A MANUFACTURING DATABASE OF ADVANCED MATERIALS USED IN SPACECRAFT STRUCTURES

by

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Cost savings opportunities over the life cycle of a product are highest in the early exploratory phase when different design alternatives are evaluated not only for their performance characteristics but also their methods of fabrication which really control the ultimate manufacturing costs of the product. In the past, Design-To-Cost methodologies for spacecraft design concentrated on the sizing and weight issues more than anything else at the early so-called "Vehicle Level" (Ref: DOD/NASA Advanced Composites Design Guide). Given the impact of manufacturing cost, the objective of this study is to identify the principal cost drivers for each materials technology and propose a quantitative approach to incorporating these cost drivers into the family of optimization tools used by the Vehicle Analysis Branch of NASA LaRC to assess various conceptual vehicle designs.

The advanced materials being considered include aluminum-lithium alloys, thermoplastic graphite-polyether etherketone composites, graphite-bismaleimide composites, graphite- polyimide composites, and carbon-carbon composites. Two conventional materials are added to the study to serve as baseline materials against which the other materials are compared. These two conventional materials are aircraft aluminum alloys series 2000 and series 7000, and graphite-epoxy composites T-300/934.

The following information is available in the database. For each material type, the mechanical, physical, thermal, and environmental properties are first listed. Next the principal manufacturing processes are described. Whenever possible, guidelines for optimum processing conditions for specific applications are provided. Finally, six categories of cost drivers are discussed. They include, design features affecting processing, tooling , materials, fabrication, joining/assembly, and quality assurance issues. It should be emphasized that this database is not an exhaustive database. Its primary use is to make the vehicle designer aware of some of the most important aspects of manufacturing associated with his/her choice of the structural materials .

The other objective of this study is to propose a quantitative method to determine a Manufacturing Complexity Factor (MCF) for each material being contemplated. This MCF is derived on the basis of the six cost drivers mentioned above plus a Technology Readiness Factor which is very closely related to the Technology Readiness Level (TRL) as defined in the *Access To Space* final report. Short of any manufacturing information, our MCF is equivalent to the inverse of TRL. As more manufacturing information is available, our MCF is a better representation (than TRL) of the fabrication processes involved. The most likely application for MCF is in cost modeling for trade studies. On-going work is being pursued to expand the potential applications of MCF.