STRUCTURAL REORGANIZATION IN THE INFORMATIONAL - TECHNICAL SYSTEM OF A PRODUCTION MACHINE (HYBRID) FOR OPERATING IN THE INDUSTRY 4.0

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Abstract: *Research of the relationship between the technical and informational indicators of a production machine (hybrid). Analysis of impact on flexibility, interoperability, decentralization and receiving information in real time. The relationships are represented with the optimization models.*

Keywords: INDUSTRY 4.0 , INFORMATION-TECHNICAL SYSTÉM, STRUCTURAL REORGANIZATION

1. Introduction

The significance of the problem of structural reorganization of informational-technical system of the production machinery for operating in the Industry 4.0 is determined by the degree of influence of the factors as: Improving of consumer requirements about terms of flexibility and products customization, integration of customers, suppliers and contractors into processing of production project, real-time information and quality control.

The main objective of this article is to present analytical approach Step by Step of correlations between the technical and informational indicators of manufacturing machine (hybrid) following demands of Industry 4.0, as to analyze impact on flexibility, decentralization and data processing in real time.

2. Approach „Step by Step".

First step. Compliance with the principles and Strategy of Industry 4.0

The term "Industrie 4.0" was introduced in 2011, when an Initiative named "Industrie 4.0" - an association of representatives from business and researchers promoted the idea as an approach to strengthening the competitiveness of the German manufacturing industry. The subsequently formed "Industry 4.0 Working Group" developed first recommendations for implementation[2.] Through " White Paper" developed by members of the "Platform Industry 4.0"[3] is defined a Strategy for development of the project areas until 2035, shown in Fig.1. It understands Industry 4.0 as "a new level of value chain organization and management across the lifecycle of products"[4]

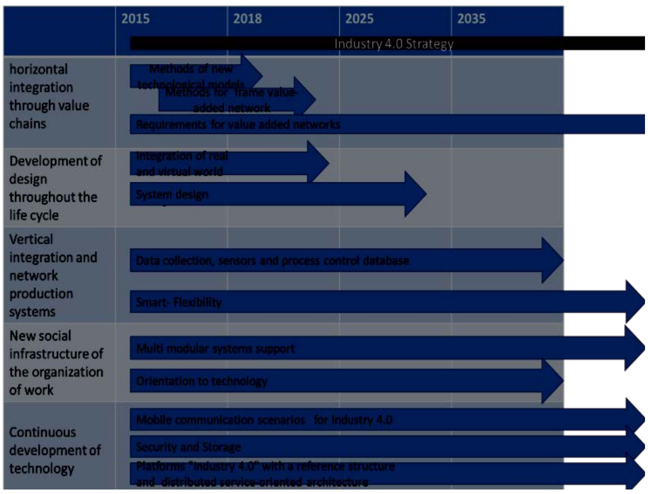

Fig. 1 *Strategy of the Industry 4.0 to 2035*

Based on the findings from the literature review are determining the principle for its implementation: interoperability, virtualization, decentralization, real-time capability, service orientation, and modularity[5].

Second step. Sequence of the stages for development a hybrid component (machine).

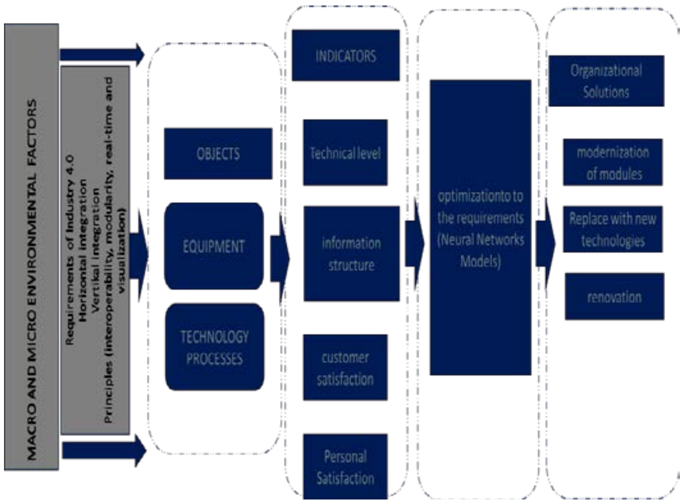

***Fig**. 2 Stages of implementation*

The stages for structural reorganization in the informational - technical system of a production machine (hybrid)for operating in the Industry 4.0 are shown in Fig.2.

Factors regarding to structural reorganization

The influencing factors can be grouped meeting the equipment of Industry 4.0 as follows:

- Factors influencing physical wear, which reduce production capacity. These factors are directly related to the requirement of flexibility;
- Factors influencing innovation aging. This group is directly related to the requirement of interoperability;
- Factors influencing level of technical system, level of automation These group of factors directly related to the requirement of decentralization;
- Factors influencing level of information system related to decentralization and virtual copy;
- Factors influencing system flexibility These factors are related requirement of the modularity;
- Factors related automation software (CAD / CAM / CAE), meeting the requerements of information online;
- Factors related to the operational and functional compatibility;
- Factors associated with horizontal and vertical integration.

Above factors are methodological base of the analytical approach for implementation of Industry 4.0.

Factors associated with horizontal and vertical integration are shown in Fig. 3.

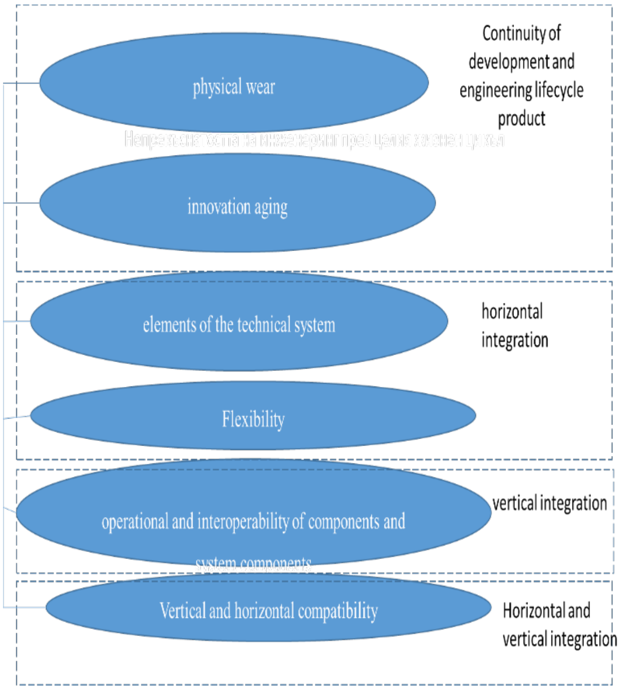

Fig.3 *Factors for the Horizontal and vertical integration*

Research of correlations between the technical and information indicators. Defining the level of information structure.

Table 1 lists the Indicators, influencing the information system.

Table. 1. *Factors influencing the information system*

1.	*Security and reliability systems*
1.1.	Information environment
1.1.1.	Continuity of information
1.1.2.	Comprehensive exchange of information in real time
1.1.3.	Confidentiality of information
1.1.4.	Specific information requirements
1.2.	*Horizontal and vertical integration*
1.2.1.	Information systems with horizontal level of integration (information material, energy, technology, etc.).
1.2.2.	Information systems with vertical integration level (hierarchical levels of production management and technology).
1.3.	*Software products*
1.3.1.	Degree of digitalisation (individual solutions, integration models) in the vertical and horizontal direction
1.3.2	Reliability

Third step. Choosing a machine (hybrid)

Structural reorganization of information - technical system of production machine (hybrid) meeting the requirements of Industry 4.0 -Lathe HARRIS L33 CNC (Fig. 4), which will be equipped with CPS

Model		L33
maximum diameter of processing over body	mm	330
maximum processed diameter over slide	mm	190
distance between centers	mm	630
end of the spindle type CAMLOCK		D1-4
cone of the hole of the spindle		MK5
bore in the spindle	mm	38
RPM spindle	rpm	Low 80-1200 Higher 250-300
move to axis X	mm	165
Move to axis Z	mm	600
quick moving to axis X	mm/min	3000
quick Moving to axis Z	Mm/min	2000
Accuracy of positioning	mm	0.025

Fig.4 *General Characteristics*

Determination of indicators for monitoring.

Based on analytical study have been observed three indicators due to their importance for the technical-information system. These are the indicators; vibrations, cutting forces and thermal effects. Every indicator will be controlled through CPS.

First observed parameter – Vibrations.

One of the most frequently monitored parameter during the technological process are vibrations, as follows:

- Low quality of the manufactured parts;
- Damaging the instruments;
- Damaging the machine nodes.

The spindle is the main element of the machine. The vibrations may affect the durability and accuracy.

Measurement tools.

Selection of vibrometer -distanced CPS, which have the follow advantages, as follows:

- High accuracy;
- Easy to attach;
- Big range.

A vibrometer could be easily installed on the top of the machine shown in Fig. 5

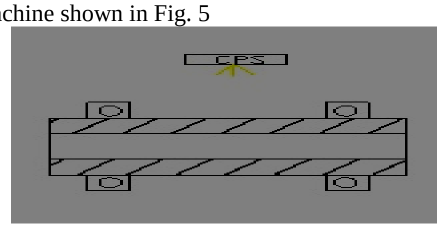

Fig.5 *Practical installed CPS*

Second observed parameter - cutting force

Cutting force acts on the cutting tool and may affect the quality. The Measurement tool is a Tensiometer. The main advantages are accurate measurement in real time.

Third indicator of study – thermal effects.

The working process generates heat that increase weariness and durability of the cutting tool and affects the quality and productivity. Measuring the temperature of the cutting tool is difficult because of the complexity of the location of the measuring tool.

The most appropriate choice is optical sensor with the Advantages, as follows:

- The optical sensor is contactless and can be located away from the cutting zone;
- Very precise temperature measurement;
- Small dimensions, easily for installment;
- Real-time Information.

The sensor can be installed on the toolholder away from the cutting zone, Fig.6.

Fig 6. Toolholder

Sensors networks

The sensor signals will be converted by neural networks (transducers) -Model performing optimization in real time and transmit the information to program planning and control. The information collected from the sensors is converted and adjust cutting program, this assure more productivity and quality control on the process. Based on their results, the preset program for turning to self-regulate and changing process parameters in real time (Fig.7)

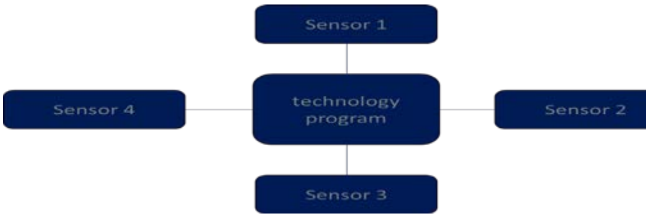

***Fig 7.** Sensors networks*

Conclusion

In this article is to present analytical approach Step by Step of correlations between the technical and informational indicators of manufacturing machine (hybrid). With the application of the proposed approach is expected technical improvements, such as reducing errors caused by vibrations, thermal deformation, and the worn tools. The hybrid system will assure more effiency work. Expected results fulfilled the requirements of Industry 4.0 as follows: real-time information, flexibility, interoperability, modularity, decentralization and virtualization.

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