11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

OPTIMIZED-AUTOMATED CHOICE OF CUTTING TOOL MACHINING MANUFACTURING FEATURES IN MILLING PROCESS

Abdelilah Elmesbahi [1], Ahmed Rechia [1] and Oussama Jaider [1]

[1] Departement of mechanical engineering, Faculty of Sciences and Techniques, University of Abdelmalek Essaadi, Tangier, Morocco, elmesbahi_abdelilah@hotmail.com

Key Words: *Milling process CAPP, Automatic Tool selection, Operation sequence, Optimization.*

Recently, an important part of research has been carried out on the integration design and manufacturing CAD/CAM to achieve a computer-integrated manufacturing (CIM) system [1]. In the past few years, the effective integration of CAD / CAM was a very difficult task because the human intervention was still necessary to convey ideas between these two disciplines and others industrial areas. Now, the integration, in Computer Assisted Process Planning CAPP, of entity "FEATURE" associated with STEP format play a key role to make easy the emergence of various technical informations into the same platform. Also, CAPP offers many benefits compared to conventional manual manufacturing.
Key techniques related to CAPP, manufacturing features recognition, design tolerance analysis, manufacturing tolerances, use of available resources, including machine tools, cutting inserts, holders, machining parameters such us cutting speed, feed rate, depth of cut, and so on [2,3].
In order to increase the effectiveness exploitation of CAD/CAM systems, One interesting components, In addition of the automatic manufacturing features recognition, is the integration of a technological databases of cutting tools, cutting inserts data and recommendation of cutting conditions selection.
Although, some manufacturers provide users of cutting-tools a wide range of applications, for example Sandvik Coromant offer Machining Calculator App that help engineers and machinists to optimize the performance of their turning, milling and drilling applications by calculating optimal cut settings based on job parameters, nevertheless, although these applications can assist, interactively, users in their choice of cutting-tools, its remain very difficult to be integrated in full-automated CAD/CAM system, due to limitation in it input/output data exchange and lack of interface between these different modules.
In this paper we present an automated and optimized tools selection of milling process which is one of module components covering most of machining process namely milling, turning and drilling. This modular platform is used to automatically, supplies, CAD / CAM system by required cutting-tools to machine manufacturing features extracted by an automatic feature recognition for prismatic parts module called "Frontier Faces of Base Face called FFBF" earlier described [4]. This sub-module is easily integrated and immerging the Feature technology and ISO Data STEP format, known by its ability of informations exchange and sharing within a large CAD/CAM Software and through the wide concept of Product Life Management (PLM) of machined part. This works is structured as follow:
A. Construction and structuration of informations Machining DATA from Handbook of

world's leading manufacturer Sandvik Coromant. This part includes:

1. ACESS Cuttig-tools Database from which, all parameters defining tool and tool holder, which are in relation with cutting conditions and materials, are stored.
2. Sandvik Coromant Features machining Database of all known elementary milling operations.
3. Programming Bloc used to computation of cutting conditions (feed rate, and cutting speed)

B. Structuration of DATA OUTPUT of FFBF Module: Database of Extracted manufacturing features from part design CAD (without GDT).

C. Sequencing of manufacturing features: this critical step is complicated by the presence of several factors contributing each with its own weight of selection. The algorithm must be able to deal with this many settings simultaneously, weighting each with its own relevance. Factors that act in this stages are:

1. Multiple interpretations of interacting machining features.
2. GDT extracted from Input STEP format of CAD parts.
3. Database of cutting tools for MF machining, knowing that several tools can be valid to machining the same manufacturing feature and the same tool can be also valid to machining many features of the same workpiece (optimization of selected cutting-tools parameters, minimizing the number of tool-changes and time of machining operation are required).

D. Determination of optimized sequencing and cutting-tools uses a hybrid approach based on expertise rules associated with geometric reasoning. Tools used for this purpose are:

1. Matrix of precedence: This matrix is based in GDT precedence in order to generate machining Sequencing of features.
2. Rules defining priority based in economical or technological constraints.
3. Geometric reasoning, Expertise rules.
4. Minimization of tools number and cutting-time.
5. Criteria evaluated with grid quotation by taking a scale of 0 to 10. This allows measuring and comparing together, in case of conflicting choice, strength of each component participating to MF machining.
6. Roughness of entities faces necessary in defining of required-steps to machining feature (roughing, semi-finishing and finishing).

Finally, a demonstrative sample, of extracted manufacturing feature, is presented to illustrate the correctness of optimized choice of milling cutters and machining operation sequences and validate our methodology.

REFERENCES

[1] Mohammad T. Hayasi, Bahram Asiabanpour , Extraction of manufacturing information from design-by-feature solid model through feature recognition, Int J Adv Manuf Technol 44, 1191–1203 (2009).

[2] Songgang Xu, John Keyser, Geometric computation and optimization on tolerance dimensioning, Computer-Aided Design 46, 127-137 (2014).

[3] F. Ju, G. BalTow, A Technologically Oriented Approach for the Economic Tool Selection and Tool Balancing of Milled Components, Int J Adv Manuf Technol t4, 307-320 (1998).

[4]: A. Elmesbahi, A new methodology for recognition of interacting features using Frontier Faces of Base Face, 6th International Conference of Integrated Design and manufacturing, CPI'2009, Fez: Morocco (2009).