contents

A look back, and then forward, for a thorough review of past and current technologies in automated forming processes, their limitations, and variables that affect performance in the production of large scale components. In particular, this chapter will focus on the application of force and heat within secondary forming processes. It will then review the effects of these variables against the structure of the required composite component and identify viability of the technology. Through this, an understanding of the key criteria involved in the forming of composite aerospace components can be utilized to better inform improved manufacturing processes and capabilities.

The authors take a provocative look at how practical it really is to manufacture advanced composite parts to rigid, though at times untestable, industrial specifications and requirements (such as “the part shall be free from internal and external imperfections”). Ultimately, there are still some areas in which the specified limits are outside of what is practically achievable. This could be remedied by creating the acceptance criteria in collaboration with manufacturers, combining both design and manufacturing knowledge to distil the best outcomes.

CHAPTER 3

Carbon-fiber-reinforced plastic (CFRP) is one of the most commonly used materials in the aerospace industry today. CFRP in pre-impregnated form is an anisotropic material whose properties can be controlled to a high level by the designer. Sometimes, these properties make the material hard to predict with regards to how the geometry affects manufacturing aspects. This chapter describes 11 design rules that describe geometrical design choices and deals with manufacturability problems that are connected to them, why they are connected, and how they can be minimized or avoided. Examples of design choices dealt with in the rules include double curvature shapes, assembly of uncured CFRP components, and access for nondestructive testing.

CHAPTER 4

Replacing metals with composites in aircraft has never been a drop-in occasion, for a variety of reasons, but in particular their different material properties when it comes to manufacturing. Machining components made from CFRP are particularly risky, in part due to the potential of extensive delamination. Cutting tools for machining aircraft parts should work "fail safe," with respect to the high-quality specifications even when the tool has reached the end of its longevity. This chapter will first provide several food analogies for the reader to gain a better understanding of material properties, and then discuss the aspect of fail safe as a new approach for designing cutting tools for aircraft applications, providing a design approach that prevents delamination while drilling and trimming composites.

As the use of composites continues to increase, so too does the requirement for the development of manufacturing processes that enable larger and more complex geometries, while ensuring that the functionality and specific properties of the component are maintained. To achieve this, methods such as thermal roll forming are being considered. This method is relatively new to composite forming in the aerospace sector, and as such there are currently issues with the formation of part defects during manufacture. Previous work has shown that precise control of the force applied to the composite surface during forming has the potential to prevent the formation of wrinkle defects. The development of various control strategies that can robustly adapt to different complex geometries are presented and compared within simulated and small scale experimental environments on varying surface profiles.