# NEW TOOLS FOR THE SELECTION OF TECHNOLOGIES; APPLICATION TO SHEET METAL FORMING

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## ABSTRACT

The development of new technologies and equipment for manufacturing processes contributes short term benefits that are reflected in diverse areas of production. For this reason, it is necessary to develop teaching/training tools able to transmit the new competitive advantages for future designers.

At the present time, diverse designing tools (software) have been developed; these tools optimize and accelerate the resources to allow the designer to obtain prototypes and calculations faster and more efficiently. However, these tools (generally graphical systems) are limited only for the design of a piece which parameters are known and the manufacturing process has been selected.

Process selection is one of the most difficult decisions that occurs in the design and manufacture of a new product. A competitive advantage before entering the design is to know each one of the manufacturing processes with its possibilities and relative advantages.  This knowledge will help to select the best option.

Within our research area of sheet metal forming, we have observed that there exists a great necessity of tools that can offer detailed and precise information of the characteristics of the different forming technologies, which can be applied to small series, and can be an effective aid at the time of choosing the most appropriate process as well.

This article discus the necessity of process selection tools and proposes the development of an expert system for the selection of sheet metal forming processes that can be applied to small series.

*Keywords: Training Technologies, Expert Systems, Design, Sheet Metal Forming*

## 1   INTRODUCTION

Manufacturing processes vary enormously between different industries, according to the type of goods and the size of the series to produce. A small batch of sheet metal components has to be flexible and capable to quickly adapt to market demands.

Consequentially, new technologies and manufacturing concepts are developing and evolving in order to enable a fast and reliable production of complex components and parts. Today we are facing increasing investigations on new sheet metal forming technologies [1-2], tools [3] and process parameters [4].

The increase of small series production by sheet metal forming processes shows the necessity of knowing the diverse processes in order to be used correctly. With the diversity of processes we will have a great amount of information that will be necessary to characterize and analyze (advantages, boundaries, costs, etc.).

This article discus the necessity of these tools and proposes the development of an expert system for the selection of sheet metal forming processes that can be applied to small series. This tool will have to display the advantages and opportunities that offer the diverse forming processes. In addition to this information, this tool will have to contain a process selection procedure that permits making a comparative analysis between the processes.

The article is organized as follows: The discussion is presented in next subsection. Section 2 shows a summary of the present tools that the designer has to his disposition to select the forming process. Section 3, introduces the proposed system. Finally in Section 4 some conclusions are presented.

## 1.1 Discussion

Process selection is one of the most difficult decisions that occurs in the design and manufacture of a new product. In most current design cases, the only process considered is one that has been used on similar products. Sometimes other processes or new technologies are not considered, because they have not been analyzed or compared with alternative solutions, that is to say, the selection of a process can change when processes that can be more efficient are considered.

When a decision is made about the manufacturing process, most of the product life cycle costs will have been determined. Thus, it is extremely critical that the correct process decision be made to keep costs competitive. The major difficulty in comparing processes is that the process criteria are different for the major processes.

In sheet metal forming is extremely difficult to compare processes, and considerable specialized knowledge is required. The traditional approach is to compare the product process requirements with the process performance criteria of different processes in a reference source to find a match. A major problem is that the reference sources often do not list the process performance criteria required by the product.

For this reason, it is essential to count on new tools that will help to select appropriately the sheet metal forming process, assistance tools / expert systems which can provide information of processes, engineering, costs, or production data.

## 2 ASSISTANCE TOOLS FOR THE SELECTION OF SHEET METAL FORMING PROCESSES

In this part a summary of two assistance "tools" are presented: Sheet Metal Design Software and Knowledge Bases.

## 2.1 Sheet Metal Design Software

Many systems of this type have been developed to assist in the design of sheet metal pieces. Some of these tools offer advice [5] on how to avoid manufacturing errors. These types of tools can detect design defects and give resolution suggestions.

Furthermore there are systems [6] that in addition to virtual design capabilities permit making calculations of costs. Yet another group of computer-aided design tools exists that include a technology database or parameters table.

In general, these systems are used for the design of a piece which parameters are known and the manufacturing process has been selected.

## 2.2 Knowledge Bases

A Knowledge Base is a collection of facts, rules, and procedures organized in schemes that can be processed by a computer. In the sheet metal forming field, these kinds of bases have been developed as assistance tools in the design process.

An example of this kind of system or information base is the Sheet Metal Forming Knowledge Base [7], developed by the Society of Manufacturing Engineers. In addition to the information on metal forming processes, it contains interactive equations that help to calculate, among others; forces, diameters, sizes of press, and deformation limits.

In spite of having an ample number of subjects (2300 pages of information), it is an informative tool oriented to large series production, that does not decide or compare the forming processes.

## 3    PROPOSED SYSTEM

An important trend in industry has been the use of expert systems to aid designers in different aspects of the design phase. The task of matching product features with process capabilities and studying the tradeoffs inherent in using different processes to produce the same part are some of the most difficult a designer faces.

An expert system is a computer program designed to imitate a human expert, mimicking the knowledge base and the decision making process of a human expert.

Most expert systems organize information into two bases, a knowledge base and an inference engine or rule interpreter. Applying this to the selection of forming processes, the knowledge base contains all of the various characteristics, parameters and rules the designer uses throughout the process, and the inference engine represents the method used to select which process or processes to invoke.

The proposed system should make use of a database which contains several processes. Each record contains data for the attributes of the process: Geometric Properties (greatest wall thickness, dimensions (length, width, height), weight, shape and complexity), Technological Properties (tolerances, surface finish), Production / Economic Properties (processing cost/part, production volume, time-to-market, capital cost, tooling cost, and rate of production).

The starting point is the idea that all processes are potential candidates until shown otherwise. First, a short-list of candidates is extracted eliminating those processes which cannot meet the design specification (engineering data and product data) and then ranking the survivors by economic criteria (cost information).

In general, an enlarged classification system, that takes the factors affecting the forming process in consideration, is needed to allow objective search in the product database. With the aid of this system, any new product could be inspected, classified, and the parameters required for the process could be concluded. Figure 2 shows the scheme of an enlarged classification system.
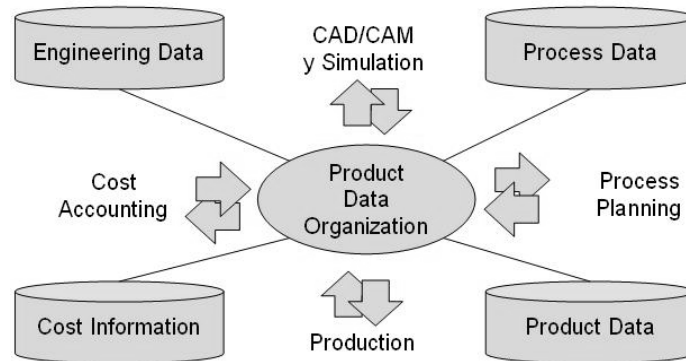


*Figure 1  Enlarged Classification System*

Many process selection procedures have been proposed [8-9] as a result of it, the following phase of the investigation is to define a procedure that fulfils the characteristics of the enlarged classification system.

## 4   CONCLUSIONS AND FUTURE WORK

The development of an expert system for the selection of sheet metal forming processes in small series production has been proposed.  It is proposed to continue this work by setting the process selection procedure in order to develop this system.

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