DESIGNING FOR MANUFACTURE

EVALUATING MANUFACTURABILITY AT THE DESIGN STAGE

Communication walls creep into organizations that have departments performing specialized operations. If employees are not knowledgeable about what goes on in other departments, they finish their job and throw it over the wall for the other department to work on. A classic case in turbomachinery design would be the manufacturing department proclaiming that a design is not manufacturable.

The onus may well be on the designer to fix this problem since he is the first player in the process. "If the designer can incorporate stress concerns and manufacturing fundamentals in the design from the get go, it can lead to significant savings in time and hence cost," says Mark Anderson, Vice President, Software Development at Concepts NREC.

The information flow can be organizational — better team work and communication — or through software. For instance, a design software that integrates with the analysis and manufacturing software can also help in this process. Such software tools facilitate easy data transfer earlier on in the process, resulting in fewer iterations through the cycle.

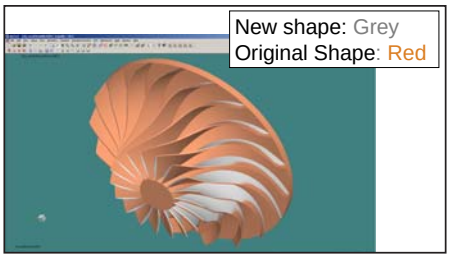
Tearing down the walls

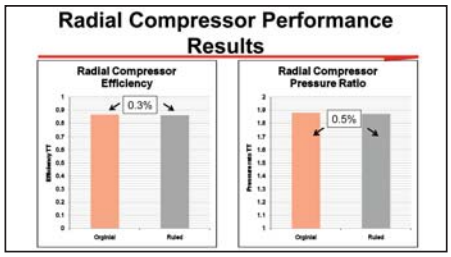
The communication walls seem to be more common in firms that use advanced tools and techniques. The more specialized engineers become the less they seem to know in general, says Anderson.

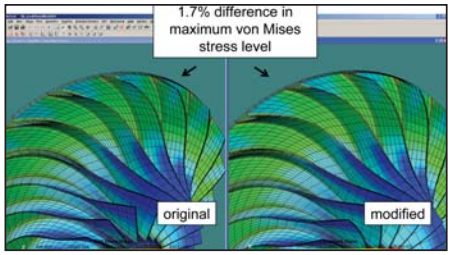
Some generic rules regarding manufacturability can be incorporated in the design stage. However, there is a significant gray area where parts can, in theory, be manufactured, but the costs are high. A minimal sacrifice in design performance can lead to significant improvements in manufacturability — and hence cost and time (Figures 1, 2, 3). "Someday we may have a bar with a dollar sign on it for manufacturing costs going up or down on the screen every time the engineer makes a design change" adds Anderson.

In some scenarios, such as where performance is everything, these considerations may not be viable. However, in most turbomachinery cases a balance can be struck. "Performance is one facet of cost, and reduction in manufacturing cost may, in some cases, significantly exceed increase in performance-related costs," says Anderson.

For mass-produced components, manufacturing considerations are often







Clockwise from top

Figure 1: Concepts NREC's AxCent tool changes the geometry to make it more conducive to five-axis machining

Figures 2, 3: The new geometry has negligible effect on performance

paramount and need to be given more weight at the design stage. In the case of Concepts, the AxCent software shapes the blade and transfers to Maxpack, the CAM software, and minimizes the motion of five axis machining, says Peter Klein, Associate Director, CAM Software at Concepts NREC.

Recent trends in Computational Fluid Dynamics (CFD) tools may facilitate information flow. While CFD use remains a highly specialized discipline, the tools are becoming more and more user-friendly. The algorithms are becoming more automated for grid generation , the solver setup easier, and post processing is becoming more intuitive.

All this means that CFD is no longer a black box impermeable to others. This may help facilitate information flow across departments.

Stress analysis software is also going through a similar trend. Today's stress analysts can go back and make minor changes to the geometry, and all the information is available for one person, rather than having the design move from one department to the other. Even more valuable is feedback from the software that lets the designer minimize inter-department cycles in the first place.

Often, manufacturing is done in the supply chain and not within the organization. The walls could get higher in such cases. There are times Turbocam, a manufacturer of turbomachinery components, gets an integrally shrouded part that is simply not manufacturable with milling. "We still do not have end mills that go around corners," says Rob Bujeaud, VP Engineering at Turbocam.

For this reason, Turbocam has engineers working specifically on the concept of Design for Manufacture. Its CNC machine programmers are degreed engineers, and they spend time to not only evaluate how best to manufacture the part but also understand its design and functions, says Bujeaud, and adds, "If we think that there are issues that make the part significantly more expensive to manufacture, we work upfront with the customer."

Sometimes it is a question of finding the right person in the OEM to convince that a design alteration is in everyone's best interest. For instance, if the flow conditions allow, it may be better to have a ruled surface than an arbitrary one, as it is more expensive to use point milling compared to flank milling, because cycle times are often higher. Or a larger fillet radius may reduce cycle time substantially. In some other cases, the turning dimensions may be altered for the sake of ease of manufacturing.

Understanding the design and its function may help manufacturers ask for changes that can be accommodated. "If we go to the designer and ask for a tolerance of 0.010 inch on a bore diameter on a part spinning at 150,000 rpm, we will look foolish," adds Bujeaud.

The walls may rise up within departments, not just between them. For instance, the CAD-CAM system may produce "pretty" programs that look good on the computer screen, but on the machine the part may spin, flip and crash. An interface between the CAD-CAM system and the machine may help to electronically view the toolpaths and see if there will be a collision or if the quarter-inch end mill will come out from the other side. Turbocam uses Truepath, a software by CAMplete Solutions Inc., to bridge this gap. TI