PROCESSING CAPABILITIES OF MODERN WIRE EDM EQUIPMENTS

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ABSTRACT: The trend towards micro-technology demands high speed and high accuracy, assuring also energy efficiency, flexibility and ergonomics. In order to achieve these quality standards, equipments manufacturers developed solutions including linear motor controls, power supply units capable of high-speed, high rigidity basic machine structure, ceramic components. Moreover, the NC control system permits the direct transfer of 3D solid model data to the axes controllers and their conversion into a CNC program, therefore reducing set-up time.

KEYWORDS: wire EDM, CNC programming, linear motor drive, high speed machining centers

1. INTRODUCTION

Since the commercial exploitation of wire EDM machines, at the end of the seventh decade of the XX century, considerable improvements have been made in terms of processing performance, reliability, device cost and processing cost. System's design and processing technology by wire EDM has acquired a continuous development with regard to each of its elements, perfecting almost all of the equipments subsystems, due to the general progress achieved in electronics, new materials research, CAE technologies, control theory, reaching today's high level, which is continuously improving.

The most important performance criteria applicable to wire EDM processing are:

- cutting speed (for different manufactured objects thickness and different materials;
- processing cost;
- precision of processing, including the surface roughness obtained;
- processing efficiency.

Increased performance, achieved through actions to improve the level of all subsystems and processing devices involved in attaining the criteria mentioned above, depends on the following factors:

- stronger pulse generators (erosion pulses generating subsystem);
- new wire electrodes (wire electrode – workpiece subsystem);
- optimized mechanical structures (mechanical driving, guiding and wire tensioning subsystem,);
- increasing machine intelligence (control, management and optimization subsystem);
- improved methods for dielectric liquid flushing (dielectric liquid preparation and circulation subsystem);
- worpieces material and worpieces geometric form (fixing subsystem).

2. PERFORMANCES AND FACILITIES OF UP TO DATE WIRE EDM MACHINES

The performance of modern EDM equipment is extremely high: high cutting speeds, highly efficient automation, interlinking and storage of very long and recurring machining cycles.

Leading manufacturers, like Sodick or Charmilles, have developed EDM wire systems with improved basic machine structure of optimized rib arrangements, assuring increase rigidity by approximately 70% with respect to the classic models.

There are three ways followed by Charmilles for developing wire EDM machining capabilities:

- *Micro-maching*, which offers opportunities for ultra-precise machining of miniaturized components in various fields of technology, including aerospace, defense, medical instruments, semiconductor that may require wire diameters down to 0.02 mm.
- *Top End Accuracy*, implying **s**ubmicron positioning precision for

ultimate part accuracy and nano level surface finish down to Ra = 0.04 μm.

- *High Speed Machining*, for satisfying high-speed and surface integrity machining requirements for complex and large workpieces in die manufacturing, aerospace precision engineering, and other part productions.

Currently wire EDM is not conceivable without a computerized, automatic processing. In case of Sodick equipments, the Wire CAM function provides a series of operations to create NC data from a part print. When data on the *Parameters Definition* dialog box is set and the machining shape is defined, Heart NC creates a machining path – wire machining definition *Wire Cut Deft* – and converts it into a NC program – NC data creation *Gen NC Data* (*figure 1*).

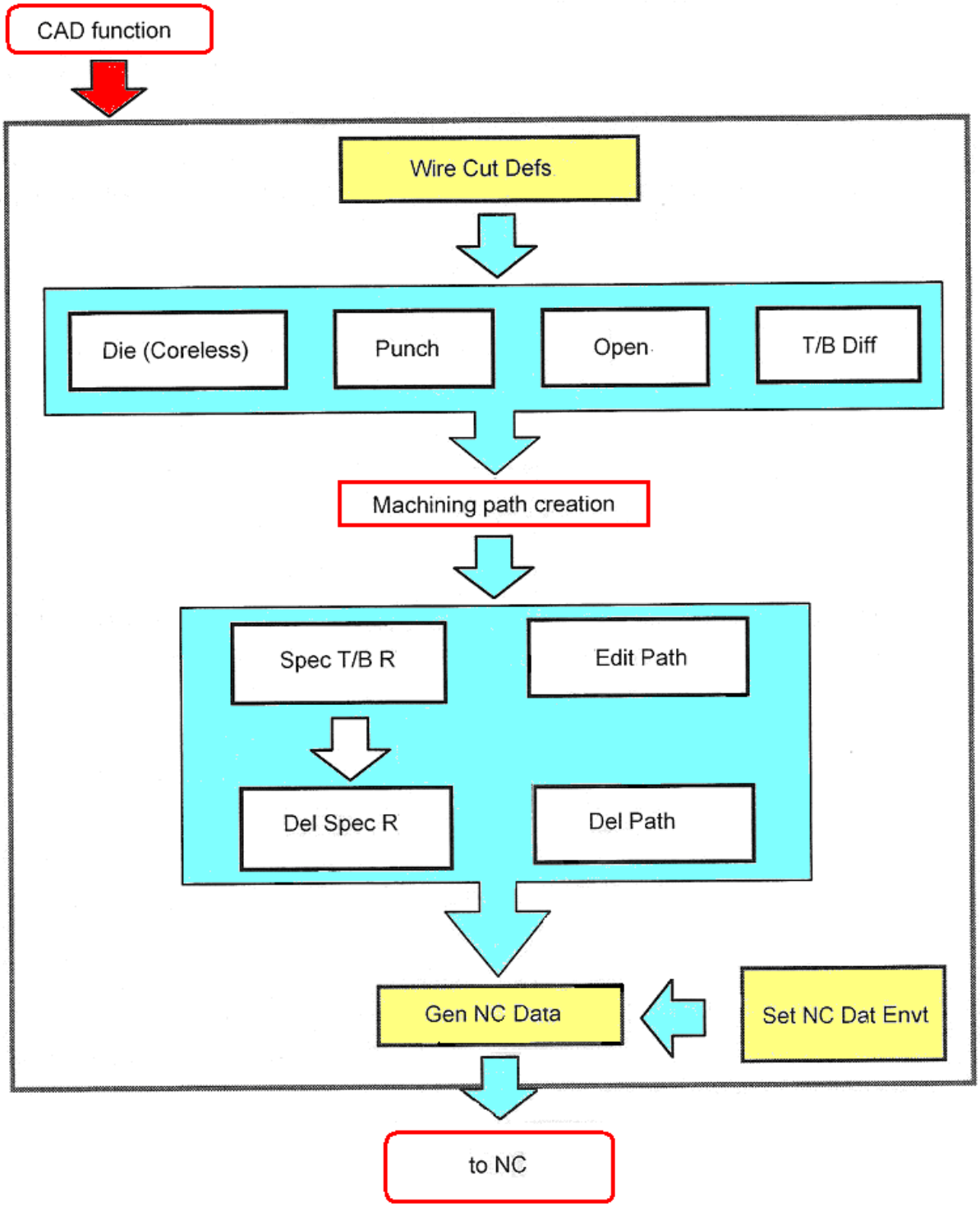

Fig. 1. Heart NC Wire CAM Flowchart

Sodick up to date equipments have linear motor drives, which are vibration free devices, assuring acceleration and positioning accuracy and high dynamid responsiveness. The wire can be inclined, thus making it possible to make parts with taper or with different profiles at the top and bottom.

3. WIRE EDM EQUIPMENTS PROGRAMMING – CASE STUDY

In the following, wire EDM processing of the workpiece shown in *figure 2* is presented. It is a medium complexity workpiece, more precisely a counter-weight, typical for the vibration unit of the separation equipments used in food industry. The decision of manufacturing the counter-weight by wire EDM was taken considering the precision requirements imposed for the assembly that includes this part.

The necessary precision of size, surface form and surface finish are achieved by setting up the workpiece in the same position, for both inner and outer contours cutting.

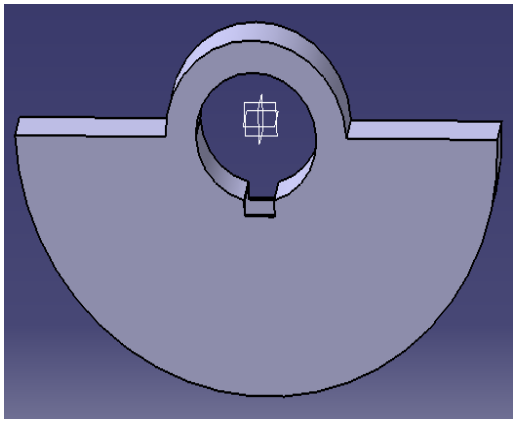

Fig. 2. CAD 3D model of the workpiece

For machining the part, the Wire EDM Centre SODICK AQ300L, using a Φ0.25 mm brass electrode, HQW 250 P5-6, was selected.

After previously designing the workpiece using CAD software – CATIA – the 3D solid model is transferred directly to the 3D controller and converted into an optimized CNC program with no detours. The machining form is displayed on the control panel (*figure 3*).

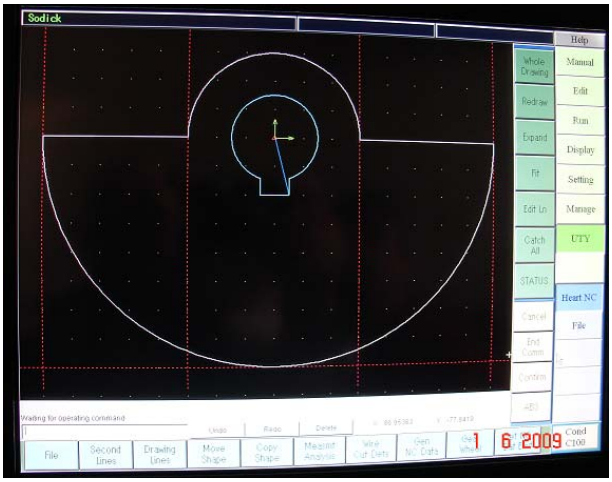

Fig. 3. Display of the imported workpiece

The generation of the G-code source program involves several steps (*figure 4*):

- workpiece material and thickness specification;
- setting of the coordinate system and of the start point position;
- processed surface roughness specification;
- selection of the wire electrode material and diameter;
- selection of the gap washing mode.

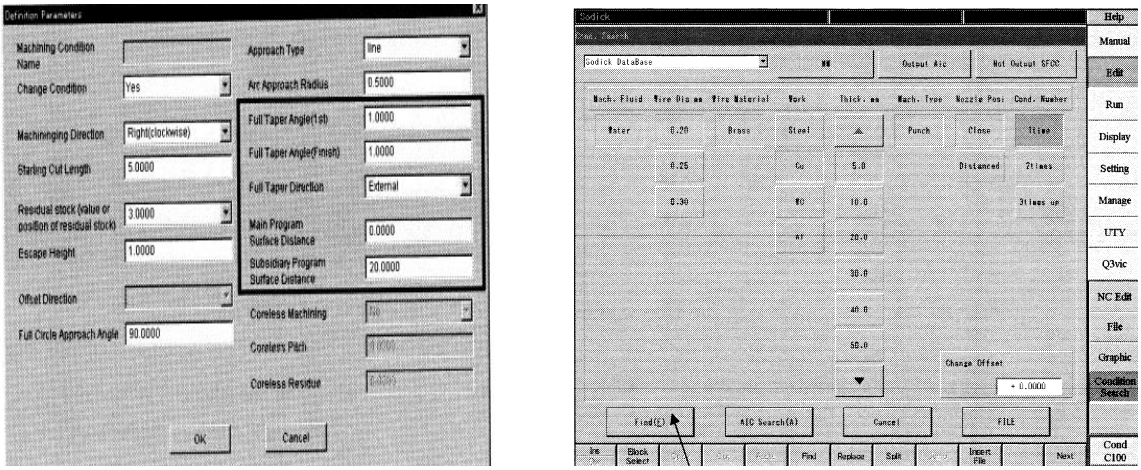

Fig. 4. Specification of processing parameters

At the beginning of the processing, the execution program extracts from the database the following data:

- Number of passes to obtain the required roughness,
- Processing parameters for each pass,
- Offset value, required for computing the trajectory of the wire electrode with respect to the contour of the part.

Before starting the machining, the pipe guide runs between the upper and the lower guide and automatically threads the wire electrode (*figure 5*). This operating phase is followed by auto-centering, workpiece origin materialization and calculus of the center position.

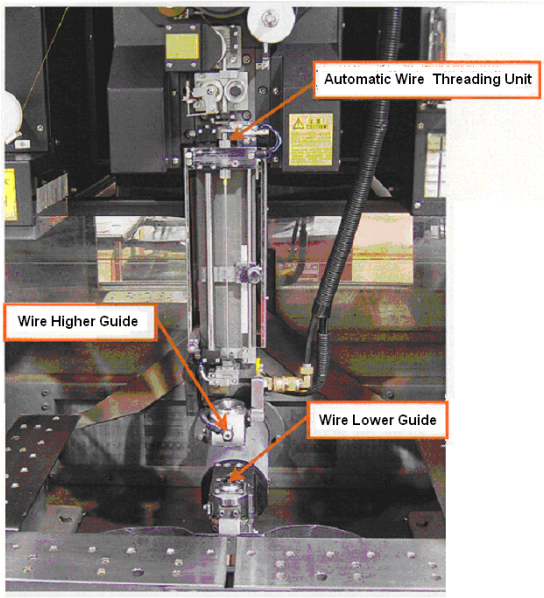

Fig. 5. Automatic wire threading unit

The source program generated, for the inner contour, is presented below:

```
(      =    ON   OFF   IP   HRP   MAO
SV   V    SF   C   PIK   CTRL   WK
WT   WS   WP);
 C000   =   004 015 2215 000 250 040
8 0130 0 000 0000 020 120 100 040;
 C001   =   006 015 2215 000 250 035
8 0130 0 000 0000 020 120 100 045;
 H000   = +000000.0100;
 H001   = +000000.1250;

( FIG-1  1ST ALL CIRCUMFERENCE);

QAIC(2,1,0.1000,000.5,0.1250,0.0100,0
02.0,0033,0110,15,035);
 G54;
 G90;
 G92X0.0Y0.0Z0;
 G29;
 T94;
 T84;
 C000;
 G42H000G01X2.9104Y-11.6417;
 C001X5.0Y-20.0;
 H001;
 M98P0001;
 T85;
 G149G249;
 M02;
 ;
 N0001;
 G01X4.4763Y-20.0;
 M00;
 X-5.0;
 Y-14.1421;
 G02X15.0Y0.0I5.0J14.1421;
 X5.0Y-14.1421I-15.0J0.0;
 G01Y-20.0;
 G40H000X0.0Y0.0;
 M99;
```

3. CONCLUSIONS

After full machining of the part, it was found that the productivity is relatively good, reaching values of 150 mm^3/min. The maximum part height that can be process is 120 mm, which means that it is possible to cut simultaneously a package up to 10 pieces, having the same form and dimensional accuracy and surface roughness.

Increased performance of wire EDM machining is obtained by controlling the process using units compatible with 3D models, therefore eliminating the need of 2D contour data and the possibility of human error. Process optimization is achieved by means of selecting best working conditions for a particular case from the manufacturer detailed database provided. Moreover, the user can add to the original data base its own know-how.

REFERENCE

1. NANU, D., s.a.: Tratat de tehnologii neconventionale, vol. II, Prelucrarea prin eroziune electrica, Editura Universitatii Lucian Blaga, Sibiu, 2004;

2. GUBENCU, D., REVICZKY-LEVAY, A., MNERIE, A., SLAVICI, T.: Procese tehnologice asistate de calculator, Editura Fundatiei pentru cultura si invatamant „Ioan Slavici", Timisoara, 2009;

3. *** SODICK Programming Manual AQ300L, 2008;

4. www.gfac.com