CARISMA

Aircraft Cabin and Cabin System Refurbishing Optimization of Technical Processes

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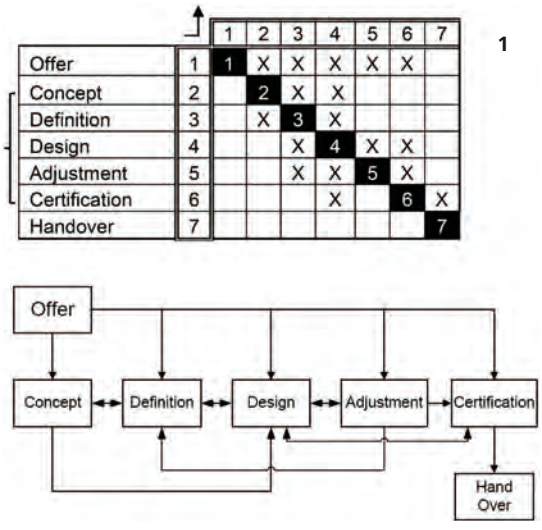
» The research project CARISMA started at Hamburg University of Applied Sciences in October 2008. The aim is to optimize the engineering processes inside an organization delivering cabin conversions.



1 Process chain representation models – matrices versus flow charts

2 Representation of the conversion processing cycle

Completion Center
Organizations able to deliver cabin conversions and cabin upgrades are known under the name Completion Center. Such organizations undertake the difficult tasks of design and certification, seeking continuously to optimize the engineering processes behind their activities.

Type Design
The type design represents the sum of data, consisting of the drawings, specifications, information on materials and processes and on methods of manufacture and assembly, created by the design organization holding the type certificate [1].

Project Partners: The industrial partner involved in the research project CARISMA is ELAN GmbH. ELAN is an internationally operating engineering office with the focus on aeronautical engineering and many years of experience in the domain of cabin conversion. The two universities involved in the project are: Hamburg University of Applied Sciences (HAW Hamburg), leading the project and POLITEHNICA University of Bucharest (PUB), providing the partnership required to conduct doctoral studies and a monthly scholarship for the candidate.

Project Work Packages: Five Work Packages (WP) were defined together with ELAN GmbH for a research period of two years:

WP 1: Identification of the Process Chain "Cabin Conversion"
WP 2: Market Research "Completion Center"
WP 3: Analysis of the Process Chain "Cabin Conversion"
WP 4: Research, Analysis, Evaluation and Selection of Tools
WP 5: Planning of a "Business Case" for the "Completion Center"

At the end of each Work Package a Technical Note (TN) gathers the research results. In addition, the aim is to write a publication based on each of the WPs and further considerations on cabin design. While the TNs are confidential, the publications allow sharing the gathered knowledge in the international community.

Project Objectives: WP 1 aims to identify and describe the necessary process steps in order to carry out an independent and successful cabin conversion, while fulfilling all the EASA requirements.

WP 2 aims to analyze and forecast the demand for cabin conversions for the next 20 years.

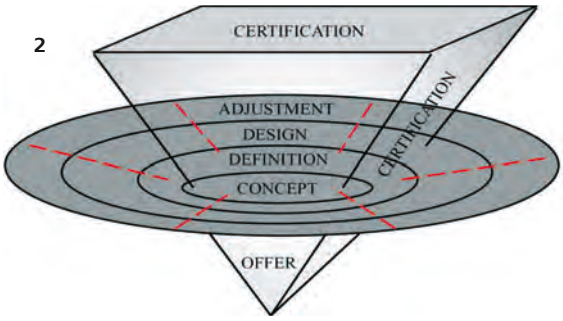
WP 3 aims to analyze the process chain identified in WP 1 using Dependency and Structure Modeling tools and to identify the required input information based on a case study approach.

WP 4 aims to provide an effective selection and evaluation of tools (in both engineering and management), suitable inside a completion center.

WP 5 aims to investigate the project "completion center" as an investment for ELAN in order to support decision making by the management board.

The Process Chain to a Certified Cabin Design and Conversion: The conversion of a cabin can be defined as the sum of (cabin-related) changes to the type design of the aircraft. There are numerous approaches available to support process management in this area. Most important ones are the flow chart and matrix approaches (**Figure 1**). For a large number of processes the flow charts become difficult to implement.

The main phases for the cabin conversion activities are illustrated in **Figure 2**. The starting phase is the offer phase, which highly depends on the correlation between the customer requirements and the capabilities of the design organization. The certification phase must start at an early stage of the design and has a major influence on the entire process chain.



Process Chain Analysis Methods: Behind the phases a large number of processes were identified and illustrated using the Design Structure Matrix (DSM). The DSM is a square matrix which illustrates the process dependencies and allows their optimization.

The first step in using this approach is to identify all the sub-systems of the system. In this case the system is represented by the set of tasks to be performed inside the Completion Center, for achieving a certified cabin conversion. The task names are placed on the left side of the matrix as row headings and across the top as column headings in the same order. If there exists a relationship between node i and node j, then the value of element ij (row i, column j) is unity (or marked with an X). Otherwise, the value of the element is zero (or left empty) [2].

Based on the DSM several analyses are possible. An algorithm called partitioning allows finding the optimal sequence of the processes – a sequence which minimizes the feedback. Another algorithm, called clustering allows grouping of tasks or processes that are interconnected to an important extent while being hardly connected to the rest of the system.

Another analysis can be performed in order to estimate the amount of rework necessary for a specific process in connection with the number of iterations. A Work Transformation Matrix (WTM), based on the DSM, quantifies this amount. The eigenstructure of the WTM determines the nature of the convergence of the design process comparable to the damping of aircraft dynamics:

- The eigenvalues give information about the rate of convergence.
- The eigenvectors give information about the shape of the natural motion.

Besides DSM analysis methods, the evaluation can be extended by creating a Cross Impact Diagram. The aim of the Cross-Impact Analysis is to identify several meaningful influence zones and the processes belonging to them. The values representing the strength of the relations are summarized per row and per column. There are five meaningful zones which can be identified (**Figure 3**):

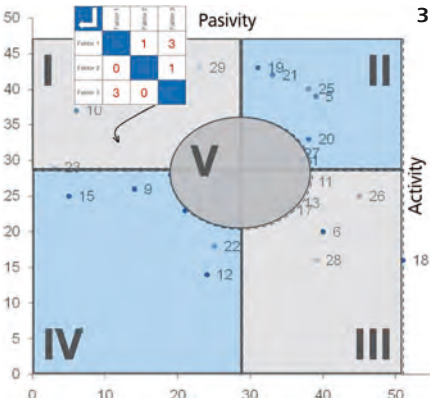
Zone I: Impulsive Processes – have a strong influence on the system; they give a lot of information to the rest of the components.

Zone II: Dynamic Processes – have an important influence on the system; the information exchange is strong on both sides.

Zone III: Reactive Processes – have a small influence on the system but are strongly influenced by other system changes.

Zone IV: Low Impact Processes – have a small influence on the system and are poorly influenced by other system changes.

Zone V: Neutral Processes – find themselves at the intersection with other domains; neutral means safe from unexpected effects.



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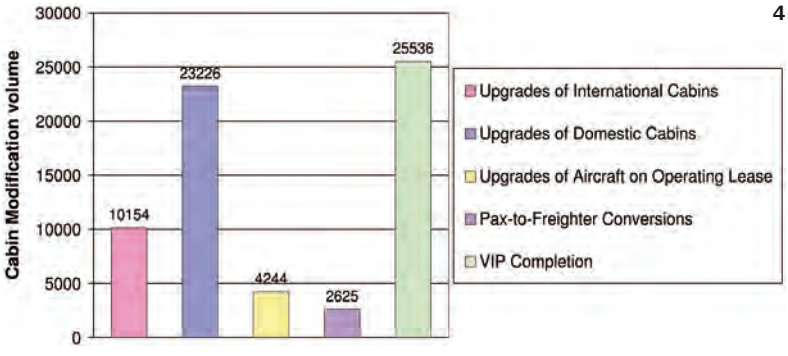
Business Opportunities in Aircraft Cabin Conversion and Refurbishing: The need to modify the aircraft interior during its useful life has grown to an unprecedented level over the last years. It was found interesting to investigate this emerging and growing market, and to forecast its evolution for the next 20 years. Several conversion scenarios were identified, aircraft data analyzed and the market growth was forecasted. It was found out that about 38000 cabin redesigns will be undertaken within the next 20 years. About 2500 conversions from jetliners into freighters and 25000 cabin modifications at VIP standards will emerge on the market [4]. The North American and European markets will keep providing good business opportunities in this area. The Asian market, however, is growing fast, and its very strong influence on demand puts it in the front rank for the next 20 years (**Figure 4**). «

3 Cross Impact Matrix and Cross Impact Diagram [3]

4 Cabin Modification World Volume 2009–2029



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[1] European Aviation Safety Agency: *Commission Regulation (EC) No 1702/2003 : Annex Part 21, 2003* [online]. <http://eur-lex.europa.eu/LexUriServ/site/en/oj/2003/l_243/l_24320030927en00060079.pdf> [Zugriff: 2009-07-08].

[2] [online] <http://www.dsmweb.org> [Zugriff: 2009-11-29].

[3] Phleps, Peter: *Szenariostudie im Rahmen des Spitzencluster Leuchtturmprojektes „Effizienter Flughafen"*. Workshop presentation, 14.–15. October 2009.

[4] Niță, M.; Scholz, D.: *Business Opportunities in Aircraft Cabin Conversion and Refurbishing*. In: Air Transport and Operations Symposium, Delft University of Technology, 14.–16. April 2010.