11th International Research/Expert Conference
”Trends in the Development of Machinery and Associated Technology”
TMT 2007, Hammamet, Tunisia, 05-09 September, 2007.

THE DECREASING OF THE SPRINGBACK PHENOMENA ON THE THIN METAL SHEETS FORMING WITH USING ARTIFICIAL NEURAL NETWORKS. EXPERIMENTAL STAGE- THE BLANCKHOLDER FORCE TO CONICAL DRAW PARTS

E. Ciucescu
State University of Bacau
Calea Marasesti nr 157, Bacău - 600115
Romania

G. Brabie
State University of Bacau
Calea Marasesti nr 157, Bacau-600115
Romania

N.Nanu
State University of Bacau
Calea Marasesti nr 157, Bacău - 600115
Romania

ABSTRACT
The springback behaviour of a sheet-metal is dependent on the properties of the metal and the bending conditions, namely the thickness of the sheet-metal, geometry of the tooling and the amount of force used for bending. Sheet-metal component manufacturing often requires near zero springback angle to obtain the correct shape of the product. This paper presents the artificial neuronal networks like solution to decrease the springback phenomena.
Keywords: springback phenomena, control, artificial neural networks, conical draw parts

1. INTRODUCTION
Springback in a forming process is due to the elastic deformation of the part during unloading. This manufacturing defect can be accounted for through proper tooling design or through proper design and control of the magnitude and history of restraining force. Using finite element analyses of the process:

- the effects of restraining force on the springback phenomena when stamping channels from aluminium sheet are investigated;
- a strategy to control the binder force during the forming operation in order to reduce springback and simultaneously avoid tearing failure is described;
- a binder force control strategy which provides robustness in the presence of process parameter uncertainty is implemented. [1]

The process history and controller designed using finite element analyses is then experimentally verified: excellent agreement between simulation and experiments is obtained. A binder force history, which leads to a significant reduction in the amount of springback incurred by the formed part without reaching critical stretching conditions, was proposed. Although an optimal forming history was found, in order to ensure that part shape error remained minimized even in the event of variations in processing parameters such as friction, a closed-loop control algorithm was developed whereby the binder force is altered during the process in order to provide a robust, repeatable stretching history.[2]

2. EXPERIMENTAL STUDY

The experimental part has the following steps:

- The analysis was performed with 25 simulations in ABAQUS software (Table 1) to model a metal (Steel E220) sheet in to a conic piece; in the all simulations, at the end of the punching process the bottom has not any tear.
- At the end of each simulation the profile of the metal sheet is transferred to SOLIDWORKS software to measure the angle due to the springback effect;
- To find the right value of the BHF, the data system composed with all numerical inputs (independent numerical values, dependent numerical value) of the simulations is transferred to PALISADE-Neural Tools software. Due to its abilities the software can predict the value of the outputs, in our case the value of the BHF. [3]

  The inputs parameters are:
  - the radius of the punch R_p [mm];
  - the punch linkage radius R_{rp} [mm];
  - the bottom radius r_1 [mm];
  - the flinch connected radius[mm].

  The output parameter is:
  - the BHF F_r[kN].
- The results of the Palisade Neural-tools are given in the Table 2.
- With those results we are going to tray another simulation in ABAQUS software with the predicted value of BHF.
- After the simulation we have new values of the bottom radius from 4.118 mm to 4.08 mm and for the flinch connected radius from 6.174 mm to 6.06 mm (figure 1). If the desired values for this radius are 4.00 mm and 6.00 mm, we can conclude that the prediction of the BHF value using the neural network it's a step to done more economically and qualitative the forming process of a thin

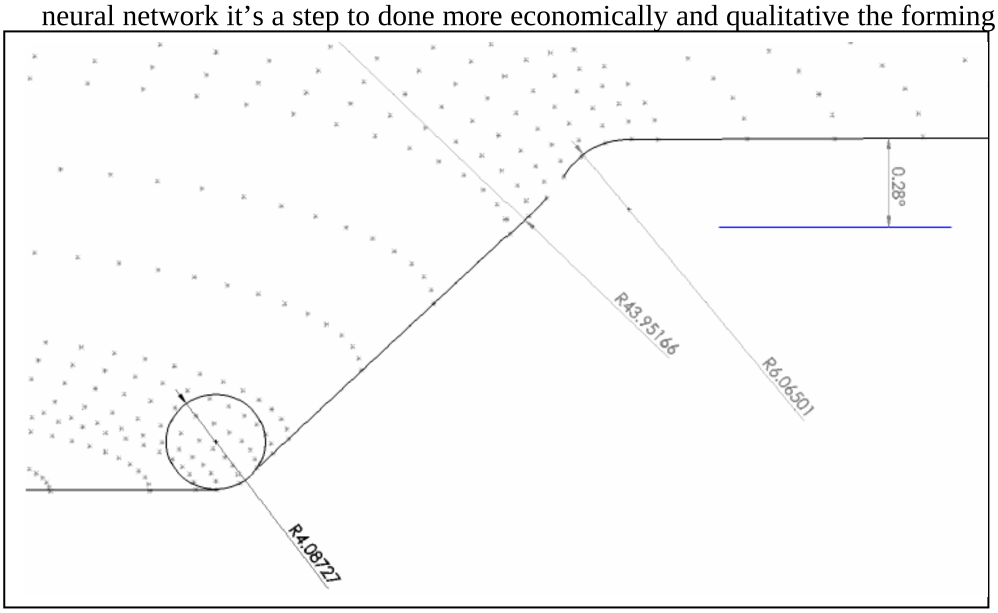

Figure 1. The values of radius after the simulation with the predicted value for BHF.

Table 1. The experimental simulations.

	Rp[mm]	Rm[mm]	μ	r1[mm]	r2[mm]	ρ [mm]	α[grd]	Fr[kN]
1	4	4	0.005	5.244	4.413	13.491	-0.53	20
2	6	4	0.15	4.79	5.096	20.147	-0.15	20
3	4	6	0.005	4.566	6.28	97.835	0.77	20
4	4	6	0.15	6.648	6.852	85.767	-0.3	20
5	6	4	0.005	6.531	4.932	35.513	0.09	20
6	6	4	0.15	6.331	6.785	33.037	0.32	20
7	6	6	0.005	6.451	7.062	98.851	0.95	20
8	6	6	0.15	6.563	6.432	87.007	0.38	20
9	4	4	0.005	4.39	4.447	36.316	0.43	40
10	4	4	0.15	4.681	5.177	28.522	0.06	40
11	4	6	0.005	4.667	6.378	20.808	1.05	40
12	4	6	0.15	4.872	6.481	72.482	0.37	40
13	6	4	0.005	6.559	4.627	30.461	0.76	40
14	6	4	0.15	6.526	5.559	31.975	0.11	40
15	6	6	0.005	6.489	6.222	90.088	1.19	40
16	6	6	0.15	6.336	6.465	113.85	0.11	40
17	5	5	0.0775	5.368	5.239	24.931	0.54	30
18	5	5	0.0775	5.38	6.397	39.153	1.03	12.8
19	5	5	0.0775	5.795	5.855	53.542	0.53	47.6
20	3.28	5	0.0775	4.118	6.174	44.876	0.13	30
21	6.72	5	0.0775	9.68	5.217	21.174	0.81	30
22	5	3.28	0.0775	5.786	4.286	23.802	-0.06	30
23	5	6.72	0.0775	5.474	6.851	91.63	0.62	30
24	5	5	0	5.363	5.486	23.437	0.61	30
25	5	5	0.2	5.505	6.332	49.778	0.59	30

Table 2. Summary report generated by Palisade-Neural Tools Software.

NeuralTools	(Report: Neural Net Training and Auto-Testing)
Created for:	C.C.I.M.T
Date:	Monday, May 08, 2007
Summary	
Net Information	
Name	Net Trained on Data Set #1
Configuration	GRNN Numeric Predictor
Location	This Workbook
Independent Category Variables	0
Independent Numeric Variables	4 Rp[mm], Rm[mm], r1[mm], r2[mm])
Dependent Variable	Numeric Var. (Fr)
Training	
Number of Cases	20
Root Mean Square Error	8.660
Mean Absolute Error	6.884
Std. Deviation of Abs. Error	5.254
Testing	
Number of Cases	5
Root Mean Square Error	11.80
Mean Absolute Error	11.47
Std. Deviation of Abs. Error	2.791
Data Set	
Number of Rows	25

Table 2 (follow up)

Training Data (Row Number)	Actual	Predicted
1	20.00	30.12
3	20.00	29.87
4	20.00	29.78
5	20.00	30.05
6	20.00	29.79
7	20.00	29.75
8	20.00	29.85
9	40.00	30.11
11	40.00	29.85
12	40.00	29.84
13	40.00	30.09
14	40.00	29.97
17	30.00	30.01
19	47.60	29.93
20	30.00	38.84
21	30.00	30.01
22	30.00	30.13
23	30.00	29.78
24	30.00	29.98
25	30.00	29.86

3. CONCLUSIONS

This paper is a start in to a better control for the punching process of a thin metal sheet. With the help of neural networks the value of the springback phenomena has decreased with 2.9 times; the new value of the punch linkage radius is 6.06 mm and the desired value is 6.00 mm. Repeating the process of teaching and improving the network it is possible to find the right value of the BHF.

4. ACKNOWLEDGMENTS:

The present research was performed in the frame of the CEEX M2 grant 1534/2006 with the financial support from MEC-ANCS.

5. REFERENCES

[1] Slomp, J., Klingenberg,W., A Proposal to Use Artificial Neural Networks for Process Control of Punching/Blanking Operations, Flexible Automation and Intelligent Manufacturing-FAIM 2004, Toronto, Canada, 2004.,

[2] Brabie, G., Optimizarea proceselor si echipamentelor tehnologice de prelucrare mecanica, Editura AGIR, ISBN 973-720-079-9, 2006.,

[3] Ciucescu, E., Brabie, G., The Neural Network - A Way to Control the Springback Effect for Thin Metal Sheet Forming. Experimental Stage- to find out the right value of the blank holder force, Optimum Technologies, Technologic Systems and Materials in the Machines Building Field, TSTM-12, no.12, ISSN 1224-7499, Technical Science Academy of Romania-University of Bacau, 2006.