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NUMBER 5
INSTITUTE OF ENGINEERING PROCESSES AUTOMATION
AND INTEGRATED MANUFACTURING SYSTEMS

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MANUFACTURING PROCESSES OPTIMIZATION WITH APPLICATION OF GRIP NC PROGRAMMING LANGUAGE

Abstract: This paper presents the possible application of GRIP NC programming language in order to optimise a manufacturing process. The possible optimization could be provided in Siemens NX Software with use of .Net programing language, SNAP libraries or GRIP NC language supported up to current version. Simplicity of use is a main advantage especially in situation when industrial company starts applying automated optimization in a technological process preparation. Automation should be considered also in order to manage with multi machine processes. In the proposed solution there is an algorithm that executes the loop until parameters, trajectory and strategy of cutting satisfy the set ranges. The software application could be extended for other types of manufacturing. Simultaneously the result of manufacturing process is important according to quality of surface, and chip removal process.

1. Introduction

The Siemens NX routine tasks can be automated with software that is prepared by a user. The Siemens NX programming environment tools are MS Visual Studio and GRADE (Graphics Advanced Development Environment) [3]. GRADE is easy to operate (text menu) and GRIP/GRIP NC language is easy to learn and applying in practice. The important advantage of GRIP NC programs is their compatibility with all Siemens NX versions (also with current NX9.0) in opposite to .Net languages which are compiled with specific version of libraries. If software is created with current version of NX, the program is incompatible backwards (obsolete library objects definitions). In result the proper selection of environment has an major impact to the future adaptation of a prepared tool. The GRIP NC functions (procedural language) are oriented to prepare operations like: inner and outer surfaces turning (rough, finish, threading, cut, drilling), milling (blind shape pockets, planar surfaces according to contour, multi-axial, plane surfacing according to contour, sequence, cavitation based, drilling, electro wired). The environment is also supported with Siemens NX manufacturing module with already implemented tools, especially the simulation tool that helps to analyse the result of cutting in particular operation.

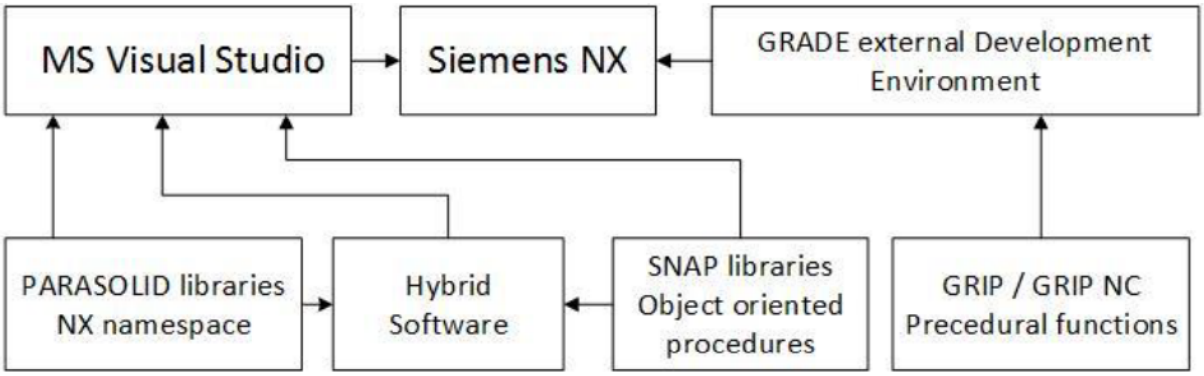

Fig.1. The programming tools environments bounded with Siemens NX software

2. Solution of optimization process automation

The preparation of technological process operation could be automated in various ranges. According to existing already defined operations or with simultaneously it creation the prepared operation could be automatically corrected in order to optimize cut parameters, trajectory of tools etc.. Furthermore the GPA symbols are used to set all main operations parameters and with additionally bounded code fragment with labels there is possibility to prepare iterative algorithm in order to generate operations with optimized cut parameters or a trajectory distribution points set.

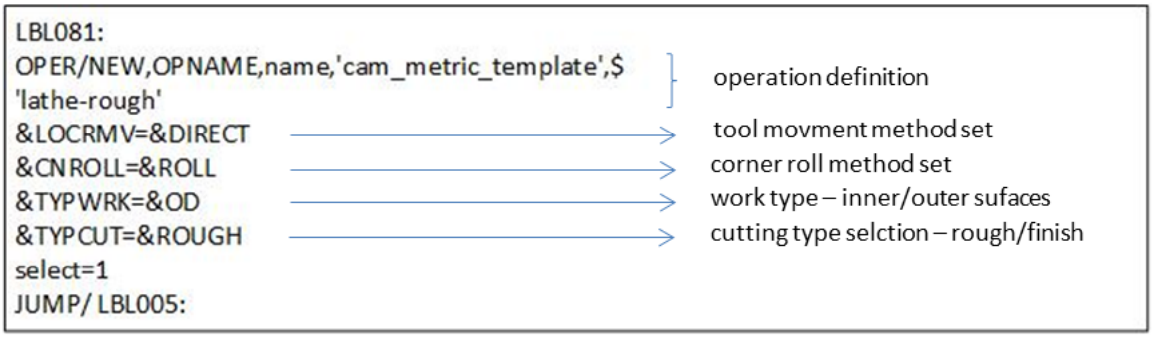

Fig.2. Example of operation generation code with standard set of parameters

For proper optimizations main parameters should not be considered as adjustable with algorithm, except &CNROLL GPA symbol. This parameter can be optimized, but with awareness of possible inaccuracy result of final machined surfaces. &CNROLL could be set as:

a) &ROLL – roll around corner GPA set,

b) &CLEAR – cut around corner using extended tangent.

In order to optimize technological operation algorithm should be implemented, according to schema presented in fig 3. The general algorithm is prepared in the loops that iteratively analyse the efficiency of proposed paths and parameters. When the primary set of parameters is prepared, the general algorithm start the loop until comparator confirms optimal values (technological operation selected data like: total time, path, parameters) according to an estimated range. The other possibility is an expert estimation of a generated machining

simulation, but it is not as fast as the previous method. The method could be also used for manufacturing based on models gained from 3D scanning [1].

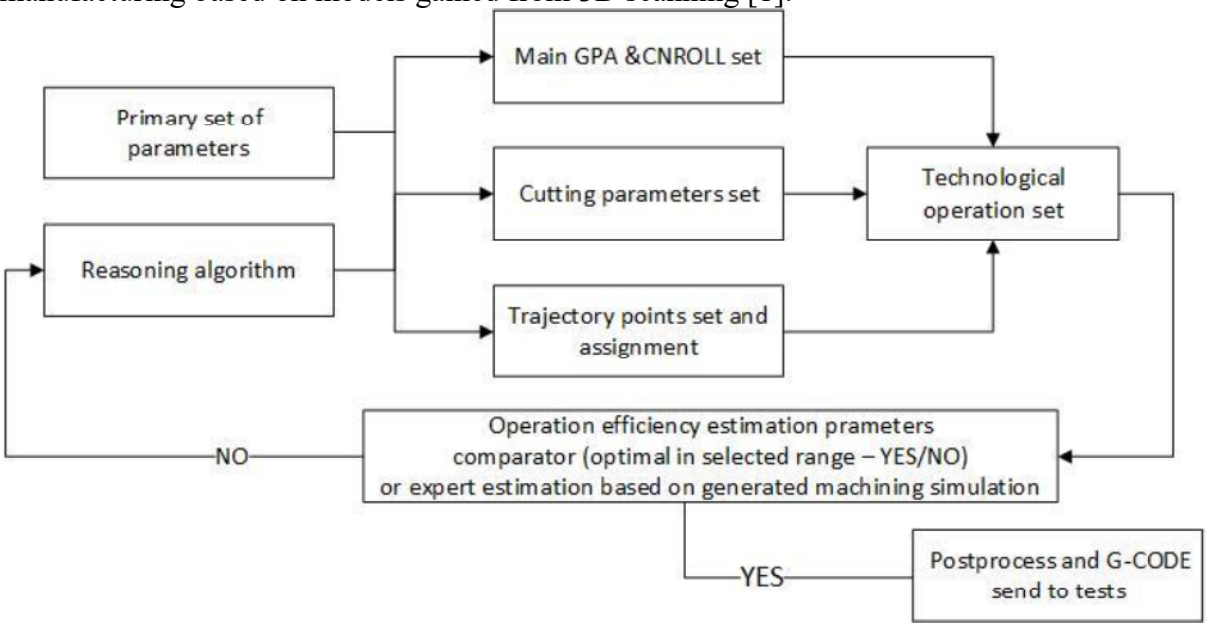

Fig.3. Solution for operation generation code with standard set of parameters

If the parameters fulfil rules stored in comparator algorithm according to technological data the post processing should be executed.

In order to ensure that the process is correctly optimized the practical verification should be always executed. Important aspect is that the practical verification can bring knowledge needed to adjust additional set of parameters or path manually or automatically. The automatically generated path is presented on fig. 4 where the path is optimized with the practical verification and the chip removal check. In example the chip removal during cutting process have a significant impact to a possible need of parameters optimization and path correction. The used local return point (LRT) for instance, brings possibility to avoid chip jam between tool and material, as well as cool down tool in order to prevent surface melting of the turned PA material. Disadvantage of a LRT use is an operation main time extension, which is worth to trade off in specific circumstances. All data modification made according to practical verification, should be saved in data base and described in order to modify existing algorithms or to modify a comparator values set. The additional development of program should bring the proper results that are also repeatable in similar cases. In other approach the optimization algorithm could be set in order to achieve a specified quality of surface, especially when technological operation is prepared with a share of cost effective analysis. If surface of specific manufactured element has similar surfaces quality to other it surfaces, the set of parameter of quality for each one should be assigned. The algorithm should adapt other parameters to reach specific level of other surface layer roughness [5].

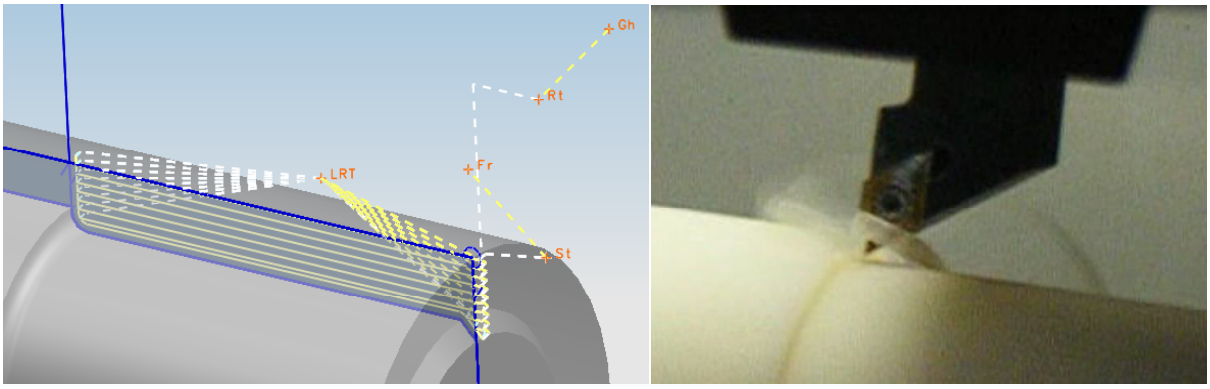

Fig.4. Automatically generated tool trajectory according to point-set distribution generated with algorithm and practical verification of chip removal

3. Summary

The software development environment like MS Visual Studio or GRADE, gives possibility to prepare software that can optimise: a trajectory, cutting parameters and a strategy of cutting. The balance of surface quality and operation time is a major problem to solve with the optimization algorithm. Furthermore the optimization algorithm can be bounded with data stored in a database which contains empirical data gathered during tests. Each solution of an optimized operation should be well described and gathered according to similar type of operations, for future use without need of additional research and tests, with only proper adjustment.

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