.
2. Bussy P. Sustainable Development for industry. URL: <https://www.easy-skill.com/fr/blog/defi-du-developpement-durable-pour-industrie>.
3. How sustainable development applies to the industry. URL: <https://www.industrieweb.fr/news/25858-comment-le-d%C3%A9veloppement-durable-s-applique-%C3%A0-l-industrie>.
4. What is the impact of ESG on the industry? URL: <https://www.atpi.com/fr/quel-est-l'impact-de-lesg-sur-l'industrie>.
5. Purvis B., Robinson D. Three pillars of sustainability: in search of conceptual origins. 2019. P. 681–695.