POLISH ACADEMY OF SCIENCES - MATERIALS SCIENCE COMMITTEE
SILESIAN UNIVERSITY OF TECHNOLOGY OF GLIWICE
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Conference Proceedings

11th INTERNATIONAL SCIENTIFIC CONFERENCE
ACHIEVEMENTS IN MECHANICAL & MATERIALS ENGINEERING

Technological database as a brain of an intelligent manufacturing system*

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An intelligent manufacturing system is intended to produce one or more subjects that it is designed for in an optimal way. This means that it has to find a proper production process to produce the subject in an optimal way. The manufacturing system can be called 'intelligent' when it is able to find applicable optimisation criteria upon its past experiences thus improving its performance in future. Therefore an intelligent manufacturing system needs capabilities to store data and make decisions upon them. Such a 'brain' can be established by a proper design of a technological database and its database management system (DBMS). Examining all constitutive parameters of a work operation a model of a production process organization can be made, which can serve as a basis for a suitable database design. In addition, an application programme that will check the existence and availability of work operations in the database has to be added to the DBMS. What remains are some optimisation criteria upon which we will choose an operation among suitable and available work operations. This task is fulfilled by a genetic algorithm optimisation techniques that would consider work operations' data as parameters of optimisation and on this basis search the optimal one out of the set of available operation.

1. INTRODUCTION

In order to classify machines as "thinking", it is necessary to establish to what degree does intelligence consist of, for example, solving complex problems, or making generalizations and relationships? And what about perception and comprehension? Researches into the areas of learning, of language, and of sensory perception have aided scientists in building intelligent machines. One of the most challenging approaches facing experts is building systems that mimic the behavior of the human brain, made up of billions of neurons, and arguably the most complex matter in the universe. Perhaps the best way to gauge the intelligence of a machine is British computer scientist Alan Turing's test. He stated that a computer would deserves to be called intelligent if it could deceive a human into believing that it was human [1].

Fritz wrote a useful definition by which a system is part of the universe, with a limited extension in space and time. Stronger or more correlations exist between one part of the system and another, than between this part of the system and parts outside the system. Adding the definition of intelligence to this we can say that an intelligent system is a system that has its own main objective, as well as senses and actuators. To reach its objective it chooses an action based on its experiences [2].

* Authors participate in the CEEPUS No PL-013/02-03 project headed by Prof. L.A. Dobrzański.

2. INTELLIGENT MANUFACTURING SYSTEMS

Following these definitions, we can move to artificial intelligent system. That means a machine, which will possess the properties described in above definitions. Nowadays the only system that can gain some of the intelligent properties is a computer. According to this fact and above definitions a mechanical system has to consist of all necessary mechanical parts, a computer and sensors that will enable it to gather new data for making new conclusions.

This brought us to a definition of an intelligent manufacturing system. Characteristically for manufacturing system is that it consists of many subsystems. Intelligence can therefore be brought into the system through:

- subsystems,
- by a supervisory unit of the system or
- both.

A manufacturing system is also distributed over a considerably big area what involves a use of some kind of transport and a computer network to connect all involved computers. On the other hand is a manufacturing system limited in its actions to tasks and jobs defined by its subsystems. Therefore are learning tasks limited to finding a best solution inside its efficiency frame. "Finding the best solution" is in other words called optimisation, so a process in which the possibilities are compared to certain criteria, and those best fitted to them are the result of the process. Hence, the objective of an intelligent manufacturing system is to produce a subject that it is designed for in an optimal way, and to find proper optimisation criteria upon its past experiences to improve its performance in future.

The intelligent production systems consist of several subsystems out of which the subsystem for detection, the subsystem for deciding and the subsystem for execution are the most important. To conclude, we can say that an intelligent system has to communicate with its environment, store gathered data, and make new conclusion upon them in order to improve its future performance. Gathered data have to be stored in a way in which they can be quickly retrieved when needed. Since not all of the gathered data are necessary in all times of system's activity there should also be a mechanism for filtering and sorting data. To all these purposes a whole bunch of computer programs have been developed through years that are called databases. Since a database is a system's memory unit we can freely name it "a key concept" of an intelligent manufacturing system. Why a concept? A concept is the basic element of thought. It is a physical, material storage of information (in neurons or electronics). All the concepts in memory are interrelated; they form a web, a net.

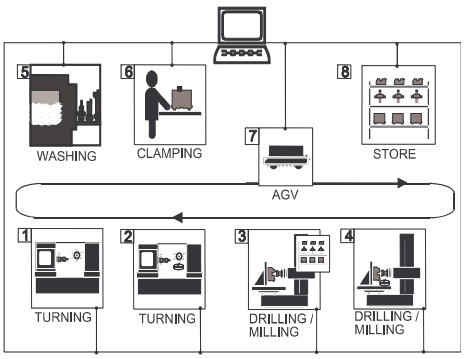

Figure 1. Intelligent manufacturing system consists of many subsystems and an intelligent control device [3].

3. TECHNOLOGICAL DATABASE

First databases were used to manage data in business systems. The reason is simple: business systems are very uncomplicated in informational sense. Instead of filling out paper forms, people have been doing the same job using computers' keyboards. The benefit is shown later when application programs that are parts of a DBMS do the calculations automatically. A lot more complicated is to build a technological database. The basic reason is in the fact that documentation in technological process doesn't represent the main objective of the working process and it isn't "form-like". To cover a technological process with a database means a lot more than studying the organisation and preparing reports.

3.1 Key information

Researches showed that majority of disturbances in production systems are consequences of communication mistakes, and these again come out from wrong interpretations of data [4]. Therefore is data integration the key element of any organisation. This means a uniform database with uniform database management system. When discussing production organisations we can make some generalisations. One is obvious. Every production organisation produces something by adding new value to some raw part. This procedure is usually called work, and consists of sequence of operations that we can call work operations. If we stop this generalisation here, we can conclude that a production organisation is in fact a store with definite stock of work operations. Objects in a store can be counted, described and registered in some form. The problem is that objects in a store are usually single data whereas work operations are sets of data, e.g. information. This means we have to analyse the work operation to find its components and define them.

Examining all constitutive parameters of a work operation we can make a model of a production process organization. A production process always starts with an order that describes the subject of the production, and consequently defines work operations. To complete, and control a work operation some production / information resources are needed, e.g., a machine where a manufacture will take place, an operator to control and serve the machine, a tool to machine with, and some auxiliary devices to hold and manipulate a work piece. All the resources involved will eventually need some maintenance, and will produce rests. Their activity needs some energy, and energy with rests and maintenance represents the cost's category that finally influences the new value of the finished order / work part.

Productivity, costs, and quality of the production process depend on the selection of the work operation. Therefore, optimisation of procedures means a selection of the combination of work operations that will give the demanded result (work order) at less possible costs [5].

According the above deduction we can now write the definition of work operation in informational sense. The work operation is a group of working means that bounded together enable execution of the operation. Execution of operation means adding a new value to the raw part and this value is what the organisation will try to sell in the market. Therefore is the cost of this added value major concern of every PPC department and researches in the TDB field should address these issues. Selection of work operations determines

- costs,
- productivity and
- quality of production.

The objective of PPC department is to find a combination of work operations that will give demanded results in demanded time frame at lowest possible costs. Our task is to define such

a structure of work operation, which will assure the data for mentioned criteria and will be suitable for automatic handling in a database. In this manner the operation would consist of 6 groups of data:

- Manufacturing mean (machine tool)
- Tool
- Auxiliary mean
- Operator
- Maintenance means

4. CONCLUSION

The main goals that we are trying to reach by our research work are:

- reduction of preparation times, and
- speeding up the decision making process.

The model rather tends to support the operator in the decision making process than to replace him or her. It isn't a kind of so-called intelligent interfaces because the intelligence has to be brought into it by the operator. It is on the other hand a very powerful automation tool that prevents most of errors that usually occur as an outcome of sequential human errors [6]. The structure of the model guarantees that all influencing production factors will be promptly taken into account thus assuring a precise planning and accurate scheduling, what brings an important competitive advantage in nowadays markets.

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