

# MANAGEMENT OF CAD-CAM TURNING OPERATIONS

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**Abstract:** The paper presents aspects regarding the management of the CAD-CAM turning operations. Activities and processes carried out in order to obtain a shaft of relatively medium complexity are described. For the constructive design SolidWorks software is used, for technological design – SolidCAM, and the manufacturing processes are performed on a numerical control lathe of EMCO Concept Turn 55 type.

**Keywords:** CAD-CAM management, turning operation, lathe machine.

## 1. Introduction

In the actual manufacturing landscape, Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) technologies have become widely used tools for enhancing productivity, precision, and flexibility. Both constructive design and technological design can be included in CAD activities.

Among various machining processes, turning operations remain fundamental for producing rotational components with high dimensional accuracy and surface finish. The integration of CAD-CAM systems into turning operations has revolutionized the way components are designed, simulated, and manufactured, streamlining workflows and minimizing human error.

Studies on turning CAD-CAM systems were accomplished in the beginning of the 80's, focusing on making them more interactive [4] and on developing manufacturing methodologies [18].

Some actual research and development directions in the CAD-CAM turning operations field are as follows: automatic generation of the machining processes [2], [19], accelerating the tool path computing [3], increasing manufacturing accuracy [9], and teaching the material removal processes for new generations of students [10].

In authors' previous work, improvements of CAD models [6], [8], [15], analyses of numerical control (NC) systems [11], [12], [13], of CAM processes [1], [14], [16], and of manufacturing parameters [5], [7] were accomplished.

This paper explores the effective management of CAD-CAM turning operations, focusing on the coordination of design, numerical control machine tool (NCMT) setup, and manufacturing processes. By presenting current technologies and best practices, the paper aims to provide a comprehensive framework for the successful implementation of CAD-CAM turning systems in industrial environment.

The paper presents the steps taken in order to obtain a shaft by turning on a numerical control machine tool, starting from the geometrical model of the shaft.

## 2. CAD-CAM Systems Management

CAD-CAM systems management represents a complex set of activities aimed to integrate CAD and CAM processes, with the ultimate goal of producing finished components quickly and efficiently. As illustrated in fig. 1, this involves the computer-aided coordination of two fundamental areas: constructive and technological design activities, on the one hand, and manufacturing processes carried out on NCMT, on the other. The result of these activities and processes is the finite component, based on the geometrical model.

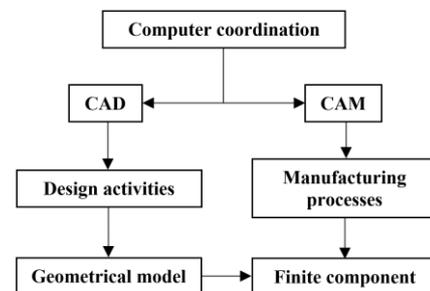


Fig. 1. CAD-CAM computer coordination.

The coordination between CAD and CAM systems can be accomplished through a local area network, or, more simply, the CAD and CAM software can be installed and used on the same computer which is connected to a NCMT. Obviously, the second option ensures better management of all activities and processes.

The first advantage of operational management is data integration and traceability. The geometric model resulting from the CAD design stage becomes the basis for developing CAM processing technologies. Through this link, errors associated with manual transcription of information are eliminated and full coherence between the design and manufacturing phases is ensured. Moreover, this flow can be bidirectional: data resulting from production can be used as feedback for the subsequent CAD-CAM optimization.

The second advantage of CAD-CAM operational management is given by increasing efficiency and reducing costs. CAD-CAM management has the role of centralizing data in a unitary system, capable of minimizing human errors and reducing production launch time.

The third advantage of CAD-CAM management is the flexibility and adaptability it offers. Any change made to the CAD model is immediately reflected on the processing technologies generated in CAM, which allows rapid adaptation to market requirements or specific customer requests.

As a practical example of CAD-CAM management, the technology of machining a shaft-type part is presented. The entire flow of activities from idea to finite component can be summarized in the following stages:

1. Design stage (CAD) – the design engineer uses SolidWorks to develop the 3D model of the part;
2. Transfer of the CAD model to the CAM environment by importing into SolidCAM, where the semi-finished part to be machined is defined;
3. Definition of machining processes – the machining operations are established: roughing/finishing turning, grooving and/or threading;
4. Simulation and optimization of processing by appropriately setting the technological working parameters;
5. Generation of CNC code – G-code compatible with Sinumerik 840D is obtained;
6. Manufacturing of the part on the CNC machine – the operator launches the program and the part is processed;
7. Feedback and quality control – the part is checked, and the results can be used for new optimizations.

### 3. Computer Aided Constructive Design - The Geometrical Model

The first step in achieving the geometrical model is to create the shaft profile planar sketch, in SolidWorks *Sketcher* module, as shown in fig. 2. Then, revolving the profile around the horizontal axis by applying the *Revolved Boss/Base* option in *Features* module, fig. 3, the geometrical model is obtained, fig. 4.

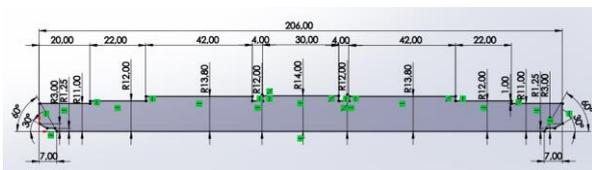


Fig. 2. The shaft profile planar sketch.

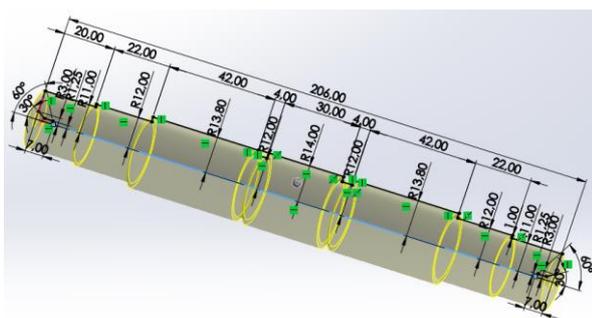


Fig. 3. Applying the *Revolved Boss/Base* option.

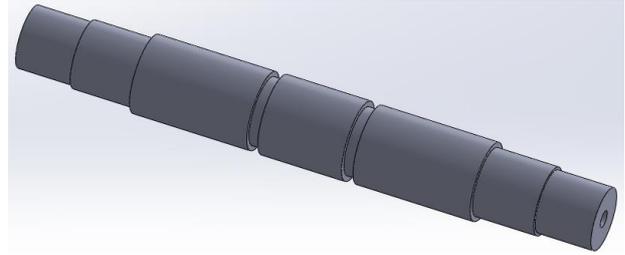


Fig. 4. Shaft geometrical model.

### 4. Computer Aided Technological Design - The Technological Parameters

The technological itinerary is as follows:

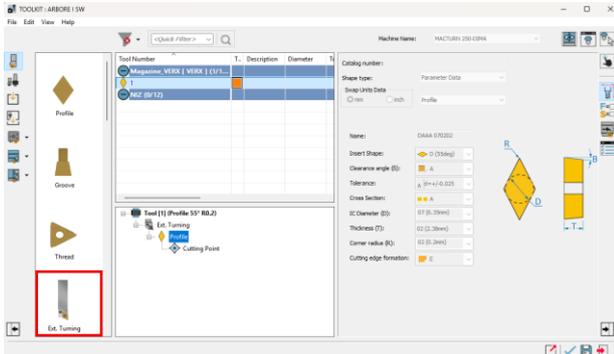
- cutting the semi-finished part to a length of 210 mm;
- centering;
- clamping 1 - fixing in the universal chuck and supporting with the centering tip;
- selecting the cutting tool for external turning;
- frontal turning to a depth of 2 mm;
- longitudinal turning: diameter of 22 mm on a length of 20 mm, diameter of 24 mm on a length of 22 mm, diameter of 27.6 mm on a length of 44 mm, diameter 28 mm on a length of 34 mm, diameter of 27.6 mm on a length of 44 mm;
- stopping and checking the processed dimensions (rearrange if necessary);
- loosening the centering tip and opening the universal chuck;
- turning the part for clamping 2;
- fixing in the universal chuck the part with the processed diameter of 22 mm and supporting it with the centering tip;
- front turning to a depth of 2 mm;
- machining dimensions: diameter of 22 mm on a length of 20 mm, diameter 24 mm on a length of 22 mm;
- changing the cutting tool for groove turning;
- turning 2 grooves with a diameter of 24 mm on a length of 4 mm;
- stopping the lathe and checking the machined dimensions if they correspond, otherwise they are reworked from the same clamping;
- loosening the centering tip and releasing the part from the universal chuck;
- quality control.

The calculus of the cutting regime parameters was accomplished according to [17], thus the following values resulting:

- rough turning cutting depth:  $a = 1 \text{ mm}$ ;
- finishing turning cutting depth:  $a = 0.2 \text{ mm}$ ;
- machine-tool feed rate:  $f_{MT} = 0.1 \text{ mm/rev}$ ;
- machine-tool spin rate:  $n_{MT} = 1100 \text{ rev/min}$ .

In order to simulate the turning processes by using the SolidCAM software, the stock / semi-finished part, the finite part, the surface to be processed, the cutting tools are defined, and the values of cutting regime parameters and other technological data are introduced.

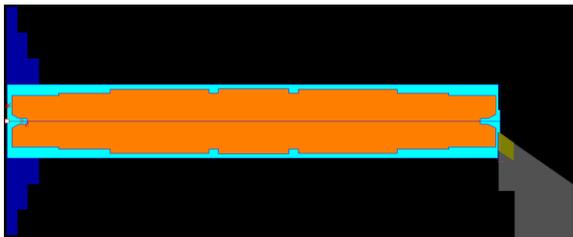
For example, fig. 5 shows the definition of the external turning knife cutting plate.



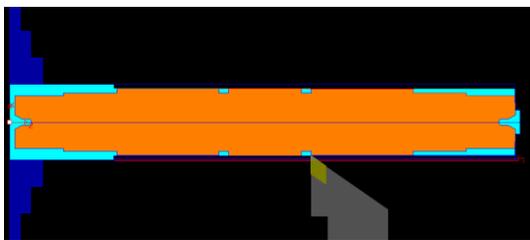
**Fig. 5.** The definition of the external turning knife cutting plate.

After setting the data, the simulations can be achieved in different visualization modes.

The simulations of frontal and longitudinal external turning - clamping 1, in *Turning* mode, are presented in fig. 6, and the simulation of groove turning – clamping 2, in *SolidVerify* mode, is presented in fig. 7.

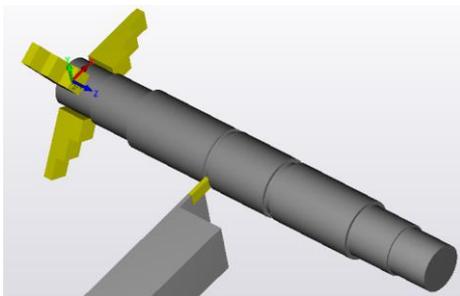


a)



b)

**Fig. 6.** Simulation of frontal turning (a) and longitudinal turning (b) - clamping 1, in *Turning* mode.



**Fig. 7.** Simulation of groove turning – clamping 2, in *SolidVerify* mode.

After the processing simulations are functional, the NC programs could be generated by using the *GCode* option, verified and adapted to the specific NCMT if necessary.

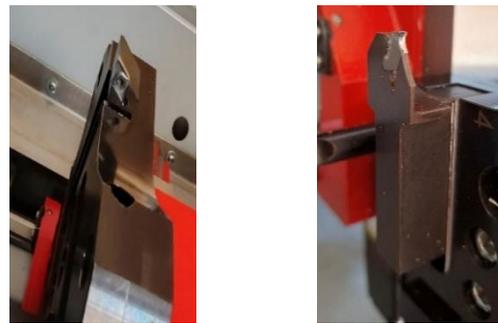
## 5. Computer Aided Manufacturing – The Processing

The NCMT used is an EMCO Concept Turn 55, as shown in fig. 8.



**Fig. 8.** NC lathe EMCO Concept Turn 55.

In fig. 9, the turning knives used are presented.



a)

b)

**Fig. 9.** Turning knives used: for frontal and longitudinal turning (a) and for grooving (b).

In fig. 10 - 12, different stages of manufacturing are shown, corresponding to simulations in fig. 6, a), b), and 7.



**Fig. 10.** Frontal turning - clamping 1.



**Fig. 11.** Longitudinal turning - clamping 1.



**Fig. 12.** Groove turning – clamping 2.

## 6. Conclusions

From a strategic perspective, CAD-CAM management should not be viewed only as a technical issue, but as a modern organizational process. Its success depends not only on the performance of the software used (such as SolidWorks and SolidCAM), respectively of the CNC equipment controlled by advanced systems such as Sinumerik 840D, but also on the way in which the organization ensures personnel training, equipment maintenance and constant updating of technologies. Only through such an integrated approach can the goal of quickly and efficiently transforming a geometric model into a high-quality finished part be achieved.

Good management of CAD-CAM turning operations supposes high compatibility between the factors involved – human, hardware, and software.

If the finite components have a relatively medium complexity, as presented in the paper, then all the activities and processes could be performed by a single well-trained operator.

If the finite components are complex, specialized work teams for constructive design, technological design, and manufacturing are necessary.

A company may choose the type of CAD-CAM systems management depending on the resources and on the financial power.

This paper referred only to turning operations. As further research, the milling operations can be studied.

## 6. References

- [1] Cojocaru V., Miclosina C.-O., Lata M.V., Popovici G.: “Contributions on Computer Aided Manufacturing of Drill-Jig Bushings”, Annals of “Eftimie Murgu” University of Resita, Engineering Fascicle, Year XVI, No. 1, pp. 69-73, 2009.
- [2] Dodok T., Cubonová N., Cisar M., Ivanov V.: “Automatic Generation of the Machining Processes for Turned Components in CAD/CAM System”, Advances in Manufacturing Engineering and Materials II, ICMEM 2020, pp. 404-410, 2021.
- [3] Jimeno-Morenilla A., Martinez A., Cuenca S., Sánchez-Romero J.L.: “Accelerating Tool Path Computing in CAD/CAM: A FPGA Architecture for Turning Lathe Machining”, 2007 International Conference on Field Programmable Logic and Applications, Proceedings, Vols. 1 and 2, pp. 702-705, 2007, DOI 10.1109/FPL.2007.4380749.
- [4] Khurmi S.K., Besant C.B., Jebb A., Pak H.A.: “A Microcomputer Based Interactive CAD/CAM System for Turning and Milling Operations”, Computer-Aided Design, Vol. 14, Issue 2, p. 112, 1982.
- [5] Korca Z.-I., Miclosina C.-O., Cojocaru V.: „An Experimental Study of the Cutting Forces in Metal Turning”, Multi-Conference on Systems & Structures (SysStruc '13), published in Annals of “Eftimie Murgu” University of Resita, Engineering Fascicle, Year XX, No. 2, pp. 25-32, 2013.
- [6] Korca Z.-I., Cojocaru V., Micloșină C.-O.: „Simulation of the Tooth Helix Angle Influence on the Vibration of a Single Stage Helical Gearbox”, 6th International Conference on Advanced Concepts in Mechanical Engineering (ACME 2014), June 12-13, 2014, Iasi, Romania, published in Applied Mechanics and Materials, vol. 658, Advanced Concepts in Mechanical Engineering I, pp. 83-88, 2014.
- [7] Korca Z.-I., Miclosina C.-O., Cojocaru V.: „Influence of the Cutting Parameters on Vibration Level in Metal Turning”, Annals of “Eftimie Murgu” University of Resita, Engineering Fascicle, Year XXI, No. 1, pp. 157-164, 2014.
- [8] Korca Z.-I., Cojocaru V., Micloșină C.-O.: “Shape Improvement of a Gearbox Housing Using Modal Analysis”, Romanian Journal of Acoustics and Vibration, Volume 5, Issue 3, pp. 47-52, 2018.
- [9] Leonov O.A., Shkaruba N.Z., Vergazova Y.G., Khasyanova D.U., Pupkova D.A.: “Analysis of the Accuracy of Manufacturing of Shaft Surfaces and Cylindrical Keyed Joint Holes”, Journal of Machinery Manufacture and Reliability, vol. 52, suppl. no. 2, pp. S126-S131, 2023.
- [10] Luis C.J., Puertas I., Ramirez C., León J., Luri R.: “Methodology for Teaching the Material Removal Processes by Using CAD/CAM Software: Turning Processes”, New Frontiers in Materials Processing Training and Learning, Vol. 625, pp. 67-75, 2009.
- [11] Lungu I., Miclosina C.: „Comanda sistemelor DNC” (Command of DNC Systems), Robotica & Management, Vol. 7, No. 2, December 2002, pp. 49-52.
- [12] Lungu I., Miclosina C.: „Analiza sistemelor de programare NC” (Analysis of NC Programming Systems), Robotica & Management, Vol. 8, No. 1, June 2003, pp. 45-48.
- [13] Lungu I., Miclosina C.: „Particularități ale comenzii numerice la mașini de rectificat” (Particularities of Numerical Control on Grinding Machines), Robotica & Management, Vol. 8, No. 2, December 2003, pp. 54-56.
- [14] Miclosina C.-O., Korca Z. I., Cojocaru V.: „Some Aspects on Technological Design of a Cam Type Workpiece Using CATIA Software”, Multi-Conference on Systems & Structures (SysStruc '13), published in Annals of “Eftimie Murgu” University of Resita, Engineering Fascicle, Year XX, No. 2, 2013, pp. 33-38.
- [15] Miclosina C.-O.: „Bazele proiectării asistate de calculator”, (Basics of Computer Aided Design), Eftimie Murgu Publishing House, Resita, 2018.
- [16] Miclosina C.-O., Filip A.-S., Cojocaru V., Vela D.-G.: “On the Milling Process Simulation of an Injection Mold Part”, Studia Universitatis Babeș-Bolyai, 67 (1), 2022.
- [17] Popovici G.: „Tehnologia construcțiilor de mașini” (Machine Building Technology), Editura Didactică și Pedagogică (Didactical and Pedagogical Publishing House), Bucharest, 2010.
- [18] Plummer J.C.S., Hannam R.G.: “Design for Manufacture Using a CAD/CAM System - A Methodology for Turned Parts”, Proceedings of the Institution of Mechanical Engineers Part B-Journal of Engineering Manufacture, pp.187-195, 1983.
- [19] Varga J., Tóth T., Frankovsky P., Dulebová L., Spisák E., Zajacko I., Zivcák J.: „The Influence of Automated Machining Strategy on Geometric Deviations of Machined Surfaces”, Applied Sciences-Basel, vol. 11, nr. 5, art. 2353, 2021, DOI 10.3390/app11052353.