

PROCEEDINGS OF THE
**6TH INTERNATIONAL WORKSHOP ON
AIRCRAFT SYSTEM TECHNOLOGIES**
FEBRUARY 21 – 22, 2017, HAMBURG, GERMANY

EDITED BY
OTTO VON ESTORFF
FRANK THIELECKE

Berichte aus der Luft- und Raumfahrttechnik

**Otto von Estorff,
Frank Thielecke (eds.)**

**Proceedings of the 6th International Workshop
on Aircraft System Technologies**

February 21-22, 2017, Hamburg, Germany

Shaker Verlag
Aachen 2017

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>.

Copyright Shaker Verlag 2017

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publishers.

Printed in Germany.

ISBN 978-3-8440-5086-8

ISSN 0945-2214

Shaker Verlag GmbH • P.O. BOX 101818 • D-52018 Aachen

Phone: 0049/2407/9596-0 • Telefax: 0049/2407/9596-9

Internet: www.shaker.de • e-mail: info@shaker.de

WELCOME

In view of the many positive comments by the participants of all former AST workshops, the TUHH team was fully motivated to organize the 6th *International Workshop on Aircraft System Technologies AST 2017*. By now, the preparation work is done and we are very happy to welcome all of you here in Hamburg.

Hamburg's R&D activities in the fields of the workshop are embedded in a local network. Namely, industry, universities, and government are working closely together on innovative ideas and developments in the field of future aircrafts. The common activities are strongly supported by *Hamburg Aviation*, which is the aviation industry cluster for the Hamburg Metropolitan Region – one of the world's most important locations in the civil aviation industry.

To strengthen international cooperation, for the fifth time, the *Institut National des Sciences Appliquées de Toulouse* (INSA) is co-organizing the event. The idea to hold the AST and R3ASC (*Recent Advances in Actuation Systems and Components*, Toulouse) conferences on an alternating schedule has been proven to be very successful. The combination of the two events is highly appreciated by many scientists and engineers, who have every year – the AST is organized every odd year while the R3ASC takes place every even year – the opportunity to meet and to exchange on the latest developments in aircraft system technologies.

Traditionally the 40 high-quality contributions of the proceedings address the fields of *Airframe Systems and Equipment*, *Information and Communication Management*, *Materials and Production* as well as *Cabin and Comfort*. For practicing engineers and scientists working in one of these areas the proceedings will be a valuable source of information and document the state-of-the-art.

We all know that writing high-level conference papers takes a lot of time and is a rather considerable task. As those responsible for the conference, we would like to thank all the authors and session organizers for their contributions to the event and for their efforts to make the proceedings such a complete work. We also would like to extend our gratitude to the colleagues of the program committee and the organizing team for their great help and cooperation. Finally, we wish to express our sincere appreciation to the sponsoring and supporting companies, institutions, and associations that made the conference possible.

It has been an honor for us to support global research and development in the field of aircraft system technologies through the organization of AST 2017. We sincerely hope that when looking back, all participants will remember the two days in Hamburg as particularly prosperous and interesting, spent soaking in a great deal of useful information, meeting old and new friends, and finding some time to simply enjoy the ambiance of the workshop.

Otto von Estorff and Frank Thielecke
Conference Chairmen AST 2017

ORGANIZATION

- Conference Chairs:** Hamburg University of Technology
Prof. Dr.-Ing. Otto von Estorff
Prof. Dr.-Ing. Frank Thielecke
- Conference Co-Chair:** Institut National des Sciences Appliquées de Toulouse
Prof. Jean-Charles Maré
- Program Committee:** Hamburg University of Technology
Prof. Dr.-Ing. Claus Emmelmann
Prof. Dr.-Ing. Otto von Estorff
Prof. Dr.-Ing. Bodo Fiedler
Prof. Dr. Ralf God
Prof. Dr.-Ing. Volker Gollnick
Prof. Dr.-Ing. Wolfgang Hintze
Prof. Dr.-Ing. Dieter Krause
Prof. Dr.-Ing. Benedikt Kriegesmann
Prof. Dr.-Ing. Thomas Rung
Prof. Dr.-Ing. Gerhard Schmitz
Prof. Dr. Christian Schuster
Prof. Dr.-Ing. Thorsten Schüppstuhl
Prof. Dr.-Ing. Frank Thielecke
Prof. Dr.-Ing. Andreas Timm-Giel
Prof. Dr. Volker Turau
PD Dr.-Ing. habil. Jörg Wollnack

Institut National des Sciences Appliquées de Toulouse
Prof. Jean-Charles Maré

Helmut Schmidt University, Hamburg
Prof. Dr.-Ing. Delf Sachau

Hamburg University of Applied Sciences
Prof. Dr.-Ing. Wolfgang Gleine
- Conference Secretariat:** Dr.-Ing. Stephan Lippert
Claudia Plötz

Institute of Modelling and Computation
Hamburg University of Technology
Denickestraße 17
21073 Hamburg, Germany
Phone: +49 (0)40 42878-3232
Email: ast@tuhh.de
- Proceedings/Web/IT:** Felix Rehfeldt
Marcel Ruhnau
Michael Prohn

ACKNOWLEDGEMENTS

The 6th *International Workshop on Aircraft System Technologies AST 2017* has been

sponsored by Airbus Operations GmbH
 Lufthansa Technik AG

and supported by Deutsche Gesellschaft für Luft- und Raumfahrt DGLR
 Hamburg Aviation
 Novicos GmbH

The financial aid, the general support, and the overall commitment of these companies, institutions, and associations are greatly appreciated.

The organizers are also very thankful for the generous help provided by the Ministry of Economy, Transport and Innovation (BWVI) of the Free and Hanseatic City of Hamburg.

Contents

Airframe Systems and Equipment	1
A Functional-Driven Design Approach for Advanced Flight Control Systems of Commercial Transport Aircraft <i>Thomas Lampl, Daniel Sauterleute, Mirko Hornung</i>	3
ASTIB: A Research Programme on Innovative Electro-Mechanical Actuators and Iron Bird within the Clean Sky 2 Research Initiative <i>Andrea Dellacasa, Giovanni Jacazio, Jean-Charles Maré</i>	13
Application of Active Flow Control on Aircrafts - State of the Art <i>Ahmad Batikh, Lucien Baldas, Stéphane Colin</i>	23
Health Monitoring Applied to Electrical Systems <i>Achour Debiane, Belkacem Ould Bouamama</i>	33
Real-Time Model- and Harmonics Based Actuator Health Monitoring <i>Franciscus L.J. van der Linden, André Dorkel</i>	43
Reduction of Uncertainties in SHM Data Transmission and Failure Analysis within Limitations to Economic and Safety Aspects <i>Hendrik Meyer, Sowmya Thyagarajan, Volker Gollnick</i>	51
Towards a Model-Based Systems Life-Cycle: CPCS from Design to Operations <i>David Huart, Oskar Olechowski</i>	63
An Innovative All-Active Hybrid Actuation System Demonstrator <i>Tobias Röben, Eike Stumpf, Thomas Grom, Guido Weber</i>	73
Architecture Development for Slim Wing, Distributed Electro-Mechanical Actuation Systems <i>Matthew Slater, Peter Smith, Chris Whitley, Sebastian Rivera, Dean Evans, Andrew Gibson, Steve Laycock, Alexander O'Neil, Steve Kirk</i>	85
The Development and Testing of the Wave Gear Rotary EMA for Aerospace Applications <i>V. Ursu, E. Erofeev, A. Steblinkin</i>	95

Towards a Complete Virtual Prototype of Aircraft Ice Protection System <i>Guido S. Baruzzi, Marco Oswald, Alexander Pett, Bence I. Gerber, Raghavendra Bhat, Balasubramanyam Sasanapuri, Benjamin Lehugeur, Robert Harwood</i> . . .	105
Experimental Study of Ice Accretion and Release in Jet Fuel Flows <i>Mathias Schmitz, Gerhard Schmitz</i>	115
A Framework for the Conceptual and Preliminary Design of Embedded Mecha- tronic Systems <i>Scott Delbecq, Florent Tajan, Marc Budinger, Jean-Charles Mare, Florian Sanchez</i>	125
A Framework for Automated Design, Verification, and Simulation of Electrical Power Systems for Aircraft <i>Jonathan Menu, Mike Nicolai</i>	135
Virtual Test Platform and Simulation Analysis of the Motion Simulation Sys- tem of Redueled Aircraft <i>Chen Juan, Zhao Junwei, Wang Liyang, Fu Yongling, Chang Liang</i>	145
Electromagnetic Simulations to Complete Aircraft Testing <i>Marco Kunze</i>	155
Simulation of Helmholtz Resonance Effects in Aircraft ECS <i>Alexander Pollok, Andreas Schröffer</i>	165
Multidisciplinary Optimization and Additive Manufacture of Airbus Main Land- ing Gear Manifolds <i>Martin Muir, Jacques Roizes, Frank Schubert, Benoit Marguet</i>	173
Wireless Tyre Pressure Indication System for Aircraft <i>Andrew Bill, Jacques Roizes, Bertrand Pichon, Cédric Hennemann</i>	183
Cabin and Comfort	193
Influence of Load Elements on the Dynamic Behaviour of Lightweight Struc- tures <i>Olaf Rasmussen, Dieter Krause</i>	195
Measurement of the Influence of an Active Noise Control System on the Sound Energy Flow into an Aircraft Cabin Mock-Up <i>Steffen Ungnad, Delf Sachau</i>	205
Assessment of Thermal Comfort in Cabin and Galley Using the Dressman 2.0 Measurement System <i>Victor Norrefeldt, Marie Pschirer, Rudolph Schwab, Markus Siede, Gunnar Grün</i>	215

Information and Communication Management **225**

The Future of Cabin Management Systems – Cabin Operation with Wearable Devices <i>Sven-Olaf Berkahn, Jean-Marc Graumann</i>	227
Challenges to Wireless Sensor Network in Aircraft <i>Heiko Fimpel, Falk Lindner</i>	237
Cabin Operations – Mobile Devices as an Integral Part of the Cabin Systems <i>Hartmut Hintze, Jean-Marc Graumann</i>	245
A Methodology for the Flexible Platform Technology for Fly-By-Wire Systems <i>Florian Kraus, Tim Belschner, Reinhard Reichel</i>	255
Heterogenous All-Ethernet Networking for Aircraft Systems <i>Mirko Jakovljevic, Jacques Gatard</i>	265
Rapid Prototyping of Packet Processing Devices for Aeronautical Applications <i>Fabien Geyer, Max Winkel, Stefan Schnee</i>	273
Simulation-Based Validation of Near Field Communication Effects on Aircraft Wiring <i>Jan Philip Speichert, Thorsten Kiehl, Ralf God, Heinz-D. Brüns, Christian Schuster</i>	283

Materials and Production **293**

Potentials of Augmented Reality in Aircraft Assembly and MRO <i>Axel Friedewald, Nikolaj Meluzov, Robert Rost</i>	295
Cabin Interior Components as Substrate Material for Printed Electrical Circuits <i>Nils Ischdonat, Daniel Gräf, Wolfgang Gleine, Christian Dreyer, Monika Bauer, Jörg Franke</i>	307
Interlaminar Fracture Toughness of Fibre Metal Laminates <i>Björn Bosbach, Danny Stange, Bodo Fiedler</i>	317
Electrical Properties of Carbon Nanotube Modified Epoxy Matrix for Sensing Applications in Composites <i>Christian Leopold, Till Augustin, Jonas Lehmann, Wilfried V. Liebig, Bodo Fiedler</i>	327
Identification of the Geometrical Relationships of Sensor, Tool and Actuator Flange via Defined Machine Movements for Fully Automated Bracket Installation <i>Daniel Valencia, Jörg Wollnack</i>	337

Accuracy Analysis and Optimization of Industrial Robots for Aerospace Production	
<i>Simon Kothe, Sven Philipp von Stürmer, Philip Koch, Christian Böhlmann, Wolfgang Hintze</i>	347
Adaptive Robot Trajectory Planning for the Automated Bonding of Large CFRP Structures	
<i>Fabian Schmick, Sarvesh Rao, Jörg Wollnack</i>	355
Reliability Based Shape Optimization of Topologically Optimized Structures	
<i>Benedikt Kriegesmann, Julian K. Lüdeker</i>	365
Towards an Automated Part Screening for Additive Manufacturing	
<i>Jan-Peer Rudolph, Claus Emmelmann</i>	377
Additive Manufacturing of Large Scale Titanium Parts with Increased Productivity	
<i>Mauritz Möller, Vishnuu Jothi Prakash, Julian Weber, Claus Emmelmann</i>	387
Finish Machining of Titanium Components - Challenges of New Process Chains and Recent Alloys	
<i>Wolfgang Hintze, Carsten Möller, Robert Schötz</i>	397