Chapter 92
Investigation of Operational Characteristics of Mechatronic Systems in Industry 4.0

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ABSTRACT

This work presents the results of an analysis of the main expected potential problems that may occur in the implementation of the Industry 4.0 reform. It is proved that the pace and level of development of this reform will largely be determined by the effectiveness of the used mechatronic systems. It has also been established that as a result of systematic miniaturization of the nodes of radio-electronic equipment and microelectronic equipment and microelectronic technology, the main problem of these reforms and the implementation of complex technological processes is instrumental support, especially cutting micro-tools. Therefore, the examples of these micro-tools show methods for improving their performance characteristics.

INTRODUCTION

To date, almost every scientist in any country knows and is unequivocally recognized that at the beginning of the XXI century the whole world is at the turn of the fourth scientific and technological revolution, which fundamentally should change the style and level of thinking, the rules of life for every person and especially the young generation in all countries of the world. This is due to the fact that according to

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many scholars and authors of large-profiled studies on the state of the necessary conditions for a worthy meeting of major reforms impending change is evaluated as the most comprehensive and ambitious in the history of mankind. It will be held under the abbreviated name "Industry - 4" (*Turmanidze, Bachanadze & Popkhadze, 2017; Turmanidze, Bachanadze & Popkhadze, 2018; Turmanidze, Dašić & Popkhadze, 2018a; Turmanidze, Dašić & Popkhadze, 2018b; Turmanidze, Dašić, Popkhadze & Borodavko, 2018*).

During the first industrial revolution, which lasted for more than two centuries for the mechanization of certain operations of industry water and steam were used. As a result, the second revolution based on electricity were created mass production of many products in different areas of the economy. During the third revolution using electronic and information technology production processes have become automated. Now, based on the results of the third revolution is developing the fourth revolution, which is based on digital technologies, the development of which was started in the second half of the last century. It involves a merger of several modern technologies and the disappearance of all boundaries between physical, digital and biological spheres, is the creation of a cyber-physical systems.

In other words, the final goal of the "Industry 4.0" reform is full automation and remote control of complex technological processes and administrative and financial operations by using super modern mechatronic systems (*Turmanidze & Gviniashvili, 2011; Tzou, 1998; Van Beek, Erden & Tomiyama, 2010; Wang et al., 2005; Yu et al., 2008; Zhang et al., 2009*).

Results of the first three revolutions were general and applicable to all countries, for each enterprise and, in practice, for each person. However, the process of the fourth degree of the revolution and the consistent use of the results of its separate stages in practice will have a peculiar character for various industries. Of course, the basic principles are common, but since each individual branch has its own special modern multicenter and multivariable technology to their design and management will need special knowledge and individual approach.

To create the above-mentioned mechatronic systems, that determine the level and pace of the development of the "Industry 4.0" reform it Requires high-precision technological equipment and special micro-tools for different purposes.

We still in the 90s of the last century made a classification of all the basic micro-tools used in microelectronics and microelectronic technology, which are divided into three main groups. Cutting, mounting and assembly. Each group includes subgroups with different tool sizes and specific areas of their use.

For a significant increase in the reliability of microcircuits and, accordingly, the final product, one more group of micro-tools must be marked - control tools - devices that enable us to check before boarding on the PCB. We can check all the operational characteristics of the microchip that is already installed on electrical, mechanical and thermal changes. We have designed, manufactured, tested and patented several options for such devices for different sizes of microcircuits and their housings. Even the technological equipment-stamps and molds for their production have been created.

After testing and selection of microcircuits for such methods, it is possible to exclude early premature failures of complex microcircuits and expensive equipment and devices during operation, which provides a great economic effect. The design and operation of the above-mentioned micro-tools will be similarly reported in the presentation.

All these tools are used quite a lot, since a significant part of modern technology, from everyday to space equipment, Is a set of mechanical nodes, hydro and pneumatic equipment and microelectronic blocks or entire control systems, that is, a complex mechatronic system. For their manufacture requires the implementation of many technological operations of different profiles.