THEORETICAL ASPECTS OF PROCESS PLAN PARAMETRIZATION

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1. INTRODUCTION

Goal of parametrization using in process plan design is to make a CA system class, which is able to maintain technology model described by number of parameters. Beside off this the economic evaluation of modeled process plan is possible throught criterial computing from parameter set. This paper deals with theory of future system for rapid cost evaluation system consists from base CAPP system for technology process plans maintain, adding and edit and also for utilizing this enhancements of parametrization for rapid cost evaluation from set of parameters.

2. CAPP SYSTEM

CAPP system (Computer Aided Process Planning) uses virtual model of technology process plan. This virtual model is stored in data structure (and has object dynamic properties). This data are stored both in SQL database and text file on disk. Principally, each machined part (classified by independent variant CAPP system) could to have number of process plans and concrete proces plan have one record set in database (row in plans list and a table).

This technolohy model is strictly parametrized, this mean that all features of concrete operation (each row one operation, see frame process plan) must be written in array of parameters. As we explain in next text, also criterias are assigned for each operation.

Kuric [1] said about those informations stored in technology model of CAPP system:

- surface identificator (ID),
- informations from part geometry model (geometry, topology, relation and more),
- nedded surfaces,
- actual status of process over semiproduct.

In our approach each row in technology model (and also in technology proces plan) has interpretation as machining (or other) operation, described by set of parameters and criterias and also technology parameters (SPID).

3. SEMISTATUS AND SEMIFORM

„Technology process is set of operations, by which the change from initial properties (semiproduct, prefabricate) into final status of material properties (product) is achieved. Throught

fade geometry and physical changes, the semproduct is during technology process transformed into final product. There some number of status part semi-finishing exists. Semiforms of product depend on gemoetry properties changes. Semistatus depend on physical changes.“ (Kuric, I., [2]).

Semiforms are defined by form of semi-finished part in concrete phase of machining (manufacturing). This form depend on previous semiform and on actual operation (going used). Chain of semiforms

$$\{\mathbf{d_0},\mathbf{d_1},\ldots,\mathbf{d_i},\ldots,\mathbf{d_{k-1}},\mathbf{d_k}\} \quad (1)$$

is also prescribed technology process plan (history of creation). In this case transformation function can be defined

$$\mathbf{d_i} = f(\mathbf{d_{i-1}}) \quad (2)$$

Chain of semistatus as chain of realization operations:

$$\{\mathbf{o_0},\mathbf{o_1},\ldots,\mathbf{o_i},\ldots,\mathbf{o_{k-2}},\mathbf{o_{k-1}}\} \quad (3)$$

New terminology also load terminus the removed volume of material **oom**. It sign chain of geometry continuum changes during the manufacturing process. In case of forward process plan design those formulas stand:

$$\begin{aligned} &\mathbf{d_0} - \mathbf{oom_1} = \mathbf{d_1} \quad (4)\\ &\mathbf{d_1} - \mathbf{oom_2} = \mathbf{d_2}\\ &\ldots\\ &\ldots\\ &\mathbf{d_{k-1}} - \mathbf{oom_k} = \mathbf{d_k} \end{aligned}$$

4. PARAMETERS AND CRITERIAS

For overcovering many mechanical technologies (machining, cutting, casting, ...) we must to design data structures very universal, exactly to wide dynamics. For this reason, we had to create matrix of parameters, where each parameter has 2D vector definition:

$$[\mathbf{P}] = [\boldsymbol{p_1},\boldsymbol{p_2},\ldots,\boldsymbol{p_i},\ldots,\boldsymbol{p_{m-1}},\boldsymbol{p_m}]^{\mathbf{T}} \quad (5)$$

Size of matrix m is also count of operations. Each operation dispose with one parameter matrix. Vector $\boldsymbol{p_1}$ is planar definition of parameter, defining:

1. parameter's ID,
2. parameter's value – real number.

$$[\boldsymbol{p_i}] = (\mathrm{ID};\ \mathrm{val}) \quad (6)$$

As example of concrete machining operation we explain the classic machining operation cycle, parametrization of the radial lathing (Fig. 1).

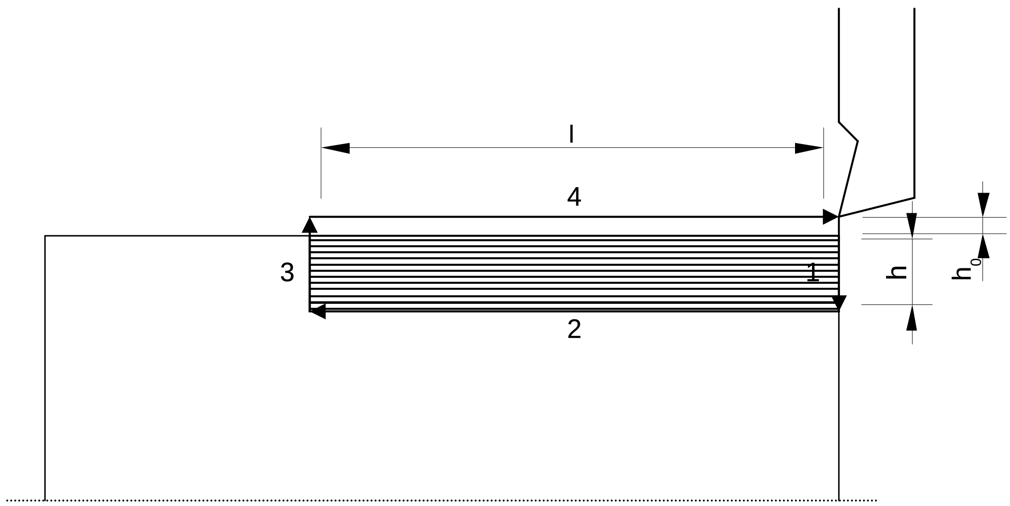

Fig. 1 Radial lathing

We can to setup criteria build upon parameters matrix. These criterias depend on existing matrix of parameters throught criterial function G:

$\mathbf{k_i} = G[\mathbf{P}]$ (7)

$\mathbf{k_i} = G[\boldsymbol{p_1},\boldsymbol{p_2},\ldots,\boldsymbol{p_i},\ldots,\boldsymbol{p_{m-1}},\boldsymbol{p_m}]^{\mathbf{T}}$

$[\mathbf{K}] = G[\mathbf{P}]$

Criterial matrix represents functional link for next computer processing to economic pointers, as working and idle times, working taxes, energies etc.

5. FORMULAS

For example from Fig. 1 we can to build some utilized expressions for time evaluation, where time will be economy evaluation from geometry and technolgy parameters:

$\mathbf{k_T} = t(\mathbf{l}, \mathbf{h}, \boldsymbol{f}, \mathbf{a_p})$ (8)

$\mathbf{k_T} = t(\mathbf{l}, \mathbf{h}, \boldsymbol{f})$

$\mathbf{k_T} = \mathbf{k_{T1}} + \mathbf{k_{T2}} + \mathbf{k_{T3}} + \mathbf{k_{T4}} + \mathbf{t_0}$

where

$\mathbf{k_{T1}} = (\mathbf{h} + h_0)/\boldsymbol{f}$ (9)

is non-machining time, during which the tool is going to the begin of the cut,

$\mathbf{k_{T2}} = \mathbf{l}/\boldsymbol{f}$ (10)

is time of main radial cutting,

$\mathbf{k_{T3}} = (\mathbf{h} + h_0)/\boldsymbol{f'}$ (11)

time of axial cutting and

$\mathbf{k_{T4}} = \mathbf{l}/\boldsymbol{f'}$ (12)

is time to return into initial position.

6. CONCLUSION

Approach described in previous text allows to build-up set of criterial and parametric matrix, which can be used for economic evaluation. CAPP modul, which will to use this algorithm, must create final criterias summary and evaluation throught table of results (XLS, CSV od dB interpretation) and/or graphics diagram. These results can be also used for thin points of manufacturing.

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