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Materials Today: Proceedings 5 (2018) 3895–3902

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ICMPC 2017

Application of Additive Manufacturing technology to an Aerospace component for better trade-off's

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Abstract

Establishing the feasibility to Metal Additive Manufacturing has been a cumbersome task for any industry adapting this technology. Through this research we have identified few areas which needed to be discussed to establish such feasibility. Various constrains of part identification, static strength analysis, design intent, materials properties, process parameters have been identified. To evaluate our research findings, we have selected an aero structural part Flap Lever, developed a 3D model using CATIA software, and performed static strength checks, followed by optimization with respect to design intent. As part of material properties, Density issue, Surface quality, Mechanical properties, Microstructure, Residual stresses, Built up Direction and grain Orientation adopted to map design intent have been briefly mentioned. The design intent was weight optimization and savings on build to fly ratio, fuel costs, time to market etc., complimented by ease of customization with AM will give edge to this product. The generic mentions of the various constraints and their possible guidelines applied to critical structural aerospace component (flap lever) will be able pave path towards better application of critical aerospace parts with similar design intent.

Selection and/or Peer-review under responsibility of 7th International Conference of Materials Processing and Characterization.

Keywords: Additive Manufacturing; AM constraints; Aerospace; Structural; Critical Components; Weight Optimization;

1.1 Introduction

The primary manufacturing processes like casting, forging and the secondary processes like machining are tool based. The current demand of manufacturing is to have shorter cycle of production with innovation. One such development in the recent years is additive manufacturing. Additive manufacturing involves production of any complex product on the basis of 3D CAD data.

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Allen, et.al.[1]pursued studies on comparing the Additive manufacturing and Traditional manufacturing to achieve near net shape. Atezeni, et.al., [2, 3] highlighted the utility of rapid prototyping for plastic parts and metal parts for cost saving. Baumers, et.al., [4,5] studied the implication of power consumption due to rapid prototyping technique. Byun, et.al., [6] studied about the optimal build-up direction when a part is built with the variable layer thickness for different 3D manufacturing systems. Choi, et.al., [7] proposed a Virtual Reality (VR) system for modeling and optimization of Rapid Prototyping (RP) processes. Ginnats is, et.al., [8] examined the problem of build time estimation for steoro lithography systems. Gibson, et.al [9] and Hasan S, et.al.,[10] studied about additive manufacturing and its application in spare parts industry. Kellens, et.al., [11] implicated the environmental analysis due to various rapid prototyping techniques like SLS, SLM etc. Rickenbacher, et.al., [12] developed a cost model for SLM process including pre and post processing steps. Senthilkumaran et. al. [13] explained about the effects of different building strategies. Thus, typically very little work has been carried out w.r.t. specific aerospace components. The present work focuses on aerospace component flap lever by additive manufacturing technique.

2. Methodology adopted for an Aerospace component: Flap lever

All airplane wings contain flap levers to control lift and drag. Some airplane wings, especially those of larger jets, even have spoilers in addition to flaps that will further increase control over the airplane. This is important when landing must be done at the slowest speed possible without stalling and then vary the airplane's movement as quickly as possible. In larger air planes the wings often have the engines fixed onto them which make flaps crucial. Flaps increase the wing area when required cruise the lift. Spoilers (red) increase the turbulence to cause 'drag', flaps and spoilers maximize drag and minimize lift while landing. Flaps can also increase lift during take-off, while the airplane speed is increasing. The effect of flap lever is depicted in fig.1 and Fig 2.

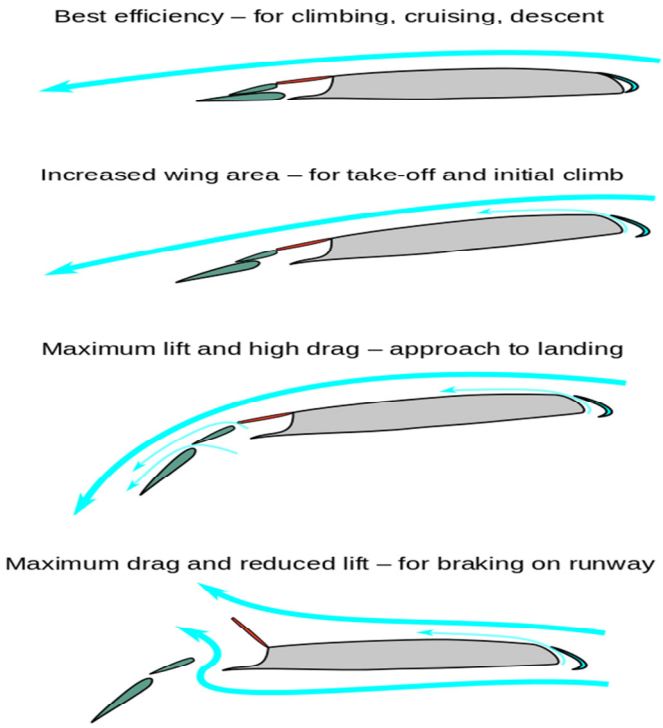

Figure 1: Representation of different functions of the flap lever in controlling the aeroplane