Innovative Model Based Systems Engineering approach for the design of hypersonic transportation systems

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By

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Abstract of the Dissertation

The Dissertation proposes a new methodology for conceptual and preliminary design of hypersonic transportation systems. Particularly, after a short introduction on historical studies on hypersonic regimes and projects, the Dissertation presents the overall design methodology, formalized through the Systems and Software Engineering Meta-model (SPEM). Notably, the analysis is focused on the conceptual design and validation of the STRATOFLY MR3 concept, a commercial civil hypersonic cruiser capable to reach Mach 8 along antipodal routes. In details, the presented methodology has been designed to support both the conceptual as well as the preliminary design phases. As far as the conceptual design is concerned, the process starts from the derivation of the mission statement, conceived to mirror the high-level mission objectives, and continues with functional and interface analyses to end up in the vehicle matching analysis and feasibility analysis. In particular, these studies include the definition of mission objectives and requirements, the identification of proper high-level performance indexes, such as required Thrust-to-Weight ratio (T/W) and wing

loading, for the different flight phases, as well as a vehicle size assessment in terms of wing surface and internal available volume. For this purposes, an innovative Multiple Matching Chart approach is proposed. Complementary, the preliminary design process for on-board subsystems is described, and specifically applied to the design of the Thermal and Energy Management Subsystem (TEMS) allocated on STRATOFLY MR3 vehicle. Preliminary design methodology includes functional and interface analyses up to component level, performance and physical characterization of the subsystem and constituent components, with special attention to safety and reliability considerations as well as to design margin policies. Ultimately, the preliminary analysis is completed with a Life Cycle Cost (LCC) assessment including new cost estimation models specifically developed to support the estimation of development, production and operating costs for high-speed vehicles.