SEER

Reduces Time to Calculate Cost by 75 Percent

Lockheed Martin Tactical Aircraft Systems

At Lockheed Martin Tactical Aircraft Systems, the use of commercial design for manufacturability (DFM) software is reducing the time needed to perform cost estimates for airframe components by 75 percent. Instead of searching through data files for costs of similar parts already in production, cost analysts enter cost-related characteristics from a CAD model into the DFM program. The software does historical research and generates the estimate. Estimates that previously took weeks are done in two days with an accuracy of +/- five percent.

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"Once the new cost estimation process is fully implemented, we expect to save up to 400 hours per month on proposals, trade studies, and engineering change proposals (ECPs)," says Bryan Tom, a staff specialist handling estimating, proposing, and contracting at Lockheed Martin Tactical Aircraft Systems in Fort Worth, Texas. "In addition to saving time, the new approach makes it possible to consider more design parameters and search a much larger historical database than is practical with the manual approach."

Lockheed Martin Tactical Aircraft Systems is the lead site for Lockheed Martin's Fighter Enterprise, the combination of the fighter expertise and capabilities from throughout Lockheed Martin. The Fighter Enterprise designs, produces, and supports today's proven affordable fighter, the F-16; the-next generation in fighter aircraft, the F-22; and the multi-service, multi-mission Joint Strike Fighter.

Cost analysts at the Fort Worth facility provide cost estimates for all Lockheed Martin tactical aircraft programs. Analysts from this facility frequently travel to other Lockheed Martin sites to evaluate costs of new and on-going programs. In addition to estimating the cost of airframe components and assemblies at the conceptual, preliminary, prototype, and detailed design stages, they also evaluate design trades and ECPs. They review proposals from vendors to double-check their cost estimates as well.

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Reviewing the previous costing method

The traditional approach for determining the cost for a new airframe component entails searching a database of previous components to find one or more that are similar in terms of material type and design. It normally takes between 10 and 20 minutes to search for a single component. However, many airframe components are actually assemblies of a dozen or more parts, so this process needs repeating for each component in the assembly.

The analyst also has to study the design and decide how many and what types of fasteners to use. With this information, finding the correct parameters to estimate the cost of the required assembly operations takes between five and ten minutes per part. For an assembly of a dozen parts, it takes about one day to generate a cost estimate.

Larger assemblies could take longer. In one example, it takes three analysts one week to estimate the cost of an airframe. Design trade studies require analysts to evaluate multiple combinations of design alternatives, so they take two to five times as long as estimating the cost of a single assembly.

In an attempt to shorten the cost estimating process, analysts research commercial software designed for this purpose. After a rigorous evaluation, the SEER-DFM™ software package from Galorath Incorporated (www.galorath.com) in El Segundo, California is selected. The company's SEER-DFM provides a framework for estimation and has the capability of accepting custom cost models as plug-ins.

The software selection committee is also drawn to SEER-DFM's four-quadrant user interface. The work element breakdown for an estimate is found in the upper left quadrant while the parameter view is found in the upper right quadrant. The user can select from a variety of reports to display in the lower left quadrant, each instantly updated when the estimate is modified. Charts can be displayed in the lower right quadrant.

One of the first uses of the program involves estimating the cost of fuel tank components requested by an F-16 customer. The item needing an estimate was a 30-pound assembly consisting of castings, forgings, and sheet metal parts that had been modeled in CATIA . The purpose of this estimate was to calculate the T1, or theoretical first unit cost of the component. The analyst uses the CATIA data to obtain cost characterization information, which he downloads into a spreadsheet. The analyst enters the cost parameters that provide all of the information needed to create the cost estimate, such as length, width, thickness, material type, weight, finish, and fastener count. He manually enters the information from the spreadsheet into SEER-DFM.

Using SEER-DFM spares the analyst from manually searching a database for comparison information. The software program estimates cost and yield data by building an analogy between the current project and an historical database. This technique, called metrics mapping, relies upon a complex database of technical, programmatic, and cost information that is continually reviewed for applicability to current estimating requirements and technology maturity.

Key mapping parameters are individually mapped into a matrix of actual data. This map, combined with an appropriate weighting scheme, generates an analogous cost estimate. Cost estimating relationships are applied to this value to generate acquisition cost estimates reflecting user-defined development and production environments and program schedules. Using this approach, the analyst arrives at the predicted cost of the fuel tank assembly in two hours. "That job would have taken at least one day using the previous method," says Tom.

Saving time throughout the estimation process

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Time savings are greater on large estimates, such as that of an entire airframe. An estimate involving an entire 8,300-pound airframe configuration and several thousand parts recently has been performed using the historical grass roots estimate method. It takes three estimators one week to calculate the cost of the airframe, even though detailed part descriptions aren't used. A newer concept for that same airframe is evaluated later using SEER-DFM.

"Even though we evaluated many more parameters and a larger historical database than for the previous estimate, the new approach made it possible to turn around the estimate in the same time it took to perform the original one." says Tom, "The majority of this time involved data entry and with this process completed, we expect to save significant downstream time on this project. The airframe cost estimate will have to be repeated multiple times in the future, such as when a change to the outer mold line of the aircraft affects the geometry of almost all the 5,000 parts in the assembly. With the data already in the system, it should be possible to produce a new cost estimate in response to this type of change in about one day."

Substantial time savings in all aspects of the cost estimation process are expected once this new process is fully implemented. ECPs normally take approximately 40 hours to evaluate, assuming a design involving approximately 20 parts. Using SEER-DFM, they can be done in 10 hours. Similarly, trade studies involving five different design options for an assembly with a dozen parts normally take about two days. They can now be done in one-half day.

Proposal estimates can be reduced from one to two days to two hours. Tom expects that he and his colleagues will eventually use the software to estimate between five and 10 proposals, 10 to 20 trade iterations, and two or three ECPs per month. Under these assumptions, the software should generate about 400 hours per month in time savings over the previous costing method.

Since the use of this program is relatively new, Lockheed Martin is still in the process of validating its accuracy. One way they are doing this is by comparing the estimates generated by the software for certain detailed parts and small assemblies with known costs. For example, information about an existing bulkhead that takes 50 hours to machine and 25 hours to sand is entered into the cost estimating program. The cost that the software predicted is within five percent of the actual cost. A number of similar studies consistently show that the accuracy of the new method is at least as good as the conventional approach.

Creating a plug-in to add more time savings

Tom believes that Lockheed Martin will be able to speed cost estimates by an additional order of magnitude when inputs from the engineering department are entered into SEER-DFM directly, rather than manually. "We need a cost characteri-

zation interface that will apply the majority of the mundane cost characteristics, such as length, width, and material thickness automatically," Tom says. "Then analysts will be free to concentrate on the ten percent of the parts that require some fine-tuning and judgment."

Work is underway to develop such an interface. Lockheed Martin is collaborating with the five other aircraft manufacturers involved in the Composites Affordability Initiative (CAI) on the development of a plug-in to automatically transfer cost characteristics from a CATIA model to SEER-DFM.

When the plug-in is available, estimates that previously took an hour should be available in minutes. Estimates of an entire airframe will also be considerably faster. "When we have direct access to design data, an estimate of an entire airframe, which now takes several weeks, should be available in about two days," says Tom. "A design trade estimation with ten different designs, each with different materials and parts, will be done in an hour, rather than an hour for each iteration."

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