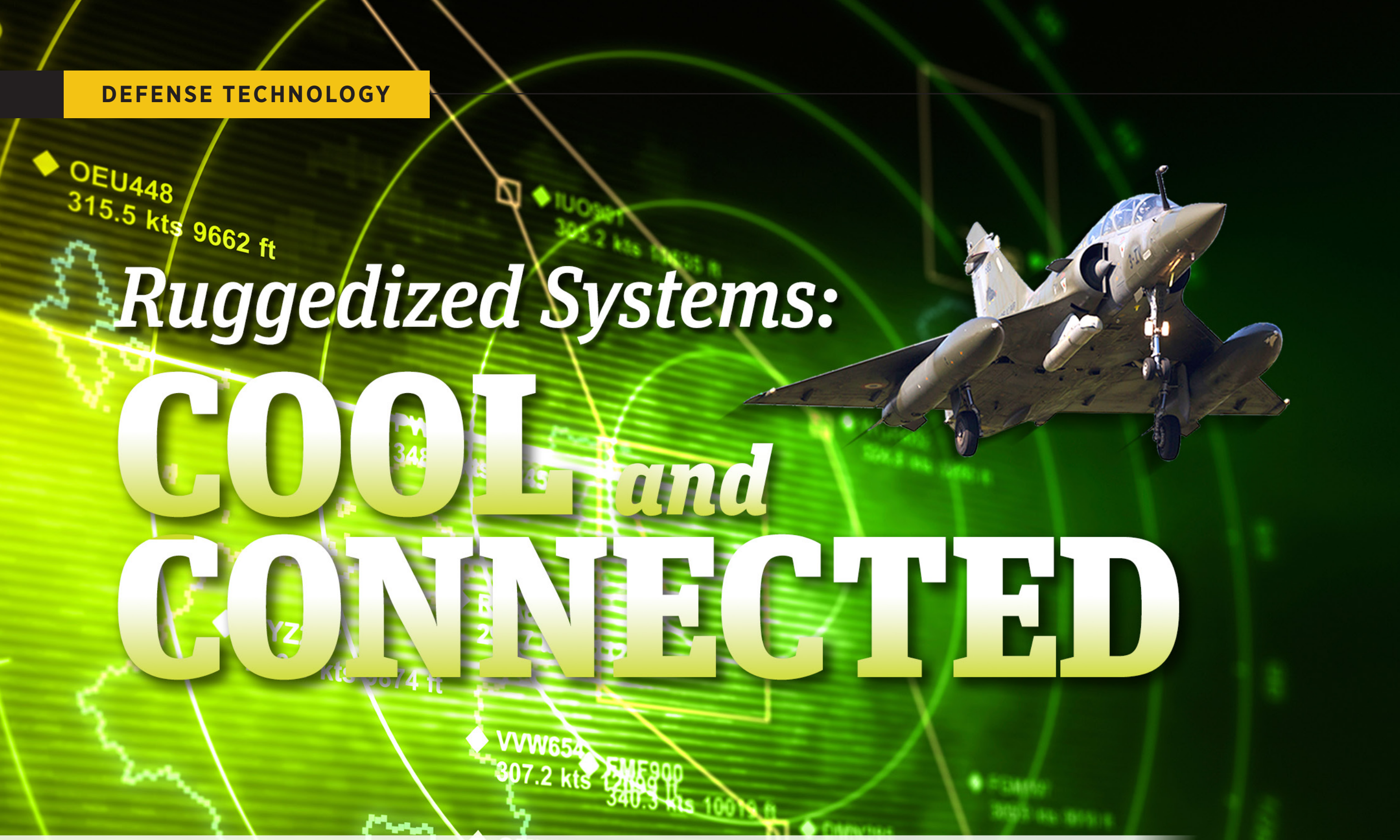

Ruggedized Systems: COOL and CONNECTED

To meet demanding military specifications for mobile and interconnected surveillance, communication and operational devices, Kontron uses sophisticated thermal simulation to balance size, weight, power and cooling (SWAP-C) trade-offs for "ruggedized" modular chassis that support customized solutions for mission-critical operations.

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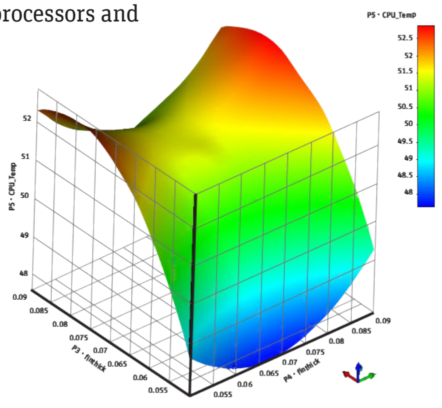
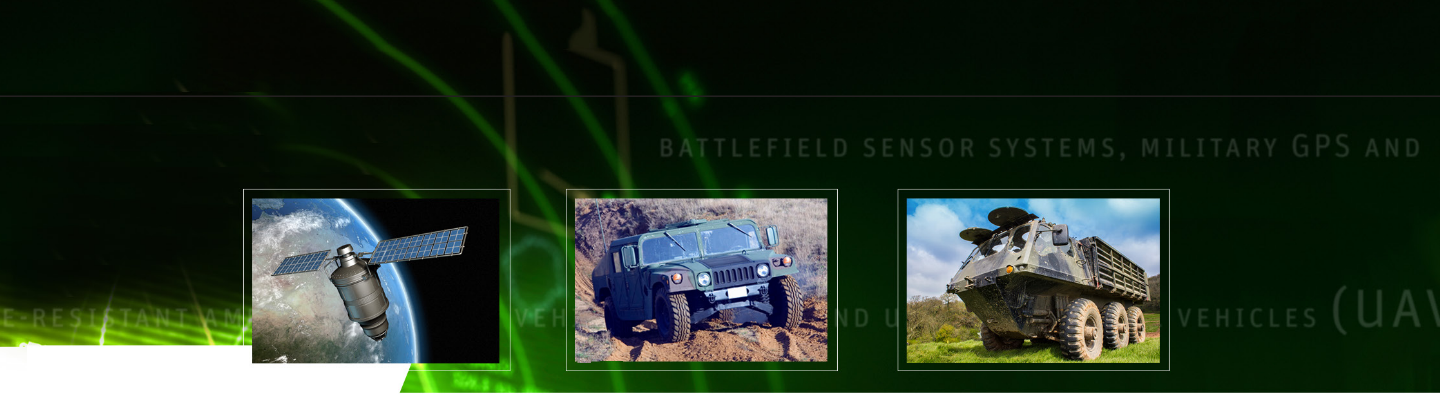
Today's military vehicles depend on state-of-the-art visualization, imaging and networking technologies to improve situational awareness and enable military leaders to make the best possible decisions. Vehicles such as Humvees, armored mine-resistant ambush protected vehicles (MRAPs) and unmanned aerial vehicles (UAVs) increasingly rely on advanced electronics, such as processors and circuitry, in compact systems to support their missions.

To satisfy the military's demand for these electronic systems that can be adapted to a range of uses, defense contractors must meet a host of requirements and specifications. The devices placed on vehicles, such as battlefield sensor systems, military GPS and next-generation communications equipment, must be able to communicate and interact in extreme physical environments where they might be exposed to severe electromagnetic conditions. Military standards require that these devices withstand specified extremes of temperature, vibration, shock, salt spray, sand and chemical exposure. Size, weight, power and cooling (SWAP-C) requirements demand that the electronic systems that power these devices be small enough that they do not hinder mobility.



Parametric optimization of enclosure cooling fins

The approach that has proven most effective is to contain the electronic system functionality in a chassis that has been precertified for "ruggedized" operation. Using this chassis, designers can ensure that the system is maintained in a sealed and temperature-controlled environment. To design these ruggedized systems, Kontron, a global leader in embedded computer technology and an IoT leader, uses sophisticated computational



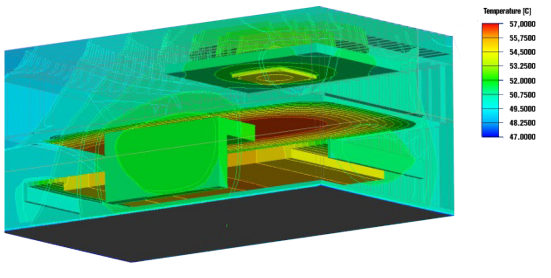
“*Defense contractors* must meet a host of requirements and specifications to satisfy the military’s demand for *flexible electronic* systems.”

fluid dynamics (CFD) analysis to accurately manage thermal reliability for components and ultimately the complete integrated system. The chassis they provide enables original equipment manufacturers to build customized solutions for mission-critical applications.

Ruggedized Systems

Kontron’s COBALT line of computing platforms uses a modular approach to deliver a rugged, sealed computing system with a specialized carrier board and configurable front panel that can be integrated into the electronics bay of a Humvee, MRAP-type vehicle or UAV. The box-level system provides processing power to enable third-party developers to maintain flexibility, compatibility and interoperability for many types of rugged applications. Using standard interfaces reduces long-term costs and makes it easy to upgrade, replace and reuse capabilities across systems. Hundreds of these systems can be fitted onto a single aircraft or ground vehicle.

To develop a truly flexible system, Kontron must take many variables into account and identify trade-offs. Surveillance applications, for example, require high I/O and fast processing speeds. They also require low signal bandwidth for communications efficiency, and reliable wireless communication to send information back to data centers. For these applications, customers want a chassis that can ensure that powerful processors or other components do not impair the radio signal. Power consumption and thermal management are also important; the heat from a processor can impede the performance of other components, and thermal cycling stresses as the processor heats and cools, especially in conditions such as extreme desert heat or the cold of high altitudes, can cause fatigue in components and the chassis. As systems become more complex and are required to incorporate more capabilities, managing SWAP-C requirements is even more critical, and design priorities depend upon the size of the vehicle, the nature of the applications, and the missions for which the vehicles are employed.



System-level thermal trade-off analysis, used to build the Excel product thermal configurator

CFD Analysis for Thermal Management and Reliability

To develop these chassis, designers of the COBALT product line have adopted a “five-gate” process of sign-off procedures, from loose specification (Gate 1) through various iterations, to a finished product (Gate 5). Typically, they introduce Ansys analysis at Gate 1 to anticipate problems and trade-offs early in the design phase, leading to more complex products in a shorter design frame. The team uses Ansys DesignModeler to import geometries, Ansys Icepak to determine temperatures, Ansys DesignXplorer for design exploration, and Ansys HPC for faster results. Ansys Workbench provides the common environment to integrate the simulation process.

The Kontron design team uses CFD analysis to evaluate and optimize chassis thermal performance. Some key activities are:

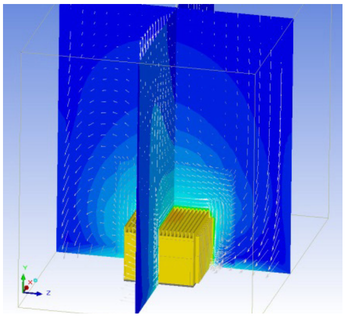
- Designing the enclosure to draw as much heat as possible from the circuit board and processor. The team uses Ansys Icepak to streamline CFD analysis to design finned surfaces and heat sinks, and arrive at an optimal design.
- Determining placement of electronic components and subsystems within the chassis and balancing

Conceptual CAD rendering of the Kontron COBALT (computer brick alternative)

the trade-offs necessary to meet SWAP-C requirements. For example, engineers analyze the power dissipated by an expansion board and its effect on the temperature of a nearby processor.

- Reviewing internal thermal conduction paths from high-power components to ensure that there are efficient paths to the enclosure walls.
- Exploring external environmental factors in situations where the full system will be deployed. If the system chassis is deployed in a UAV, for example, the cooler temperatures and thinner air in high altitudes will affect thermal management. Another factor might be the location of the chassis in the vehicle. If additional chassis are located nearby, heat and radiation exchange need to be considered.

Besides the early focus on optimal design for SWAP-C considerations, Kontron designers are also concerned about longevity. When the chassis is added to a ground vehicle or plane, it's expected to last three to five years, plus another two years with maintenance. The mean time between failures (MTBF) is very important to their customers.



Initial natural convection cooling assessment

Evaluating Design Trade-Offs

Recently, the design team introduced a new gate, Gate Zero, wherein they talk to customers and work with product managers to get new ideas for their products. This enables the team to create "what-if" scenarios even before they write the specifications. To test the Gate Zero concept, Kontron engineers modeled a sample heatsink using rough designs in Icepak and tested various configurations to determine what trade-offs would be required.

In the past, they would analyze thermal problems by running an initial analysis, trying some manual design variations, and after seven or eight design iterations that included physical mockups, perform a final analysis and publish their results. Using DesignXplorer to drive Icepak, the team was able to exceed those limitations, identifying 240 potential design variations to test. The software then used mathematical models to narrow down the list to just 70 essential variations for further study. By running 70 intelligent design iterations over a weekend, engineers were able to evaluate 10x more design variables than was possible with the old methodology in the same amount of time. The designers were presented with three optimal design candidates to choose from.

From the large design space that was explored using simulation and driven by DesignXplorer, the Kontron team developed a chassis configuration tool with an Excel® interface that their sales team can use in customer meetings to rapidly design a chassis customized to client requirements.

Starting with a baseline configuration with the desired maximum ambient temperature, application engineers add design variables, such as CPU max power or electronic expansion trays; operating parameters, such as the orientation and position of the device; and the altitude where it will be used. The spreadsheet shows the power consumption of each component in the box and how their interaction affects the temperature within the box. They can also plot out remediation options, such as extending the size of the heat sinks, to calculate their effect on the temperature. The spreadsheet can also be used to factor in the cost of changes, for example, the cost of adding a heatsink based on the number of fins and their thickness. Using the inputs and relationships they have learned using Ansys software enables them to better inform their customers so that they can find the best configuration together.

With the ability to increase virtual tests by a full order of magnitude in less time, Kontron can avoid potential problems, adapt to their customers' needs, and provide rugged, reliable systems for the connected army of the present and the future.

Ansys Icepak
Ansys.com/icepak