The Airframe Design Environment (ADE) is specialized engineering software tailored for the design and manufacture of airframe assemblies (Fig. 1). The ADE is integrated into commercial computer-aided design systems to provide a means of capturing non-geometric design data, such as information about structural material properties, adhesives, and manufacturing processes. The ADE includes powerful tools that support assembly modeling, fastener selection, and many other tasks, including the selection and specification of materials.

The software gives engineers the ability to assemble information from the myriad digital resources that aerospace companies use daily. Product data in the ADE is highly structured and readily searchable. Members of the product development team can highlight a feature of the CAD model and bring up all ADE forms that contain information associated with that feature. Also, by clicking on a form in the ADE, they can highlight every place on the model where that data is applicable, eliminating many tedious manual engineering tasks.

XML tools in the software share the non-geometric data with other software applications downstream, including in the supply chain. The format and content of the shared information is customizable, so that everyone receives the appropriate data in its most usable form, such as an EBOM, MBOM, or quality assurance documentation. This capability is very important to airframe design because suppliers in aerospace are now tightly integrated with OEMs, contributing to part design and building a complex, rich information path to manage product data.

Accessing data

Companies keep a great deal of essential materials information in high-level documents, such as military standards, design handbooks, or materials databases. An engineer designing with the ADE can access and copy such information easily.

For instance, airframes frequently use graphite composites. Because graphite and steel are quite far apart in the galvanic series, galvanic corrosion could occur if the graphite of the composite were to come into contact with a steel fastener. It is common practice, when using steel fasteners on an airframe that includes composites, to call for a protective coating for any fastener holes in the composite part to prevent corrosion.

With the ADE, engineers can automatically link coating information from a document or database to each point on the 3D model where a fastener hole passes through composite materials. People who need that information later can click on any of the fastener holes and retrieve the coating data. Clicking on the data itself highlights all of the applicable hole locations on the model. In the same way, an engineer could provide warnings about materials that should be kept out of potential contact with fuel or hydraulic fluid.

Replacing 2D drawings

Some manufacturing information was formerly called out on 2D drawings. For example, callouts often indicated where a portion of an airframe required a conductive coating to provide electrical grounding. As drawings are phased out in favor of 3D-model-based design, engineers can instead access a form in the ADE to spell out the nature and thickness of the coating material, while iden-
tifying the area of the finish on the CAD model. Once the area and thickness of the coating are defined, the ADE can calculate the volume of coating material, which helps engineers achieve more-accurate early product costing. In the same manner, the ADE is useful for specifying other finishing applications, such as paints or sealants.

The ADE can also document joining processes such as brazing, welding, or adhesive bonding, which is more convenient than annotating drawings. Traditionally in airframe design, each part being joined would require an individual drawing. Once the parts formed an inseparable assembly, the assembly had its own drawing as well. Now engineers can offer suppliers a 3D model that defines the individual parts, the processes needed to join them, and the final inseparable assembly (Fig. 2). A model might show two metal plates and include a process note about joining them with friction stir welding. This capability is especially beneficial for aerospace OEMs, who frequently purchase parts from suppliers and assemble the aircraft themselves.

Sharing certification data

Aerospace engineers frequently require copies of materials documentation from manufacturing, quality control, purchasing, and the supply chain. This documentation is vital to verifying later in the manufacturing process that a part meets all specifications. The format and content of shared information is customizable, so that each team member receives the appropriate data in its most usable form, such as a manufacturing process report, without needing to edit or re-enter it.

For example, an engineer using the ADE to design a part made from high-strength steel can access information about alloy composition from a supplier, and share it with a metallurgist for review and approval. Or revisions to the material for the part over time may be tracked within the CAD model, providing a self-contained history of material changes that can guide the engineer in the future.

Reviewing manufacturing processes

The ADE gives engineers the means to review and share information based on in-house or supply chain manufacturing processes and capabilities. If, for example, an airframe design calls for a titanium part, the engineer can use the ADE to link to documentation detailing all available capabilities for machining. By reviewing part geometry in conjunction with materials and process information, engineers can generate a far more manufacturable and cost-effective part than they could with CAD alone. They can also cost it more accurately.

Another example would be using the ADE to gather information about recommended feeds and speeds during machining. By entering this kind of data into the ADE, the engineer can move important process information downstream with the 3D model when the part documentation is sent out for manufacture. The direct transfer of machining process data with the 3D model ensures that all members of the supply chain have the exact information they need to create the part to specifications.

Reusing designs

Companies reap the greatest benefits when they are reusing or modifying a design previously created with CAD and the ADE. For example, engineers who are creating a next-generation airplane may want to include more composites, and now they can review the rationales behind design decisions on an earlier generation of airframe.

As another example, perhaps an earlier aluminum airframe required an additional layer of vibration-damping material to protect electronic equipment mounted inside the aircraft. If the innate damping properties of the composite materials are sufficient by themselves to absorb the vibration, then the engineers might choose to eliminate the protective layer, reducing aircraft weight and costs.

Exploring new technologies

As aircraft technology continues to evolve, companies are exploring a wealth of unique materials and processes that require exhaustive documentation. Few members of a product development team will have in-depth knowledge of the load-bearing properties of a new investment-cast titanium alloy part, or about the finer points of friction stir welding. The Airframe Design Environment is a valuable tool for assembling such vital data in a single, searchable repository and communicating it throughout the enterprise.

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