

## CAD - CAM PROCEDURES USED FOR RAPID PROTOTYPING OF AN ELECTRIC MOTOR DRIVING SHIELD

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**Abstract:** *The paper presents CAD-CAM procedures used for rapid prototyping of an electric motor driving shield. Computer Aided Design is an activity that uses a computing system in the modification, analysis and optimization of design. The computing system consists of hardware and software optimized design. The prototype models used by CAD/ CAM, allow a rapid improvement and an efficient design. A particular advantage of used CAD/CAM procedures refer to the fact that these components can be adequately and effectively tested before the prototyping, in terms of mechanical stress, due to previous simulations, eliminating all costs which means waste or adjustments.*

**Keywords:** *CAD-CAM, prototyping, electric motor, driving shield.*

### 1. INTRODUCTION

In a society of sustainable development, consumption should be streamlined and rationalized and waste production must be minimized. Modern trends require high technologies which afford a higher power density and, therefore, the continuous monitoring of process flow becomes a necessity; In order to increase the reliability, nowadays there is a tendency of CAD-CAM integration tools. Computer technology has greatly influenced the structure of machine tools. The proper product to current requirements should include features that meet the relevant points on ease of assembly, recycling (disposal, reuse, etc.), environment (pollution in the production, use and disposal), user interaction and ease of use (for ergonomic reasons), among others, which do have a significant increase in product time analysis made by different domain designers. Thus, it is necessary to use Computer-Aided Design systems, Computer Aided Engineering, Computer-Aided Manufacturing (CAD, CAE and CAM) and design standardization. These systems are allowing a more efficient communication between different systems [1]

### 2. THE TECHNOLOGY OF MANUFACTURING OF ELECTRIC MOTORS SHIELDS

The shape is dictated by the design of the shield: the type of used bearing; bearing position on machines; the connection way with the case. An economical way to achieve high dimensional precision of parts is the modeling, simulation and processing CAD technology. CAD technologies have made the transition from traditional power tool to a computerized machine, able to act intelligently.

### 3. CAD ENVIRONMENT AND CAM PROCEDURES

In the literature, CAD / CAM is an acronym that means using computer design and manufacturing. This innovative technology that uses digital computers to conduct various design and manufacturing functions tends to fully integrate these activities which, traditionally, have been regarded as two distinct and separate functions. Overall, CAD /CAM develop future enterprise advanced technology, full assisted by computer. The computing system consists of optimized for design hardware and software. Within CAD activity, based on executing drawings, were made 3D models of shields. Based on the overall design, taking into account the existing links between the components, it has been established asynchronous motor assembly. CAM includes indirect applications in which the computer has the support role for manufacturing operations. CNC machine tools are designed to change the shape and size of objects in terms of productivity, dimensional accuracy and quality of machined surface. I followed the issues such as energy consumption, process complexity and costs.

The emergence and integration of CAD/CAM systems within the production process, enabled engineers to create 3D CAD project, to generate trajectories in the generic language of CAM system and then to perform conversions in multiple languages.

The CAD and CAM activities are closely interdependent, because CAD is underlying CAM activities. CAD tools are defined based on three concepts: geometric modeling, computer graphics and design tools . CAM tools consist of the intersection of three fields used in manufacturing: CAD tools, network concepts and machine tools. .

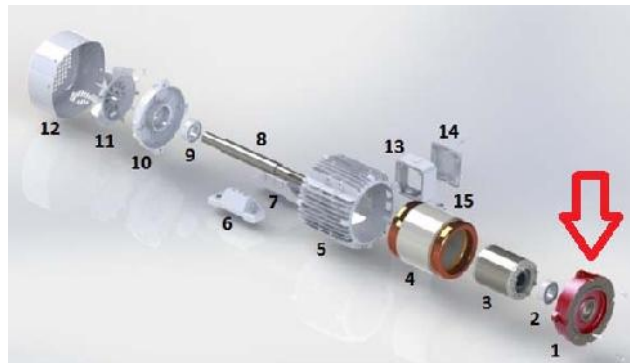
Computer-aided manufacturing – CAM is defined as the use of a computer system in planning, management and control of the operations of a plant ,by any direct or indirect interface between the computer and production resources.

### 4. THREE-PHASE INDUCTION MOTOR

Three-phase induction motor is the most electric motor used in electric drivers (Fig. 1).By means of electromagnetic induction, the rotating magnetic field will induce a voltage in rotor windings. Regardless of the type of engine, it has based on its construction two main components: stator and rotor. Other design elements are shown in Fig. 2:



**FIG. 1.** Three phase asynchronous motor



**FIG. 2.** Motor assembly components:

1- shield drive, 2 and 9 bearings, 3- rotor cage, 4- stator, 5- housing, 6 and 7 feet, 8- rotor shaft, 10- shield fan, 11- fan , 12- protective hood, 13- terminal box, 14- cover, 15- gland.

## 5. DESIGNING A SHIELD DRIVE IN SOLIDWORKS

For CAD modeling, as software environment, we used SolidWorks and for tool trajectory simulation was used ESPRIT program. SolidWorks software is a CAD software that offers powerful features allowing automating tasks and optimizing the technological process.

For the mark "shield" of the electric motor, the design was executed in Solid Works 3D program, after which the machine codes have been generated using ESPRIT program. The machine code generation is made automatically and the choice of cutting tools required for processing is made manually. To achieve the electric motor driving shield, we were started to outline its section (Fig. 3), following both the casting of blank odds and execution plan quotas (Fig.4).

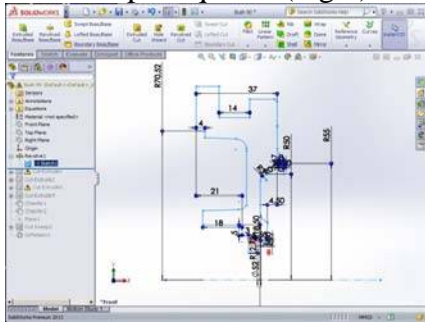


FIG. 3. The outline section of driving shield

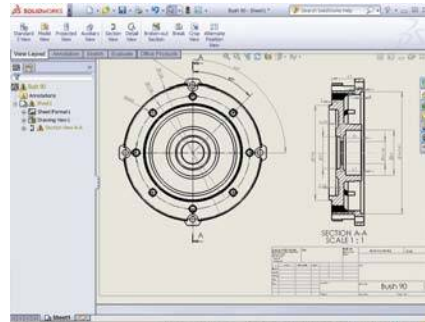


FIG. 4. The execution plan of driving shield.

The next step was to use the REVOLVE command, which has generated the solid body of the piece.

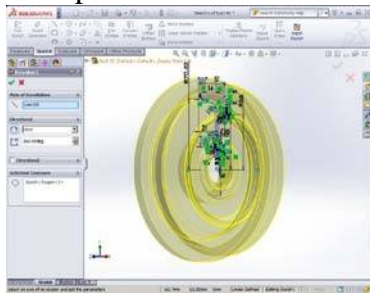


FIG. 5. Generating driving shield lugs

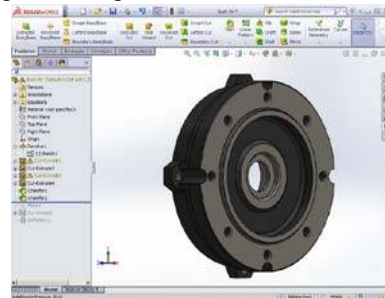
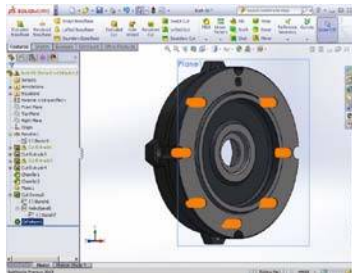


FIG. 6. Making holes

The functions „Chamfer 1" and „Chamfer 2" had achieved the edges beveling and holes for internal threads execution (Fig. 6).

To mark the processed areas, we have selected their surface by editing surfaces texture. In order to solve this issue, we have chosen from the SolidWorks library texture of the material processed „ machined steel "(Fig. 7,8).

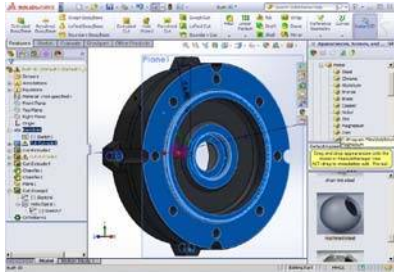


FIG. 7. The outline section of driving shield

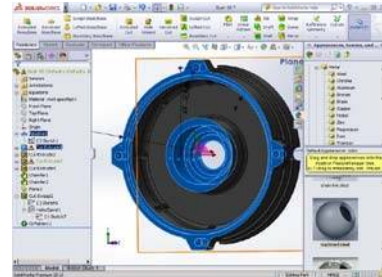


FIG. 8. The execution plan of driving shield.

The final model of piece after completion of design stages (Fig. 9).

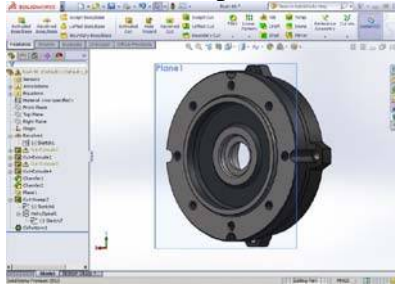


FIG. 9. The final modeling

Using the rendering process I have achieved a realistic image of the piece after modeling phase (Fig. 9).

After we have being obtained CAD models, we can open this model using EspritCam 3D (\* .esp)

Since ESPRIT is based on the Parasolid kernel, it is adept at opening a variety of solid model files such as 3D files from other CAD systems as SolidWorks or Pro/ E, files and translated files Such as IGES and Step.

ESPRIT CAM (developed by DP Technology) has developed and adapted a whole library of postprocessors for the whole range of machines OKUMA, has created optimized machining strategies for any type of processing, highlighting the high-technology and OKUMA machinery power, regardless of their configuration. Since the ESPRIT CAM is 100% Windows compatible, can be installed directly on the OSP control of OKUMA machines, can achieve programming, programs testing directly on the machine, and any changes that should be made in the program, can be made directly on CNC's machine without the need to first make the adjustments on your PC and then to be transferred to the machine, thereby reducing setup times of the machine. The manufacturing processes of engine component assembly, made by ESPRIT software are: roughing and finishing on the right part of the face (Fig. 10); milling bay for fixing screws (Fig. 11); lugs drilling for fixing the shield on the electric motor assembly and internal threads pre-drilling (Fig. 12); holes tapping (Fig. 13); roughing and finishing of inner diameter (Fig. 14).

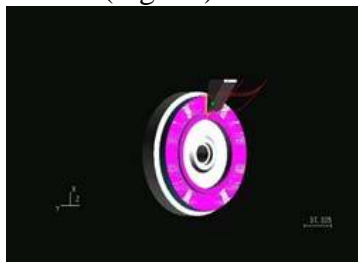


FIG. 10. The outline section of driving shield

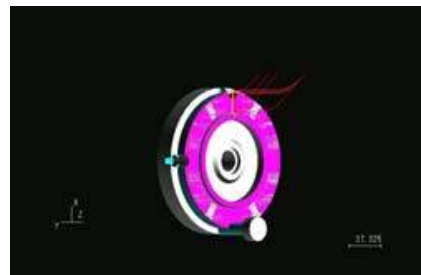


FIG. 11. The execution plan of driving shield.

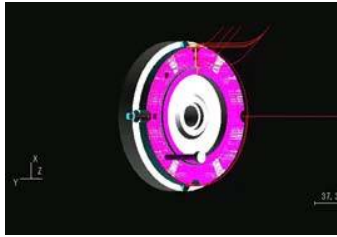


FIG. 12. Lugs drilling

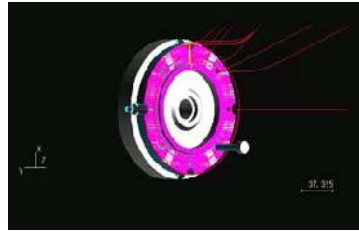


FIG. 13. Holes tapping

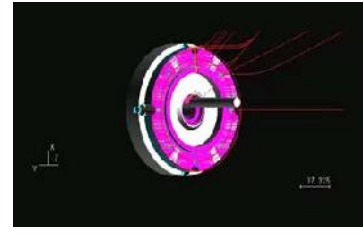


FIG. 14. Roughing and finishing

The program is transferred to Okuma machine as illustrated below (Fig.15 ):

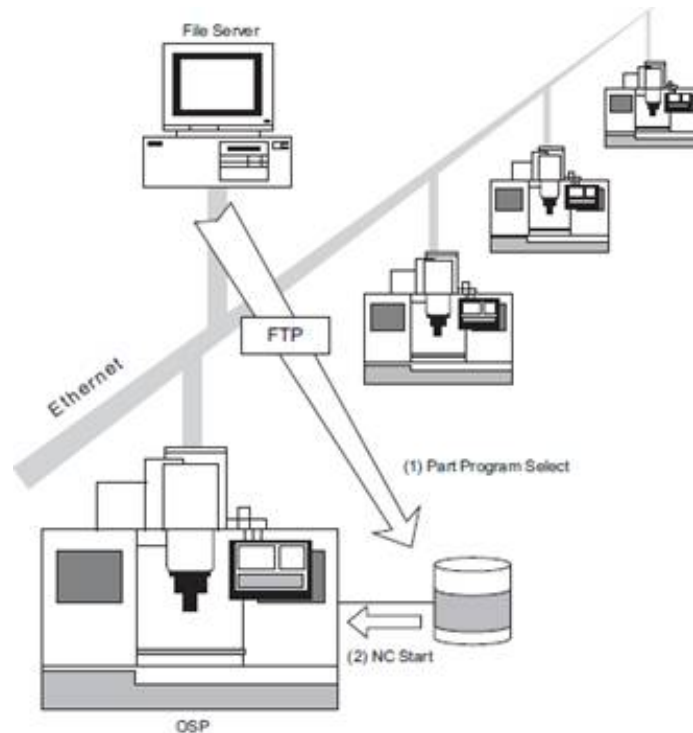


FIG. 15. The program transfer to Okuma machine

## 5. DETERMINATION OF THE CUTTING REGIME PARAMETERS

Cutting regime parameters are fed into the machine controller and further the process computer determines the cutting regime optimum.

### *Processing technologies of engine assembly components*

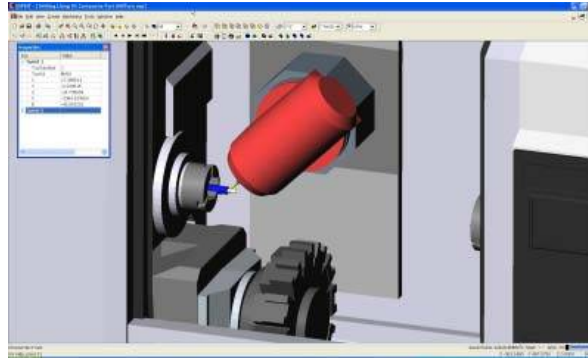
The driving shield is made of cast iron and went through several technological operations on a CNC machine tool. The driving shield can be processed by: turning, rotary milling, outside broaching and grinding.

The conical surfaces are manufactured by turning and grinding.

### *Turning*

The lathe is a machine that provides the power for piece turning at a determined rotational speed and for cutting tool advance along and depth of work piece. Turning is accomplished by combining the main rotation movement (usually executed by the piece), with the advance movement of the knife.

The advance movement is generally rectilinear in longitudinal direction, transverse or after an inclined direction, relative to main axis movement (Fig. 16)



**FIG. 16.**The advanced movement operation

The machine-tool choice is made on economic criteria: processing operation with minimum value cost price.

*The choice of the cutting tool*

With the fixing of processing operations, the working tool type is indicated by default. After establishing the cutting tool type and knowing the machining surface and work stage (finishing, semi-finishing or roughing) we choose up the tool with the optimal appropriate geometry. We are choose the cutting tool material taking in consideration the nature of the processed material, its physical and mechanical properties and the adopted cyclonic. If the surface processing can be performed by several versions of the same operation, the choices require the use of different tools; In this case, our tool choice is based on the calculation of the economics compared to the two versions of processing. The cutting tools used for the driving shield processing are: turning knife for outside roughing WNMG, turning knife for outside finishing CNMG, 14mm diameter cutter, 6.8 mm diameter drill, M8 tap, turning knife for inner roughing CCMT. Depending on the destination knives can be: machining knives for roughing or finishing of outer surfaces; machining knives for interior surfaces processing; processing knives for the interior or exterior profile surfaces

*Description and operation of CNC machine*



**FIG. 17.** Computerized machine tool



**FIG. 18.** Components of a CNC machine

A CNC lathe are using mathematics and different coordinate systems for processing received information, following which determines the piece machining process. The precision and accuracy of movement are two important functions of the CNC machine. Most CNC machines have at least two directions of movement during a process ( two axes).The axes ensure precise movement and positioning within a movement interval. The machine movements must lead to some machining tool as following: on a certain route; a precise speed of rotation of the shaft; a precise forward speed of the tool.

*Components*

A CNC machine (Fig. 17,18) consists of two main components: the machine-tool proper (lathe, planer, drill, boring or laser cutting machine, etc.) and data processing unit (controller) required to control machine axes. Also, there are auxiliary components: a computer permanently connected to the machine for the process modeling and simulation and to achieve processing programs.

*CNC production process*

Programming a CNC machine is achieved by three methods:

Manual - is carried out line by line by the programmer and produce the most compact and optimized processing programs;

Assisted - it is easier way to achieve, because the basic forms are stored in a data library and the programmer only selects those required;

Using a CAM (Computer Aided Manufacturing software - is the most complex form of programming and can be done on a personal computer and transferred directly into the machine's memory.

*CNC Modes of operation*

CNC machines are provided by default with different operating modes.

The control units are designed to enable the operator to use the machine in three different modes.

These modes have practical uses for production process improvement

The three modes of operation of a CNC machine tool:

*The manual operating mode*

In this mode, the operator can make manual positioning of the machine, can give the command to references research axes, can start and stop the tool rotation or coolant function. Generally, in manual mode, the operator can operate the various buttons and menus to realize the operations. Any operator order will have immediate response from the machine.

*MDI (Manual Data Input) operating mode*

The commands which cannot run in *manual operating mode* can be executed in MDI mode. This operating mode allows the operator to enter data into the CNC controller. On the latest generation CNC machines, the MDI technique is used to make manually operated commands. All information is displayed on the programming console display. It should be borne in mind that the operator to be careful when enters a command in MDI mode (Fig. 19), because the command will be executed without validating data entry, there is a danger of collision.

*The automatic mode*

In this operating mode CNC machine automatically running the programs (Fig. 20,21).

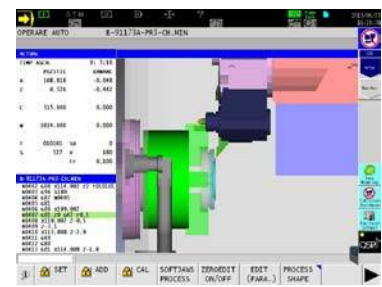
It is the normal operating mode of the machine.. The program is read from the machine's memory.



**FIG. 19.** MDI mode of Okuma CNC machine



**FIG. 20.** Automatic mode of Okuma CNC machine



**FIG. 21.** Collision Avoidance

The driving shield machining made from cast iron was carried out on the Okuma LB 3000 EX II CNC machine tools.

## CONCLUSIONS

At present, development and improvement of modeling, simulation and processing technologies have a very important role in machine tools domain, representing an economical method of making parts with high dimensional accuracy. With few exceptions, the most CAD systems have began by implementing geometric tools in two sizes, reaching up to level 5 D. CAM programming can be done relatively quickly for achieving very complex parts. Instead, CAM software can produce 1000 lines of program that are equivalent in terms of effect, with 4- program line achieved manually. Using CAM software - is the most complex form of programming and can be done on a personal computer and transferred directly into the machine's memory. Programming with CAM software allows the user to reach a level of performance far higher than manual programming.

In recent years this way of working has become quite popular, because the CAM software will generate the program in G code which will be transferred directly to CNC machine's memory. Automotive, aviation and shipping are using CAM software because their facilities have comprised a lot of mechanical parts, which are processed very precise

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