UNCONVENTIONAL TECHNOLOGIES – AN ALTERNATIVE SOLUTION?

1. MOTIVATIONS

It is a well-known fact that classical machining, for many years called conventional technologies, presents several particularities, resulted from materials physical properties, functional configuration of machined workpieces, execution accuracy imposed to them and others.
Alongside those, and in good measure determined by them, can be considered that material-processing methods based on chip removal presents a whole range of exploitation limits. These are related to the shape more or less complex of future generated surfaces, to the accuracy grade, to quality imposed by technologist engineer etc. The significant fact that limits machining possibilities is the harness of materials subject of processing. All these particularities constitute general concept of “technological friendly”.
In order to specify compatibility between unconventional technologies and nowadays conditions, some significant aspects should be reviewed. This fact can be illustrated by the development of electro discharge machining area but it can be noticed that technologies were evolved and diversified considerably.
Equipments for unconventional technologies were developed matching, in same manner, technological studies and in some case were ahead of them. The explanation of this phenomenon resides in firm’s intention to secure priority for constructive solutions that they developed. This historical fact was the reason that makes the growing rate of machines based on unconventional technologies and especially those for electro discharge machining to be so high, in same case over 15 - 20 %. These values are extremely high considering that for so-called conventional machines the growing rate is somewhere near 1 % (without CNC machines).

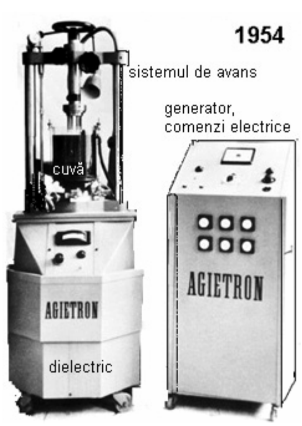

Fig. 1 One of the first EDM machine at AGIE

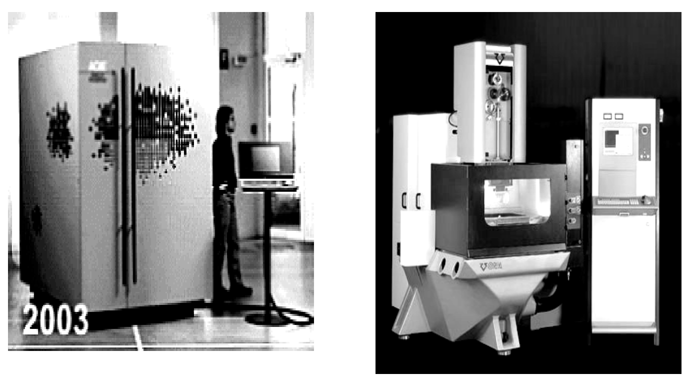

Fig. 2 Two modern designs of electro discharge machines

At the beginnings, equipments were realised with a very simple structure, with few devices. For this reason, technological capabilities were corresponding restricted. The first machines were equipped with relaxation generators and have a simplified mechanical structure: a frame, which also contain working tank. Inside tank was positioned, as well, dielectric reservoir. Over the structure was mounted an elementary feed mechanism with a partial stiff command. Alongside the mechanical construction is positioned a RC pulse generator. In figure 1 is presented such kind of machine, one of the first manufactured by the Swiss firm AGIE in 1954.
As was mentioned above, the field development was rapid and the expansion was ample. In figure 2 are presented two modern equipments developed in 2003 by AGIE (up) and ONA (down).
Differences between shapes and performances amid old and new machines are remarkable. From speeds near a couple of mm^3/min, nowadays speeds are reaching hundred of mm^3/min. As regarding roughness, today values are under one µm hardly to reach by classical technologies.
At first stages, electro discharge machining was used mainly to copy the shape of tool electrode to

workpieces. Today even die sinking equipments are able, due to CNC kits, to generate cinematically various surfaces and complex cavities.

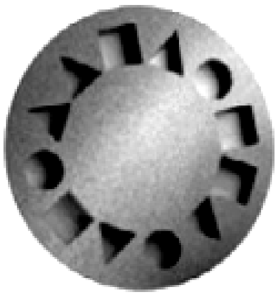

Fig. 3 Part machined with indexing device

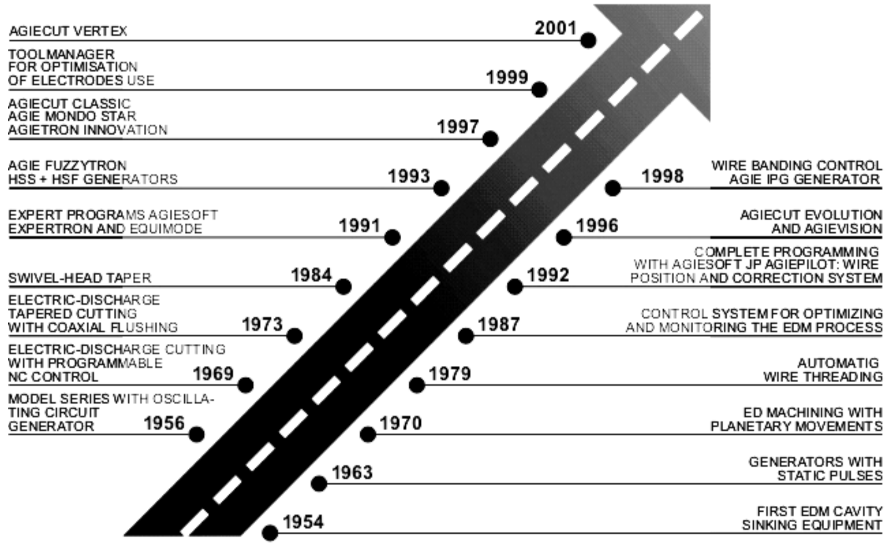

Fig. 4 Production evolution of electro discharge machines

Modern designs of electro discharge machines incorporate many of features that can be founded on conventional machines such as CNC, tools bins, modular devices, planetary movements and specific components that can be founded on EDMachines (tool-electrode centring device, protection systems for electrodes and generators, automatic wire threading etc.)
Development of such ED machines has experience a dynamic growth with an accentuated rate. In figure 4 is illustrated the evolution of development and production program at AGIE. From figure can be noticed that are both new approaches and adaptations of classical devices in electro discharge machines manufacturing.
The production dynamics of above-mentioned firm is comparable to other producers in this field and in fact similar to the evolution of entire unconventional technologies area.
Such kind of evolution is possible only when resources are adequate allocated and when market is interested in this type of equipments. The reality of these ascertains is demonstrated by graphics from figure 5.
A review of principal advantages of no matter what unconventional technologies is showing the followings:
1. The possibility to process any material, regardless hardness,
2. The possibilities of processing any material disregarding chemical composition (except electro chemical machining),
3. Complex configurations achievable with simple procedures,
4. Tools easy to obtain from common materials,
5. Electrodes low wear (null in some cases)
6. Consequence to small or no forces machining, devices for clamping are simple and accessible,
7. Machines are easy to use but are requesting a higher specialisation in processes set up,
8. Environmental friendly machines.
Of course are several disadvantages such as the impossibility of machining non-metallic parts in EDM or ECM case. Even in this case several techniques can be used in order to make machining possible (typical cases are EDM of ceramics or polycrystalline diamond).
Figure 6 present, as a conclusion, a comparison between several classical and unconventional technologies. Situation depicted in figure is corresponding to '80s but in present, is more in the favour of unconventional technologies.
This positive evolution with such a high ratio is owing to quick development of knowledge in technological field and close to that to vast area of resources that are now available to manufacturers.
Accomplishments can be noticed as well regarding components that are introduced from scientific

laboratories in technological practice and from there to the area of equipments manufacture for specific unconventional methods.

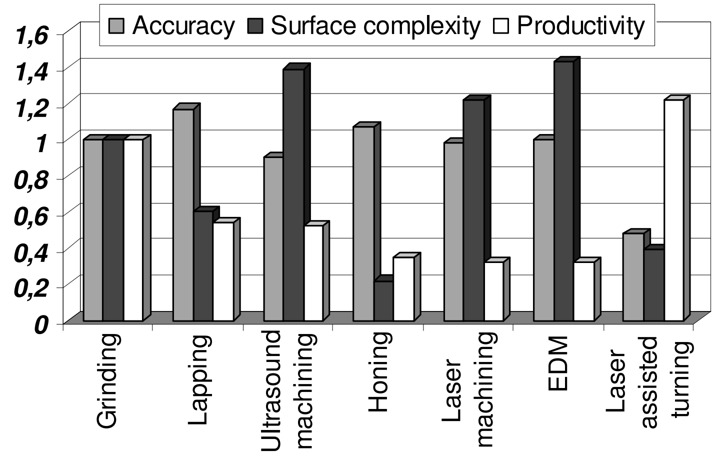

Fig. 6 Comparison between accuracy, complexity and productivity of unconventional technologies

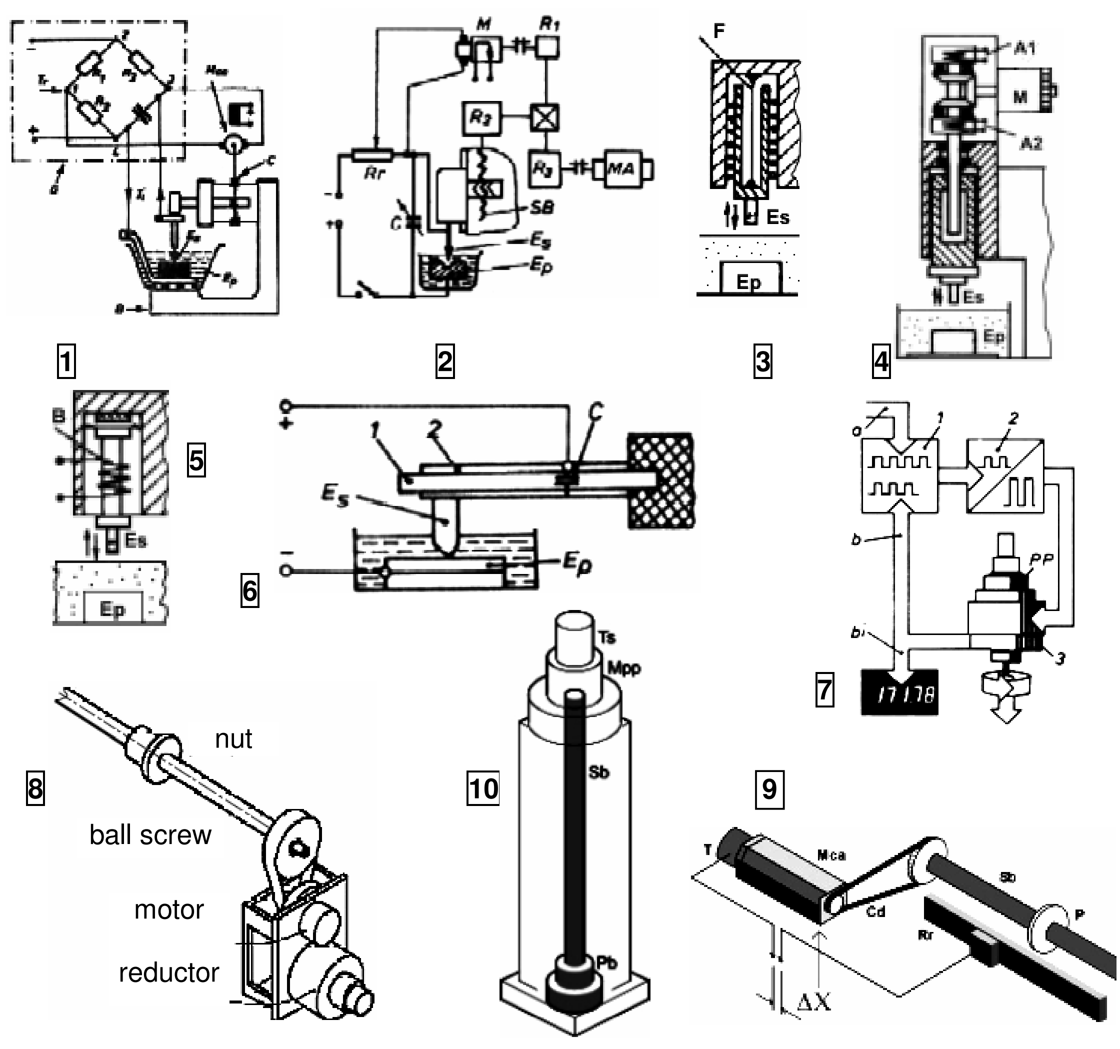

Fig. 7 Evolution of feed mechanisms

In order to set up the dynamic of evolution, an overview of electro discharge machining through past 50 years will be presented.

2. DESIGN, DRIVING AND ELECTRIC CONTROL

Most of electro discharge machines or electrochemical ones were developed in various variants depending on feed mechanism and on the knowledge on automation.
Main components of EDM or ECM machines are:
a. pulse generators, which are, mostly, over 80 % independent generators. The relaxation types are still used only in finishing stages, for special equipments, in some wire electro discharge machines (WEDM) (mostly for machining ceramics or PCD) or for wire / disk cutting machines
b. mechanical design and especially the frame is the most similar part with conventional machines. It still fulfils the same task and assures the position of the other blocks. On the frame are mounted working tables, and in couple of cases the working tank.
The physical construction is relatively simply and it makes use of current materials. Are few situations when are used unconventional materials such as granite or stainless steel (in case of ECM machines).
c. driving control kinematics of tool electrode and working tables has evolved a lot as it can be seen on examples presented in figure 7.
The very first machines were equipped with c.c. driving motors with the main disadvantage that the human operator should always supervise the machining process. When, for example, a short-circuit occurred, an operator intervention was a compulsory act.
Evidently, efficiency of such kind of machine was very low. This fact conducted to short circuits detection systems and, in this way, human operator was relieved from permanent watching of erosion process. Consequently, the efficiency of ED machines rose amazingly.
Chronological, driving system evolution was as follows:

[1] c.c. driving motor, controlled, very simple, by the medium discharge amperage;
[2] two M and Ma driving motors, the first one controlled by the process and movements are combined in a differential gear mechanism;
[3] heat deformable wire is connected to an electrical system which is delivering an inverted amperage dependant on the one that is evolving on working gap;
[4] single motor drive (M) and two clutches (A1 and A2) controlled by the interstitial conditions;
[5] with the help of coil B the electrode support has an oscillating movement superimposed over the continuous one;
[6] electrode support movement is assured by an piezoelectric transducer; system is designed for electro discharge engraving machines;
[7] another 80's system, utilised in many machines. System is using a step by step motor (PP) which ensure optimal feed speed. Permanent speed adaptation is assured by a feed back circuit b. This one is transmitting signals to comparator 1, the resultant being the electrical energy acting as a supply voltage for motor (after a previous amplification);
[8] working table for die sinking or wire electro discharge machining. The specificity of this drive is that is using a c.a. motor, an further evolution of servo and step motors;
[9] system analogous with the previous, being supplied with a high performance position control loop;
[10] the cinematic of tool electrode support with ball screw is driven, through a reduction, by a step motor and a reaction transducer.

The presentation until here is a modest and a succinct evolution overview of an extremely important field of alternative technologies. Those presented are specific to electro discharge machining area but the evolution trend is, as mentioned above, fully similar to all processes used in present and as well to those that are only in developing or research stages.

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