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SUBSYSTEM OF RHEOLOGICAL FORMING MODELLING IN INTEGRATED CAD/CAPP/CAM SYSTEM IN MACHINE BUILDING

In the article the brought analysis of automated technological planning process for the machine-building production (ICAM) trends. The offered perfection of ICAM structure of the system as introduction of the Computer Aided Forming sub-system (CAF-system). The brought arguments over in relation to introduction of conception of the parallel engineering, introduction of CALS – technologies and functionally-oriented technologies.

Key words: automated technological planning process, CALS, CAF, rheological modelling.

Описано аналіз процесу автоматизованого технологічного планування машинобудівного виробництва (ICAM). Запропоновано вдосконалення структури системи ICAM із впровадженням підсистеми автоматизованого формування (CAF-системи). Наведено аргументи щодо впровадження концепції паралельної розробки, впровадження CALS-технологій та функціонально-орієнтованих технологій.

Ключові слова: процес автоматизованого технологічного планування, CALS, CAF, реологічне моделювання.

Introduction

The generalized analysis of trends for the modern machine-building computer-assisted operation sequence planning systems (CAD/CAPP/CAM/PDM) gives a possibility to mark such features.

For all most effective machine-building CAD of middle and high level (Pro/Engineer, Unigraphics, CATIA, SolidWorks; Nastran, Solid Edge) characteristic system integration of software product (optimally is creation of hybrid CAD/CAE/CAPP/CAM software) is with the aim of more effective exchange by design-engineering information in only compatible formats and prototypes of data repository (MIL – STD – 2549 Configuration Management Data Interface). In addition, there is a tendency to unitization of technological preparation, that shows up in the use normatively-legal base of CALS-technology (ISO 11179, MIL – STD – 1840, MIL – STD – 1808A, MIL – STD – 974) and others like that.

Introduction of PLM (CALS) – technologies are required by planning of the functionally-oriented technologies for machine-building production, i.e. taking into account already on the stage of technological preproduction of not only parameters of exactness of sizes and roughness of the processed surfaces but also complex of new qualimetrycal indexes that will have substantial influence on providing of operating, repair, heat-recovery and other functional properties of the fabricated products.

The rapid rates of introduction of new materials of the base machine-building and instrumental setting, newest technologies of treatment in combination with the tendency of reduction to the rangeability of machine-building products puts at a basic place in technology engineer such indexes, as an operationability and optimality of preproduction of new products.

Adequacy of the mathematic models and optimality of the automated technological planning of high-speed methods of treatment (especially for hard-processing materials) it is complicated by that a cutting model in this case is characterized by the adiabaticity of thermodynamics processes, instead of classic duotermical model that is the basis of programmatic-methodical modus of the CAPP-system.

Implementation of automated technological subsystem analysis products of the machine surface forming (CAF-system – *Computer Aided Forming*)

Taking into account all these factors, it is possible to do a basic conclusion that the generally accepted chart of the integrated complex-automated system of technological preparation of the automated production (ICAM – *Integer Computer Aided Manufacturing*), resulted on Fig.1(a) needs perfection.

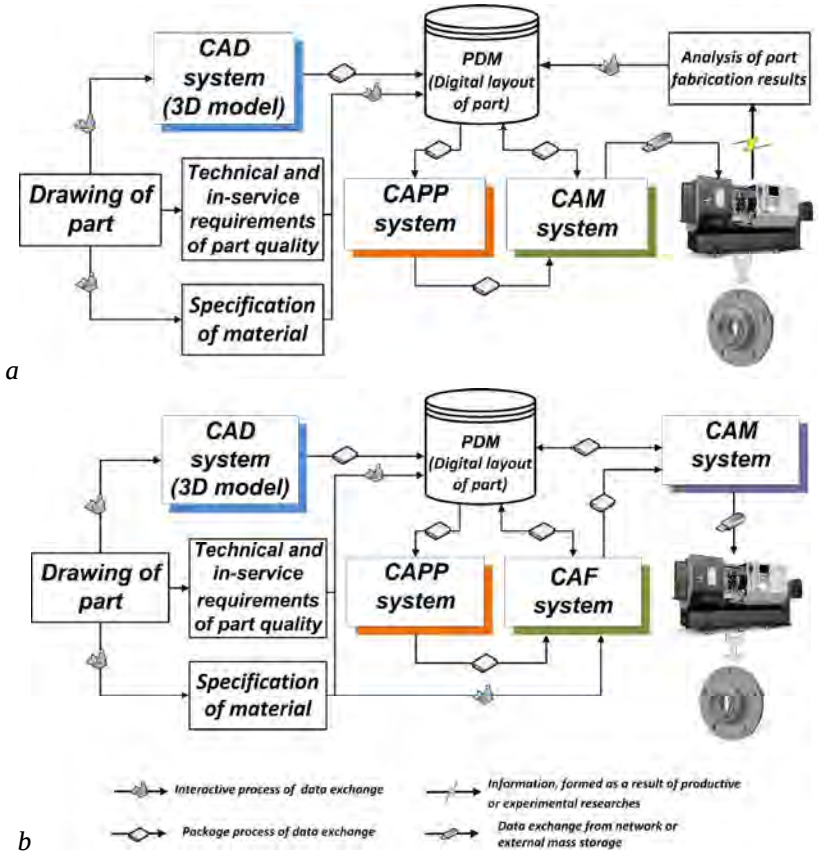

Fig. 1. Existing (a) and new (b) structure of the ICAM-system

The main difference of the offered system (Fig. 1.(b)) is a presence of the automated technological subsystem of forming (CAF-system – *Computer Aided Forming*), that an analysis of simulation rheological model of cutting technological steps and complex of the analytically-applied programs of forming, accuracy, thermally-deformation, microgeometric, structural and phase parameters of the processed surfaces, possibility them imitation design and establishment of dependence of basic qualimetrycal indexes of products from a structure and parameters of technological process. Filling of data repository by perfection of digital layout of products takes place already on the stage of preproduction, but not as a result of experimental research.

Basic software for CAF-system can be one of the such known programmatic complexes as DEFORM – 3D, ABAQUS, AdvantEdge, LS – DYNA. All these systems are the multipurpose programs of FEM analysis and intended for the decision of three-dimensional dynamic nonlinear tasks of mechanics of the deformed solid, and also tasks related to this process. In them realized obvious and non-obvious

method of eventual elements with possibility of construction of Lagrange, Eulerian and hybrid nets, multicomponent hydrodynamics, method of the smoothed out grates, based on the Galerkin method. The programs have built-in procedures of automatic alteration and smoothing of usually-element net at degeneration of elements, high-efficiency algorithms of decision for Hertzian problems, wide set of the materials specifications, possibility of user's programming.

The generalized algorithm of CAF system functioning in the structure of CAD/CAPP/CAM system is given in Fig. 2.

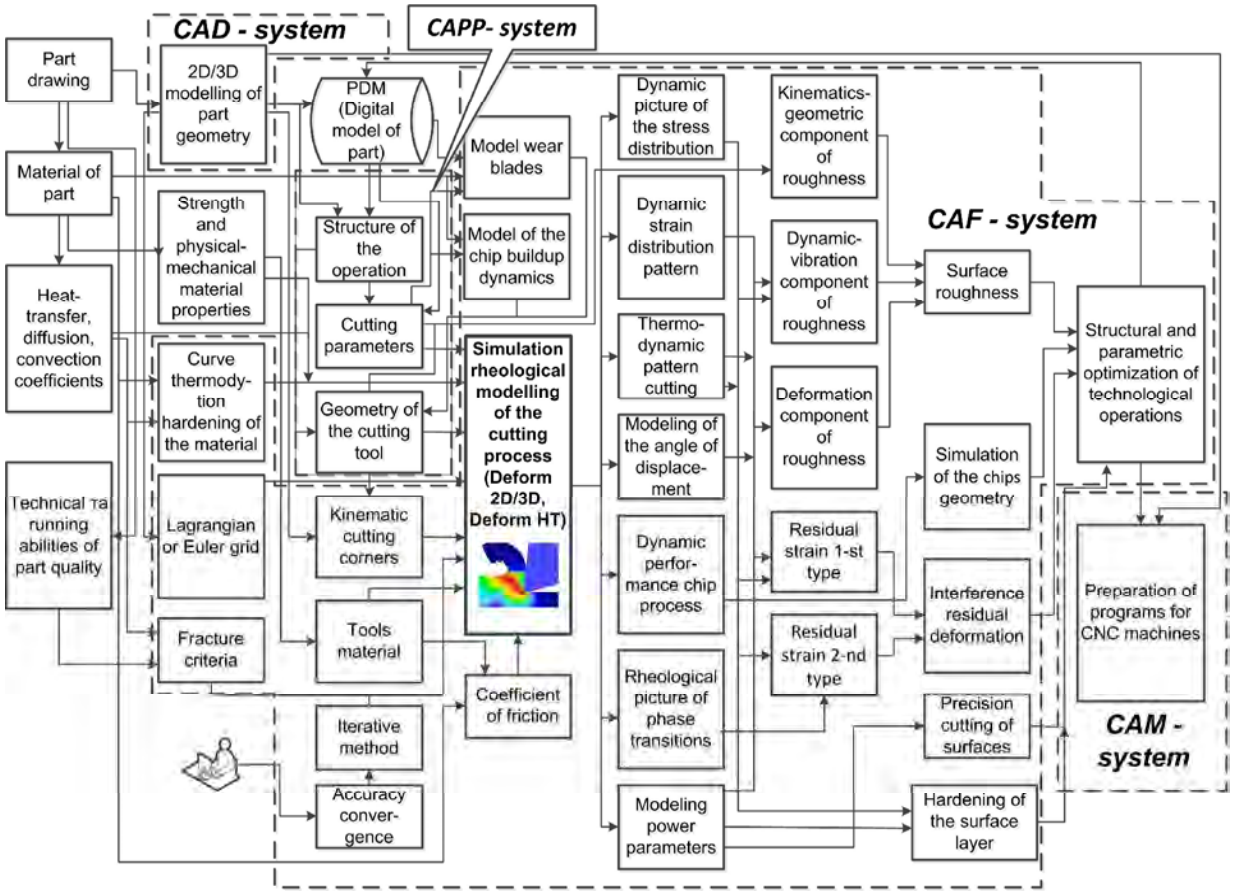

Fig. 2. Structure of integer CAD/CAPP/CAF/CAM system

Initial data for CAF-system are:

– 2D or 3D model parts (has influence on the kinematic angle cutting, shaping in Euler or Lagrangian mesh). Source of information – CAD system.

– The structure of the technological operation (has a direct influence on the rheological model cutting). Source of information – CAPP system.

– Geometry of cutting tool (has influence on the dynamics, geometric parameters of technological step). Source of information – CAPP system.

– Tool material (has a direct influence on the rheological model of technological step).

– Modes of treatment. Source of information – CAPP system.

– Strength, physical, mechanical, thermal characteristics of processed material (has influence on the choice of the curve thermodynamic strengthening friction and selection criteria destruction). Source of information – CAD system.

– Models wear blade tools and dynamics of chip buildup (have a direct influence on the rheological model of technological step). Source of information – analytic modeling.

– The error convergence of simulation results on the force vector and the velocity vector and the acceptable level of accuracy geometric, select the type of task (Lagrangial Incremental or Steady-State

Machining), the choice of iterative method (direct or iterative Newton-Rafsen) Choosing a kernel method (sparse matrices or method Skyline). Source of information – an interactive mode with the designer.

By a job of CAF-system are complex of tensely-deformation, power and thermodynamics parameters of cutting, dynamic of kinematic corner change and picture of phase transformations on the machining surface of material. All of it gives an opportunity to carry out prognostication of such important operating parameters, as surface microrelief, remaining tensions 1 and to 2 typies, physical and chemical state of superficial layer and others like that.

The example of rheological simulation of lathe machining part from a titanic alloy Ti6Al4V is shown on Fig. 3.

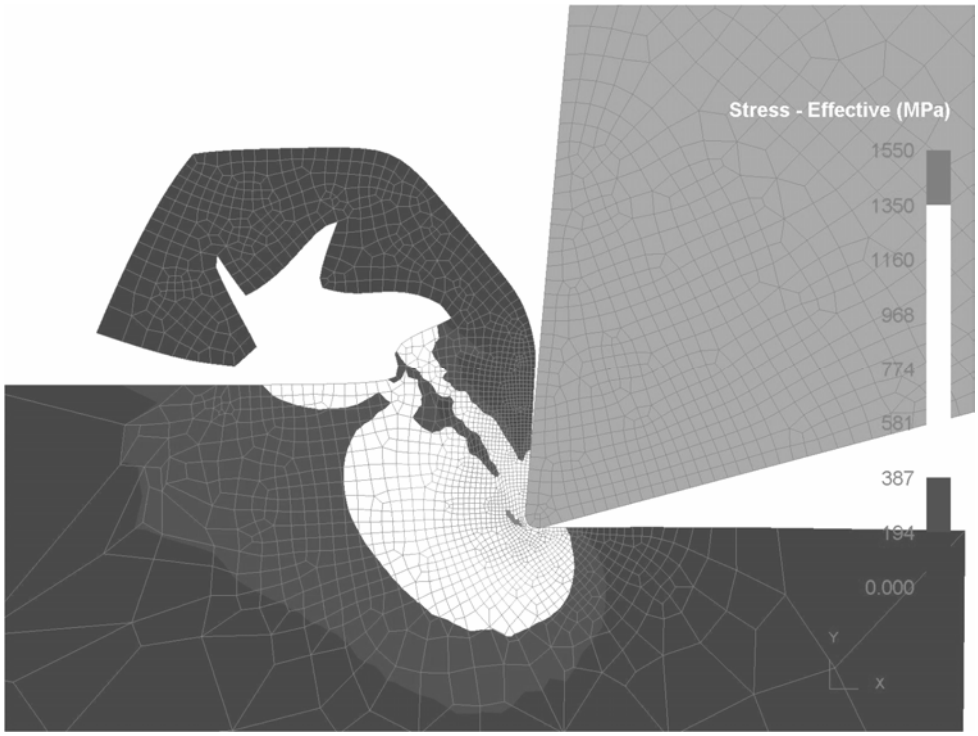

Fig.3. Example of rheological simulation of lathe machining part from a titanic alloy Ti6Al4V

Resume

It is a possible to draw conclusion, that the offered structure of the CAF – system organically combines and complements existent complex of CAD/CAE/CAPP/CAM software products. Practically all information for work of CAF-system comes from the stages of the previous planning and is automated. Results of such system performances allow substantially to become better quality of acceptance of technological decisions, necessary for realization conception of the parallel engineering, introduction of PLM (CALS) – technologies and functionally-oriented technologies of machine-building production, that is taking into account already on the stage of technological preproduction of not only parameters of exactness of sizes and roughness of the machined surfaces but also complex of new qualimetrical indexes that will have substantial influence on providing of operating, repair, heat-recovery and other functional internalss of machine building products.

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