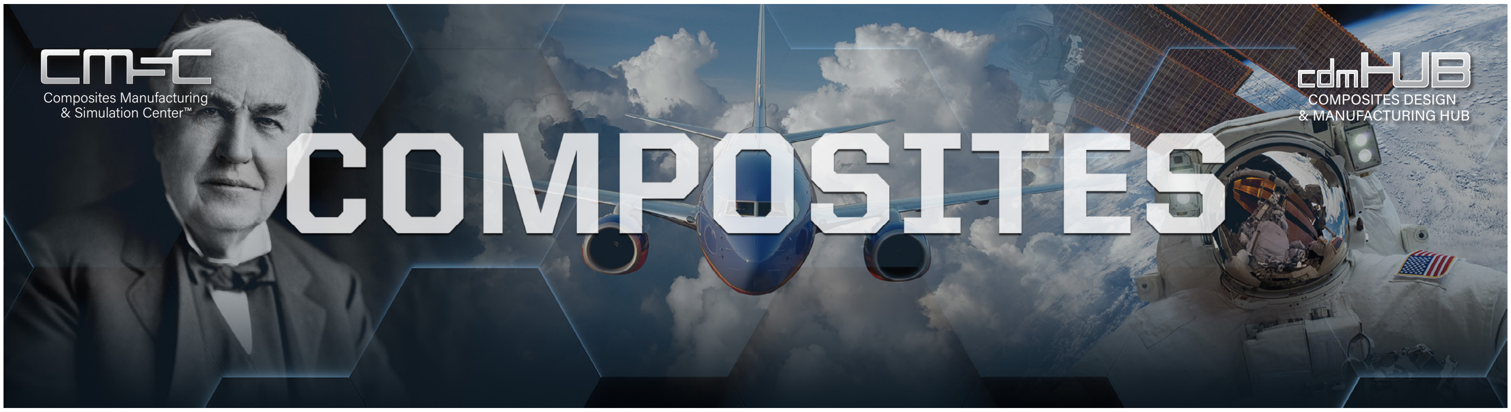

Automating The Lay-Up

Of geometrically complex composite structures made from preimpregnated reinforcements A route to a Roadmap

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A B S T R A C T

A significant amount of research and industrial effort has been expended on the development of equipment such as automated fibre placement machines to lay-up prepregged reinforcements into structures of relatively simple geometry such as wing skins and spars, and fuselage structures. These structures represent the primary structures that are critical elements of an aircraft and probably make up the largest proportion of composite structures by weight on aircraft such as the Boeing 787 or Airbus A350. However, for these aircraft (and for many other aircraft types where the primary structures are metallic) there is also a very much larger number of secondary and tertiary composite structures in the wing surfaces, engine nacelles, aircraft interior etc., which are geometrically much more complex, cannot be laid up by current AFP equipment and must most often be manufactured by manual lay-up processes. These structures are often off-shored through the supply chain to low cost labour economies. In practice this off-shoring has not always resulted in the predicted level of cost savings, and in any case as the low cost labour economies develop the assumption of low cost labour will inevitably decay, requiring an alternative approach to be taken to cost reduction. This talk will attempt to tease out the reasons for our limited success to date in automating the lay-up of prepreg into very complex parts, identify some blockers that need to be removed - not all of them are technical by any means - and point the way towards a roadmap that can be followed to a successful outcome.

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BIO

By training I'm a Materials Scientist, but I've only worked at the materials level occasionally, although my approach is clearly focused through my training - as is my preference for spending time in the lab and not in front of a computer screen. Most of my working life has been spent on issues of materials performance, manufacturing processes, and product development - with forays into areas such as reinforcement forms, hybrids, mechanical testing, deformation of woven cloth and UD prepreg, mechanical fastening, adhesive bonding, impact, cellulose fibres, recycling, residual stresses, defect taxonomy, multistable laminates, costing, failure investigations and resin formulation - in support of my three major interests; as well as teaching in my university years. The first ten years of my working life were spent in a Government lab; the next ten years were in the commercial world, firstly in Corporate R&D, then moving new resin transfer moulding technology through the development cycle, supporting its international marketing, then helping develop and troubleshoot the production line. I spent a couple of years working on debugging other production lines and improving quality - giving me an intense interest in defects in mouldings. I then spent two years on international secondment before leaving the commercial world and joining the academic one at the end of 1995. The University of Bristol needed someone with research experience in an industrial environment to manage an innovative manufacturing programme. I joined the University expecting to merge back into industry three years later, that's clearly not happened and I stayed in the University for the next 24 years, moving from contract researcher to Faculty to a Chair in Composites Manufacturing. Ten years ago we started work on the UK's National Composites Centre, which has been on a strong growth trajectory ever since, and I closed out my working career as National Composites Centre Professor in Composites Manufacturing.