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Aviation and the Supply Chain

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Aircraft manufacturing engineers know the value of environmental monitoring throughout the supply chain. Despite the extreme temperatures and vibrations experienced by aircraft, individual components can be surprisingly sensitive during shipping and storage. These components need controlled environments to ensure they meet the tight mechanical tolerances necessary for secure flight.

For example, certain rivets used for aircraft assembly are routinely shipped at the deep frozen temperature of -40°C. The reason tracks back to a basic law of thermodynamics – metals expand when heated and contract when chilled. At -40°C, they can be installed into extremely tight holes. Then, as the rivet warms, it expands, making the space ever tighter so that the riveted space is almost as strong as the surrounding area. When the rivet and the surrounding structure are of similar alloys, their coefficient of thermal expansion is virtually the same throughout a flight.

Some composite materials also may be shipped and stored at frozen temperatures. In these cases, they may have been impregnated with adhesives that begin to cure at temperatures above freezing. So, until the component is assembled, they may need to maintain sub-zero temperatures to prevent premature curing. Some sealants also must be chilled.

Impacts also are a concern. Although designed to withstand the force of landings and the vibrations that are inherent in flight, sensitive electronics are installed in systems designed to attenuate those shocks and vibrations. During transit, however, they may not be mounted in their final assemblies. Instead, they are protected by packaging materials and are susceptible to damage. As aerospace engineers point out, any component can be damaged or ruined because of a drop. After a drop, a component will be evaluated, repaired and reevaluated to determine whether it is usable or is scrap, using valuable expertise and resources in the process.

Standards

The aviation industry flourishes through strict adherence to a plethora of federal regulations, including guidelines for procurement, environmental considerations, space transport, air worthiness, and parts certification.

While federal guidelines tend to focus on performance criteria, suppliers understand that meeting those guidelines depends upon components that meet exacting requirements during design and manufacturing and, importantly, during shipping. Consequently, the Aviation Suppliers Association has developed Quality System Standard ASA-100 to help aviation suppliers meet stringent quality requirements and become accredited suppliers. Two of the points in ASA-100 address the use of environmental controls and thorough documentation. Under this standard, suppliers are expected to monitor and document the environmental conditions experienced by their components between their facilities and their customers' plants.

Handwritten documentation, it says, is not acceptable. Instead, suppliers meeting the ASA-100 standard are expected to use systems that automatically log data, thus providing one additional assurance that the data is accurate and objective.

ASA-100 ACCREDITED
ASA
AVIATION SUPPLIERS ASSOCIATION

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Spotting the damage

In the aerospace industry, federal and industry standards have become the foundation of companies' own standard operating procedures. For manufacturing engineers, the challenge is knowing whether those standards have been maintained for each shipment, throughout the supply chain.

Sometimes the damage is obvious. In 2010, for example, one of three fasteners suspending a 7 metric ton Russian Soyuz spacecraft failed as the vehicle was shipped from its Moscow manufacturing site to its launch site in Kazakhstan. The Soyuz dropped several centimeters and rolled slightly on the floor for much of the trip, damaging the heat shield attachments and displacing the capsule's axis by two millimeters.

Private organizations report other damage. In Australia in 2005, the Bathurst Soaring Club – one of that nation's largest soaring clubs – trailered its new glider to a club hanger, only to find the aircraft's elevator had shaken out of its mounting during transit, damaging both the elevator and part of the fuselage.

Although monitoring may not have prevented the event causing the damage, in both cases, impact or vibration monitors could have alerted handlers of the handling requirements of the shipments. With real-time alerts, those transporting the spacecraft and the glider each could have known that something had happened, allowing them to take actions to prevent further damage.

These Russian and Australia examples exhibited obvious damage, but sometimes the damage isn't so obvious. Adhesives, for example, may pose a risk if they begin curing too early, before components are properly joined. Other chemicals may begin to separate when too cold or too warm, sometimes altering their functional properties.

Aerospace electronics pose another concern. Printed circuit boards, for example, may be damaged by impacts or vibrations that fracture solder joints and thin wires or damage substrates or mounting brackets.

To prioritize testing, aerospace manufacturing engineers need to know exactly what environmental conditions these components, chemicals and adhesives have experienced, immediately when they are received. With this information, incoming shipments that may be damaged can be flagged

Russian Soyuz Capsule

for special attention, examined, and either accepted or rejected. This alert helps minimize the risk that hidden damage will remain hidden until the component is installed.

Monitoring

Monitoring aviation components throughout transportation and storage is an important step in ensuring their integrity. While temperature or drop-shock impact monitors provide instant, visual indications that components need additional inspection to ensure safety, more sophisticated data loggers can provide the detailed, accurate electronic records that meet regulatory requirements. Data loggers also allow procurement specialists to peer more deeply into their supply chains to identify patterns of damage and attribute it to specific causes, carriers, or locations. With heightened reporting requirements, data loggers offer a simple way to provide detailed, accurate information that meets regulatory requirements.

A variety of data loggers are available, with a wide variety of capabilities. For example, entry-level loggers like the ShockWatch® G-View monitors and records impacts whenever specific impact thresholds are exceeded along the X, Y, and Z axis. This device also records the dates and times of impacts as well as their acceleration levels. The G-View can record up to 100 events per axis and lights up, thanks to LEDs, to provide an obvious visual alert.

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At the higher end, the ShockWatch® ShockLog 298 monitors and records shock, vibration, and environmental conditions (including temperature) and alerts users when unacceptable conditions have been encountered. Its sensors also record amplitude and duration of impact. The ShockLog 298 can record data for 870 events and 262,000 time slots with up to 18 months of battery life. Optional sensors can also report tilt and roll, temperature, humidity, and atmospheric pressure as well as GPS locations for every event and summary interval.

For temperature monitoring, dedicated temperature monitors may be set to provide alerts when temperatures drop below or exceed defined parameters. Some devices, such as the TrekView for Dry Ice, record temperatures as low as -80°C. That particular monitor is designed for a single use, but other TrekView monitors can record temperatures between -30°C and 75°C.

The aerospace supply chain is a complicated network made of suppliers throughout the world. The Boeing Dreamliner – the 787 – is a good example. Its manufacturing connects more than 450 pairs of cities. Components were shipped to Seattle and assembled at Boeing Field. The 787 may have a more complicated supply chain than many aircraft, but they all rely upon multiple suppliers and multiple locations.

With such a far-flung supply chain coupled with the degree of precision and accuracy to ensure safe flights, monitoring aeronautical components during shipping is good business.

To learn more about how environmental monitoring can help ensure safety in the aeronautics industry, contact ShockWatch.

Sources

Russian Soyuz Capsul Image < http://historicspacecraft.com/soyuz.html >