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TECHNICAL REPORT

Opportunities for Systems Engineering to Contribute to Durability and Damage Tolerance of Hybrid Structures for Airframes

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Prepared for the United States Air Force

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Summary

Although a general approach to fielding durable, damage-tolerant structures has been well defined for several decades for metal airframes, the rising use of other materials and the growing role of hybrid structures in airframes are creating a need to tailor the general approach to deal with new damage mechanisms. This has created opportunities for systems engineering to contribute to the tailoring and implementation of the general approach to hybrid structures for airframes. Such implementation can help ensure that an appropriate sequence of investments is made in time to support key decisions related to the research, design, development, test, manufacturing, and sustainment of airframes that have hybrid structures. As industry and operators are tailoring the implementation of the general approach, this may be a good time to pause and consider how well materials engineers, structural engineers, and systems engineers are performing as a team in assuring the durability and damage tolerance of hybrid structures for airframes over their life cycles.

To support such considerations, this report starts by summarizing the Air Force's general approach to developing and sustaining durable, damage-tolerant structures for airframes (see pp. 15–20). Although the details of the approach evolved during an era of metal airframes, its general framework is broadly applicable to airframes in general. Because hybrid structures that have multiple classes of materials are accounting for a growing proportion of the structural assemblies in modern airframes and because they introduce new challenges for durability and damage tolerance, this report explores how systems-engineering efforts may help tailor implementation of the general approach to hybrid structures for airframes.

The report also identifies technical and programmatic considerations that need to be addressed by a systems-engineering approach (see pp. 21–24). Next, the report identifies opportunities for materials engineers and structural engineers to collaborate with systems engineers in ensuring the durability and damage tolerance of hybrid structures in airframes (see pp. 25–27). Finally, it describes a candidate framework for facilitating such collaboration (see pp. 29–34). Such a framework may provide a useful basis for considering and continuously improving the team performance of the materials engineers, structural engineers, and systems engineers who are responsible for ensuring the durability and damage tolerance of hybrid structures over an airframe's life cycle.