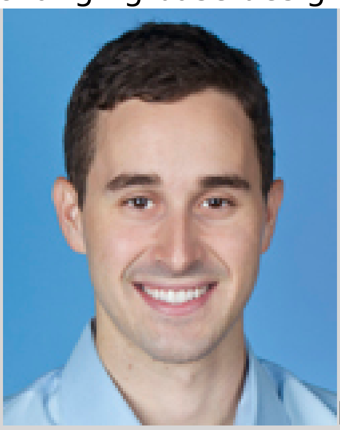
Brainstorm: Military & Aerospace

In which area of component development have you seen the most advancement in providing better or more rugged solutions for military and aerospace specifications?

James Stossel, Abbott Technologies, www.abbott-tech.com **[1]**

Each new generation of digital processor technology has been a principal driver in achieving better and more rugged solutions for military and aerospace applications. Using more advanced processors actually has helped engineers reduce the parts count in typical systems, leading directly to higher MTBFs and significantly improved reliability. At the same time, new generations of processors typically required less power and operated at lower voltages. This led to systems that ran cooler and also lasted longer. These devices also make systems more flexible with much of the functionality implemented using easily changeable software or firmware routines. In addition, digital processors allow engineers to develop a single design that can span a variety of operating requirements, like a range of input and output voltages. Such flexibility allows them to build families of products without changing base design topologies.



David Nosbusch, National Instruments, www.ni.com **[2]**

Modular test platforms, like PXI, continue to be used as COTS solutions for complex military and aerospace test systems. Recent design advancements that maximize system uptime in the instrumentation chassis component of these test systems have enabled PXI to better serve military and aerospace applications.

The instrumentation chassis, as the backbone of the system, must be designed with critical components like power supplies and cooling mechanisms that are rugged and reliable enough to meet not only the specifications of the particular installation environment but also the availability requirement of the system mission.

As the system uptime requirements of applications have increased, the need for redundancy of the system’s critical components has emerged. Critical component redundancy, combined with sparing strategies and efficient maintenance scheduling, can greatly improve the system’s ability to perform its intended function, even in the midst of component failure. Adding the element of redundancy to the power supplies and cooling fans can improve the availability rating of instrumentation chassis to beyond 99.9998 percent, or five “nines,” to keep mission-critical test systems operational.


Kirk Peterson, ON Semiconductor, www.onsemi.com **[3]**

Electronic systems are becoming more and more complex each year, driving design implementation into advanced technologies and requiring more stringent verification strategies. As high reliability designs follow this technology curve, the demand for more rugged products increasingly requires improved radiation tolerance, extended temperature capability, DO-254 traceability, and a trusted supply chain.

To improve radiation tolerance, layout methodologies and redundant logic are being used, in addition to the development of custom libraries.

Because device physics prevent advanced technologies from running at high temperatures for extended periods of time, an application temperature profile is often required and placed into a model to understand and predict device life spans.

Aerospace requirements in particular are becoming more stringent. Included is the requirement to show compliance in the design phase for complex electronics in order to ensure continued airworthiness. The DO-254 standard enables hardware design assurances by tracking and capturing the requirements throughout the design and verification process.

Counterfeit parts have become a hot issue over the past several years. Companies are developing systems to ensure only qualified product are placed in critical applications. The Trusted Access Program developed by the U.S. government provides a path for delivery of critical systems.

Peter Dutton, TE Connectivity, www.te.com/adm **[4]**

The biggest changes in components used in aerospace and military applications will be driven by the availability of new materials.

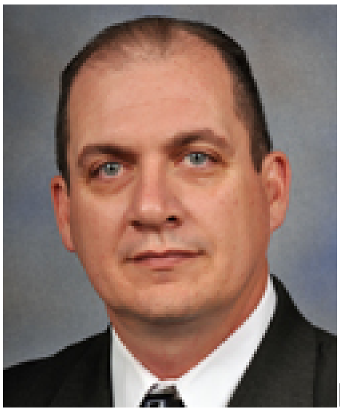
New materials of every type are being developed: polymers, metal alloys, semiconductors, inorganics and ceramics. New material development is driven by the need for smaller size, lighter weight, and the ability to handle more electric power (SWaP). To these drivers can be added the performance improvements available through higher bandwidth components and increased reliability. Smaller size and increased power often result in operating higher temperatures thatresult in decreased reliability unless new materials are used.

Specific examples can be found in many different applications. Aluminum structure and skin has been replaced by thermoset composites in newer aircraft and an ever-increasing use of polymer composites (especially carbon fiber composites) will be found in electrical components and avionics boxes. These polymers are needed to handle the same strength, EMI shielding, and thermal packaging problems as current materials but their fundamental properties are very different. (For example a carbon fiber composite may be two orders of magnitude less thermally conductive than aluminum.)

New high-temperature polymers are becoming available and these new materials can be combined with newer filler materials such as carbon nanotubes, graphene, and aerogels to enhance specific properties.

The copper interconnections on aircraft and in military applications are a significant portion of the total weight of a vehicle. In some newer commercial aircraft replacing the aluminum skin of an aircraft with a polymer composite has increased this interconnection weight because additional EMI and lightning shielding has been required. Aluminum alloys are attractive possible substitutes for copper but terminations are an issue. Longer term, carbon nanotube conductors hold the promise of providing conductivity approaching that of copper at drastically reduced weight.

In the semiconductor area, existing highly-reliable electromagnetic relays can be replaced by faster-operating solid state devices as materials such as GaN and SiC become increasingly used for high-power switching applications. The pace of materials development will continue to increase resulting in opportunities for new components and the ability to combine functions in components.

**Brad Little, Texas Instruments,** www.ti.com **[5]**

Advancements in aerospace for defense electronics are increasingly driving the use of commercial off-the-shelf (COTS) components to support the new generation of aerospace and defense applications' size, weight and power constraints (SWaP). This has created multiple challenges for design engineers, who have to worry about component functionality, as well as address counterfeit ICs, product longevity, and long-term component quality and reliability.

There are a number of military and aerospace specifications that help engineers to conduct a risk assessment on COTs components. One example is the NASA Plastic Encapsulated Microcircuit (PEM) specification, NASA/TP—2003–212244, which provides recommendations for COTs component selection, screening, and qualification. This is done in an effort to help mitigate potential quality and reliability issues faced when using PEMs in applications such as aerospace. Another specification commonly used by avionic suppliers is the Aerospace Qualified Electronic Component (AQEC), GEIA-STD-0002-1. Harsh environment semiconductor suppliers meet this standard with their qualified enhanced product (EP) lines introduced in 2001.

These types of standards have become more relevant today for engineers who must address the latest advancements in commercial packaging. For example, simple material changes driven by cost reductions must be fully understood and qualified before production use due to reliability concerns. A recent trend is for PEMs packaging to move from gold bond wires to copper bond wires. However, this may result in long-term dormant storage failures due to the unknowns with using copper bond wire on aluminum pads. Some other issues to consider are packaging lead finish and thermal efficiency, which may limit a device's useful operating life at extended temperatures.

In summary, the aerospace and defense industry will continue to see advancements in SWaP component development driven by the commercial electronics industry. These advancements present many challenges to engineers who need to rely on existing and new military and aerospace standards to qualify the use of commercial off-the-shelf components in harsh environments.

Links:
[1] http://www.abbott-tech.com
[2] http://www.ni.com
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