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SOLUTIONS FOR TECHNOLOGICAL PROBLEMS USING THE AUTOCAD SOFTWARE

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ABSTRACT

The diminishing of the energy and time waste is reflected also by the diminishing of the manufacturing costs. It is well known that the AutoCad software offers multiple programming interfaces such as Visual Basic for Application and AutoLisp, the users having the possibility to develop specific applications. The paper proposes a 2D CAD/CAM program written in Visual Basic for Applications under AutoCad; the program allows the CNC programming for 2 axis machine tools such as lathe, drilling and milling machines, by taking into consideration the engineering drawing of the parts. The proposed program offers some other facilities as machining process simulation, machining time calculating, comparing and correcting the part dimensions according with the drawing prescriptions.

KEYWORDS: numerical control, machining, process simulation

1. INTRODUCTION

The numerical control (NC) concerns a modality of the automation of the machine tools based on the processing of the information stored and processed exclusive on a numerical way; this information is transmitted to the machine tool as the machining develops.

Usually, the machining speeds could be controlled by different machine elements, such cranks, cams or / and gears.

The computer numerical control (CNC) allows the machining with optimal sizes of the depths of cut, feed rates, and cutting speeds. This fact ensures precise, repeatable movements of the machine tools subassemblies, so that it is really possible to reach the optimal speeds, feeds, and machine cycles.

The operating parameters and the tools selection could be determined by carefully weighing the tool life, the production rates, and operator qualities [1]. By the using of the computer numerical control, such parameters can be once established, and, afterwards, they could be repeated in adequate conditions for each subsequent machine cycle. For this reason, the computer numerical control machines is mainly preferred when a high flexibility is necessary, and complex shape pieces could be performed at a large scale [2-5].

2. AUTOCAD PROGRAMMING INTERFACES

AutoCAD is considered as general-purpose drafting software elaborated as an open architecture. The clients can customize and extend its many structures. It can be completed by the use of a number of important application programming interfaces (APIs) to improve and to modify AutoCAD. Some of the programming interfaces under AutoCad are AutoLISP, Visual LISP ActiveX Automation, VBA (Visual Basic for Applications), ObjectARX and .NET.

The Microsoft Visual Basic for Applications (VBA) is an object-based programming environment. The main difference between VBA and VB (Visual Basic 6) is that VBA can be applied in the same process space as AutoCAD.

VBA is able to send messages to AutoCAD by the AutoCAD ActiveX Automation interface.
AutoCAD VBA accepts the VBA environment to run at the same time with AutoCAD and ensures a programmatic control of AutoCAD by means of the ActiveX Automation interface. This coupling of AutoCAD, ActiveX Automation, and VBA provides an interesting powerful tool not only for using the AutoCAD objects, but for processing and transmitting

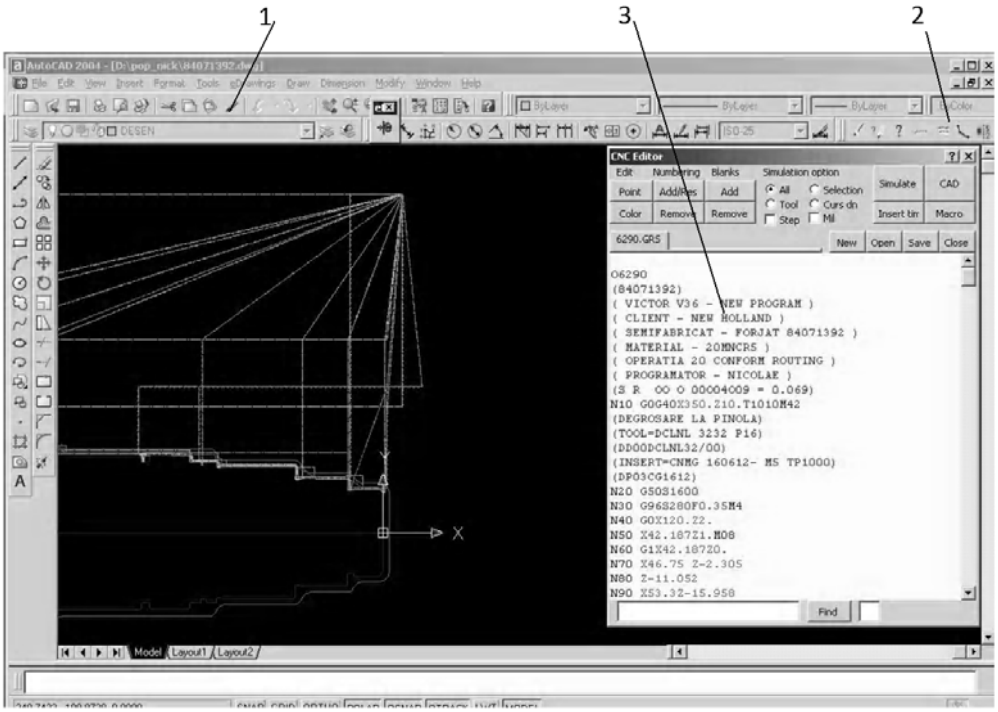

Fig. 1. CNC application interface in AutoCAD IDE

the information or retrieving the information from other applications.

Application. The idea of this application appeared to one of the paper author just at the beginning of working as CNC programmer. Sometimes, the CNC programmer has to modify and verify the programs written very fast and which must not include mistakes. Any such mistakes could cause loosing of time and of company money, fact which is not acceptable.

To avoid error correction, the programmer needs to simulate the CNC programs. The simulation part of software that was recommended to be used was not enough and a work group developed an application to easy simulate the so-called G code list of CNC program on the personal computer.

Afterwards, the programmers tried to design some tools able to allow the modifying and correcting the errors in the text editor window near to simulation window.

The next step was to search and to find some tools to modify or write the CNC programs more easy than the writing procedure used frequently and, of course, for a certain kind of parts.

The main reason to develop such an application in AutoCAD was based on the fact that AutoCad 2000 and CAM 2000 was the only software existing in the company, firstly for drawing and secondly for CNC programming; the second reason was that for all of the programmers of the company, the AutoCad software was familiar.

Application description. The application called *NC Interpreter* (fig. 1) is embedded in AutoCAD interface (1) and contains one CNC toolbar (2) and a program text editor window (3) with common Windows controls such as buttons, option buttons, tabs, checkbox and textboxes in a form. The text editor control was designed from a third party free rich text format control that allows managing the format of text.

The CNC toolbar (fig. 2) has 6 buttons and one fly out button for programming options. Each button has a tool tip with a short description about what does.

The program editor window (fig. 3) includes a group of buttons that help to edit the program and formatting the text such as *add* and *remove* the blanks characters, add/remove the line number and renumbering the CNC program, applying colours and getting coordinates of points from model space.

The simulation option group controls the simulation. The CNC program can be entirely simulated, selecting a part of program, from cursor down, to the next tool function, continuously or step by step by pressing the *Spacebar*, *Enter from keyboard* or right click from mouse. Simulation can be interrupted at a line by pressing *Esc key* and resume the simulation later by the last point by clicking a simulation button from CNC toolbar.

Simulation of G-code CNC program. For simulation, the CNC program must be loaded in editor window in 2 methods: open a file or copy text of CNC program from another application and paste in editor

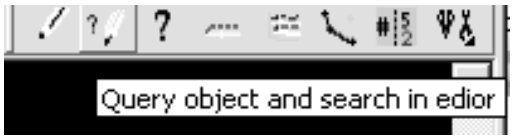

Fig.2. CNC toolbar

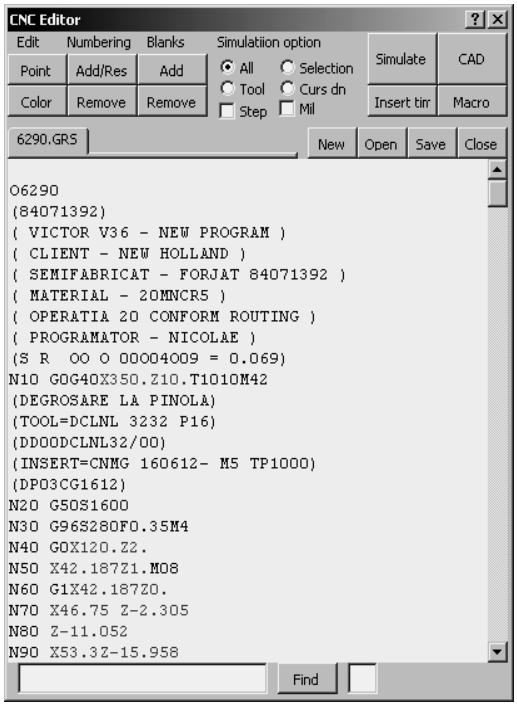

Fig. 3. CNC Editor window

window. Simulation parameter is *All*, *Tool*, *Step*, *Sel*, *Cursor*. Default mode is *Turning* in axes *X* and *Z*. The mill option allows simulating *X, Y, Z* coordinates system for milling and wire cutting machine.

The colours of lines and arcs are in relation with tool number. Rapid travel movement has a different colour and line type.

The arrows indicate the sense of movement. The offset of arrow to the left and to the right are in accordance with the left and right tool path radius correction.

Behind the scenes. The text from editor windows firstly is split in blocks represented by a line of text preceded by *Return* and *Linefeed* characters. Then, a routine search for preliminary, auxiliary, tool, speed and feed functions characters *G, M , T, S, F* respectively. These letters are preceded by 1 to 5 numeric figures.

The absolute or incremental coordinates are processed in similar manner. The letters are: *X, Y, Z, U, V, W, I, J, K* for centers positions of arcs and *R* for arc radius.

The last coordinate is stored as start point and the current coordinate as end point of current object (line or arc).

```
Function lin(type1 As Boolean, xsp As Double, ysp As
Double, zsp As Double, xep As Double, yep As Double, zep
As Double, data As String, regim As String)
   Dim lo As AcadLine
   Dim sp(0 To 2) As Double
   Dim ep(0 To 2) As Double
   ' Punctul de start si punctul de end
   If Frezare Then
      sp(0) = (xsp)
      sp(1) = (ysp)
      sp(2) = IIf(Zet, (zsp), 0)
      ep(0) = (xep)
      ep(1) = (yep)
      ep(2) = IIf(Zet, (zep), 0)
   Else
```

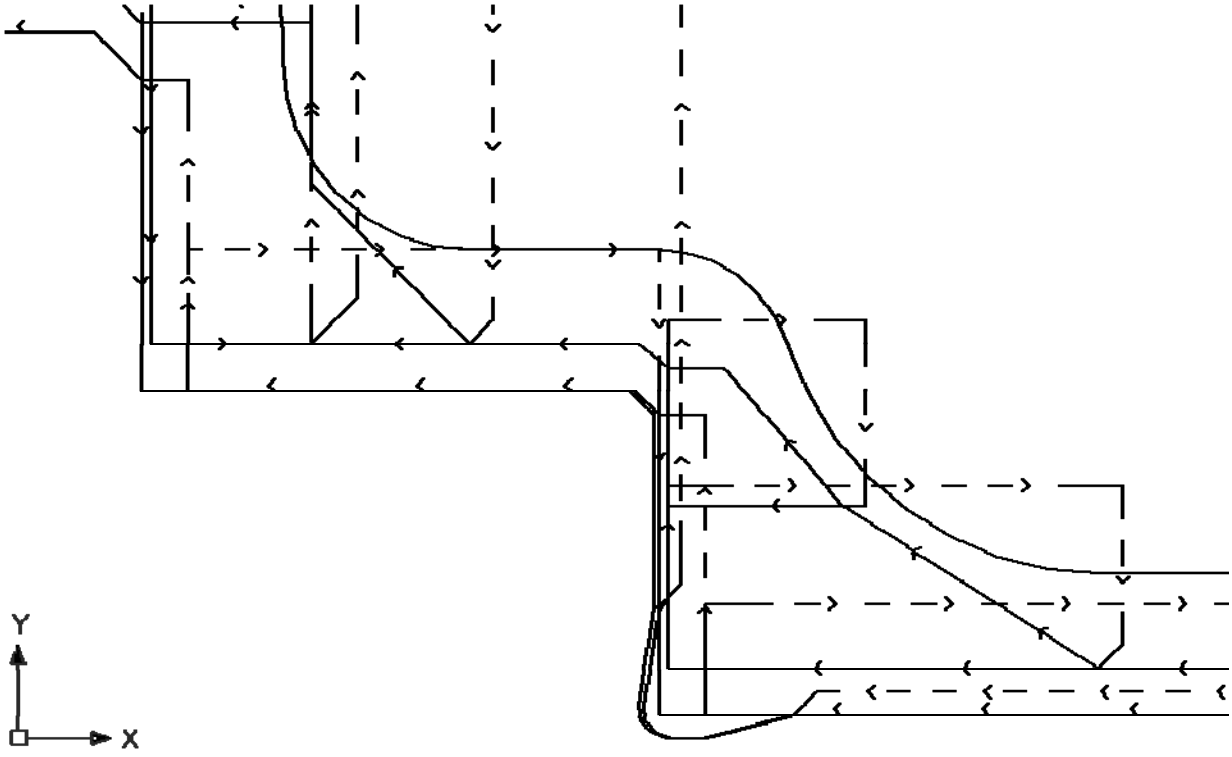

Fig. 4. Simulation

```
    sp(0) = zsp
    sp(1) = xsp / 2
    sp(2) = 0
    ep(0) = zep
    ep(1) = xep / 2
    ep(2) = 0
  End If
  ' Desenarea liniei in spatiul model
  Set lo = ThisDrawing.ModelSpace.AddLine(sp, ep)
  lo.Linetype = IIf(type1, "RAPID", "FEEDT") & IIf(g41,
"1", "") & IIf(g42, "2", "")
  lo.Color = IIf(type1, col + 3, col)
  lo.LinetypeScale = 0.25
  lin = lo.ObjectID
'…
End Function
```

The properties of line object in VBA that can be used in application are the coordinates for start point and end point, line type, line colour and line scale.

A very useful function of the simulation part is *"Query object"* that allows to read the additional information of the object generated by simulation from model space. With *XData*, one can put the program context additional information when line or arc was created.

By choosing "*Yes*", the CNC editor window opens, the command is highlight and the cursor jumps at the end of block.

CNC programming tools. One can start from the graphical representation of the part and the workpiece drawn in corresponding layers.

A program structure can be loaded in editor by clicking "*Macro*" button from CNC editor window. From the *CNC toolbar*, *CNC option*, *Option form,* the depth of cut, the finishing allowance and the retraction can be established for current operation.

After the method of cutting is selected, it is necessary to click a start point of final profile, a chain of objects and a boundary.

Fig. 5. Additional information about AutoCAD objects

The generated program is simulated in AutoCAD model space and it is put on clipboard.

Another method is to interrogate the AutoCAD objects by clicking buttons from the CNC toolbar. The information about start point, end point and, if the object is an arc, the radius and center position is put in clipboard as CNC G code.

To modify easily the some coordinates or a manufactured part especially to correct the machine misalignment or lacks of rigidity of tool a new coordinate of start or endpoint can be translated in G-code by clicking *Point* button from the CNC Editor window.

Parametric program translator. A special module that we created can transform a parametric CNC program in ordinary G-code CNC program.

3. CONCLUSIONS

AutoCAD and other CAD-CAM modern software allows to user to develop own application for special tasks.

The NC Interpreter is easy to learn and easy to use CAM application for turning, drilling, wire cutting and simple milling programming, highly productive and the programmer work in same AutoCAD interface to draw a part and write CNC program.

With NC Interpreter the skilful programmers can optimize all the tool movement to increase the tool life and improve the run time efficiency

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