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# ANALYSIS OF THE PRECISION OF THE HUMAN-MACHINE METHOD[1]

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***Abstract:*** *The dynamic development and achievements of machine-building enterprises lead to newer and more precise requirements for the functionalities of the human-machine method. The precision of the method of human-machine interaction varies depending on the level of knowledge of the technological process and the extent to which the human or machine is involved. Participation can be distributed so that in a given situation when the machine is operating, the person has to control the control of the machine precisely, and this can lead to the greatest efficiency.*

***Keywords:*** *Quality, Quality Management, Quality Management System, Human–Machine System, Modelling*

## INTRODUCTION

In the modern development of technical means it is increasingly observed how the person from the control system passes to the control system. Man retains his leading role in decision-making in the automated control system, as the very definition of "automated" rather than "automatic" determines the position of man in the automated control system. Each method has its individuality and precision depending on the level of knowledge that is applied in the human-machine system. Knowing the levels of the information model of the process (Kirov & Proynov, 2021) and the presented classification of the six types of „human-machine“ systems (Kirov, 2018), we will present an analysis of the precision of using the models applied in the production process in the „human-machine“ system.

## EXPOSITION

### “Human-machine” system

The concept of a "human-machine" system was introduced relatively long ago, a system consisting of people and technology with all the accompanying elements. Complementing each other, they make the most of their advantages. Distinguishing between the two elements, man contributes with the use of his creative mind, complemented by his ability to approach heuristically to solve non-standard tasks. For it’s part, the machine contributes with speed and ability to accurately perform repetitive actions. The automated production control system combines economic and mathematical methods and modern technical resources and tools for data processing. As a result of the use and implementation of the automated control system, the rapid processing of a large volume of information, rationalization of information flows, scientifically based decision-making based on the availability of complete information is ensured. The main task is to determine the level of automation, which in turn will determine the distribution of control functions (human or machine). To distribute the functions, the peculiarities of interaction, social and economic fact between man and machine are taken into account.

Our familiar levels of knowledge of the information model, determining the level of knowledge of the process, are defined by the application of various mathematical and theoretical models. For each level of knowledge, several mathematical and / or theoretical models are applied, which determine the possibilities and the way of working at the certain level of knowledge. Each level determines a technological process, each process applied to the different types of "human-machine" systems determines different possibilities for the technological process. Depending on

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the use of the active and passive element (s), each system determines different quality parameters of the final product. Each system can be assigned a level of knowledge that determines how well the system is known for use and to what extent the production process can be controlled. The active element in the "human" system determines which models of knowledge can be applied to a given system. All models (mathematical and theoretical) define different possibilities for use and application by the active element "human". By defining these models we can determine which models can be applied in line and which off line.

**Types of tools (models) for description and subsequent implementation and management**

The model itself can be a real object or be abstract, in which an object from the real world can be represented by human or technical language. The main types of models that serve to simplify the representation or duplication of real things: physical, theoretical, logical, simulation and mathematical. The quality level of each applied model depends on and is determined by the level of knowledge about the specific model. With the right choice of the information model, efficient and effective implementation and management of the process is achieved, which contributes to improvement and enhancement of the qualities of the final product. Knowledge of the process varies between two boundaries, the theoretical model that always gives an accurate answer, in which when changing the factors that affect the process we get what we get as a final result. The second most accurate is the probabilistic method and the planned experiment, this is the statistical modeling that determines the process in a given variance.

**Logical model**

Through a logical model we can model certain actions that make up the whole technological process. We cannot model the whole process, we can determine which process when to act, which process we can execute and which process we cannot. Describing the considered model, logically determined steps of the process remain undefined.

**Theoretical model**

Mathematical description of the equation by which the model is controlled. The most accurate model that we can give to a model is the theoretical one, through it we determine the equation with the parameters that will be controlled in the process. Generalization of specific models is the main purpose of the theoretical model, while not repeating specific theories, but summarizing them. In essence, the theoretical model uses a set of idealized abstractions and objects to represent reality in the form of theoretical and schematic representation.

**Deterministic model**

In the deterministic model all parameters of the system and characteristics of the production base are known in advance and constantly. This includes how many jobs there are, technological routes, the type and number of machines, etc. The deterministic planning tasks are reduced to a significant sequence, where it is enough to know the beginning of the first operation of the first of the tasks and their sequence of operations performed by each machine. The purpose of planning is to optimize some aggregate indicator by accurately measuring the control variables associated with the production base. In the deterministic model, it is desirable to build normative models.

**Stochastic model**

Stochastic modelling is data and predicts results that take into account certain levels of unpredictability and randomness. Through the stochastic model we define an equation with which we determine a probability forecast, an equation to determine a probability result, the result of these equations determines a result for some probability. Each parameter of the system and the characteristics of the production base can be changed at random. The planning tasks in the stochastic model refer to systems whose parameters change at random. A set of random variables arranged by some parameter in time or space defines the stochastic process. Stochastic patterns are mostly descriptive. In this model, the probability of a quality product is a variable that can be a different value each time.

**Planned experiment**

Experiment planning is a set of requirements that determine the solution of the planned experiment with the necessary accuracy. This set required for the organization and conduct of the study usually includes the following stages: defining a plan for conducting the experiment, minimizing the volume of experiments, control of these experiments, correct selection of measuring instruments with the required accuracy and determining accuracy of the results, respectively the conduct of the experiment and analysis and synthesis of the obtained results.

**Probabilistic model**

Probability theory serves to study the models of random phenomena, as well as the basis for building their solutions, these are random variables, random events, their properties and influence on them. The probability model allows to estimate the degree of probability of occurrence of an event. The probability model is similar to the stochastic one, but in this model the modelled function is known in which the probable solutions are a variance around this function. In this model we have a percentage of probability at which to produce a product.

**Analysis of the Models Applied in the Levels of Knowledge**

Knowing the applied models that are involved in determining each level of knowledge, we determine how each of the levels of knowledge affects and / or applies to different types of “human-machine” systems. This definition will allow us to know about the different types of systems, what level of knowledge is suitable for application. All this depends on the type of active element in the type of system, which at the same time determines the possibility of application of a given level of knowledge.

**Level of knowledge „α“**

The first level determines the objective knowledge, which is determined by the only form of scientific knowledge "law". This level of knowledge allows theoretical analysis of mathematical structures through the tools of theoretical mathematics, which achieves the desired accuracy in forecasting. The level predetermines the use and application of the logical and theoretical model.

**Level of knowledge „β“**

This level combines the logical, theoretical and deterministic, in which the basic concept they apply is theory. It allows to predict future events and their observation, the results obtained imply conducting subsequent experiments to confirm or reject the theory.

**Level of knowledge „γ“**

This level combines most of the presented models. Process management functions are the application of statistical control and achieving the process to be under control and to fulfill the set output parameters. Improvement to reduce distraction. The change may require minimal changes, but may also require a redesign of the process or a change in operating conditions. These models are sensitive to changes in the field of study or object of study. The aim is to use the level of knowledge "γ" to define tasks and problems to be studied and find a solution.

**Level of knowledge „δ“**

The construction of a hypothesis combines for the most part all the levels listed so far. In cases where there is no objective information about the object and / or the field of research, this level can be applied. Each hypothesis is an approximately true explanation that has the character of relative truth. (Penev, 1976)

### Application of Knowledge Levels to Types of “Human-Machine” Systems

The “human-machine” system itself predetermines two main active elements that participate in the types of systems. The two active elements define different approaches and methods for creating a workflow, each element uses a different method for data processing and transmission.

Types of “human-machine” systems from A to C. (Kirov & Proynov, 2021) determine the main active element to be human. All levels of knowledge can be applied to these types, but not in their entirety. Depending on at what point in the process they are applied, whether it is inline or offline. Man does not predispose to the use of many of these models at the time of the inline process. The main model that can be applied at the time of an inline process is the logical model. This model aims to build a graphical representation of the logical structure in the field of research. One can determine which processes to perform, which ice process to follow, and which processes to skip if necessary. All other models that are listed can be used by humans only before or after the implementation of a technological process. It would be more difficult for a person to cope with significant changes needed during the technological process or work during the inline process.

Types of “human-machine” systems from D to F (Kirov & Proynov, 2021) determine the main active element in the system to be the machine. In these types of systems, man is also present, but he is needed only at certain stages of the production process: setup, programming, introduction of new processes and more. As an active element, a machine can apply most of the considered models during the inline process. During the inline process, the machine immediately processes the information transmitted to it by man, necessary for management, control and change of the technological process in real time.

## CONCLUSION

The correct choice of the level of knowledge determines the quality of the final result achieved by the correct application of the information models. The degree of quality is determined by the level of knowledge of the applied models. Each of the active elements is defined by the accompanying at this stage of technology development advantages and disadvantages.

The person as an active element defines as the main advantage that it can be easily adapted to solve non-standard tasks. Gaining experience based on certain activities that he performs, he achieves constant improvement and refinement, which leads to increased results in future tasks. The disadvantage is the slower transmission of information from man to machine without specialized CAD / CAM / CAE software.

The machine as an active element defines as the main advantage that it can quickly perceive the information it needs to control the process, compared to humans. The disadvantage is the inability to adapt and solve non-standard tasks, and decision-making during the inline process. The adaptability and the solution of non-standard tasks will be able to be realized at the moment when the artificial intelligence is introduced.

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