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KNOWLEDGE-BASED PLANNING ASSISTANT FOR TECHNOLOGY OPTIMIZATION USING PROCESS STANDARDS (WATOP)

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Abstract: Increasing product diversity with decreasing numbers of pieces lead to high and complex technology variants in parts manufacturing. This trend has resulted to difficult controllable process variants. This is associated with an increase in the planning and production costs. Coupled with this are much higher expenses in manufacturing planning. The skills required for knowledge and experience in the application of manufacturing technologies also is often lost for a wide use in the companies. Objective of the project is through the development of a knowledge-based planning assistant to optimize the technological processes in the manufacturing companies using process standards.
Keywords: knowledge-based planning assistant, technology optimization, process standards, parts manufacturing

1. INTRODUCTION

The continuously increasing of product variants leads to a variety of different technological processes and parameter combinations, especially in the series production of the automobile industry. This trend results in a large number of technological alternatives for the same or similar machining processes in manufacturing. Causes of heterogeneity are primarily in the increase of product variants and the separation of production areas for different components [1]. Standardization is possible with the using of process step categories and the creation of process modules [2,3].

2. STEPS IN THE DEVELOPMENT OF PROCESS STANDARDS

Objective of the industrial project is the development of process standards for series manufacturing.
With this project, the following objectives can be achieved:

- ✓ Reduction the variety of design and technologies
- ✓ Increasing planning flexibility and reduction of planning and manufacturing times
- ✓ Minimizing the variety of tools and reduction of tool inventory
- ✓ Application of "best technologies"
- ✓ Comprehensive use of technological knowledge and experience in the design and manufacturing planning
- ✓ Increase the technological cost transparency

The developed process standards must be integrated into the production chains of the enterprises (see figure 1).

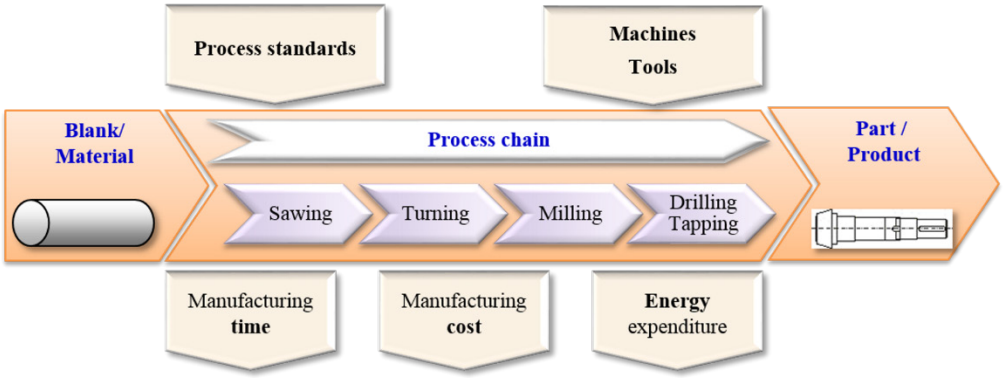

Figure 1 – Example of process chain [4]

The process standards contain organizational, geometrical and technological data. The technological data, such as cutting speed and feed must be standardized for the respective machining processes as "best technologies". "Best technologies" are the result of the standardization process. Criteria for the standardization are manufacturing time, production cost and manufacturing quality.

Depending on the design- and technological features (see figure 2), the process standards are knowledge-based integrated in the process sequence.

The development of process standards can be done in three steps (see figure 3):

- ✓ Technology-oriented part analysis
- ✓ Modeling of process standards
- ✓ Determination of process sequence

Process sequence will be generated automatically from machining features using different rules: e.g. geometrical and technological rules.

Requirement for this approach is the systematization of the product-features in feature-classes (figure 4). On this basis, the machining features can be determined with the relevant parameters (e.g. technological data). Then, the process standards are optimized using evaluation algorithms and integrated in the process sequence with the link algorithms. The developed algorithms optimize the technological variants according to manufacturing time and production costs [5]. The user gets a guideline for the development of process standards.

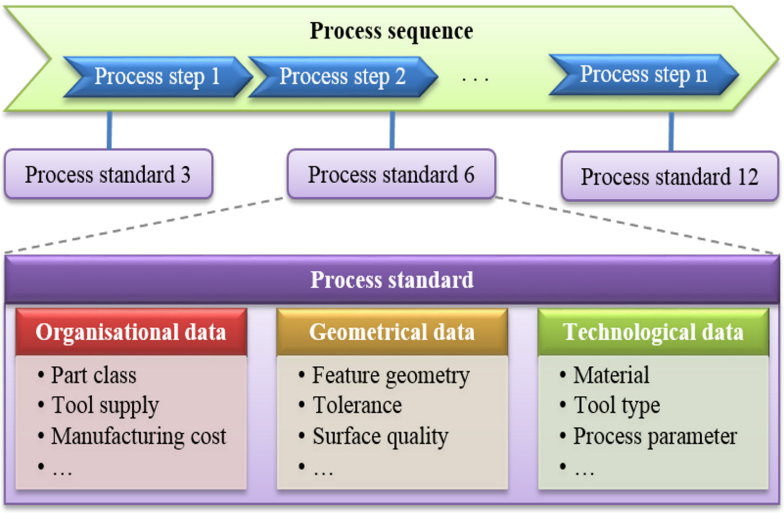

Figure 2 – Data of process standards [1]

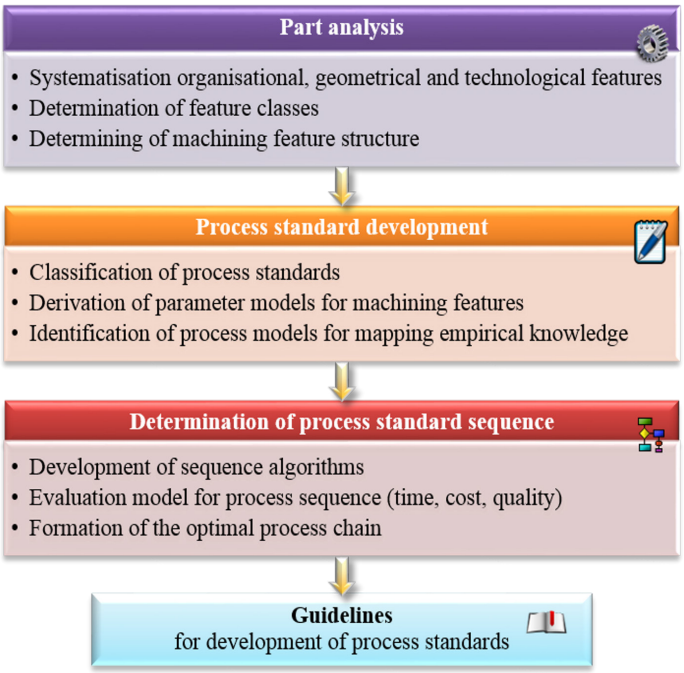

Figure 3 – Steps in the development of process standards

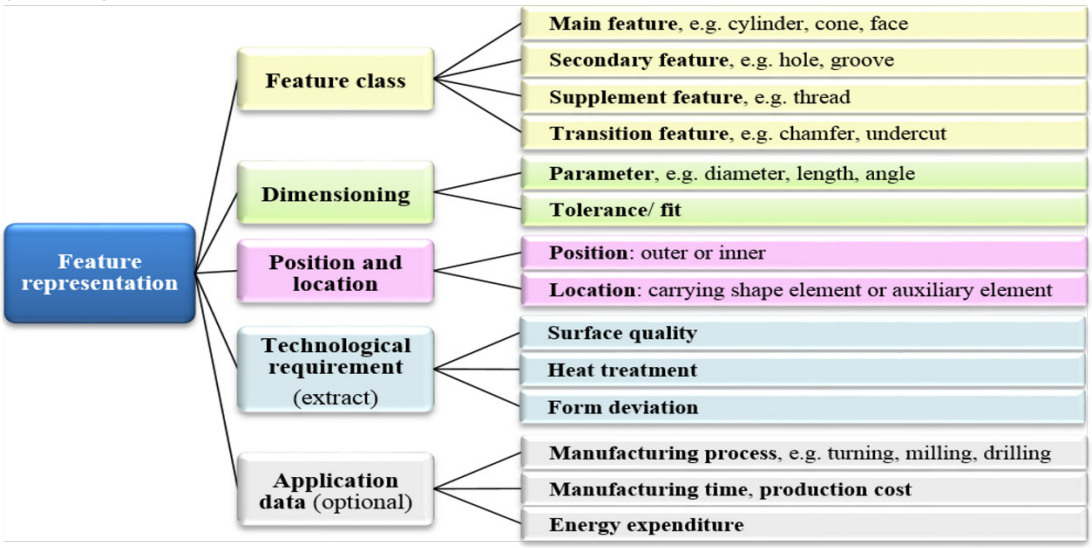

Figure 4 – Feature representation structure [6]

3. KNOWLEDGE-BASED PROCESSING OF PROCESS STANDARDS

The knowledge-based processing takes place in a planning assistant. As a result of chapter two, this assistant uses three steps (see figure 5):

- ✓ Geometrical analysis with recognition of machining features [5]
- ✓ Automated determination and technological mapping of process standards
- ✓ Evaluation and chaining of process standards for the technological process sequence

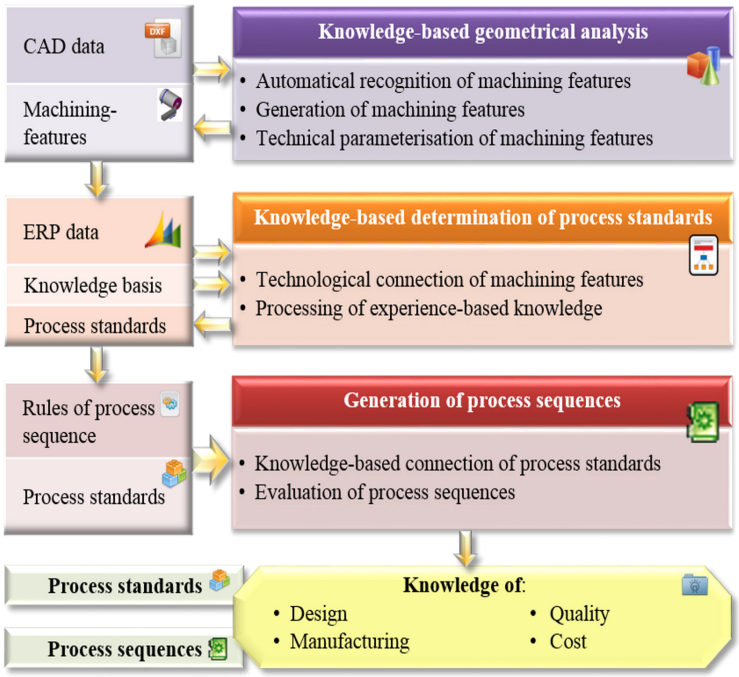

Figure 5 – Knowledge-based processing of process standards (WATOP)

The developed modules for knowledge-based processing of process standards have to be integrated into the existing enterprise software (CAD and ERP) via interfaces. Available data will be used primarily as sources of information in the system (see figure 6). Thus, the feature data can be taken from the CAD system (e.g. Inventor, Pro E) via DFX-File. The technological data and machine data, designed as a feature-oriented database, come from the ERP-System, e.g. Dynamics Ax (machines, tools and operations). Further receiving the knowledge and experience of the design engineer, manufacturing planner and economists has to be incorporated into the planning assistant.

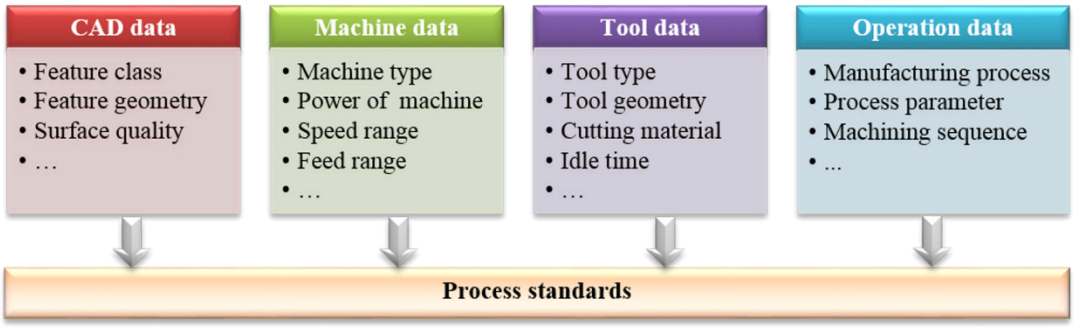

Figure 6 – Information resources for process standards (referring to [1])

4. EXAMPLE OF PROCESS STANDARD

The developed process standards can be applied in different parts and in several process sequences. In principle, the process standards are systematized according to group of parts, materials and machining features.

Figure 7 shows the application of process standards using the example of a groove on a bevel gear shaft. Within the sequence of operations are the process steps "plunge milling" and "face milling" deposited. The process step "face milling" contains the machine type, the tool parameters and cutting parameters. The standardized process can also be applied part-neutral.

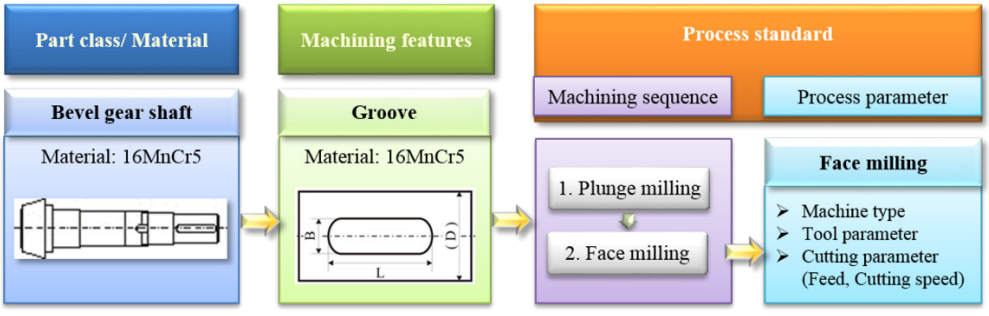

Figure 7 – Process standard on the example of the body of a bevel gear shaft

In the development of process standards, only the most important parameters should be considered. This simplifies required changes in the influence factors. According to [1] company-specific standardization committees are responsible for the continuous re-evaluation of process standards (see Figure 8).

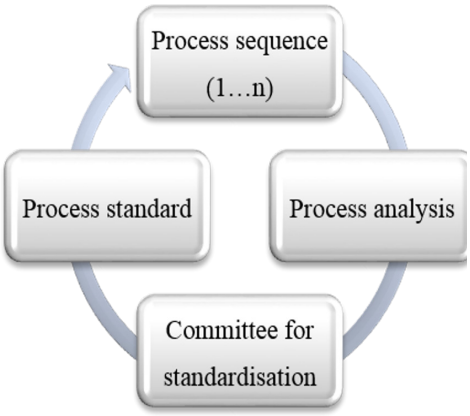

Figure 8 – Control loop for continuous process evaluation [1]

5. CONCLUSION

The technological variety is reduced through the development of knowledge-based planning assistant and the application of process standards. Based on an analysis of the design features the technological parameters for the machining processes are defined and stored in the process standards as "best technologies". With the developing process standards optimized technological processes can be implemented according to quality, time and cost.

The benefits of the project are mainly in the quality assurance of manufacturing processes, the reduction of the planning and manufacturing time and the minimization of the variety of tools in the enterprises of manufacturing parts. With the integration of the planning assistant in the CAD- and ERP- systems, technological processes can be determined automatically.

Acknowledgements

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