Proposal Model for Stamping Application Using Artificial Neural Networks System

Noureddine Ben Yahia, Sabeur Abid and Ali Zghal

ESSTT, University of Tunis, 5 avenue Taha Hussein, Montfleury,1008 Tunis, Tunisie;

Abstract. In this research, the approaches of feature stamping design and Artificial Neural Networks (ANN) are combined to automate the process planning task and to generate process groups for set-ups. The model created in Computer Aided Process Planning (CAPP) system can provides different process using ANN for cylindrical parts. This model is composed by three principal modules, the first relates to geometrical in 3D modeling, the second treats calculations of the stamping process parameters and the third module proposes the processes of obtaining a final part using ANN system. The development of this system is based on the experiments and the knowledge to make specialists in this field. Indeed in this work we started with a theoretical study concerning the influence of the parameters of stamping and the causes of the principal defects of an operation of working of the cylindrical parts and the proposal for several typical examples of processes which are validated with industrialists. In this work we focus only in ANN structure for this application, what is Input? What is output ? to give industrial solution. The proposal method can substantially reduce the time needed to generate process plan and the results are of consistentquality.

1 Introduction

Computer Aided Design and Manufacturing (CAD/CAM) technologies have evolved over the last decade to automate and integrate various stages of the product cycle to improve the productivity of the conventional design and manufacturing activities. In typical product development processes, the manufacturing process passes by several stages in the manufacturing companies. The research works is directed to the automation of manufacture, such as the automatic range in machining, folding, cutting like in stamping. The automation of stamping forms the object of this research [1, 9, 10, 13].

Furthermore Process Planning is the critical bridge between design and manufacturing. Design information can be translated into manufacturing language only through process planning.

In this paper, we present an intelligent CAPP methodology based on trained Artificial Neural Networks which help the designer to choose the sequence of stamping operations based on the attribute of feature components and matrix [6, 8].

The paper is organized as follows. In section 2 we describe the problem of stamping process planning, while in section 3 we present the model for design by feature. In

Ben Yahia N., Abid S. and Zghal A. (2005).
Proposal Model for Stamping Application Using Artificial Neural Networks System.
In *Proceedings of the 1st International Workshop on Artificial Neural Networks and Intelligent Information Processing*, pages 103-111
DOI: 10.5220/0001177001030111

section 4 we propose the new neural method for automated stamping process. Finally in section 5 we give a conclusion and perspectives.

2 Problem Formulation

The traditional method of process planning is centered on the "process planner". The process planner typically needs diverse applied knowledge in both design and manufacturing and uses this knowledge, past experience, handbooks and/or various databases to translate the product engineering requirements into detailed manufacturing.

Examining the recent developments in CAPP, it can be observed that is now in a strategic position. Key research issues of CAPP must include:

- Development of methodologies for complete product definition that captures the design, functional, and manufacturing aspects of the part,
- Automation of process planning knowledge acquisition with artificial intelligence pradigms,
- Development of intelligent interface between CAD and CAM.

3 Model for Design by Features

3.1 Knowledge Base for Process Planning

The first part of this paper presents a new methodology for the description of the profile aimed job. This method is called Job kind in dynamic study, known as ETED [5].

The analysis of a knowledge planner consists to extract the knowledge of the expert that it has acquired in general by an initial training of professional experience displayed on several years, perhaps of tens years. This task of knowledge experts extraction is the spring of an analyst. This analyst is capable to identify the different real problem types well often complex that pose. It has to find methods of representation of real closest environment.

In our case of study, we are placed in the context of a workshop producing in middle and/or big batch size of various pieces that are composed by several cylindrical parts.

Following this, we have constituted a sample of persons to inquire, that represent several activities :

- The use of mechanical factories including the operators on numerical machine-tool, the planner and the expert in stamping,
- Mechanical teachers for, technological institutes, professional training centers and study offices which are specialized in CAD/CAM solutions.

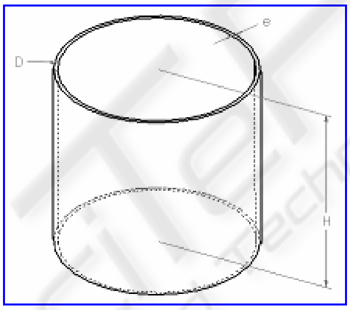
From centering of the planner's competence, we proceed directly to the individual which concerns the deciphering of the function of CAPP applied on cylindrical parts. Waited results of these meeting are:

- identify constraints used during the elaboration of manufacturing plan,

- identify the order of constraints according to their importance,
- determine the organization of sequences operations for stamping parts,
- determine of the choice criteria for operations organization in dimensions and in constraint function,
- determine criteria of the choice of manufacturing tools for cylindrical features

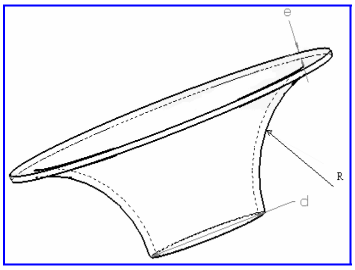
3.2 Feature Based Modeller

The results of Process Planing Knowledge base concerns the creation and manipulation of manufacturing feartures for each free types or interaction between them. The feature modeller is based on standard STEP [5].
In this work, features are considered to be regions of a part having some manufacturing significance. The particular manufacturing context consider a stamping features. In our examples we have developed 12 cylindrical features denoted: F1, F2, F3,….F12. Each feature is composed by a set of attributes. In figure 1 and 2 we give tow examples (F3, F9) of features and their attributes.
In this work we consider cylindrical parts. Each part is composed by one or some cylindrical features (figure 3).
In the following we will describe the Neural Network method for process organization.



N°	Attributes	
1	Code	F3
2	Number	1
3	diameter	D
4	Width	e
5	Height	H
6	Orientation	(0,0,1)
7	Tolerance (e)	IT(e)
8	Tolerance (H)	IT(H)
9	Tolerance (D)	IT (D)
10	Position	A3

Fig. 1. Feature F3



N°	Attributes	
1	Code	F9
2	Number	1
3	Radius	R
4	Width	e
5	Diameter	d
6	Orientation	(0,0,-1)
7	Tolerance (e)	IT(e)
8	Tolerance (R)	IT(R)
9	Tolerance (d)	IT (d)
10	Position	A3

Fig. 2. Feature F9.

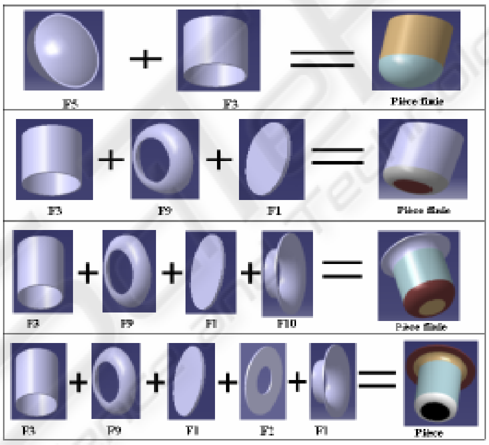


Fig. 3. Examples of composed features

4 New ANN Method for Automated Stamping Process

4.1 Neural Networks Architecture

In this section, we present a method of process organization of manufacturing by using an Artificial Feed-Forward Neural Networks system where the learning mechanism is the *backpropagation* algorithm [2, 3, 4, 7].

The basic Neural Networks architecture includes an input layer of neurons that receive the binary or continuous valued input signals, a number of hidden (intermediate) layers that are highly interconnected and output layer with one or more neurons [9, 10, 11].
The global system for process planning is composed by two related Neural Networks (NN1 and NN2) with a parallel structure (Figure 4):
- NN1 is capable to select a machining operations:
A stamping operation is attributed to a previously recognized manufacturing features. The choice is made according to specific technological knowledge and is based on rules following geometric and tolerance considerations [14].
- NN2 is capable to select machining tools to be used:
The same logic is applied to each operation and feature, and the appropriate machining tools are selected. Outputs of the Neural Networks system constitute a matrix, which is represented by binary form.

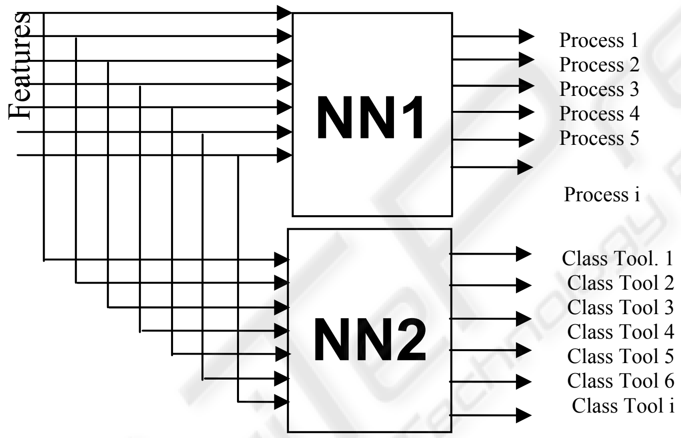


Fig. 4. Global Neural Networks architecture

NN1 architecture is composed by five elementary Neural Networks (NN11, NN12, NN13, NN14, NN15) given in Figure 5.

In Figure 6 we propose one example of outputs of neural Networks NN1. this system can provide five process possible for the same final shape but we don't have the same tools.

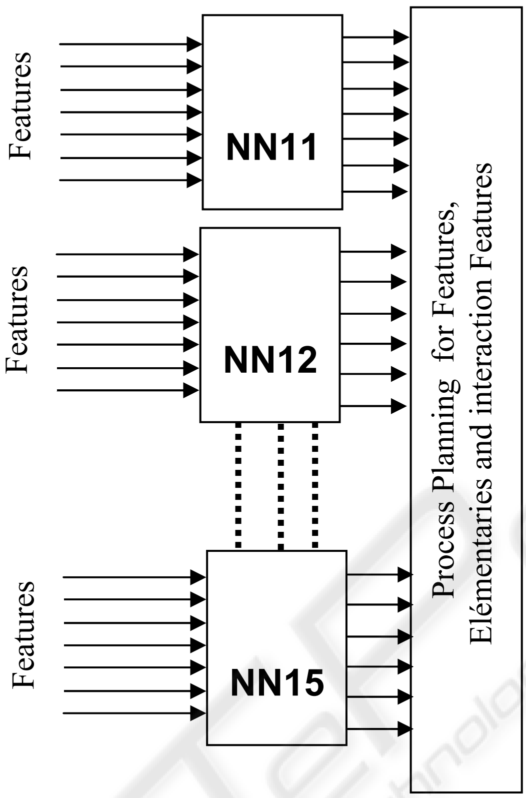


Fig. 5. Architecture for NN1

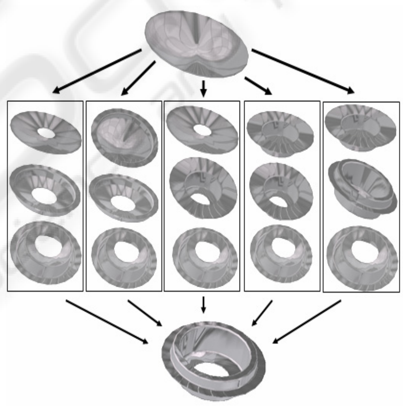
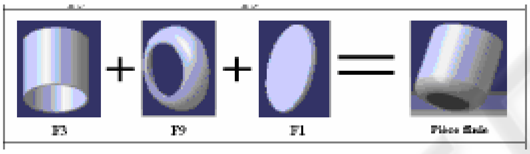


Fig. 6. Output of NN1 system

In order to prepare database for NN1 system we have to construct matrix for each composed parts with cylindrical features. For example in figure 7 we consider three simple elements to construct a final cylindrical parts.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
(F1, F6)			+	+					+	+		
(F1, F8)			+	+					+	+		
(F2, F6)	–		+	+					+	+		
(F2, F8)	_		+	+					X	+		
(F2, F9)			+	+		X						
(F2, F12)											+	
(F3, F5)									–	–		
(F3, F6)	+	+							–	–		+
(F3, F8)	+	+							–	–		+
(F3, F9)		+			–	X	–	X			+	
(F3, F10)				–	–	–	–	–				
(F4, F7)			–						–	–		
(F5, F9)		+										
(F5, F10)			+	+								
(F6, F9)	–	X									+	–
(F6, F10)	–	–	+	+								–
(F8, F9)	–	X				+						–
(F8, F10)	–	–	+	+					+			
(F9, F10)		–	+	+							–	



(-): First element added to the part
(+): last element added to the part
(X): the third element added can be the first or the last element of the part

Fig. 7. Example of matrix parts with three simple elements

4.2 Development of Neural Networks System

The structure of the automated choice system for stamping process that we have used is based on the multi-layer neural networks. They have the advantage of making it possible with a certain number of tests to model the machining process to prismatic features by the proposal of the cutting tools (figure 8).

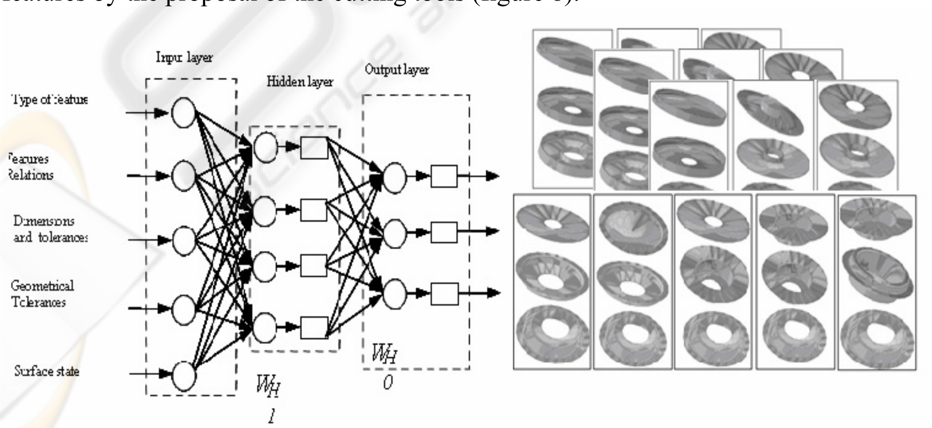


Fig. 8. Example, Neural Networks structure of NN11.

For the example of figure 8 we present in the flowing Input and output vectors for the NN1 system.
The input vector is formed by feature attributes and output vector represent the automated stamping process (figure 9)

NN1 INPUT					NN1 OUTPUT						
R (mm)	h/d (mm)	d (mm)	e (mm)	Ma	S01	S02	S03	S04	S05	S06	S07
>d/4	> 0.5	>10	0.2	1	1	1	1	1	1	1	1
>d/4	> 0.5	>10	0.2	2	0	1	1	1	1	0	0
>d/4	> 0.5	>10	0.2	3	0	1	1	1	0	0	0
>d/4	> 0.5	>10	0.4	1	1	1	1	1	1	1	1
>d/4	> 0.5	>10	0.4	2	0	1	1	1	1	0	0
>d/4	> 0.5	>10	0.4	3	0	1	1	1	0	0	0
>d/4	> 0.5	>10	0.6	1	1	1	1	1	1	1	1
>d/4	> 0.5	>10	0.6	2	0	1	1	1	1	0	0
>d/4	> 0.5	>10	0.6	3	0	1	1	1	0	0	0
>d/4	> 0.5	>10	0.8	1	0	1	1	1	1	1	0
>d/4	> 0.5	>10	0.8	2	0	1	1	1	1	0	0
>d/4	> 0.5	>10	0.8	3	0	1	1	1	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---
>d/20	>2	> 100	> 2	1	1	1	1	1	0	0	0
>d/20	>2	> 100	> 2	2	0	1	1	1	0	0	0
>d/20	>2	> 100	> 2	3	0	1	1	1	0	0	0
>d/20	>2.5	> 100	> 2	1	0	1	1	1	0	0	0
>d/20	>2.5	> 100	> 2	2	0	1	1	1	0	0	0
>d/20	>2.5	> 100	> 2	3	0	1	1	1	0	0	0

Fig. 9. Matrix of input and output vectors.

5 Conclusion

In this paper we have presented a new method of automated stamping process (CAPP system) based on Artificial Neural Network.
The development of powerful and flexible CAPP system will be useful to the manufacturing engineering specialists working in concurrent engineering teams.
The advantage of this new method of process planning is the ability to generate an optimal sequence which is difficult in a real manufacturing environment.
In the present work, use of Artificial Neural Networks approach has enabled to develop a very flexible intelligent CAPP methodology that can be easily trained to handle new types of components. A component with cylindrical features has been analyzed by this procedure. The methodology presented here can substantially reduce the time needed to generate process plans and the results are of consistent quality.

References

1. A. Zouidi, A. Chaari M. Stambouli and F. Fnaiech 2004 «Nonlinear Continuous Time Modeling of a High Pressure Mercury Vapor Discharge Lamp Using Feed
2. D. Kiritsis ''A Review of Knowledge-Based Expert Systems for Process Planning. Methods and Problems''Advanced Manufacturing Technology 10:240-262. 1995
3. I. Drstvensek et M. Brezocnik '' On inteligent CAD/CAP Integration Based on feature Recognition and Evolutionary Computation.'' IDMME 2000, 3rd International Conference on integrated Design and Manifacturing for Mecanical ingineering, Cnadien Society for Mechanical Engineering 2000.
4. J.P.Hao, Y.L. Yu, Q. Xue 2002 « A maintainability analysis visualization system and its development under the AutoCAD environment" journal of Materials Processing technology 129 p 277-282, 2002
5. N. Ben Yahia, F.Fnaiech, B.Hadj Sassi 2000 « Application des réseaux de neurones multicouche pour l'élaboration de phase d'usinages.'' *Conférence international Francophonie d'automatique CIFA pp6410,645,5-7 juillet 2000*
6. N. Ben Yahia et B.Hadj Sassi, 1999 « Elaboration automatique de phases d'usinage basé sur les réseau de neurones artificielles *» Conférence International de Productique (CPI 99) 25-26 Nov. 1999 au Maroc (FST de Tanger).*
7. N. B. Yahia, F. Fnaiech, and S. ABID, "Manufacturing Scheduling using Multilayer Neural Network", Computational Engineering in Systems Applications CESA'2003, July 9-11, 2003, Lille, France.
8. N. B. Yahia, F. Fnaiech and S. ABID, "Manufacturing Process Planning Application using Artificial Neural Networks", 2002 IEEE International Conference on Systems, Man and Cybernetics (SMC'02), October 6-9, 2002, Hammamet, Tunisia.
9. R. Ben Khalifa, N. Ben Yahia, A. Zghal, «Automated selection of machines-tools using artificial neural networks », 2nd AUS International Symposium on Mechatronics, AUS-ISM05, April 19–21, 2005, American University of Sharjah Sharjah, United Arab Emirates.
10. R. Ben Khalifa, N. Ben Yahia, A. Zghal, «Intégration des réseaux de neurones multicouches pour le choix automatique des machines-outils », 6e Congrès international de génie industriel – 7-10 juin 2005 Besançon, France.
11. J. Carlos Espíndola Ferreira and A. José Álvares 2003 "CAD/CAPP/CAM integration methodology for the remote manufacture of cylindrical parts though the web" 17th International Congress of Mechanical Engineering 03, São Paulo, SP,2003.
12. J. Dunfied, M. Tarbouchi and G. Labonte 2004 « Neural Networks Based control of a Four Rotor Helicopter » IEEE icit 2004 Yasmine-Hammamet, December 8-10, 2004
13. S. Abid, F. Fnaiech and M. Najim ''A Fast FeedForward Training Algorithm Using A Modified Form of Standard Back-Propagation Algorithm'' IEEE Transactions on Neural Networks, pp. 424-430, March 2001.
14. W. Eversheim, M. Koschig, N. Michalas ''Knowledge-based Technology Data Management''The 34th CIRP International Seminar on Manufacturing Systems, 16-18, Athenes, Greece. May 2001.