

# Forecasting the Development of Mechanical Engineering Using the System Dynamics Method

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**Abstract.** At modern conditions of world economy tendencies, the connections between subjects of economy are becoming more difficult and closer. In particular, if in the past were spread hard forms of private ownership of enterprises at present-day world is going conversion to more flexible and mobile composition of subjects' activities. Computer simulation modeling is giving the best results at the areas where the participants of social and economic activities are spending significant efforts and sufficiently much time for visually playing and analysis of possible variants of the development of the events. The more difficult is the situation the more objects, factors, and possible variants of events' progress is necessary to play in different combinations between together and bigger effect possible to expect from application of simulation model for analyzing of the situation and for searching and making optimized decisions. The application of system dynamics method allows executing forecasting of economic agents including the sectors of economy.

**Keywords:** System and dynamic model, simulation modeling, economic agents, automation, manufacturing.

## INTRODUCTION

One of the consequences of public progress is the growth of pertinence between different areas of people activities, increasing the amount of technologies, local using of which may have global effects, and as the result – rapid increasing of complexity/difficulty of social and economic human environment. At these conditions the goal of computer simulation modeling is to give to the persons who are making decisions and also to the researchers of socioeconomic systems the effective tool for finding the decisions. Simulation modeling of business, active technologies, and managerial systems will give good results in day-to-day and strategic management and control of manufacturing, logistic, supply chains, and of an enterprise in total. It is useful and especially actual in the situations with large number of elements, difficult relations, and unpredictable progress of events.

## THEORETICAL BACKGROUND AND HYPOTHESES

Today the world is standing not far off Sixth Engineering Lifestyle [1]. The specialists in forecasting are thinking that if keeping modern rate of social and economic development the Sixth Engineering Lifestyle will take shape in 2010-2020 years and will achieve maturity stage in 2014 years. Incidentally in 2020-2025 years will occur the new scientific-technical and engineering revolution, the base of which will become the developments synthesizing the gains mentioned above core trends (Fig. 1).

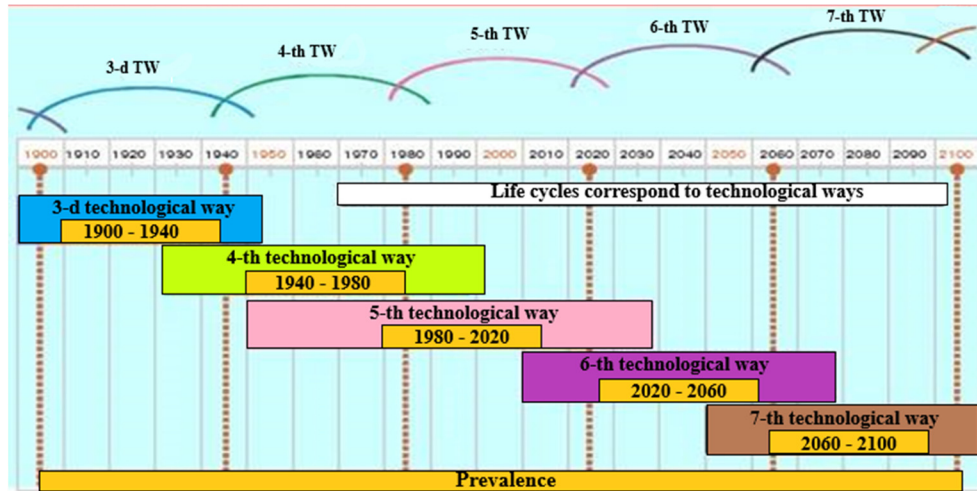


FIGURE 1. Periods of Engineering Lifestyle [1].

Under existing forms and methods of management, arrangement, and financing of operations such breakthrough into Sixth Engineering Lifestyle will be not possible to execute. Are cardinal changes necessary at these areas? The question about the role of engineering at such conditions and the prospects of the development of the sector itself is arising.

When looking to the output of CNC machine tools, one can see clear tendency of drop in production (Fig. 2).

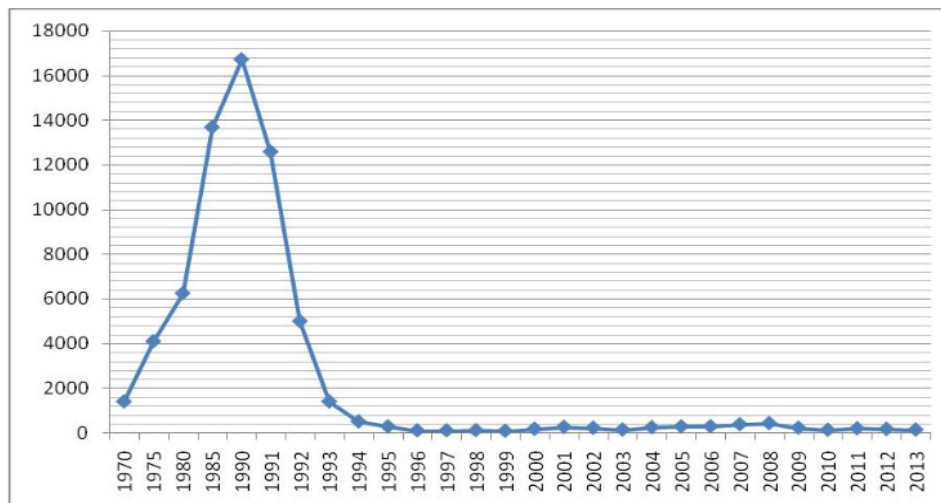


FIGURE 2. Output of CNC machine tools.

From other side, the trends concerning computer-aided manufacturing in the countries were the change-over to the Sixth Engineering Lifestyle is already going on the provision with CNC equipment is much higher than in Russia [2].

## THE METHOD AND THE EMPIRICAL RESULTS

To determine the perspective of development let make use of simulation modeling and compile system-dynamic model. Such models are often used for similar problems solving in socio-economic researches [3 - 10].

As the base of the model will be taken black box, the parameters of the model will be main social and economic indicators the set of which may be introduced as system-dynamic model of development (Fig. 3).

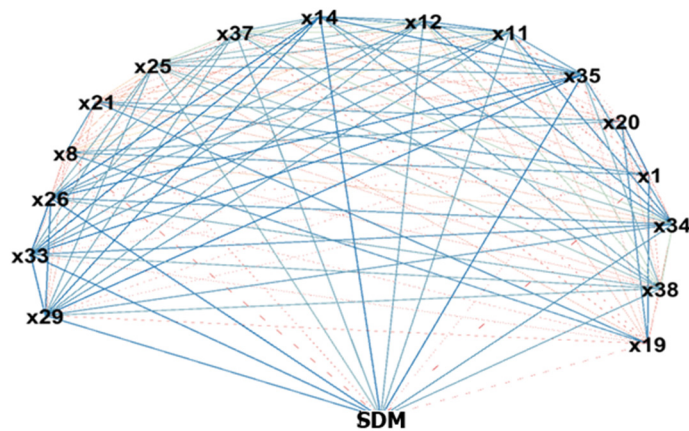


FIGURE 3. System-Dynamic model.

By main parameters of this model can be considered renew and dropout of the equipment, expenses of commissioning, installation and maintenance of monitoring systems of running CNC equipment.

Calculations using the model allow checking hypotheses of impact of one or another curve parameter analytically describing life cycle of the market and separate agents. Based on introduced model it is possible to make the conclusion about necessity of expanding monitoring systems of running the equipment at the enterprises of the region, which gives the opportunity to estimate operation rates and as consequence the conditions of sector enterprises (Fig. 4). The main technology for equipment monitoring systems are computer programs of type MDC/MDA (Machine Data Collection/Machine Data Acquisition. working efficiency are using for getting the information (data collection) about running CNC machine tools. Such data are using for analyzing of equipment working efficiency. Main goal of MDC/MDA is increasing the operating efficiency of the equipment.

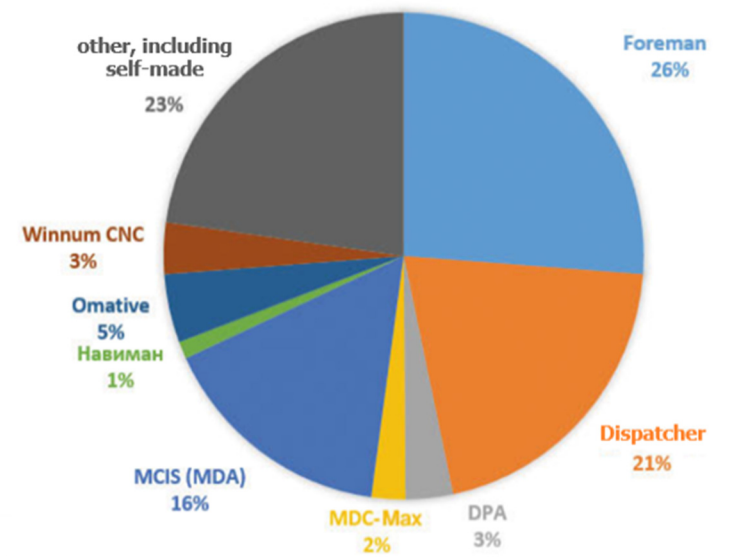


FIGURE 4. Market Share of According to Machine Tools Connected to Monitoring Systems in Russia in 2018.

The outline of monitoring systems includes the information transmission by network (local or wireless network) from machine tools to the server for data processing which is visualizing to the customer via supplements. Base on

this information possible to create the reports about equipment status, efficiency of the equipment, machines utilization, and the reasons and duration of downtime during defined time period.

Main requirement to equipment monitoring systems is the possibility of gathering data about equipment operation, improving manufacturing efficiency, reduction of unscheduled downtimes. Programs permit to gather large data arrays reducing human factor to zero.

## CONCLUSION

At modern economic conditions and subject to complication of relations and cooperation of economic persons is taking place the process of conversion to Sixth Engineering Lifestyle, which is closely links with development of innovation technologies, commissioning of new types of engineering equipment and renewing of fixed assets and widening of innovation activities within monitoring. It is restricted with the necessity for enterprises the control methods of equipment operation efficiency, and also the necessity of automation of equipment maintenance. Equipment monitoring leads to increasing of manufacturing efficiency and cost reduction. Monitoring systems are complete tools for enterprises needs. Using of such systems estimates prospects for development of key economic sectors including engineering sector.

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