The ECN Roundtable - Mil-Aero Trends

Following up on last month's Roundtable question on solid-state lighting in Military and other hi-rel applications, this month's Roundtable question was "What technology will most impact the military and aerospace market in the near future?" Our answers this month come from Matt Behr of MathWorks and Joe Moxley of Custom Electronics.

Highest Impact Technologies of the Year Will Come In Smallest Packages

By Joe Moxley, Custom Electronics (www.customelec.com [1])

Technology will spur evolution in the military and aerospace markets this year, and passive components will be most responsible for the ensuing changes. Those components -- inductors, capacitors, resistors and modular products — are already ubiquitous in industrial and consumer electronics. In broader markets, passive components yielded $22 billion in sales in 2009. As military and aerospace companies look for smaller, cheaper and better parts in the coming months, components will take on a more significant role in the industry. Specifically, manufacturers will seek out capacitors with better packaging techniques and more cost-effective processes. While these technologies are physically small, their impact in 2011 will be great.

Advances in material science have led to a rapidly increasing number of passive components designed for particular applications, and this trend will continue. The implications for superior performance are promising. Consider that the energy density of ultracapacitors ranges in value from 1 to 9000[1] F or more and has gradually increased during the last decade. Researchers are focused on finding new electrolytes and electrode materials to enhance energy density to be on par with lead acid storage batteries, which could lead to the wholesale replacement of lead acid storage devices[2].

Packaging will also remain important in the coming year. The multilayer ceramic capacitor (MLCC), with its previous error-inducing use of ceramic substrate, is an example of the impact of packaging changes. Manufacturers solved that problem by packaging the devices with flexible lead-outs, and we will see similar advances in the next 12 months. Players in the military and aerospace arenas should also expect an increase in new and nano-scale materials. The impact of these smaller-sized technologies will have an outsized effect on the large-scale applications in the market.

Evolution of Model-Based Design in Aerospace

By Matt Behr, MathWorks www.mathworks.com [2]

The further evolution of Model-Based Design [3] will yield results for the military and aerospace market in the future.Developing next-generation aerospace and defense systems present unique challenges. The first is managing their extraordinary scale and complexity. These projects are *systems of systems*, requiring integration of disparate dedicated systems. Next, low production volume means that nonrecurring engineering costs are carefully scrutinized. One-time costs for research, design, and development cannot be distributed over thousands or millions of units. Lastly, testing these systems can be difficult, costly, and unsafe e.g., commercial and military satellites cannot be fully tested on the ground and conducting flight tests on a new aircraft are both expensive and hazardous.

Aerospace and defense organizations have utilized modeling and simulation technologies for decades to help address these challenges. Early in the design cycle, simulations help engineers understand and analyze system behavior. Simulation and analysis capabilities have themselves evolved alongside the functional and performance requirements of systems. Custom environments such as FORTRAN-based models, while effective for their original task, can be difficult platforms on which to add modeling capabilities. This has resulted in the shift towards commercial-off-the-shelf (COTS) simulation packages, such as the addition of discrete event simulation to Simulink [4]. NASA and TriVector Services [5] recently used these capabilities to analyze the impact of communication latencies on the Ares I rocket.

Model-Based Design is itself an evolution of these simulations. As its name implies, it allows simulations to be reused throughout the design process.

In the test and training design phases, code generation generated code allows simulations to be re-purposed for Hardware-in-the-Loop testing and simulator development. By running models in real-time with hardware I/O, engineers can compare the behavior of the processors and hardware with the behavior of the simulated components. Re-using design simulations in flight simulators permit engineers to get operator feedback early in the design cycle and cut down on training system development cost.

During production, Model-Based Design allows the reuse of algorithmic models in production systems via the same code generation technology. Automatically generating code saves time and eliminates errors when compared with manual translation by hand. The benefits of Model-Based Design have been proven in industry.

Model-Based Design is now evolving to meet new challenges in the Aerospace Industry. These include easing the burden of compliance with industry-standards and enabling integration testing via simulation on multi-organization programs.

High-integrity programs requiring compliance with industry standards such as DO-178B mean increased burdens of testing and artifact generation significantly increase cost. Model-Based Design helps achieve certification to safety standards by supporting requirements traceability, verification, and documentation. These capabilities span multiple design stages e.g., requirements linked to model are inserted as comments in generated code. Qualification kits [6], available for several verification tools, can reduce the amount of manual review needed.

Model-Based Design is growing among large programs spanning multiple organizations. This allows system-level performance to be assessed and integration issues to be uncovered much earlier in the design process. When detailed models from multiple organizations are combined, resulting models can contain hundreds of thousands of blocks. Modeling tools, such as Simulink, have evolved to meet these challenges with improved support for large-scale modeling, including support for composite models from other model files and support for signal buses.

Modeling standards are also becoming important for these multi-organization programs, in developing collaboration support at the model level. For example, the Orion Guidance, Navigation, and Control (GN&C) MATLAB and Simulink Standards [7] document describes the modeling standards and guidelines that the Orion Crew Exploration Vehicle Flight Dynamics Team used for GN&C algorithm development. The standards provide guidelines for several aspects of the GN&C models, including stylistic rules, modeling tool selection, and configuration settings, which affect model readability a well as the generated code.

Model-Based Design is and will continue to evolve in order to continue to support a diverse and expanding group of leading organizations to improve efficiency, increase reuse, and meet new challenges in developing modern aerospace and defense systems.

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