INTELLIGENT INDUSTRIAL INTERNET of THINGS (IIIoT)

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Abstract. Currently, artificial intelligence technologies have begun to attract special attention at the state level. The development of artificial intelligence technologies will make quick and optimal decisions based on the analysis of large amounts of data, and will also give great advantages in the quality and effectiveness of engineering design and production management.

The foundation of artificial intelligence is knowledge. Knowledge is initially classified according to the attributes “clarity”, “accessibility”, “propositionality” and “level of abstraction”. To build a bank of engineering knowledge, on the basis of clarity, knowledge must be explicit, on the basis of accessibility, interorganizational, on the basis of propositionality, active, and on the level of abstraction, common.

There are two categories of knowledge - passive and active. Passive knowledge is text documents stored in books, methods, and the like. To transform this knowledge into artificial intelligence systems, a highly efficient technology is needed that allows knowledge carriers to create knowledge bases without the involvement of programmers. This technology is described in this article.

***Keywords*:** artificial intelligence, Industry 4.0, digital manufacturing, intelligent systems, intelligent design and management systems.

Introduction

Industrial digitalization is based on artificial intelligence (AI) methodology. By 2025, it is projected to quadruple the cost of AI adoption. The use of artificial intelligence will become a ubiquitous standard, as in many cases it is the only way to remain competitive.

Currently, sophisticated technologies associated with processing big data and cloud technologies, which have security problems, are used to create intelligent production control systems. To do this, you need to involve IT companies. This is difficult for small and medium-sized industries. What are needed are simple tools available for such industries. The data should be neither large nor small, but necessary and sufficient and based on existing standards, and in this case - ESTD.

As for knowledge, it must be contained in the knowledge bases of industries. At the same time, an empty technology of consciousness of such knowledge bases is needed, based on the language of "business prose", as close as possible to natural language and to be available for development by non-programming users.

These are the methods described in this article.

The digitalization of mechanical engineering should be based on the latest technologies of the industrial Internet of things IIoT (Fig. 1) and, in particular, on intelligent IIIoT.

A distinctive feature of IIIoT is the convergence of information technology (IT) and operational technology (OT). In IT, operations represent the knowledge base modules described below. In this case, it is advisable to divide the OT operations into two classes: the OT operations themselves, which are technological operations associated with changing the properties of the object being processed, and the OL operations, which are logistic operations associated with changing the location of objects

OTs are designed in advance in technological design systems and loaded into the database in relation to those items that are subject to processing at a given time. Logistic operations are generated dynamically by the production execution system as required.

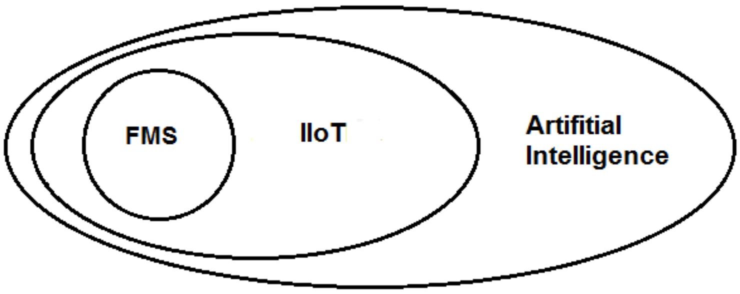

Fig. 1. General scheme for creating intelligent factories

The technical basis for the creation of intelligent manufacturing is flexible manufacturing systems (FMS). FMS is a set in various combinations of equipment with CNC, robotic technological complexes, flexible production modules, individual units of technological equipment with CNC and systems for ensuring their operation in automatic mode for a given time interval, which has the property of automated changeover during production of items of arbitrary nomenclature within the established limits of the values of their characteristics (GOST 26228-85).

The main structural elements of the FMS are a robotic technological complex (RTK), a flexible production module (FPM) and a system for ensuring functioning.

Purpose of the study - At present, using the software of the Russian company "Center SPRT-T", an intelligent system for semi-automatic design of mechanical engineering products has been developed [1]. To create end-to-end digital technologies, it is necessary to develop an intelligent control system for a flexible manufacturing system (FMS) capable of manufacturing the designed objects.

As such a GPS can be used a training mini FMS, created in England at the firm "Denford" and installed at the Moscow State Technical University (BMSTU) (Fig. 2).

FMS "Denford" includes two lathe modules 1 and milling 2. In addition, there is a product control facility 3. The transportation and storage system of the FMS includes a belt conveyor 4 and an automated warehouse 5.

Intelligent ACS FMS should provide the following functions:

1. Selecting a production facility
2. The choice of the technological process of production
3. Selection of technological operation of production and equipment
4. Delivery of technological equipment
5. Adjustment of technological operation
6. Delivery of the processing object
7. Manufacturing processing
8. Control of processing results
9. Warehousing of the processed object
10. Execution of final operations and storage of equipment

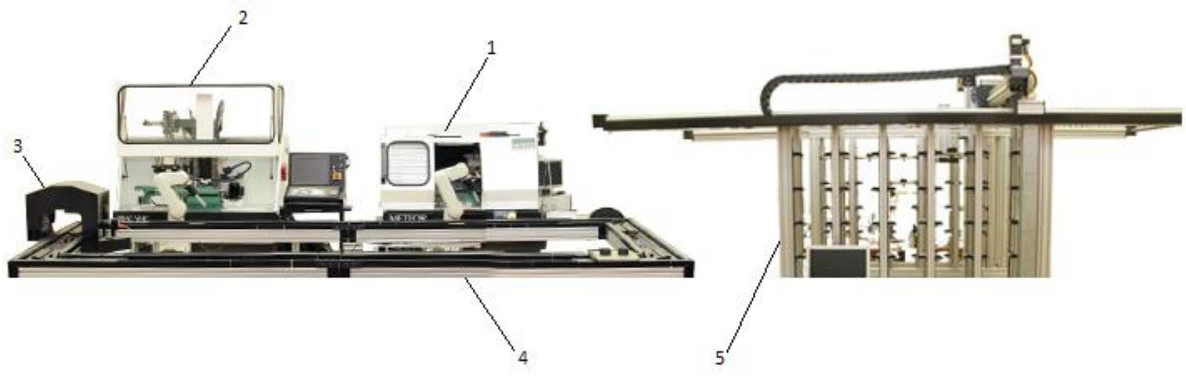

Fig. 2. Mini FMS "Denford": 1-lathe module, 2-drilling and milling module, 3-product control module, 4-belt conveyor. 5-warehouse.

Materials and methods

Fig. 3 shows a functional model of a production system. Here at the entrance there are blanks, materials, semi-finished products X = (x_1, x_2, …., x_n). Output - products and waste Y =

$(y_1, y_2, \ldots, y_n)$. Management includes production plans $U = (u_1, u_2, \ldots, u_n)$ and disturbances $E = (e_1, e_2, \ldots, e_n)$, and mechanisms are production resources R.

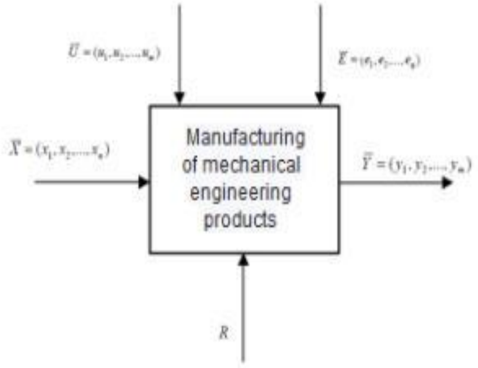

Fig. 3. Production system model

Fig. 4 shows a class diagram of digital production facilities. From the number of input objects, it displays blanks, materials and components.

The knowledge base of the intelligent control system of FMS is a semantic network of agents (Fig. 5). It provides the automated functioning of the FMS, which is necessary for solving the assigned production tasks.

Tab. 1

GPS transport operations

An object	Single production	In-line production
Blank	Warehouse Conveyor Robot 1 Workplace 1	Warehouse Conveyor Robot 1 Workplace 1
Semi-finished	Robot 1 Conveyor Conveyor	Robot 1 Conveyor Robot 2 Workplace 2
Semi-finished	Warehouse Conveyor Robot 2 Workplace 2	
Product	Robot 2 Conveyor Warehouse	Robot 2 Conveyor Warehouse

Transport operations described in Tab. 1 belong to the field of logistics

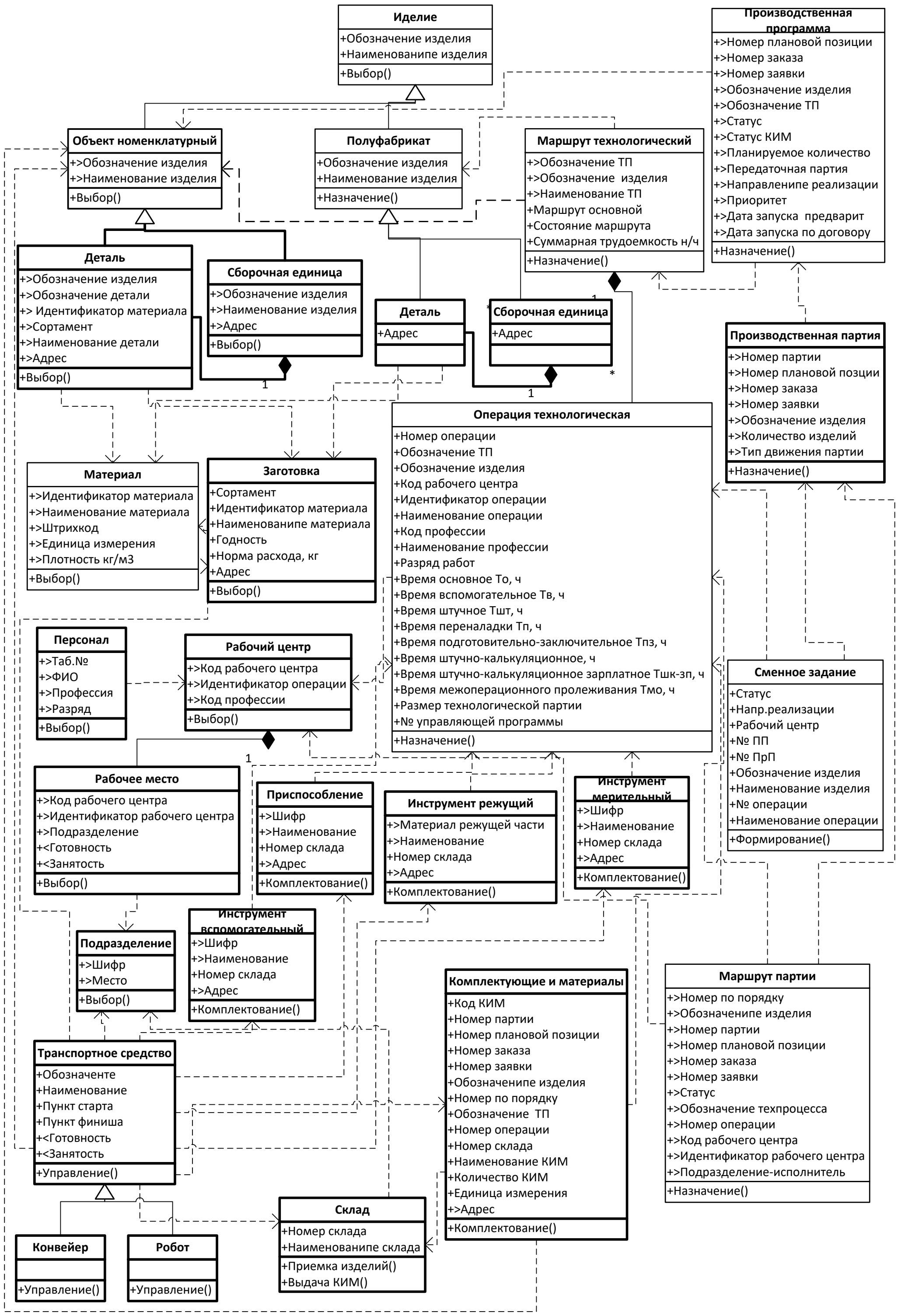

Fig. 4. Digital Manufacturing Object Class Diagram

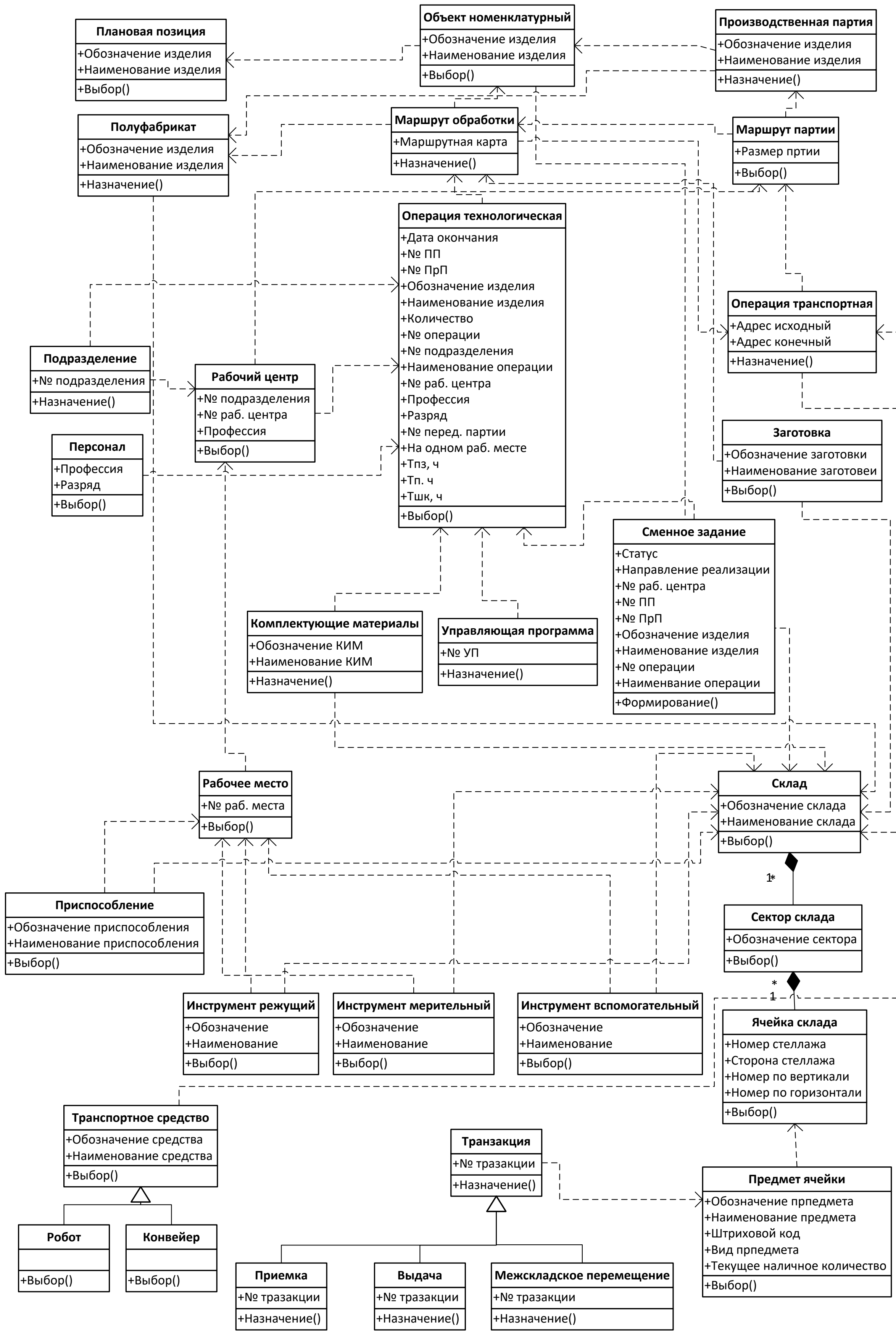

Fig. 5. FMS management system knowledge base

Results and discussion

Until recently, the Internet of Knowledge and the Internet of Things have evolved with little or no connection to each other. The Internet of Knowledge worked with virtual objects, and the Internet of Things - with real ones. To create intelligent control systems for flexible manufacturing systems, the integration of both directions is necessary. This is depicted in the object class diagram shown in Fig. 4, where virtual objects are contoured in thin lines, and real objects are in thick lines.

Conclusion

A method has been developed for creating knowledge bases for managing flexible production systems in mechanical engineering.

As the experience of operation of intelligent systems based on knowledge bases shows, the labor productivity of technologists increases 2-3 times, due to the automatic generation of technological processes. At the same time, there is an improvement in the quality of design results due to the use of the best proven solutions.

References

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