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Laser Beam Forming: A Sustainable Manufacturing Process

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Abstract

Manufacturing Industries occupy a unique position in the society for the production of both basic home utilities and modern appliances. Different manufacturing processes are employed for the fabrication of engineering commodities. Some of the conventional manufacturing processes include milling, moulding, welding, grinding, forging, machining, casting, forming. Wastages of resources, man-hour and capital often characterised most of the conventional manufacturing process. However, the technological improvement over the years brought about the sustainability of most of the manufacturing processes. This study presents Laser Beam Forming (LBF) as a sustainable manufacturing technique. LBF is one of the modern technology approaches of addressing some of the challenges in the modern manufacturing systems and complexity associated with the industrial sector. There are overwhelming advantages of LBF when compared to the traditional forming and bending technique, some of which includes minimum spring back effect, non-contact method developed for shaping metallic, plastic and composite materials. Forming is achieved without forces, presses and shaping dies providing a more friendly environment.

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1. Introduction

The quest for a new method of manufacturing system demand modern systems that can meet the societal needs and industrial problems. It is important to highlight that such a manufacturing system must be flexible, novel and sustainable. One of such systems considered in this study is the Laser Beam Forming (LBF). The introduction of a

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laser as a tool in the manufacturing industry was dated to 1917 and the first laser was invented in 1960. Consequently, the activity on LBF effectively commenced in the mid 80's with its origin from the oxy-acetylene flame bending of ship plates in the ship construction [1,2]. The viability and flexibility of the laser have made it unique for different manufacturing processes like welding, material processing, surface modification, and biomedical engineering.

The modern manufacturing techniques and processes does not only focus on meeting the societal needs and technical challenges but also more on the sustainability of the process because it will be a colossal waste if a process sustainability is in question. One of the definitions of sustainable manufacturing in the literature is the “creation of manufactured products through economic-sound processes that minimise negative environmental impacts while conserving energy and natural resources” [3]. Forming and bending have been part-manufacturing process whereby the shapes of materials are changed by the application of loads through punches and presses. This process of applying force to the material induces stress greater than the yield stress of the material but this controlled to avoid damage as a result of the applied force. The most traditional approach of forming are often characterised with spring back, which has been a setback in the manufacturing process for decades, although compensation theory has been developed to manage spring back.

2. Sustainability of the Manufacturing Industry

There are a lot of discussion on sustainability and sustainable development to date, this is for more efficiency and effectiveness and more importantly to preserve our environment. Sustainability is the preservation of valuable resources so that it is not destroyed. The process of preservation further ensures that all economic, environmental, and social costs and benefits of set out activity are considered because a sustainable society includes a healthy environment, social equity and a strong economy [4]. Haapala et al. presented that the concept of sustainability emerged from different management and documented reports as dated back as in the 70's and 80's, which was greatly motivated by the impacts on the environment, the damaging events, the uncertainty about environmental pollution and the run-out of the resources. They further contributed that global development and growth are some of the significant impact of manufacturing on the society. This is expected to increase from a growing economy as the demand for basic consumer goods increases, thus gradually improving the quality of life [5].

Furthermore, they reported that manufacturing has had a significant influence on global development and growth and they believe that the trend would likely continue because if the increased demand for consumer goods from the growing world with the quest to improve the quality of life. They also came to a conclusion that sustainable manufacturing is a philosophy that cannot be viewed independent of broader environmental and socioeconomic systems and shown in Fig. 1. is the flow diagram of the role of the manufacturing industry in a sustainable system.

A simple photo of mechanical forming of sheet is shown in Fig. 2. The process of actualizing sustainability in the manufacturing industries demands mainly that the processes, the bye products and products does not impact the people and the environment negatively and minimize waste. Most traditional manufacturing processes are often characterised with at least one of these.

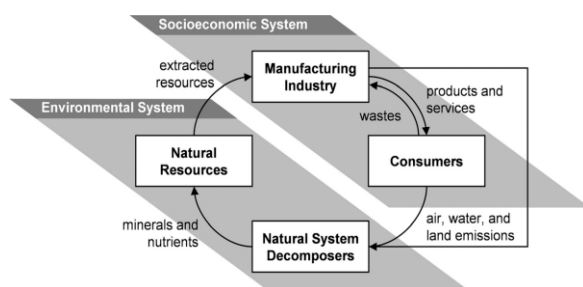


Fig.1. The role of the manufacturing industry in a sustainable system [4]

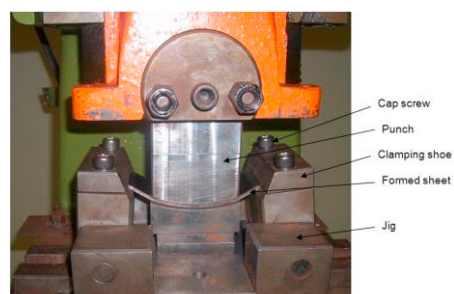


Figure 2. Mechanical forming of sheet

Conventional metal forming and bending causes deformation along one axis whereby other manufacturing operations can be performed in the formed part. Sheet metals are characterised by their high ratio of surface area to its thickness. Usually, thin materials with the thickness less than 6 mm have often involved in metal forming operations

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