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STUDY ABOUT FINITE ELEMENT ANALYSIS OF HIGH SPEED DRILLING

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Abstract: this paper present the advantage of using software for simulation of cutting process and o study of high speed drilling.

1. INTRODUCTION

In high-speed drilling processes, the conditions for optimal cutting are not easy to find, because a great many experiments are first to be made for the numerous specific cutting cases.

On the one hand, such tests are very expensive, on the other hand, tests that are made in hitherto-unknown conditions are difficult and risky, owing to the vibrations that occur in the machine tool and which may cause the tool to break. Thus, recently, a research method was set up to help finding the optimal cutting conditions in high speed drilling, one that uses modeling programs as well as simulation of cutting processes and FEM: Final Element Modeling as well as FEA, Finite Element Analysis.

2. PROGRAMS USED TO SIMULATE CUTTING PROCESSES

Some authors have used their own programs in their research, others turned to commercial programs. Currently, the world knows a large variety of specialized programs, in finite element modeling (ABAQUS, ADVANTEDGE, ANSYS, DEFORM, MSC MARC). Out of them, this author has chosen, for this paper, a program that has been developed especially for modeling cutting processes, i.e. AdvantEdge [6].

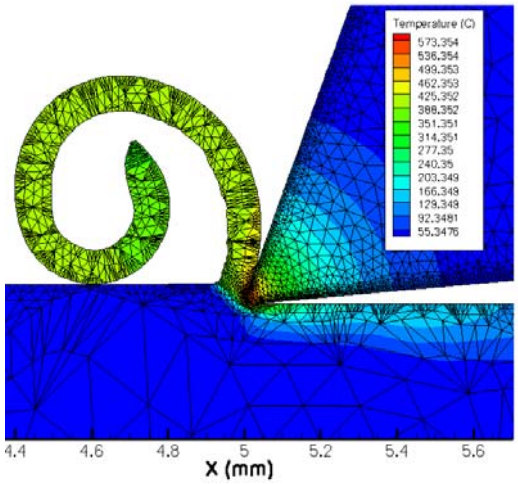
2.1 DESCRIPTION OF ADVANTEDGE PROGRAM

AdvantEdge is a product of *Third Wave Systems*, based on the analysis with a finite element and is used particularly for optimization of specific processes in machining through various forms of cutting [6].

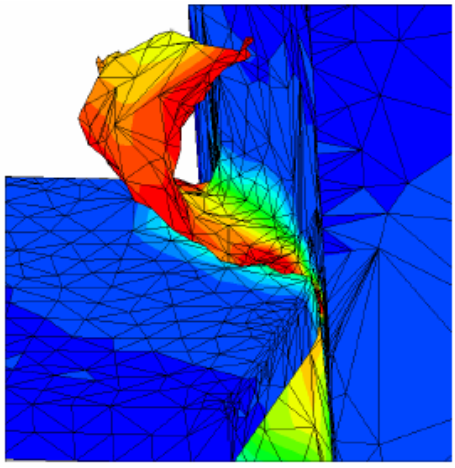
The AdvantEdge simulation program offers the possibility of running detailed analyses of the main methods of machining through cutting with a view to improving the overall conditions as well as the quality of the machined surface, of the tools' performance, etc. Compared to traditional methods, here the main advantage is that we no longer need a great number of experimental determinations, and the financial effort is less.

The machining through cutting methods that can be modeled by AdvantEdge are: for 2D simulation: turning, up milling, down milling, sawing, broaching, micro-machining, and for 3D simulation: turning, milling, drilling with and without insert, broaching. A few representative examples for modeling processes through cutting by means of AdvantEdge

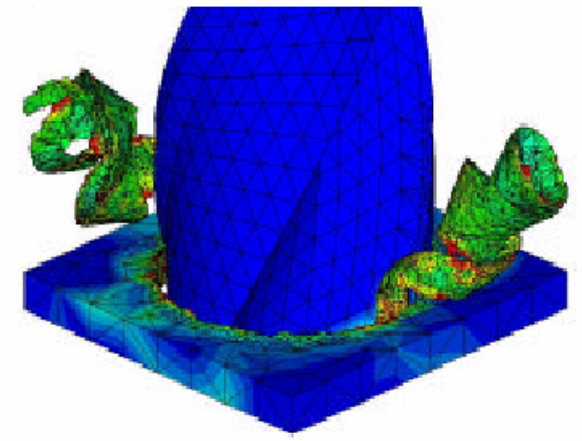
are given in figure 1.



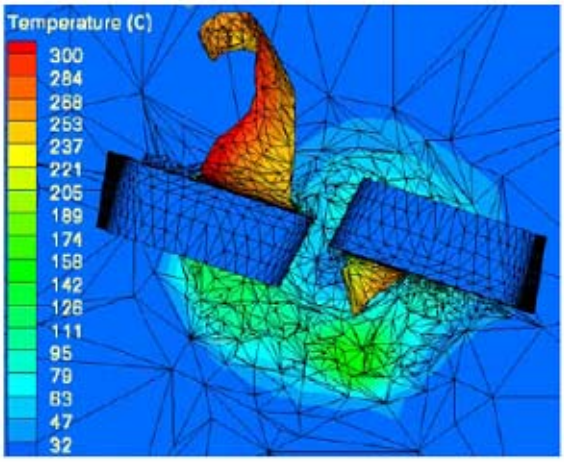
a) Turning 2D



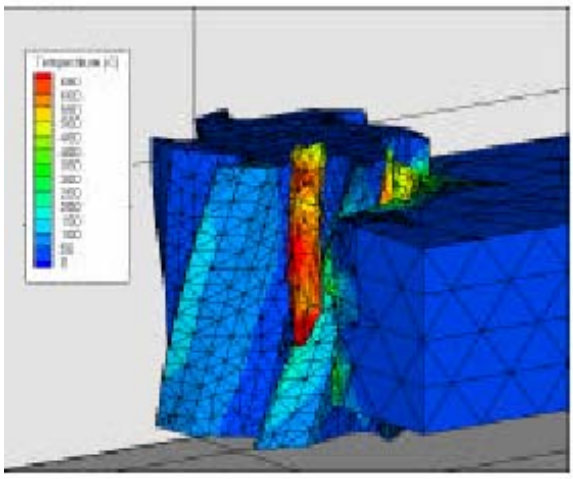
b) Turning 3D



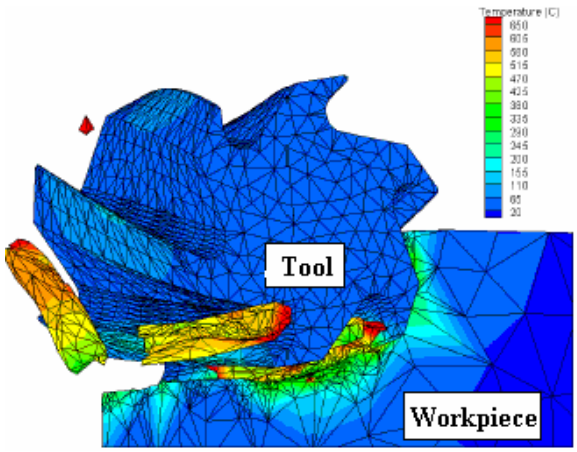
c) Drilling



d) Drilling with insert.



c) End Milling 3D



d) Cylindrical Milling 3D

Figure 1. Modeling processes with AdvantEdge [4, 5, 6].

3. CASE STUDY

This research study has run two simulations of the high speed drilling according to AdvantEdge, in order to establish its performance potential.

3.1. GEOMETRIC MODELING OF HIGH SPEED DRILLING

The dialogue window of AdvantEdge for introducing geometric parameters of the drill is shown in figure 2, while the various parameters within simulation are presented in tabel 1.

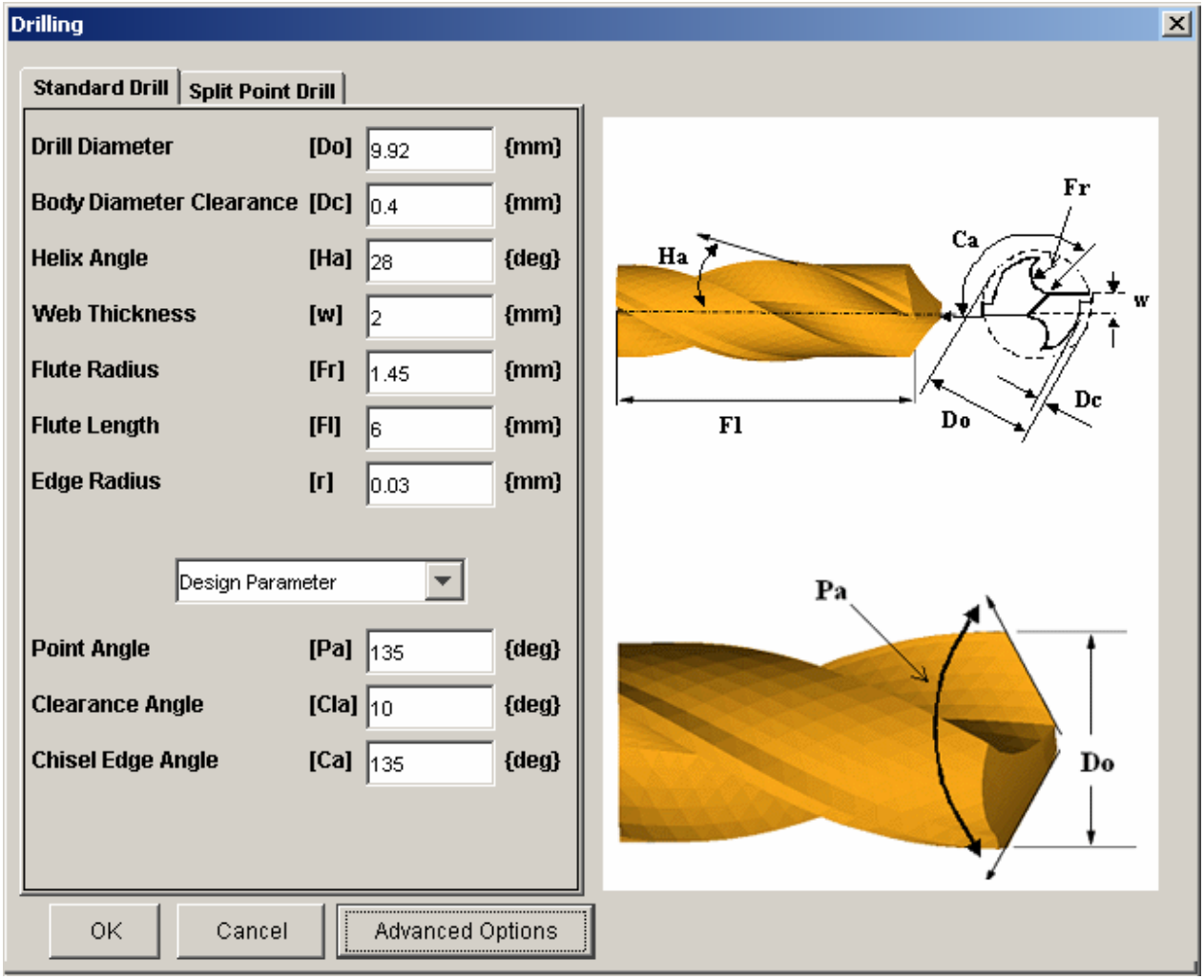


Figure 2. Window for define geometrical parameters of drill [3].

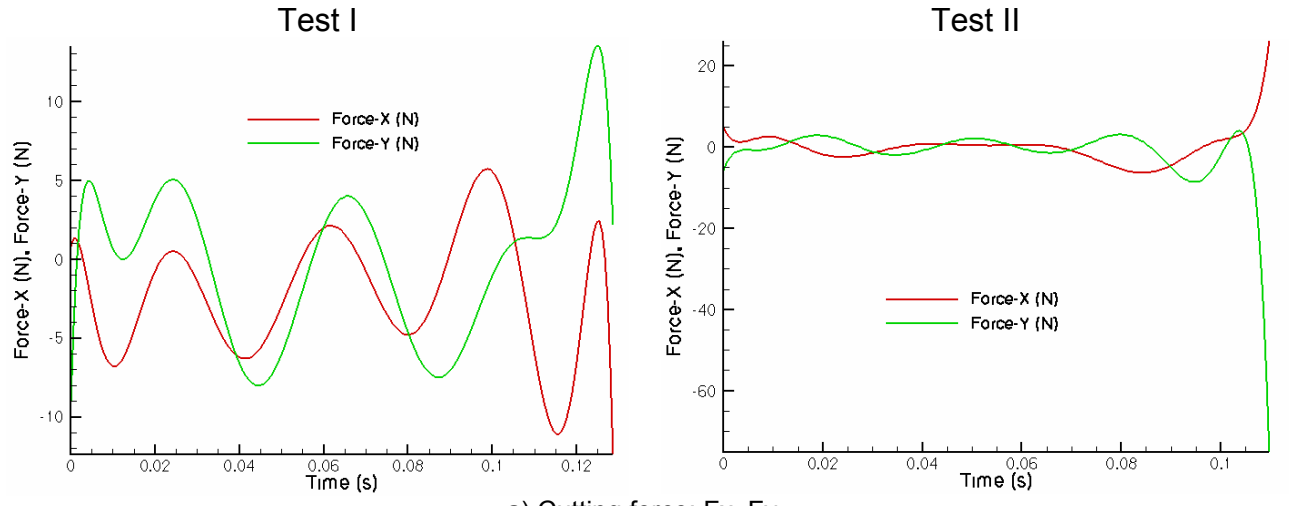
Tabel nr. 1

Test parameters	Test I	Test II
Tool parameters		
Drill Diameter, [mm]	9,92	9,92
Helix Angle, [^{0}]	28	28
Web Thickness, [mm]	2	2
Edge Radius, [mm]	0,03	0,03
Point Angle, [^{0}]	118	135
Chisel Edge Angle, [^{0}]	135	135
Clearance Angle , [^{0}]	10	10
Process parameter		
Spindle speed, [RPM]	1000	2280
Feed, [mm/rev.]	0,3	0,1524
Angular Length Of Cut, [^{0}]	1440	2160
Colant	Off	Off

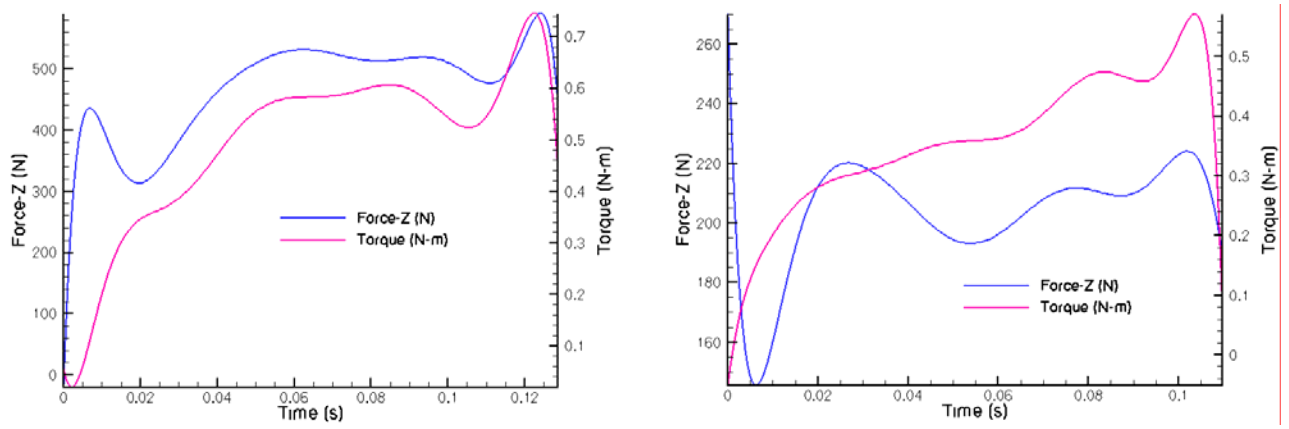
Material		
Tool	Carbide	Carbide
Workpiece	Ti-6Al-4V	Al7050

3.2. RESULTS OF THE SIMULATION

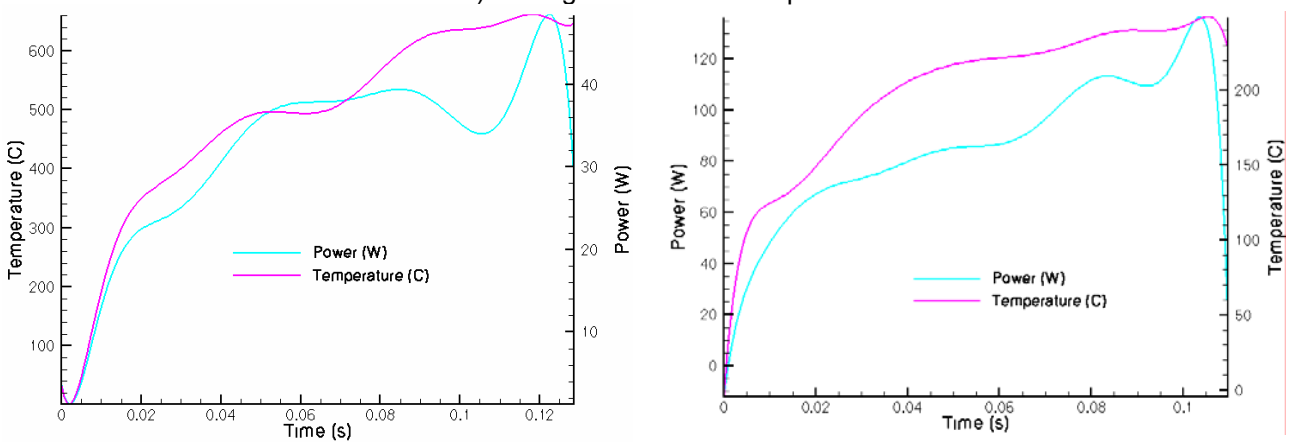
The results obtained in the AdvantEdge-aided simulation of the two described cases are shown in Figures 3 and 4. The data presented in the two mentioned figures are a mere selection from all the findings obtained in the simulation.



a) Cutting force: Fx, Fy.

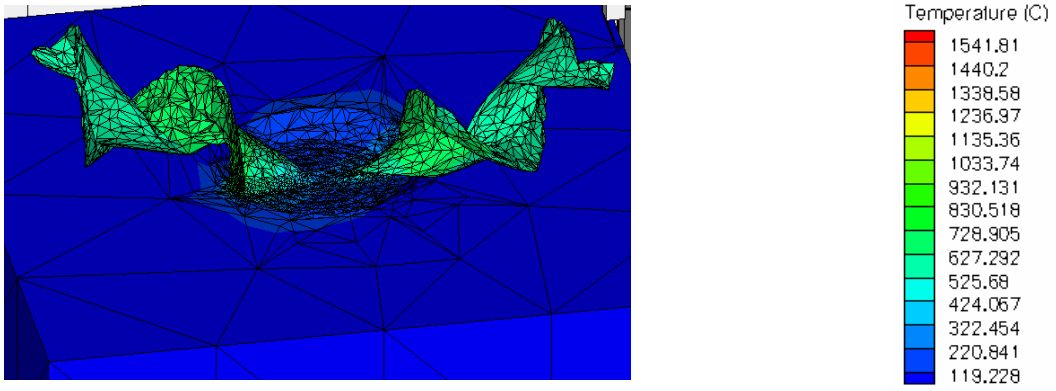


b) Cutting force: Fz and torque.

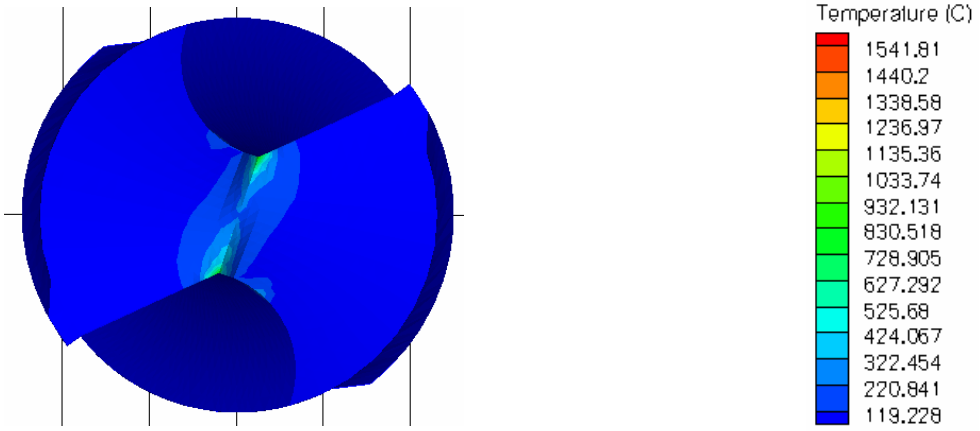


c) Temperature and power.

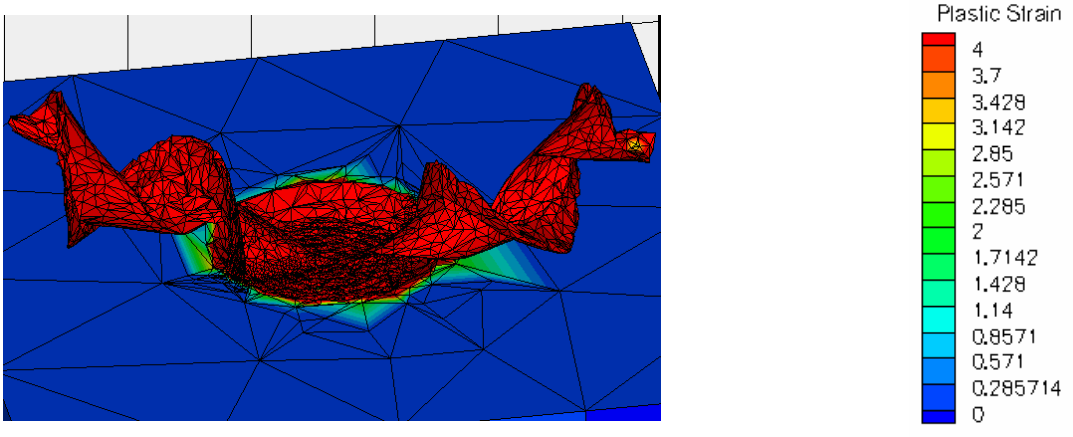
Figure 3. Diagramming of force, torque, temperature and power of cutting.



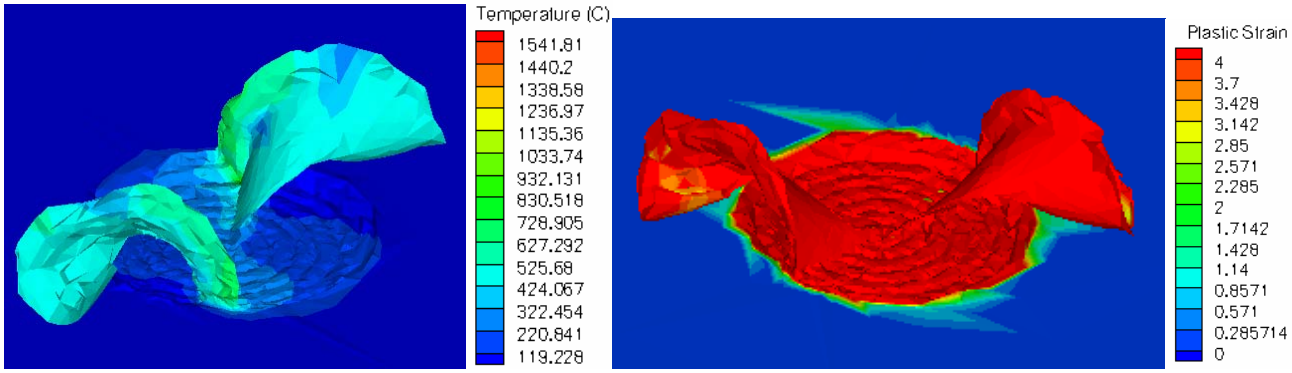
a) Temperature in workpiece, test I.



b) Temperature in tool, test I.



c) Plastic strain in workpiece, test I.



d) Temperature and plastic strain in workpiece, test II.

Figure 4. Diagramming of temperature and plastic strain in toll and workpiece.

4. CONCLUSION

Usage of finite element modeling and analysis (FEM, FEA) offers a new series of advantages, among which:

a) it analyzes several specific aspects of metal cutting with the help of the computer, and eliminates other, very expensive tests;

b) in order to establish high speed cutting feasibility, the following can be anticipated with great accuracy:

- thrust force;
- friction force;
- temperature in the cutting zone;
- heat transfer between chip and tool;
- heat distribution in the tool;
- heat distribution in the workpiece
- thermal conductivity of the tool
- residual stress in the tool and the workpiece;
- wear of cutting tool;

c) optimization of the parameters of cutting process

- feedrate;
- geometry of the tool (α, γ, δ, ρ);
- tool material

d) the degree to which simulation results and experimental results are resemblant;

The major disadvantage of using these programs lies in the large amount of time needed for calculation (approximately 24 hrs.) for a single simulation. This amount increases to a few whole days if we aim at fine meshing. To reduce calculation time, one can opt for fine meshing only in major interest areas.

5. BIBLIOGRAPHY

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