

Manufacturing of a logotype on NC machine in Autodesk environment

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Abstract

Nowadays, automation of manufacturing advertising frameworks gains particular relevance. Currently, NC machines are widely used at enterprises in various production branches, which requires a specialist that could exploit them with the highest efficiency.

This design is aimed at the developing a technological solution to the problem of automation of manufacturing processes involving NC machines on the example of manufacturing a logotype for the Department of Applied Mechanics at National aerospace university "KhAI". The main parts of the logo are: a gear wheel, a gripper, a sub gripper, a hinge joint (2), text, a backside, an accessory part, a bearing. The department logotype was designed in Solid Works environment. The designed patterns of the logo were adopted for the Autodesk environment by saving files in DFX format. This makes it possible to write a part processing program. The logo processing technology is framed considering the type of manufacturing procedure and with the use of high-yield equipment. Mechanical processing is fixed, the path of the tool is demonstrated and the control program for milling operations is received. In case the logotype is manufactured as an exterior decorative element, while designing it is necessary to consider the model of the cutting tool and the

cutting depth in order to visually specify some fragments of the parts and their mutual bracing. The design of the framework can be considered as a sample of automation of manufacturing outdoor advertisement by means of a modern machine – tool with NC operation system.

1. Introduction

Nowadays, it is hardly possible to imagine a modern city without outdoor advertising, which has become an integral part of an interior. Outdoor advertising is the catchiest of all types of adverts. Apart from this, it involves light, animation and colors. While other types of adverts have to find the way to get to the consumer, outdoor advertising effects people at shops, at work and on holidays round the clock and raises the profit on selling advertised products. The number of formats of outdoor advertising has grown up; among the most popular are: billboard, lightboX, wallscapes, citylight, streetfurniture and pointofsaledisplay [1, 2]. Having analyzed the existing methods and ways of designing the concept of the advert [3] it was proposed to introduce it as a lightboX. Since it is one of the oldest types of advertisement, it can easily transform and gain new forms due to up-to-date manufacturing technologies. As products ought not only to have an attractive outlook and be well manufactured, reliable and efficient equipment is necessary to organize

profitable production. One of the essential methods of increasing labour productivity and ensuring the reissue of qualified goods is automation of operation processes on the base of NC machine. The main distinction of this type of equipment is that processing follows a predesigned program, which ensures operation flexibility and makes it possible to use the program repeatedly [4, 5]. Engraving milling NC machines are widely used in outdoor advertisement manufacturing. They help cut sheets easily as well as produce flat and three-D objects: signboards, letters, fastening, stalls etc. Equipment selection is essential as it is necessary to consider a range of factors. But, the factor of cost is not principal. Attention should be paid to the characteristics and equipment of the machine. NC mill ought to be chosen considering the type of material, the desired size of rough parts and oncoming manufacturing operations. The main raw stuff for advertising constructions is acrylic, PVCs (with standard dimensions 2x3 m), composite panels and polycarbonates (with the length up to 6m). The dimensions of the working surface are important for cutting the sheets as well as a large working desk with vacuum fastening which is also suitable for thin or nonstandard parts. Also, it should be mentioned that, whereas there are machines with the length of their working space 4m and 6 m, it is possible to process massive materials on a smaller working space (e.g. operating 6m composite panels is possible on a 3m, however, it is more time consumable). The program for a NC machine can be uploaded from external drivers or common customized flash storages. Furthermore, modern equipment and machines can be attached to computer networks of an enterprise, which enables uploading the program by sending it through the commercial network [6, 7].

The automated creation of control programs is necessary for producing parts with complex geometry and/or high precision. Corresponding programs, such as CAD/CAM/CAE systems, can handle these tasks. The main advantages that a technologist gains when interacting with the system include work visualization, convenient geometry selection, high calculation speed, and the ability to verify and edit created trajectories. Their implementation in production is becoming increasingly necessary and allows for a new level of production [8, 9]. On the other hand, a problem lies in the exchange of information between digital models created using different technologies (SolidWorks, Autodesk) and the transmission of geometric and topological information. This work has significant practical value in constructing 3D models of complex geometry in SolidWorks, as well as integrating designed models

from the SolidWorks environment into the Autodesk environment.

The project is focused on the working out a technological solution of automation of manufacturing processes using NC machines on the example of manufacturing a department logotype for the Department of Applied mechanics at National aerospace university "KhAI". The task for designing a certain advertising product is shown in figure 1.



Figure 1: Sketch project of the logo

2. Experimental part

In general, the CNC machining process can be divided into four stages: first, a model is created using 2D drafting or 3D modeling software. Then, the tool trajectory should be prepared using automated production (CAM). Although it is theoretically possible to cut the model using a CNC machine at this stage, it is always useful to check the correctness of the cutting trajectory with simulation. This allows for making the necessary corrections. When everything is checked, and it is time to cut the part, control software is needed that communicates with the CNC machine via G-code to instruct it on what to do. At each stage of the process, the correct software is of paramount importance. The software used for modeling: Fusion 360, AutoCAD, Inkscape, SolidWorks, Aspire. The following software is used for generating and modeling G-code: eCam, HeeksCNC, G-Wizard Editor, CNC Simulator Pro, NC Viewer, PlanetCNC, ChiliPeppr, OpenCNC Pilot, OpenBuilds Control, LinuxCNC, TurboCNC, and others.

The department logotype was designed in Solid Works environment. Having studied the draft specifications, we decompounded it so that it would be possible to manufacture it on a NC machine. The main parts of the logo are: a gear wheel, a gripper, a sub gripper, a hinge joint (2), text, a backside, an accessory part, a bearing. The pattern of a gear wheel for the logo was taken from the Toolbox library. To make the logo more

attractive the gripper (Fig. 2) was decomposed to the hinge joints, the laid-on part and the gripper itself. It enables its volume image on the future board. The proportions were chosen in accordance with the logotype scaling.



Figure 2: Gripper, laid on part, hinge joints

The backside was added to support the main parts as well as to join the logo to the hanger and to create the image background.

The size of the part was chosen visually to match the proportions of the logo using the overlay technique on the completed part of the gear wheel in joint assembly.

In the end, the bearing (Fig. 3) was built up in the center of the logo. Due to the “Round Array” process it was managed to minimize the designing time and the whole image matched the pattern of a real bearing the best.

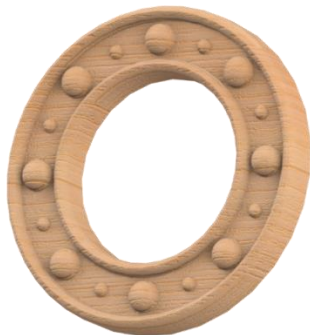


Figure 3: Model of bearing

A joining part was designed for the backside. This part is mounted between the backside and the gear wheel. The LED strip for lighting the board will be fixed along its side edges. The assembly process of all designed parts is shown in Figure 4.



Figure 4: Assembly of all designed parts

The designed patterns of the logotype were adopted for the Autodesk through saving files in DFX format. This makes it possible to write a part processing program. Fig. 5 all patterns are shown lay open to properly place the parts in the assembly. The dimensions of the logo were verified by overlapping the parts.

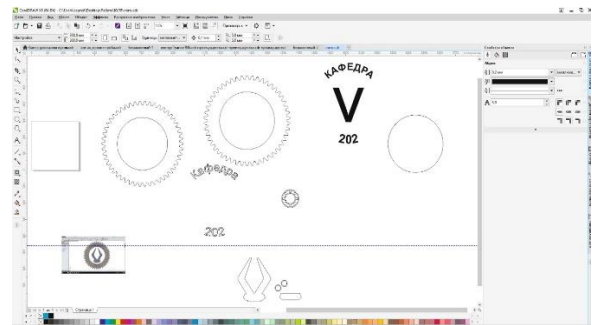


Figure 5: Parts of the logo in Autodesk environment

Figure 6 gives some sample results of the assembly. It shows the test result of an assembly of general view dimension parts and placing them relatively to each other. After the integration no demand for changing the dimensions was found, the arrangement of the components satisfies the sketch-task.



Figure 6: Arrangement of parts in assembly

For this small-scale production, it was decided to use a «Filato Optima 1325 MTV-E» CNC machine. The machine is designed for high-quality planar milling of parts from plate materials (2D milling)

and for applying various engraving on the surface of parts (2,5D milling). Also, the design of the machine allows using it for milling three-dimensional parts in 3-dimensional space (3D milling). The DNC mode enables executing the program of processing directly from a computer or another external device without recording it in the system memory.

Milling operations were adjusted by means of the window "Engraving". Figure 7 shows the configuration of the gear.

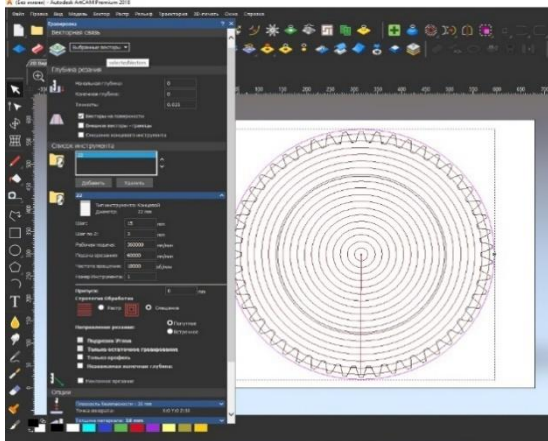


Figure 7: Setting up milling of the gear

Table 1 shows the names of each setup and the parameters that were inputted into the control program for processing.

The cutting tool path, the return point and possible deviations have been checked and adjusted. The cutter was chosen depending on the required future appearance. For example, for the gear, it was decided to first process it with a sharp 45°

cutter and then with a straight cutter along the same contour. Thus, it was possible to make the edges of the gear naturally shaped. The configuration could be obtained by engraving, but it would take much more time on the machine, which is not profitable for this type production. All the operations with the change of the tool were described in the control program in advance.

The mill is replaced on a machine manually, thus, when replacing a cutting tool in the control system, it is necessary to identify this so that the control program would go to the next cutting tool and its settings.

The most difficult to manufacture was the bearing part. To make it look as an actual bearing, it was decided to engrave the workpiece. The path of the movement can be seen in Figure 8.

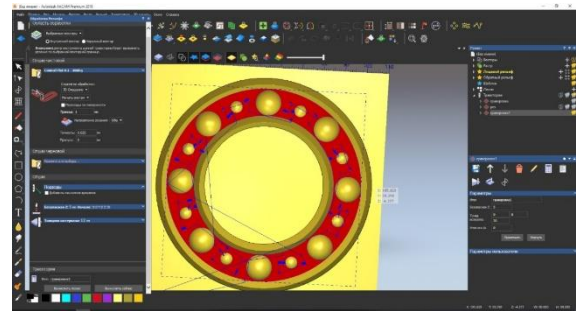


Figure 8 – Engraving path of the bearing

3. Results

In case the logotype is manufactured as an exterior decorative element, while designing it is necessary to take into consideration the model of a cutting tool and the cutting depth in order to visually specify some fragments of the parts and their mutual bracing.

Table 1: Setup and the parameters that were inputted into the control program for processing

Operation number	Cutting tool	Spindle rotation speed, mm/min	Tool feed rate, mm/min"	Cutting depth, mm
Setup 1, Gear Processing				
1	Conical Milling Cutter (Ø 22 mm)	15 000	30 000	1
2	Sharp-edge cutter 45°	18 000	12 000	30
3	Straight end mill (Ø 3mm)	20 000	15 000	10
Setup 2, Manipulator Gripper Handling				
1	Sharp-edge cutter 45°°	18 000	18 000	10
2	Straight end mill (Ø 22mm)	18 000	30 000	6
Setup 3, Bearing treatment				
1	Straight end mill	50 000	0-30 000	0-17
Setup 4, Text processing				
1	Straight end mill	50 000	0-30 000	0-17
Setup 5, Treatment of the rear panel				
1	Straight end mill	50 000	0-30 000	0-17

To synchronize the «Filato Optima 1325 MTV-E» machine with its control system, a decision was made to use NCStudioPCIMC-3D. Systems such as NC (Numerical Control) perform addressing of commands, interpolation of intermediate coordinates and implementation of typical cycles according to strictly defined algorithms. Information is entered into the NC system from the control program by separate frames. The system works properly in Windows XP/7 32 bits and has an intuitive user –friendly graphical interface, which makes enables simulating and debugging a control program with enhanced functionality for the efficient use of a CNC machine. The NC Studio system supports 3 axes, 3 end sensors and discrete spindle control (7 steps). The technological process of manufacturing the logo is designed with the most appropriate sequence of operations and transitions applying the most rational milling methods. The cutting modes and processing techniques are assigned which include common tool feed, spindle rotation speed, selection of the tool path selection and cutting depth and allowances. Finally, the program calculates the processing path using the previously configured parameters. For starting work on the machine, it is necessary to configure the zero point of the machine and the workpiece and measure the cutting tool. The end product of the logo is given in Figure 9.

4. Conclusion

The main programming language of the control system is defined in ISO6983 by the International Standards Committee and is called 'G-Code". This means that the system uses standard G-codes, which allows us to work out processing programs by applying various popular software products. However, despite the fact that manufacturers of CNC systems follow the standards in describing the main functions, they allow deviations from the rules when it comes to some special characteristics of their systems. This development will increase the efficiency of the entire enterprise by introducing CNC advertising into the industry. The proposed method for creating an automated control program for a CNC machine in the process of creating a new product allows for predicting the behavior of the system and comparing a range of different alternative design solutions with minimal time and cost. As a result, the amount of experimental work and finishing of the product is reduced, its quality is increased, and the design process is accelerated and made more cost-effective.



Figure 9: End product of the department logotype

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