Development of structural element precedent of technological process in computer-aided design

L A Simonova¹, E I Egorova²

¹Kazan Federal University, Naberezhnye Chelny Institute
423810, Naberezhnye Chelny, Mira av., 68, Russia.
²Kazan National Research Technical University named after A.N.Tupolev - KAI (KNRTU-KAI), Russia

E-mail: chelny@kpfu.ru

Abstract. Based on the methodology of building of the intelligent system of TP design, a new approach to the transformation of information on structural and technological characteristics of the part and of 3D part model and representation of it in the form of elementary constructive modules structural units of a surface to form automatically alternative TP variants on a complex of qualitative and quantitative criteria. Each constructive surface module is represented in the database of module CAM of the intelligent system for constructing TP with records of all possible transitions.

1. Introduction

A large number of unresolved problems are related to the automation of the design of technological processes (TP). Almost all domestic CAM TP (CAM (SPP- system of production preparation) systems) do not allow today to automate the TP design of a part manufacturing. In modern CAM TP used mainly the designing of routing technological processes based on analogues (standard, TP group, parameterized models of TP, "common" TP for a group of parts) [1]. Methodically different approaches are used: level view of technological processes, the representation of processes as "trees", etc. The role of technologist-designer is crucial so as he forms the routing technological process, based on his own knowledge, experience, intuition and preferences (often erroneous). Design decision is subjective.

Meanwhile, the technological process - is, first of all, the routing technological process and the accompanying it additional information about the place of his realization, used equipment, the expected labor costs. The designed technological process is the carrier of information used by the various subdivisions of the enterprise to manage current production, analysis and prediction of the new one [1, 2].

A truly creative is precisely the formation of routing TP and defining the means of technological equipment. The rest is derived from this process. However, at this important stage of designing the existing CAM TP practically do not give the technology the necessary intellectual support. All subsequent steps of the designing are less complex, but are associated with a significant amount of routine work - preparation of technical documentation, various statements and specifications. These functions in modern CAM TP automate successfully. [2-6]

It could argued that the vast majority of existing CAM TP (both of domestic and foreign design) are automation systems of technological operation level. These systems allow to raise productivity of a technologist through automation of routine work related to the process of designing, ordering
relationships of the designers in operation process, providing a wide range of convenient service functions of conducting automated archives etc. These factors contribute to improve the quality of technologist’s labour as well as they streamline their work and allow to focus more attention on the adoption of the effective technological solutions.

However, the potential for improving the quality of the design of technological solutions - the formation of their high-performance structures, is currently unused in creating intelligent CAM TP.

Similarities and lack of originality of scientific and methodological approaches used in designing of systems make some CAM TP similar in features and little distinguishable that significantly reduces their competitiveness [1].

2. Basic part

Analysis of the nomenclature of parts of engineering production showed that in the process of their production cycle the mechanical treatment is dominant [2]. In papers [2, 3] the methodology of TP construction on the design and technological characteristics of the part in the intelligent system of TP construction is described. 3D part model is represented as an elementary constructive surface modules. Each constructive module of the surface is represented in the database of CAM module of the intelligent system for constructing TP by records of all possible transitions (Figure 1).

When creating intelligent systems frame-based models in which concepts are linked with each other by different relationships are used. Relationship "is - some« (isa) » allows to organize the structure of concepts in the form of a tree. In the engineering interpretation functions of concepts standardized or uniformed largely. Their descriptions are contained in the extensive glossary of terms. Concepts (Table 1) are related by generic relationships. The term "product" is the generic and its variants - the concepts of "assembly unit" and "part".

With the help of a relation a complex concept can be separated into components by decomposition. Constructing TP is necessary to ensure the selection of the structural element at a certain stage on the qualitative and quantitative indicators.
Qualitative indicator is the complex value, which will depend on the quality indicators of each structural element.

The important quality characteristics of the TP are the processing time, which the company aims to reduce and the productivity of the process that the company aims to increase. Levels of the hierarchy of the TP, such as OPER, POZ and SET are characterized by the selected metal-cutting equipment. In modern engineering is advisable to aim to apply modern machining centers with CNC, where multi-processing which will reduce the install / reinstall is possible. This would reduce the normal time processing and therefore enable to increase a production. At levels of TP hierarchy, such as TRANZ and PS (power stroke) the quality indicator will be machining stock, which is a calculated value. Technological problem is solving, is it possible to remove machining stock for one PS or not. If the machining stock is less than the calculated value, the quality indicator by a drawing will not be obtained in the course of treatment, if machining stock is higher than the calculated values, the requirements for a specified quality will be done, but at great costs, that is, the production of the process will be reduced, and the costs of the processing will increase. Therefore it is necessary to seek to ensure that the removed machining stock will be equal to the calculated value.

Quantitative parameters of the TP are all the values that are calculated or taken from a drawing. It is very important at the design stage to eliminate calculation errors and make a choice of machines, tools, appliances not "approximately", but more or less matching the calculated values. Of course, in a
rapidly developing world, you must always be aware of the timing of technological preparation of production. According to [2] with the general ideas in mechanical engineering, TP is implemented in seven hierarchical levels, which are allocated as a result of systemic differentiation of its functions.

From the definition of the level of decomposition of the transition (TRANZ) - transition is characterized by constancy of used cutting tools. The function of the equipment is a list of ongoing technological methods that is common to the cutting tool and equipment. Operation (OPER) is characterized by the constancy of the workplace, and the setting (SET) by the constancy of basing conditions and fixing of the workpiece in the device. Device function is mounting and fixation of the workpiece and enforcement of the operation. Thus, the interaction of design objects through their function on the higher level of decomposition is carried out (Figure 1).

To each "transfer record" of a particular structural module is associated a group of cutting tools. The cutting tool type may be more than one for one transition record. Selecting the type of cutting tool depends on the structural and technological parameters of parts, machine model, the type of production and is based on the certain rules. Databases of "transition records" are associated with the database of the group and the type of cutting tool by the defined rules. The function of the cutting tool is the implemented technological method.

For the automatic selection of the cutting machine, cutting tools, machine retaining device it is necessary to design an automated selection module.

Selection of the machine, tools, device occurs in the course of the design process, and therefore it is necessary to use in a data domain a number of properties proven in practice, the structural elements of the processes - analogues. Input information for the selection of the cutting machine at the operation level is the TP indicator. Input information for the selection of the cutting tool at a transition level is TP indicator. Input information to select the device on the position level is the TP indicator. Thus information of the object and its structural components is stored in the database. Great importance for the choice of cutting tools, machine and device is the content of the transition (transient recording), its parameters, because at this level a frame model for the position, operation, a part of which is this transition, is constructed.

Base of precedents are formed on the basis of the rules of choice of cutting tools, machine and device. Precedents are the pairs like "operation - the machine", "operation - a tool", "operation - a device"; "Position - the machine", "position - a tool", "position - a device"; "Transition - the machine", "transition - a tool", "transition – a device"; "Process - the machine", "process - a tool", "process - a device."
Figure 2. The frame model of the TP
In the module CAM of an intelligent system of TP construction is suggested an idea of the TP as a hierarchy structure of the related classes and objects. Constructive module of the part surface is presented in a CAM module by the transient recording. Transient recording is associated with the cutting tool, device and cutting machine by the frame model. The appropriate part of this stage in a single database system of intellectual TP construction system is designed.

3. References

[1] CAM processes: a textbook for stud. of high school / AI. Kondakov.-M.: Publishing center "Academy", 2007.-272p.

[2] Information support of technological routes. Integrated information systems in mechanical engineering / L. Simonova. - Palmarium Academic Publishing GmbH & Co.KG, 2012-186 p.

[3] Intelligent system of technological processes designing on structural and technological characteristics of the parts / EI Egorova, V. Matveev - Forging - stamping production. Materials processing pressure. 2012. № 11. p. 33-40.

[4] Simonova LA, Kostyuk IV 2009 Formation of knowledge base system of tooling management Kuznechno-Shtampovochnoe Proizvodstvo (Obrabotka Metallov Davleniem) № 8 pp 22-28

[5] Simonova LA Formation of knowledge database of alternative technological routes' parameters (2004) Kuznechno-Shtampovochnoe Proizvodstvo (Obrabotka Metallov Davleniem) (10) pp 44-48

[6] Larisa A Simonova, Marat R Khisamutdinov 2013 Intellectual Model Control Data of the Module Integration SAP-ERP and Team center-PLM. World Applied Sciences Journal 25 (8): pp 1258-1262

[7] AV Zatonskii Synthesis of expert systems of management of socio-technical systems // Mountain information-analytical bulletin (scientific and technical journal) = Mining informational and analytical bulletin (scientific and technical journal). -2008. -№ 2. P. 82-86

[8] Norenkov IP, Kuzmik PK 2002 Information support of high-tech products CALS-technologies - M.: Publishing house MSTU. N E Bauman 320 p

[9] Knowledge Base of Intelligent Systems / TA Gavrilova, VF Horoshovsky - St. Peter 2000 384 p

[10] Intelligent systems of design: tutorial / GB Eugenev Moscow: Publishing House of the MSTU. N E Bauman 2009 334 [2] p