PROGRAMMING MODULE DESIGN FOR SETTING TECHNOLOGICAL PARAMETERS FOR WORKPIECES

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Abstract: *This paper presents an option of formalizing input data in automated design processes for machining. A tabular data model required by the technology technician is designed to develop products for the machining process, namely a workpiece. A script-based approach of human-computer dialogue in the setup of structural and technology parameters of a workpiece is adopted as well as particular algorithms to be submitted into the system.*

Keywords: SYSTEM ANALYSIS, COMPUTER AIDED PROCESS PLANNING, TABULAR DATA MODELLING, STRUCTURAL PARAMETERS, LIFECYCLE, LOGIC CONTROL

1. Introduction

Technology Design (DT) process is an idealised creative process of the human brain based on a priori information from the structural design of each item and a posteriori data, providing particular production. This determines the complexity of input data into Computer aided process planning (CAPP) systems containing both output results of structural design and basic data for resource provision of production processes. Practically, formalization of the inputs in CAPP systems and development of an efficient database (DB) schema are the main factors that ensure high quality and efficiency in managing the technology design process and the new product development.

In order to fulfill the task the following terms and clarifications have been adopted, specified in the basic concepts and related to technological design:

- Subject of our scientific research is a machine-building product, namely a workpiece, resulting from machining.
- Objective of technology design is to develop and maintain effectiveness of the product across all phases of its lifecycle from planning, analysis, design and implementation through continuous monitoring and optimization of each intermediate stage.
- Development of algorithms aims at human-computer dialogue, which is a proper combination of user-guided dialogue, system-guided dialogue and scenario-based design.
- Data is entered and selected from tables, being verified by continuous visual, and where possible mathematical and logical control.
- Entry algorithms follow the already chosen approach [4] of maximum unification and modular implementation ensuring updating.

2. Tabular Input Data Model

A source of basic inputs for CAPP system is the structural design results, derived by different means and supplemented with mandatory production and operational requirements for each particular product. Data related to supply (stock of resources, raw materials, etc.), staff (labour force, labour productivity, etc.), distribution (feasibility, cost, etc.) plays an essential role. Marketing data connected with the characteristics and prospects of every detail in the functional and structural analysis of the product at all stages of its lifecycle is also of great significance.

The perspective adopted here regards formalization of input data into technology design process as classification structure represented by functional modules in technological database (TDB):

- Data reference for the workpiece: drawing number, shape, dimensions, material, weight, accuracy, manufacturing program, etc. (Table 1);
- Billet condition data: type, shape, dimensions, etc. (Table 2);
- Additional data requirements: type of product, system, functional, structural requirements, etc. (Table 3).

Table 1: *Structural inputs for the workpiece*

General Data	Dimen-sions	Mate-rial	Weight	Accuracy Indicators	Additional Prescriptions	Production Program

Table 2: *Billet condition data*

General Data	Dimen-sions	Mate-rial	Weight	Accuracy Indicators	Surface Roughness	Additional Prescrip-tions

Table 3: *Additional requirements for the product*

General Data	Information System Requirements	Functional Requirements	Structural Requirements	Performance Requirements

It is essential for the input stage to ensure authenticity of the inputs, their accuracy and completeness across all stages of the lifecycle. Thus, two main types of data are involved, namely mandatory and recommended.

To determine mandatory data, it requires both a comprehensive systematic analysis of the information flow and definition of the necessary and sufficient conditions for managing all stages of work preparation.

Recommended data should be of the sort that the system analyst, designer and CAD technician could miss to submit, without consequences to incorrect implementation of design and planning processes.

The diversity in the type and application of the inputs in the TDB tables has to be organized into groups of products and of workpiece structure.

For instance, the structural input table, apart from the serial product numbers, includes the following groups:

- General data: drawing number, name and shape of the workpiece;
- Dimensions: maximum linear and angular dimensions of the workpiece;
- Material: type and brand name material selected by the designer;
- Workpiece weight;
- Accuracy and precision: required level of accuracy of linear measurements and angular measurements, accuracy of shape, position and orientation accuracy, beating and surface roughness.
- Additional prescriptions: requirements for hardness, additional treatments to achieve it, coating, etc.
- Production program: annual program for the production of the workpiece, batch size, etc. [1, 2, 3].

Mandatory data can include dimensions of the workpieces, such as length and diameter for rotational symmetrical workpieces; length, width and height for prismatic workpieces and so on.

Incomplete data dimensions are a prerequisite for the uncertainty of the type and dimensions of the working area of the machine and the impossibility of applying design technology, respectively.

Billet condition data is grouped in the same way as described above concerning structural input data for workpieces. The difference is in the parameters reflecting surface quality: depth of the surface deformed layer, spatial variation and relative workpiece distortion.

3. Algorithms and software to setup structural and technological parameters of workpieces

Due to the large number of structural and technological parameters of the workpieces and their complex interrelationships the task of formalizing input data needs to be decomposed into multiple subtasks so as to create a hierarchy. This suggests implementation of decision on a modular basis as each module performs a particular subtask and represents a relatively autonomous decision.

3.1. General framework for algorithms to setup structural and technological parameters of workpiece (Figure 1)

In automated design processes for machining there are two main options for entering structural and technological parameters of the workpiece: manual – from pen or pencil drawings and automated – from CAD systems. Setting parameters for workpieces from CAD systems can be done in two ways by means of reading data from the CAD model, which has been recorded in a neutral file format (STEP, DXF, etc.) or as a result of exchange of information between graphics rendering and CAD systems. In the last two cases the CAPP system must include a module for unified access, obtaining and control of input data by the design technician.

The dialogue requires an appropriate entry methodology as the result determines system’s mode of operation: manual or automated. If submitting data is manually selected, human-computer interaction (HCI) follows the user-guided model. In the automatic mode, task execution continues with the inclusion of a special module for obtaining data from CAD systems. Taking into consideration the wide variety of CAD systems and especially data completeness at data set level, the algorithm provides for mixed mode of data submission. It is realized by checks for input completeness and/or for data obtained by returning execution to General Data Entry Block for the workpiece.

Control is both logical and visual and in the absence of mandatory values for structural parameters of the workpiece the cycle of iterations closes for entering missing data. Cycle exit and data record in Structural Parameters Database (Table 1) occur when all required mandatory parameters have been entered.

The process of finishing condition data submission takes place in a similar way, however under complete supervision: visual, mathematical and logical.

Additional prescriptions are entered directly by the technologist and are visually controlled while the process of TD is repeated and indirectly controlled so it frequently involves multiple-criteria optimization. The nature of information in this table is often subjected to entering catalog data from reference tables stored in system libraries in CAPP system.

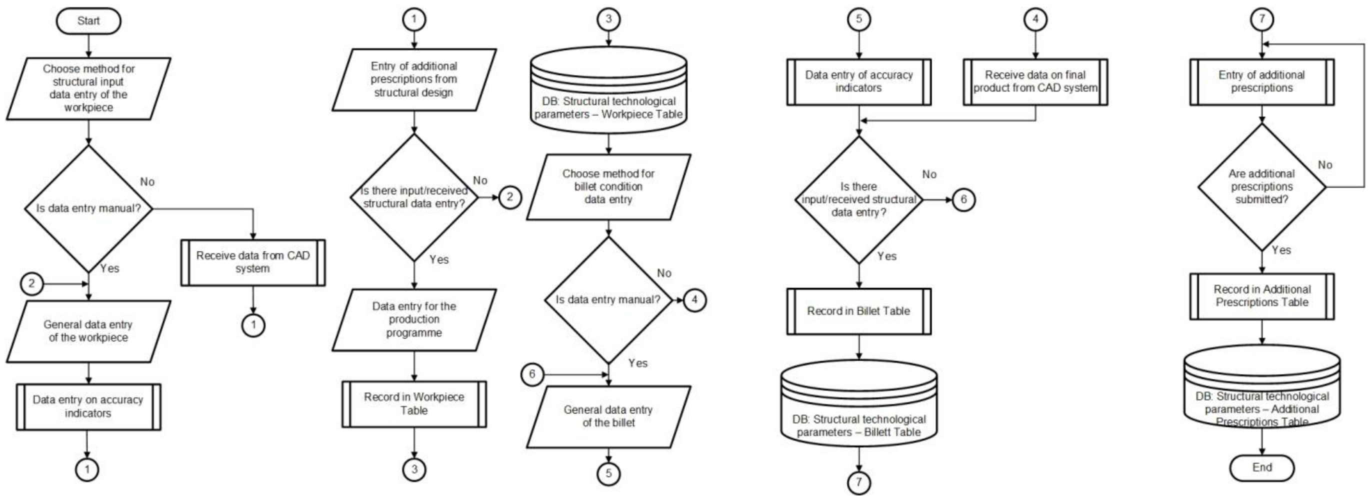

Figure 1. *General framework for algorithms to setup structural and technological parameters of workpieces*

3.2. Algorithm for accuracy indicators entry (Figure 2)

Normative documents (standards, norms, etc.) determine different ways to refer to accuracy indicators in design documentation. For example, the lack of a prescription for a minimum tolerance of linear measurements in drawings does not mean there have not been any intentions to do so. This calls for the design of CAPP system be defined a function with prescribed tolerance in accordance with the normalized by the designer maximum degree of accuracy.

In non-machine technology design it is the technician who does this prescription in the design process. Therefore, accuracy parameters entry begins with initializing made by the designer prescriptions. The step is significant for user-guided dialogue in submitting each of the indicators. The dialogue is mixed, providing full control of input (visual, logical and mathematical).

The complicated relationship between accuracy indicators requires mathematical, logical and other data processing from libraries in CAPP system. Therefore, the algorithm for accuracy parameters entry is based on modular approach. The algorithm structure is divided into fundamentally identical groups of blocks for various accuracy indicators. Indicators entry takes place consecutively, starting with possible tolerances for linear dimensions. Using control prescription and visualization help limit deviations in the absence of data from this structural design. Similarly, if there is lack of evidence of deviations from angular dimensions, values according to the ones normalized by the designer for maximum accuracy are assigned. Entering each of the following indicators for form accuracy, precision orientation and location as well as beating is carried out in case there is data for each one in the design documentation. Visual control and/or control with mathematical and logical relationships is realized between inputs and values of linear dimensions. Entering prescriptions for surface roughness and tolerances for linear and angular dimensions is managed by an interim control for entering values based on normalized by the designer maximum roughness.

4. Conclusion

The proposed table model is based on the formalization of input data and provides systematic approach to technology design.

The developed algorithms define human-computer dialogue by means of visual, logical and mathematical control so as to achieve authenticity, accuracy and completeness of the process for entry input of the workpiece and the billet.

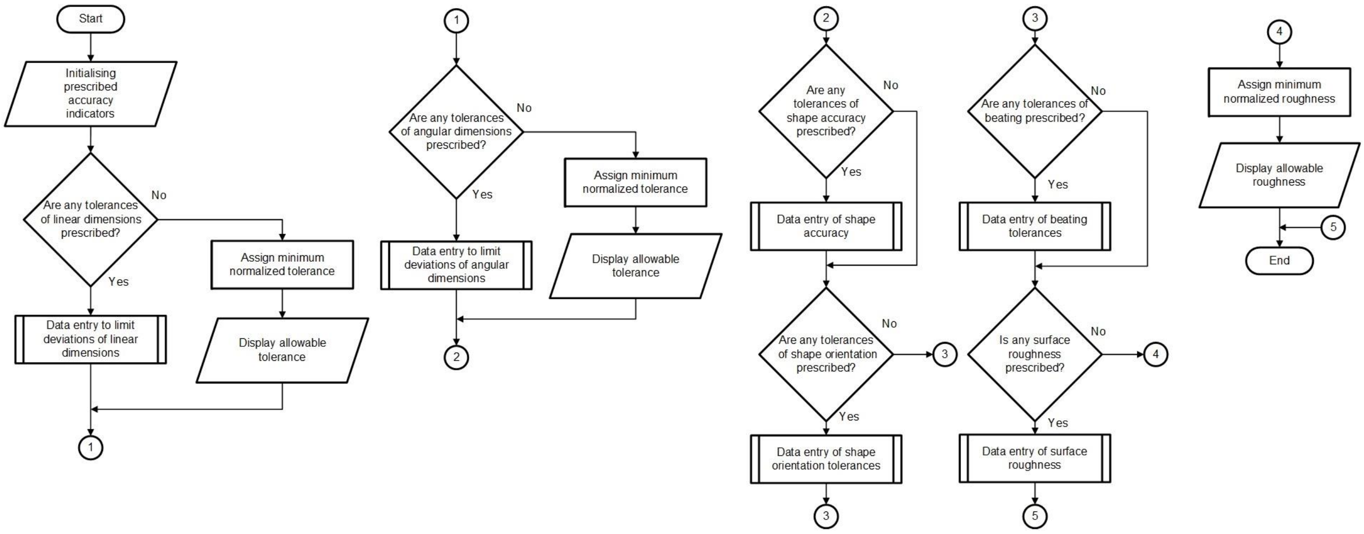

Figure 2. *A node-positioning algorithm of accuracy indicators entry*

5. References

1. Диков А. Технология на машиностроенето, С., Софттрейд, 2006, p. 323 // ISBN-10: 954-334-034-X.

2. Клепиков В. В., А. Н. Бодров. Технология машиностроения, М., Форум, 2008, p. 864 // ISBN 978-5-91134-251-7.

3. Пучков А. А., А. В. Петухов. Основы технологии машиностроения. Учебное пособие, Гомель, 2012, p. 276.

4. Цеков Л., М. Топалова, Пл. Мъцински. Таблично моделиране на технологични процеси в машиностроенето. Машиностроене и машинознание, year IX, is. 2, ТУ – Варна, 2014, pp. 30-33 // ISSN 1312-8612.

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