THEORETICAL CONTRIBUTIONS TO PRECISION OF WROUGHT COLD PARTS

Ionela IORDAN[1]

The paper presents some introductory elements of the process of drawing the wrought cold pieces, following the presentation of the results obtained by Finite Element Method (FEM), using the program LS-DYNA. At the end of the paper we will present the 3D prototype mold projects, with the help of which test pieces were performed and which were subjected to a laser scanning.

The 3D scan results will be placed in a specialized program and by superimposing it over the original virtual (ideal) model, we will get complete information on the actual deviations from the proposed model.

Keywords: cupping, finite element method, mesh network, reverse engineering.

1. Introduction

Like cast or injected pieces, where the phenomenon which is harmful to precision is contraction, in this case, the elastic recovery of the material creates distortions to the part precision and leads to the precision damage. A representative procedure in defining the spring-back phenomenon is shaping.

Design stamping dies used in industry is a process by which the studies needed for the molds and stamping dies are achieved. This process is based on the specifications of the finished piece (CAD model considered ideal). An important aspect of the design process of stamping machines (punches and dies) is to minimize the loss of the material or in other words, the waste without affecting the quality of the finished piece. This can help optimize production costs of the stamped piece.

The use of the numerical simulation system (based on finite element method) allows the check of the feasibility of the design drawing applications during the process. Cupping simulation is performed by using specialized programs. You can check multiple quality criteria, such as material thinning, the existence of corrugations or folds, elastic recovery of the workpiece after the drawing. The thinning of the material takes place as a result of plastic deformation and is defined as a percentage of the original thickness of the sheet. Simulation result is a colored mapping showing areas

[1] [1] PhD., Faculty of Engineering and Management of Technological Systems, Dept.Machine and Production Systems, University POLITEHNICA of Bucharest, Romania, e-mail: iordan_ionela2007@yahoo.com

of the thinned material. The following are the results obtained by finite element method using LS-DYNA.[1,2, 3]

2. Finite element method using LS- DYNA

Starting from the 3D model of the piece, both the model mold of stamping punch and the pre-shrinking element of the material can be created by using specialized software, (Fig.1).

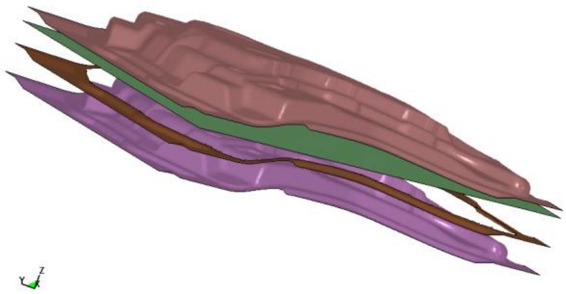

Fig.1 - Model of an ensemble piece - template - punch - pre-shrinking item

The CAD model will be decomposed into finite elements which will be then analyzed. The proposed FEM model (Finite Element Method) is shown below.The pre-shrinking of the material is required to remove creases and wrinkles of the material, but an excessive pre-shrinking can cause the crack of the piece.[4, 5, 6]

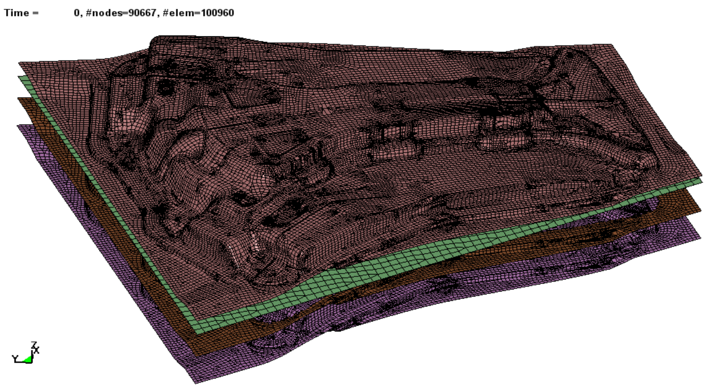

Fig. 2 - FEM model of an ensemble part - template - punch - pre-shrinking item

By running the analysis program, part deformations are obtained at all points (nodes) of the mesh network. For the analyzed model, the node

displacements, in comparison with the starting position, are between -58 and 80.
323 mm.(Fig.3)

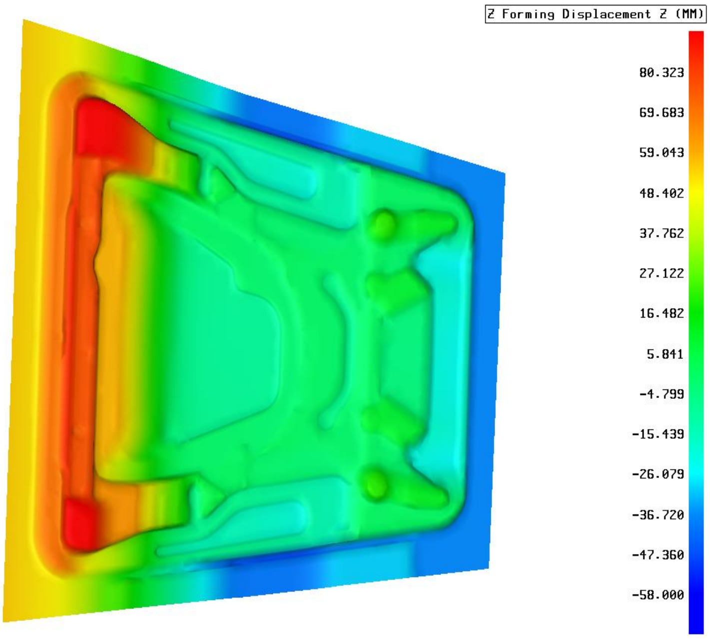

Fig. 3 - Deformations in the direction of the material pressing

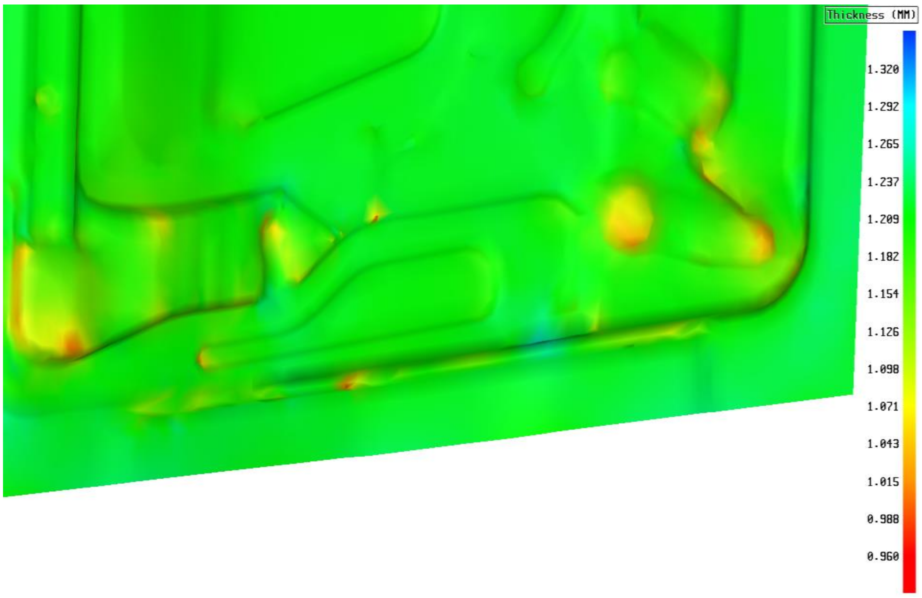

Fig. 4 - Changes in the thickness of the part by drawing

As mentioned above, the elastic recovery of the material has the most important effect on the precision stamped parts. The use of the defined parameters, or obtained by calculation for the proposed track, led to an elastic springback up to 8 mm. (Fig.4)

As seen in the image (Fig.5), high elastic recovery is on the pre-shrinking piece flange (consequently it will be removed after cutting the piece). However, a 4 mm elastic resilience (green colored area) is quite high.

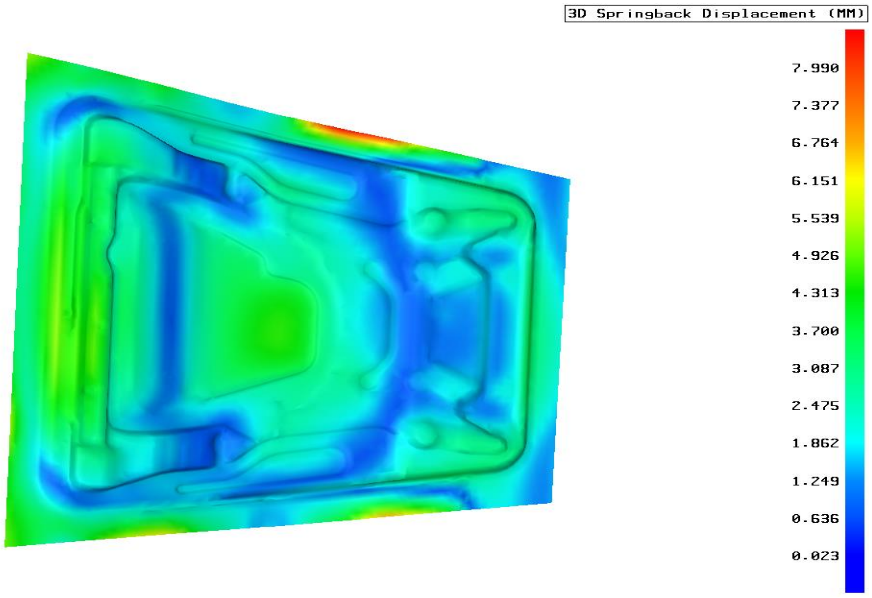

Fig. 5 - Distribution of strains caused by the elastic recovery

This reduction is optimized by designing the mold. In order to determine whether the drawing process is feasible or not, the degree of the deformation of the material in different zones is analyzed. Gray colored areas in the figure are non-deformed areas, yellow areas have critical deformations and fracture prone areas are red. (Fig.6)

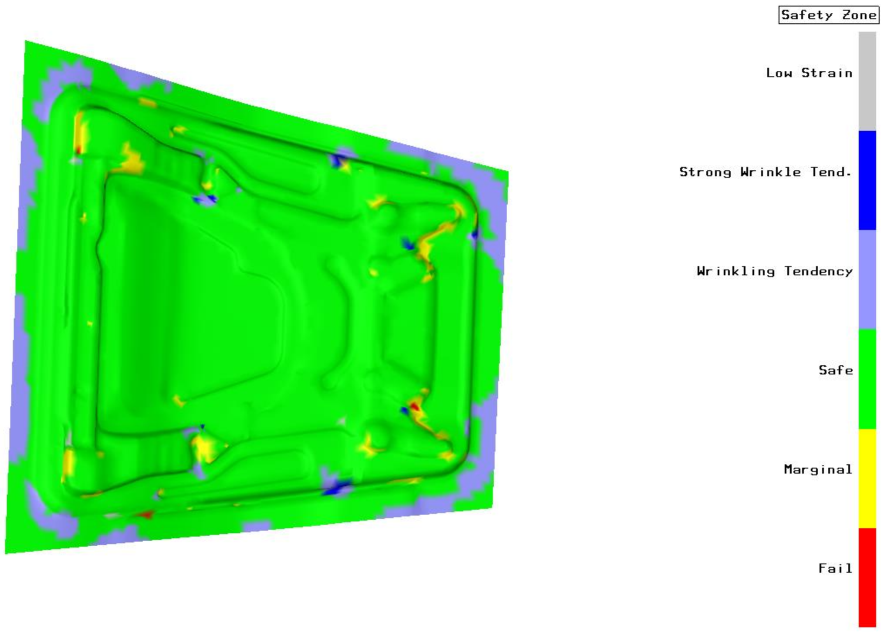

Fig. 6 - Safety zones of deformation process

Fig. 7 - Flow direction of the material during the deformation process

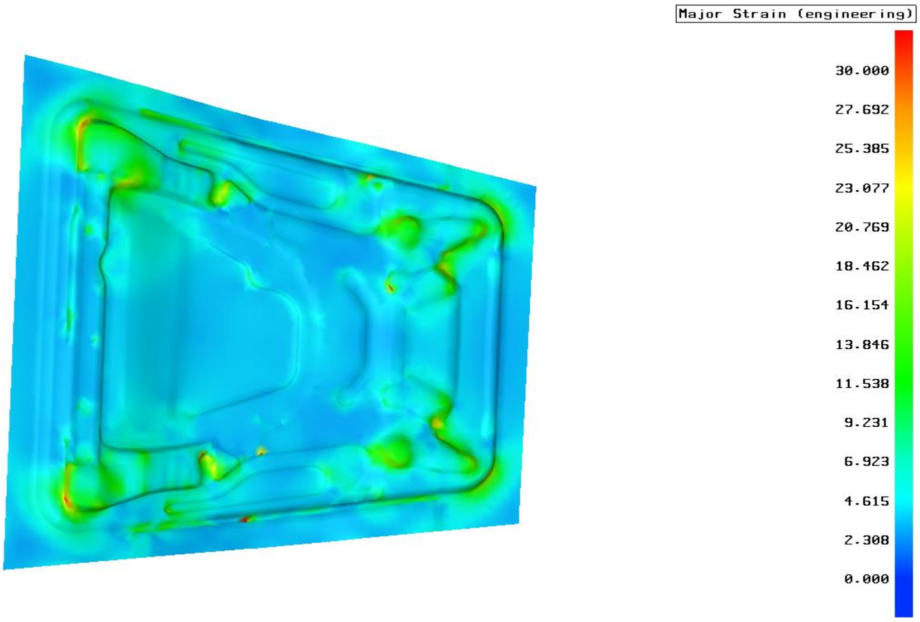

Fig. 8 - Distribution of relative deformations

Figure 7 are shown the directions of flow of the material during the deformation process. The deformability of the material is given by the value of its relative deformation in various zones. (Fig. 8, 9)

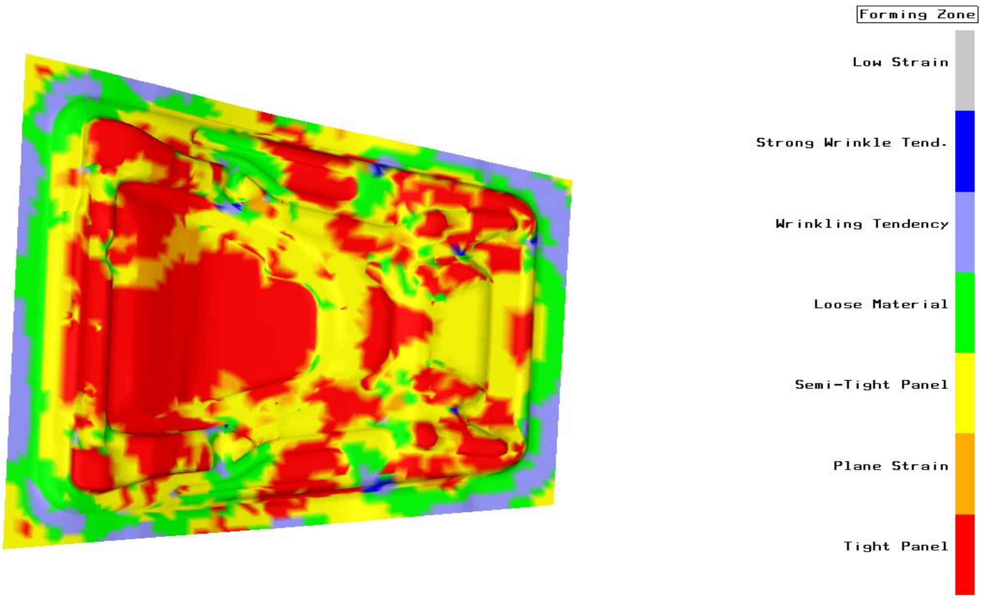

Fig. 9 - Distribution of deformation zones

The equivalent tension of the material during the deformation process provides a range of information on the occurrence of possible cracks, but also how the piece deformation will vary after the drawing process stops. Residual tensions of the parts can change the piece geometry after a long period of their production as well.(Fig.10)

For a better understanding, the change of the points on the semi-product contour is represented as vectors. Boundary displacements are much smaller than the total deformations of the part, which explains that the material undergoes thickness variations. .(Fig.11)

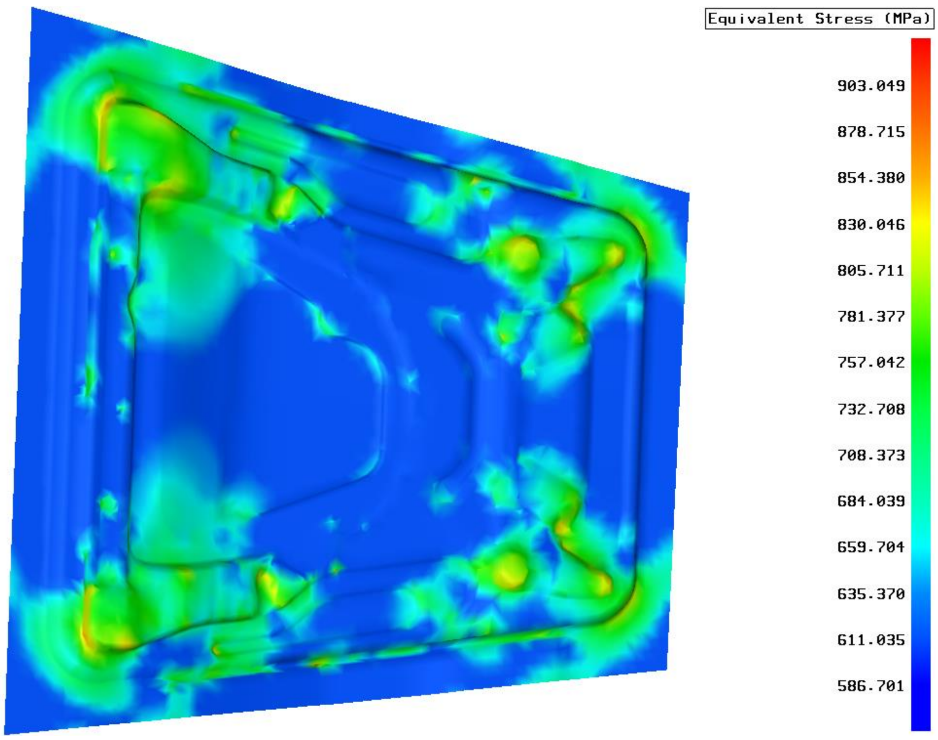

Fig.10 - Equivalent stress distribution

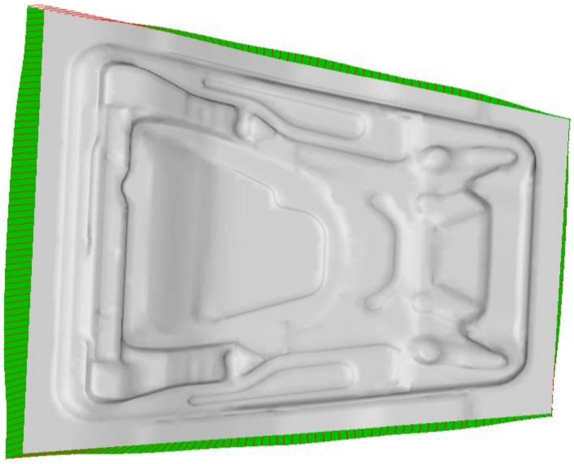

Fig. 11-Displacement contour of the material

After analyzing the simulation results, the designer can optimize the shape and size of the drawing area. Thus, it takes more iterations of the design, simulation and analysis of the results until they reach an optimum level in terms of quality and size of the piece of waste and hollows.

3. General notions on the accuracy of the parts through 3D laser scanning

Measuring three-dimensional (3D) is a relatively new technique, still under development, with appliances and equipment (3D scanners) still in the testing phase, but that could revolutionize classic and facilitate measurement techniques. 3D scanning is the process of copying digital information of a physical object geometry (solid), so it is known as digitization.

"Digitizing 3D" is a process that uses a stylus digitizer with contact or non-contact to capture shape of objects and recreate them in a virtual workspace through a network very dense points (xyz), as 3D graphical representation. Data are collected in the form of points and the resulting file is called "point cloud".

Type of information to "point cloud" are usually post-processed in a network of small polygons (Simple mode), which are called 3D polygonal network. This type of information can be saved in various CAD formats, the most common being STL format (Surface Tessellation Language).

A simplified definition specifies that the purchase is made through an interface "material" (3D scanner) using levers and sensors and modeling via an interface "software" (3D scanning software) using certain algorithms.

The experimental research was used a 3D scanner type NextEngine high resolution (HD). Typically, this control is not used in parts with a low accuracy, but I used this device to propose a methodology for 3D laser control.

3D data collected are useful for a wide range of applications. Many different technologies can be used to build these 3D scanning devices, each technology comes with its own limitations, benefits and costs.

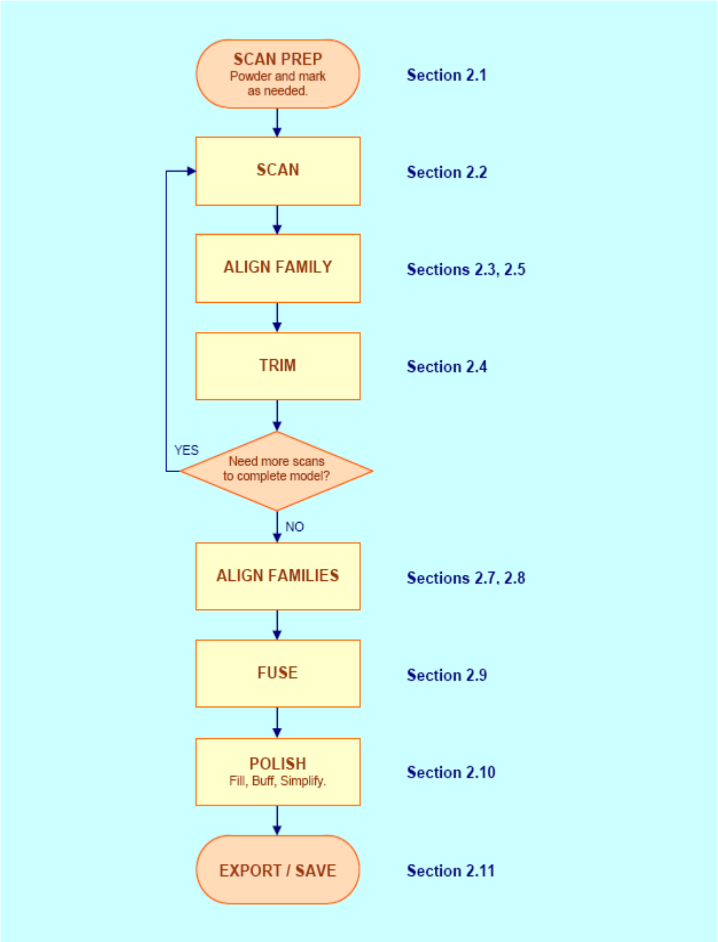

Fig. 12. Workflow diagram for using 3D scanner NextEngine

Workflow diagram (Fig.12) shows the order in which ScanStudio tools are used to scan an object and create a model of it. The sections listed to the right of each step have more information about this step.

4. Conclusions

The methodology proposed in this paper refers to the use of 3D laser scanner for 3D inspection of complex parts. It was studied in a part of pressed steel that is distorted due to springback phenomenon, this part being obtained in stamping dies.

Their optimal design to reduce strains, thus to obtain precise parts, simulation analysis is conducted these processes. Systems were used numerical simulation based on the Finite Element Method and LS- DYNA program. They were created model of the mold, the punch and the material of the pre-shrinking element, from the CAD model of the part.

They were presented partial results of the drawing process, focusing on the calculation of the theoretical deformations parts in all nodes of the mesh. After simulation projects were completed prototype mold. With this test parts were made which have undergone scanning with a 3D laser scanner, to be processed abundance of information obtained on this occasion.

Through specific procedures reverse engineering, 3D model scanning result was placed in a specialized program, and through its overlay over the original virtual model (ideal) were obtained full information on deviations from the proposed real model.

R E F E R E N C E S

[1] *Bradley N. Maker, Xinhai Zhu* - Input Parameters for Springback Simulation using LS-DYNA – Conference Livermore Software Technology Corporation, June, 2001.

[2] *M. Pearsică , St. Nedelcu , D. Luculescu* , Metode de modelare a procesului de prelucrare cu laser (Modeling methods of the processing laser), Ed. Albastră, Cluj-Napoca ,2006.

[3] *A. Bin Ramlan* - Experimental and finite element evaluation of bending for mild steel - University MALAYSIA Pahang, June 2012

[4] *M. Kaonga*. - Simulation and optimisation of a full deep drawing process- University of Zambia, 2009

[5] *D. Chira , A. Russian* - Study of the influence of the cooling time in the mould of contraction and deformation piece injected, Annals of the Oradea UNIVERSITY, Fascicle of Management and Technological Engineering, pp. 510-513 ,2012.

[6] *Abdil Kuş* -Implementation of 3D Optical Scanning Technology for Automotive Applications, *2009*