Chapter 7
Towards Smart Manufacturing Techniques Using Incremental Sheet Forming

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ABSTRACT

The current world’s economical crisis raised the necessity from the industry to produce components cheaper and faster. In this sense, the importance of smart manufacturing techniques, proper articulation between CAD/CAM techniques and integrated design and assessment becomes critical. The Single Point Incremental Forming (SPIF) process represents a breakpoint with traditional forming processes, and possibly a new era in the small batches production or customized parts, being already used by automotive industry for light components. While classical stamping processes need a punch, a die, a holder and a press, in the SPIF process the final geometry is achieved incrementally through the action of a punch with a spherical head. Since the blank is clamped at the edges, there is no need to employ a die with the shape of the final part. However, this process must be further improved in terms of speed and dimensional accuracy. Because the process is cheap and easy to implement, it is currently the subject of intensive experimental and numerical research, but yet not deeply understood. This chapter gives an overview on the techniques currently being employed to optimize the process feasibility.

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1. INTRODUCTION

Over the last centuries, sheet metal components have been produced using different tools and techniques. A method universally applied is stamping, which uses dies and punches, specifically manufactured according to the shape and dimensions of the component. However, despite being widespread, it presents technological hindrances, such as large energy costs and very high investment, which make this process very expensive. Because of the high cost of punches and dies, this method is only suitable for mass production, where the cost can be shared with a large number of parts.

On the other hand, the recent diversification in customer demand has resulted in the downsizing of the production lots. Because of this reduction the cost of manufacturing the tools needed to be reduced. This necessity gave origin to the intensification in the development of new production methods for a small lot. One of those methods is to create an incremental deformation in the sheet metal using a simple tool. The idea of Incremental Sheet Forming (ISF) with a single tool was initially patented by Leszak in 1967 (Leszak, 1967). This method has later become very attractive, due to the advance of manufacturing technology in the fields of Numerical Control and Automation. With the massification of computer or numerical control of manufacturing systems, incremental forming can now be fully automated and tends to be more available to general public. One of the great advantages of this method is ability to use small/simple tools that create a deformation along a defined path. The tool can be a simple hammer, a laser beam, or a water jet. One of the techniques that are receiving great attention by the scientific community and from the industry is the Single Point Incremental Forming (SPIF).

2. SCOPE AND MOTIVATION

As referred, Incremental Forming Processes have been gaining a growing interest both on academia and production industry. It is a low cost sheet forming process – mainly applied to metals – once it doesn’t require the use of dies and punches as in press sheet forming. Doing so, it is still a versatile option in terms of geometrical possibilities of final parts. Several applications have been found on biomedical industry (implants) and usable prototypes, which can represent considerable savings on RD costs (Ambrogio et al., 2005). However, the low production rate and relevant geometrical inaccuracy are impairing a deeper implementation into industrial environment.

Several studies are being carried out by many research groups from all over the world, covering both numerical and experimental aspects (Aerens et al., 2009; Tanaka et al., 1999). Nevertheless, there is still much to explore and understand on the field of Incremental Forming Processes and several questions remain open.

In this work, focus is more given on how these techniques can work together in order to optimize the process, make it more fast and feasible, and finally easier to implement in industrial environment. Summing up, the scope of the present survey is to highlight how computer aided design and manufacturing, computational mechanics, optimization processes and experimental techniques can act together to push up processes boundaries and enlarge its potential towards a smart manufacturing approach.

3. ABOUT SINGLE POINT INCREMENTAL FORMING

3.1 Description

Single Point Incremental Forming is a manufacturing process that has the capability of producing both axisymmetric and asymmetric