Tech focus

Technologies that address common manufacturing and maintenance concerns are the focus for this month.

Perfecting material flow

To shorten process times and retain on-time delivery of maintenanced aerospace engines, **MTU Aero Engines** built a new assembly hall that it designed to stabilize maintenance processes that are effectively supported by material-flow-oriented production methods.

MTU's restructuring of its production processes required the redefinition of core and ancillary processes. Clarification of existing processes with **Tecnomatix**'s eM-Plant simulation tool enabled the mapping out of the transition from workshop-based control to a material-flow-oriented system.

The decision to opt for the Tecnomatix tool was due to the wide acceptance of the software and the ease with which consultancy services could be brought in.

"Many universities use this tool, which makes it easy to recruit staff who are already skilled in its use," said Klaus Hanreich, Head of Parts Repair at MTU, which is involved in the development and production of engine modules for both civil and military applications, and provides engine maintenance and repair to the civil aviation industry.

When a turbine is overhauled, the material flow created by the dismantling of the engine is extended by bought-in and spare parts. After dismantling, cleaning, and examining for cracks, the individual components are inspected for damage according to legal and manufacturer guidelines. Finally, all components are assessed by experienced component examiners who determine which parts must be replaced or repaired.

"The components are very expensive, therefore repair is often an economic option, which in turn demands specialist technologies," said Hanreich.

Each dismantled engine consists of up to 3000 individual components. All the parts have unique identification numbers, which entails "the coordination of an immense flow of materials so that they come together in a short process time and conclude with the successful reassembly of the complete product," said Hanreich.

Increasing market demands such as cost, quality, and cycle time are the motivation behind engine maintenance companies such as MTU carefully examining their production organization.

The use of eM-Plant enabled more efficient material flow. "Which material moves in the workshop along which line at which speed is clearly defined," he said. "The fundamental change is that the work content is subject to a timing process."

Another change has been the renaming of the "workshop" as a "production unit." The workshop was characterized by many individual workstations, and the material meandered from one to the next. The result was that the material flow was relatively difficult to follow. Also, the control inputs were quite high as personnel, material, deadlines, and tools had to be coordinated. In contrast, with material-flow orientation, everything is subordinated to the material flow. With appropriately trained personnel, only one control variable remains.

MTU used eM-Plant simulation software from Tecnomatix to restructure its production processes and map out the transition from workshop-based control to a material-flow-oriented system, which it says resulted in a 40% lower process time and more efficient use of staff.

With more efficient production came shorter process times, which contributed to reduced warehousing costs. "The whole system became more stable, making it easier for me to integrate our suppliers into the process," said Hanreich.

Previous attempts to accelerate the process did not produce any meaningful time savings. "Before the workshop was reorganized—try as we might—we could not improve process times," he said. "It was not until we employed eM-Plant that a clear improvement and consistent realization became possible. Especially significant savings were made in time and resources through the more effective deployment of our staff. In total we have achieved improvements of 40%."

The use of eM-Plant assisted in the definition of the production structure, which required the generation of job processing schemes, material flow management via the job lists, a parts list, and work schedule routing with personnel qualification control. MTU used customized eM-Plant modules to create a complete process chain that would run smoothly.

"We processed nearly 12,000 lines of job descriptions, created a parts list with up to 600 parts, and configured about 120 staff qualifications and rules," Hanreich said.

Even after such a complex process had been integrated into the performance model and the various modules that constitute the model, "the competence for the model remained with MTU," said Hanreich. "Now more efficient use can be made of MTU's own know-how, which has been systematized as data for the simulation model."

No special training from Tecnomatix was required. "Because of the adaptability of the modules, we only need to deploy one employee to operate the tool," said Hanreich. "And now we only need about two hours to set up a single model. The evaluation of the model still takes several days, but it should be possible to improve this."

Jean L. Broge

FTI's method for installing aircraft hardware

In today's world of aircraft engineering, there is the ever-increasing demand to design and develop structures that will fly longer, weigh less, and lower production and maintenance costs. **Fatigue Technology** (FTI) is constantly striving to develop products that meet this high design objective using its proven cold expansion technology. FTI's newest process is FleXmate, an inventive method for installing aerospace hardware and fittings.

The FleXmate process uses cold expansion technology to simplify and improve the installation of aircraft hardware. FleXmate can be designed for any type of aircraft fitting—from fuel and fluid couplings to electrical connectors, and from hydraulic fittings to drain plugs. FleXmate hardware can also be installed in either metal or composite structures.

Since 1969, FTI's split sleeve cold expansion technology has been used to enhance fatigue and damage tolerance life of military and commercial aircraft and helicopters worldwide. Using a lubricated split sleeve and expansion mandrel to expand the hole (which locally yields the surrounding material and induces compressive stresses around the hole) increases the aircraft's structural life by 3 to 10 times. The process is also used to reduce the weight of assemblies by facilitating use of higher operating loads where holes are "shielded" by these beneficial residual stresses.

FTI's FleXmate fitting process involves installation of aircraft hardware and fittings via cold expansion technology.

FTI has adapted this cold expansion principle to expand bushings, fasteners, and fittings into metallic and composite structures, creating a consistent high-interference fit.

Legacy fittings are usually large and heavily flanged, requiring a thick or large pad-up around the penetration hole. The assembly is often complex, with multiple holes to accept satellite fasteners to the structure. The process adds weight to the structure and limits its design flexibility.

FTI can manufacture any type of fitting to custom design specifications. And using the same PowerPak and puller units as other FTI processes, the FleXmate part can be cold-expanded into place without the need for satellite holes, a thick pad-up, or complex assembly. The fitting receives all the advantages of a high-interference fit installation and, in most metallic cases, the benefit of residual compressive stresses to the surrounding structure. The synergistic benefits of interference fit and residual stresses combine to give the aircraft an installation that has enhanced life and fatigue strength.

Unlike legacy fittings, FleXmate parts can be cold-expanded into place without the need for satellite holes, a thick pad-up, or complex assembly.

FleXmate allows the engineer to design a more efficient aircraft. A thick pad-up and/or bulky assembly no longer limits the number of bulkhead web penetrations. The process allows for a smaller footprint and the ability to fit into much tighter spaces.

The FleXmate process has been thoroughly tested and manufactured to the high aerospace quality standards and is already being used on many flying aircraft. For example, FleXmate fuel fittings and grease fittings are installed on some of today's high-profile military aircraft. On the commercial side, FTI has installed grease fittings, drain plugs, and electrical connectors.

Tom Ramsay of Fatigue Technology wrote this article for *Aerospace Engineering.*

Eco-friendly cleaning

RWE Space Solar Power uses DBE (dibasic esters) to clean its silicon substrate wafers for the manufacture of solar cells used in space. The company replaced reproduction-toxic dimethyl formamide (DMF) with the non-classified, biodegradable solvent from **Invista** (formerly **DuPont Textiles and Interiors**) during its **ISO** 14001 eco-certification. Not only does DBE cost less than DMF, the used solvent can be sold to a recycling company.

Dibasic esters from Invista are being used by RWE Space Solar Power to clean its silicon substrate wafers for the manufacture of solar cells used in space.

The cleaning process is an essential part of production. According to Invista, during the manufacture of solar cells, the silicon substrate wafers undergo several process steps including coating, masking, exposure, and removal of the masking layer. Residual masking material is washed off in a multi-stage rinsing operation (cascade rinsing) using DBE.

Solar cells used for space applications need to withstand temperatures from -150 to +150° C. A proven substrate for this application is high-purity monocrystalline silicon. Solar cells made with this material attain an efficiency of about 17%. By comparison, terrestrial solar cells based on polycrystalline silicon (for photovoltaic systems) or its amorphous counterpart, achieve 14% at best.

Apart from silicon wafer cleaning, DBE is suitable for other applications such as cleaning diodes or as a substitute for the N-methyl pyrrolidone often employed in the production of semiconductor chips.

Stuart Birch