Available online at www.sciencedirect.com

ScienceDirect

Procedia Manufacturing 6 (2016) 132 – 139

Procedia MANUFACTURING

16th Machining Innovations Conference for Aerospace Industry - MIC 2016

Automated and cost-efficient Production of Hybrid Sheet Moulding Compound Aircraft Components

M. Fette[a,b]*, M. Hentschel[a,b], F. Köhler[b], J. Wulfsberg[a], A. Herrmann[b]

[a] *Helmut-Schmidt-University, Institute of Production Engineering, Holstenhofweg 85, 21129 Hamburg,*
[b] *CTC GmbH, Airbusstrasse 1, 21684 Stade, Germany*

* Corresponding author. Tel.: +49(0) 40 / 6541 2610; *E-mail address:* marc.fette@hsu-hh.de *and* marc.fette@airbus.com

Abstract

Nowadays, innovative lightweight structures and highly complex aircraft components are made of modern lightweight materials such as carbon fibre reinforced plastics (CFRP). In this context current production technologies for fibre composite parts in aviation industry are generally characterised by long cycle times, sub-optimal material usage and a huge effort for reworking or finishing. A promising technology for the cost-efficient and time-saving manufacturing of lightweight, geometrically complex and functional components is the combination of thermoset Sheet Moulding Compounds (SMC) with chopped fibre reinforcements and pre-impregnated, tailored continuous fibre reinforcements in a single-stage compression moulding process. In comparison to conventional production technologies for composite materials this hybrid material and process technology obtains short cycle times, functional integration, a high freedom of design, an optimum material usage and less rework. For the manufacturing of cabin, cargo and also secondary structure aircraft components a direct implementation of metallic elements, such as inserts, and the use of recycled carbon fibres can be realised. Furthermore, this process technology can be fully automated to yield an increased economic efficiency.

Hence, this paper deals with the potentials of this new technology, especially regarding to cost reduction and saving of time, by analysing and simulating the holistic process chain for the production of appropriate reference parts. In addition, different production concepts, with various grades of automation, are considered in detail and compared to each other in reference to determined criteria.

Peer-review under responsibility of the NAMRI Scientific Committee

Keywords: SMC; Automation; Hybrid Composites; Aircraft; Interior

Peer-review under responsibility of the NAMRI Scientific Committee
doi:10.1016/j.promfg.2016.11.017

1. Introduction and motivation

The aviation industry is a rapidly growing branch due to the increasing demand on passenger aircraft. About 36,800 orders for commercial aircraft are expected by the leading aircraft manufacturers until 2034 due to a rise of the passenger number of 4.7 percent per year [1, 2]. To improve the efficiency by reducing the total weight of future aircraft, the use of modern lightweight materials, such as CFRP, and appropriate design approaches are becoming increasingly important. Against this background, the development of highly productive and cost-efficient production technologies for carbon composite components and structures is one of the main objectives of the aviation industry. Nevertheless, most of the manufacturing processes for the production of fibre composite aircraft parts are expensive, time-consuming and not automated.

The combination of tailored, pre-impregnated continuous fibre reinforcements and Sheet Moulding Compounds reinforced by chopped fibres in a single-stage compression and curing process is a promising technology for the cost-efficient and time-saving production of fibre composite components. This hybrid material and process technology can be used to produce geometric complex, highly functional and lightweight cabin, cargo and also secondary structural parts for aerospace applications in an industrial way. In this context, the determination of the Level of Automation, related to economic and time aspects, has great relevance.

This publication deals with the development and potentials of the combination of SMC and pre-impregnated, tailored carbon fibre reinforcements for cabin, cargo and secondary structure applications in aerospace industry. Furthermore, the methodical determination of the level of automation for using this technology for the production of future aircraft components is another main objective of the current work. Considered criteria are the part complexity, the number of pieces, the rate of variant diversity and the required lead time.

Nomenclature

CFRP	Carbon Fibre Reinforced Plastics
FST	Fire, Smoke and Toxicity
GFRP	Glass Fibre Reinforced Plastics
LoA	Level of Automation
NC	Numerical Control
SCARA	Selective Compliance Assembly Robot Arm
SMC	Sheet Moulding Compound
SoPI	Square of Possible Improvements
TFP	Tailored Fabricated Patch

2. State of the Art

Aircraft cabin and cargo components require various properties which limit the range of possible materials. Especially requirements concerning fire resistance, smoke density, toxicity, temperature resistance, compatibility to media and abrasion of the part surface lead to only a few applicable materials. At the same time, the materials have to enable adequate mechanical properties at a low weight and low material costs, see Fig. 1. [3, 4]

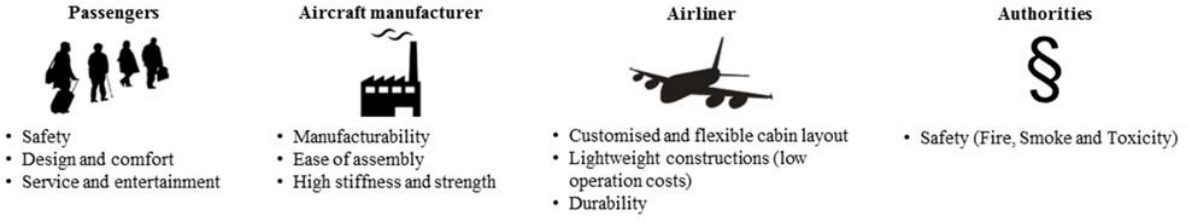

Fig. 1. Requirements on aircraft interior components.