AAE SPECIAL SEMINAR

Evolution of Aircraft Structural Design Requirements

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Abstract
Aircraft structural design and certification requirements have evolved primarily in response to catastrophic failures that exposed limitations in prevailing engineering assumptions. This presentation reviews the progression of aerospace structural certification methodologies from early safe-life concepts to modern damage tolerance, continued airworthiness, and Jet Quality Control (Jet-QC) requirements. Landmark failure events–including Liberty ship brittle fracture, the de Havilland Comet fatigue accidents, the F-111 wing pivot fitting failure, the Aloha Airlines fuselage decompression, and the United Airlines Sioux City engine failure–are examined to illustrate how material behavior, manufacturing defects, and inspection limitations drove regulatory change. Emphasis is placed on the transition from strength-based design to stress-life-based finite life assumptions to crack growth-based damage tolerance approaches that explicitly account for pre-existing flaws and inspection capability. The influence of material properties, process control, and nondestructive evaluation on certification compliance is discussed. These lessons continue to shape modern aircraft structural design and remain central to ensuring long-term safety and durability of aerospace structures.

Biography
Markus Heinimann is the Director of Technology at ATI Specialty Rolled Products. In this role he is responsible for new product development and introduction as well as product and process engineering to support market driven growth strategies and process improvements to meet customer needs in aerospace, defense, energy and other demanding markets. Prior to joining ATI in 2024, Dr. Heinimann held technology, engineering and quality leadership roles with Howmet Aerospace, Arconic and Alcoa. He started his career in engineering and engineering leadership roles at Cessna Aircraft Company.
Dr. Heinimann holds B.S., M.S. and Ph.D. degrees from Purdue University's School of Aeronautics and Astronautics. He serves on several technical and industrial advisory committees and is a Fellow of ASTM International, where is the Vice-Chair of the Committee on Fatigue and Fracture. He also received the Outstanding Aerospace Engineer Award from Purdue's School of Aeronautics & Astronautics in 2008 and has served on the School's Industrial Advisory Board since 2010.

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