Piet Christof Wölcken
Michael Papadopoulos *Editors*

Smart Intelligent Aircraft Structures (SARISTU)

Proceedings of the Final Project Conference

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In memory of Kristina Ditzel

Foreword

About 3 billion people every year use air transport to realize their business and leisure needs, whereas about 5 trillion Euros worth of goods are transported by air. And these figures are on the rise: Annual passengers are expected to reach over 6 billion by 2030, according to current projections.

As the number of flights increases, pollution and noise from air travel impose significant challenges on the industry. This is why airlines, aircraft manufacturers, and researchers are constantly searching for new ways to make their planes lighter, with increased aerodynamic performance, achieving at the same time greater fuel efficiency and thereby reduce the environmental footprint of air travel.

Coordinated by Airbus, the Smart Intelligent Aircraft Structures (SARISTU) project brought together 64 partners from 16 countries with a common goal: to demonstrate the feasibility of reducing aircraft weight and operational costs, as well as improving the flight profile-specific aerodynamic performance.

During the four years of project implementation (September 2011–August 2015), the synergy of leading entities participating in this ambitious venture has succeeded to achieve some major breakthroughs in a number of technological fields.

Firstly, developments with respect to conformal morphing, in other words the gap- and kink-less change of the shape of aerodynamic surfaces, validated not only a suitable skin material, but even the ability to integrate additional functionalities such as heating and environmental protection. Furthermore, the technical feasibility of trailing edge morphing and the ability to consider active winglet control were investigated.

Secondly, developments in the wide area of structural health monitoring covered analysis methods, physical system integration at part manufacturing level, the combination of different measurement and analysis techniques on single areas of the aircraft, and a screening program for fundamental approaches to passive damage indicating surfaces.

Thirdly, multi-functional structure developments highlighted the ability to upscale nanocomposite improvements from the basic resin all the way up to industrially relevant laminates of complex and large geometries, as well as opening development

routes to further improvement. This also includes electrically conductive nanocomposites and the investigation of possibilities for metallic co-bonding.

Finally, these technologies have been verified at assembly level on major demonstrators. All in all, SARISTU represents a major step forward in successfully integrating smart intelligent structural concepts into traditional aircraft design and reflects the potential of nanotechnology in aircraft manufacturing applications. Furthermore, the project has shown that incremental improvements taken together can lead to significant weight and operational cost reductions and lead to improved aerodynamic performance.

This book includes the research papers presented in the project's Final Conference held at Moscow, Russia, between 19 and 21 of May 2015. It provides to the reader a selection of the most significant developments, achievements, and key technological steps achieved through the four-year long cooperation of the SARISTU partners with the financial support of the European Commission.

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SARISTU: Six Years of Project Management

Piet Christof Wölcken, Andreas Kötter, Ben Newman, Rebecca Wadleich and Katrin Genzel

Abstract SARISTU—Smart Intelligent Aircraft Structures—is a large, integrated research and technology project funded by the European Union as part of its 7th Framework Programme. This paper investigates some of the key project management decisions taken in the initiation, preparation and conduct of the project in order to assess the effectiveness of individual management principles, measures and activities. In particular, it investigates the effectiveness of lean project planning when coupled with a bottom-up change process, the impact of structured quality gates in the form of both regular peer reviews as well as progress-driven design reviews. In order to do so, it exploits the one-dimensional nature of "Quality, Time, Cost" and investigates the impact of this principal project management philosophy on a project. Supporting this, the paper outlines the specific deliverable dashboard methodology followed and gives an insight into practical research and development management within a Technology Readiness Level framework. Including a short analysis of financial considerations, the paper concludes by providing some key lessons learned for prospective future managers of large, integrated and hardware-based research and technology projects.

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Nomenclature

CA	Consortium Agreement
CCR	Critical Concept Review
CDR	Critical Design Review
DoW	Description of Work
EC	European Commission
GA	Grant Agreement
PDR	Preliminary Design Review
PMO	Project Management Office
PP	Project Plan
PPCR	Project Plan Change Request
Prodaxs	PROject DAta eXchange System
QTC	Quality, Time, Cost
RPR	Regular Progress Review
R&T	Research and Technology
SARISTU	Smart Intelligent Aircraft Structures (project)
SL	Scenario Leader
TRL	Technology Readiness Level
WBS	Work Breakdown Structure
WP	Work Package

1 Introduction

The Smart Intelligent Aircraft Structures—SARISTU—project was launched with a classical Kick-off Meeting at Airbus Operations GmbH Headquarters on 06.09.2011. However, when considering the overall management of this research and technology project, it is important to understand the previous project phases of negotiation, preparation and initiation and to analyse the consequences of assumptions made during these early phases which are of fundamental importance to project success. Most importantly, it is necessary to remember the competitive nature of publicly funded research, in particular ahead of the negotiation phase.

SARISTU was conceived in the early 2000s when a number of aerospace companies and institutions identified a need for major R&T effort to bring together different developments related to the overall concept of a "smart" aircraft. At a later stage, the European Union formulated this broad concept more specifically in the 4th call of its 7th Framework Programme by focusing the project scope on the still large area of morphing structures, structural health monitoring and multifunctional materials, specifically nanocomposites. Henceforward, it was clear that the SARISTU project had to be run more like a program rather than a project as with such a wide variety of fields of technologies no single individual would be able to

identify all potential show-stoppers. Furthermore, the call for proposals established a few important boundary conditions, the most important being the requirement to demonstrate the technological capabilities in significant physical test exercises. Finally, the documents associated to the call [4–9] would prove to have a direct effect on the work breakdown structure beyond the actual work objectives.

Prior to launching the proposal generation, the overall consortium management work was broken down into the usual project phases of initiation, preparation and negotiation, conduct and closure as per [1–3] with key objectives for each phase. During project initiation, the main SARISTU consortium was built with the project partners expressing key expectations and making broad commitments. During this phase, the overall demonstration activities also began to take shape. The project initiation phase was completed by the establishment of the WBS and individual team leader nominations. The subsequent project preparation phase centred around the generation of two key documents: first of all, the written proposal itself. Based on this document, the call for proposals would be won or lost. The second key document was the initial project plan which would drive project conduct and likewise determine project success, failure and its measure of efficiency. Upon selection as one of three projects to be funded in the overall call, the negotiation phase was launched with the aim of generating the two governing contracts: first of all, the Grant Agreement containing, for example, the description of work, financial data, deliverables and milestones, between the consortium and the European Commission; secondly, the Consortium Agreement laying down the consortium internal project governance rules or the handling of potential Intellectual Property issues. The prime objectives of the main project conduct are both the easiest and hardest of all. Simply put, the conduct phase has to deliver the contractual deliverables and overall project objectives as laid out in the GA. In practice, this is much more difficult. In particular in research, it becomes necessary to change project plans as new developments arise, and in consequence, the respective contracts must be amended while still maintaining both project objectives and deliverables. Finally, the project must of course be closed with all deliverables delivered, data secured and archived, final payments organized, knowledge transferred towards product development and possible follow-on work identified and initiated. Ideally, from an R&T point of view, follow-on activities have also been launched or at least initiated where considered beneficial at this point.

Throughout this time, the ***Project management office team***, consisting of the authors of this paper in their roles as project coordinator, deputy project manager, administrative and financial focal point and the project office team, endeavours to avoid the key mistakes when managing projects.

As projects may only be tracked, controlled and administered, the PMO team works on the principle that, while projects bring deliverables, is actually people who deliver projects. This management philosophy was summarized as “for people, with people, by people” during SARISTU’s Kick-off Meeting.