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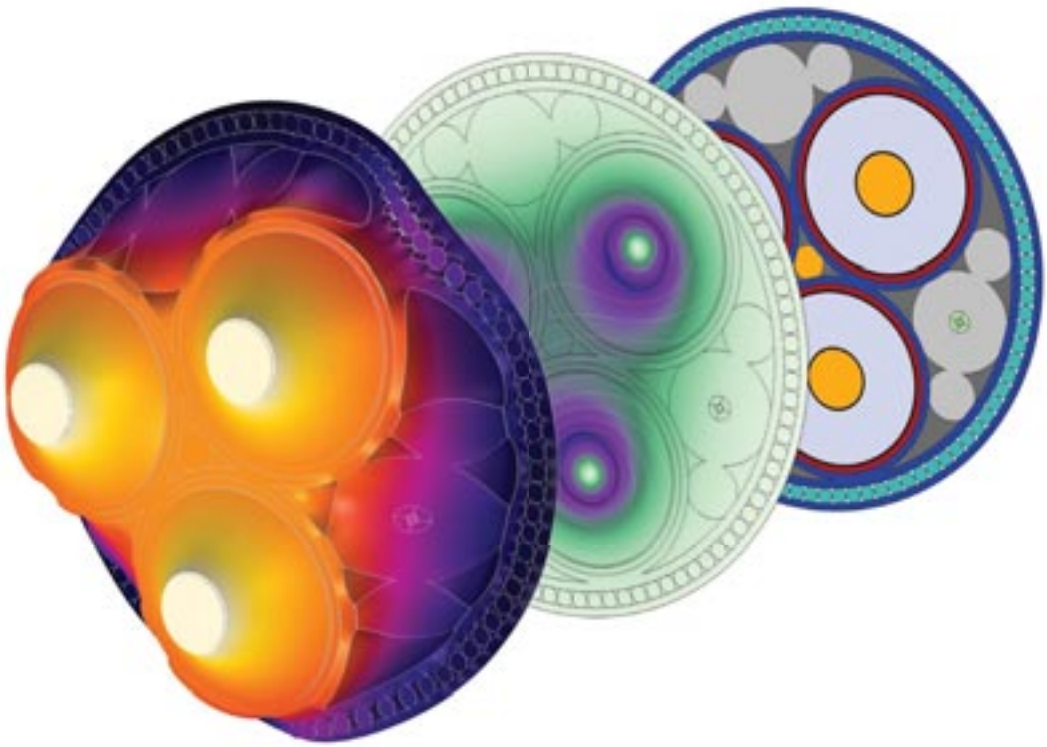

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ON THE COVER

The 70-meter antenna at the Goldstone Deep Space Communications Complex in the Mojave Desert is one of the tools used to communicate with – and retrieve data from – spacecraft in deep space. Goldstone is one of three transmission and reception facilities located about 120 degrees apart on the globe in order to provide continuous coverage. To learn more, read the feature article on page 34.

(Photo courtesy of NASA/JPL-Caltech)

Laser Detecting Systems

Enhancing Survivability and Lethality on the Battlefield

Whether engaged in an asymmetric fight with an insurgent or a conventional battle with a "near-peer" adversary, today's battlefield presents combatants with significant challenges. Rapidly advancing technology and increased lethality of weapon systems have forced the military to develop and deliver more effective technologies to protect our air and vehicle crews. One such critical technology – laser detecting systems – is designed to detect and alert crews to laser-aided threats.

Laser-Aided Threats

The number and types of laser-aided threats that are present on today's battlefield have increased exponentially over the past decade. These systems use a laser to increase a weapon's probability of a hit and kill of its adversary. These types of lasers typically fall within three categories: Laser Range Finders (LRF), Laser Target Designators (LTD) and Beamrider Missiles (LBR). Examples of each of these types of laser-aided weapons systems are depicted in Figure 1. Each of these examples poses significant risks to unknowing air and vehicle crews on today's battlefield.

Laser Range Finders and Laser Designators

Laser range finders are the most prevalent laser-aided systems found today. They are relatively cheap to produce and export. They are typically used as a single pulse designed to send and receive the reflection of laser energy in order to calculate distance to a target. These systems can range from an embedded laser in a sophisticated fire control system to a low-power model as part of ranging binoculars. These systems have become so cheap and easy to produce that some have even made their way into commer-

Figure 1. Examples of laser-aided weapon systems (Clockwise from top left – T-14 Armata Main Battle Tank with laser rangefinder and beamrider missile; Laser range finding binoculars; AT-14 Kornet ATGM – Beamrider; Krasnopol laser designated tube launch artillery)

Figure 2. AT-14 Kornet ATGM

Figure 3. ISIS fighters engaging an Iraqi M1A1 MBT with an AT-14 Kornet ATGM (Source: Youtube 24 October 2016: Video is claimed to be near Mosul, Iraq)

cial applications such as handheld devices that allow a golfer to determine which club to use to reach the green.

Like range finders, laser designators have also become increasingly prevalent as part of the world's armed forces standard inventory. Laser designators are primarily used to mark a target for a projectile and then use the laser to help the projectile hone in on its intended target. Designators have multiple pulses and can be encoded to achieve better accuracy with their corresponding weapons. Typically, the system is not employed until the projectile is closer to terminal impact. This minimizes the time for a targeted crew to identify it is being "painted" until the projectile strikes its intended target.

Typically, laser range finders and designators fall within two wavelengths: 1.06 µm (non-eye-safe) and 1.54 µm (eye-safe). Over 90 percent of these use solid state ionic rods for their material (Nd: YAG, Nd: glass, Er: YAG) and have peak powers in excess of 1MW.

Laser Beamriders

The most lethal of all laser-aided threats, the beamrider missile is a family of weapons designed to use a laser to steer a projectile onto an enemy platform. The major difference between this type of system and those that employ either a range finder or designator is that the laser energy is concentrated not on the intended platform, but rather on the tail end of the inbound missile. This low signal strength makes this type of system much harder to detect initially. Over time, as the missile gets closer to its intended target, signal strength increases. Early detection is essential to maximizing warning and reaction time for the targeted crew.

These systems typically come in both continuous wave (CW) and pulse wave (PW) configurations. Depending on the application, the missile itself may be able to fly at subsonic or supersonic speeds, significantly impacting the need for early warning times.

An example of this type of system is the Russian-built AT-14 Kornet Anti-Tank Guided Missile (ATGM). First introduced in 1998, the Kornet is a 152mm caliber munition with the capability to penetrate over 1000mm of rolled homogeneous armor (RHA). It has a maximum effective range of 5.5 km and has been sold to over 25 countries, making it one of the most lethal and proliferated ATGMs in the world. Figure 2 depicts the Kornet ATGM launcher and missile.

Figure 4. AN/AVR-2B(V) Laser Detecting Set on a UH-60M Blackhawk

The Kornet most recently has been employed by the Islamic State of Iraq and Syria (ISIS) against the Iraqi army. A recent video posted to YouTube shows just how powerful the weapon system can be to an unsuspecting tank crew (Figure 3).

Laser Warning Systems

UTC Aerospace Systems has been designing and manufacturing laser warning systems for over 40 years. They have delivered over 4,000 airborne and 2,000 ground systems to both U.S. and non-U.S. government customers, and their systems are deployed on a number of rotorcraft and ground combat vehicle platforms.

An effective laser warning system must exhibit the following key performance criteria in order to meet customer demands:

1. High Probability of Detection (PoD) – This is simply reporting all laser events that occurred. Typically this means a PoD in the high 90 percent range.
2. Low False Alarms – This is defined as reporting something that did not happen. If a system exhibits a high degree of false alarms, the user will not trust the system and will shut it off.
3. Detect all weapons with enough warning time – This will allow the crew to take evasive action, return fire or employ countermeasures.
4. Perform all of the above in all different conditions – As an electro-optical device, the system must have a high dynamic range to perform in bright daylight and dark night conditions, and under all types of engagement scenarios.

Balancing all of these system level requirements together to maximize system performance is critical in providing crews with the maximum survivability possible.

An example of a currently deployed laser warning system is the UTC Aerospace Systems AN/AVR-2B(V) Laser Detecting Set. First introduced in 1997, the 2B is the U.S. Army laser detecting system for the Blackhawk and other rotorcraft and is an integral part of the aircraft survivability suite. The 2B has demonstrated consistently excellent performance in the detection and declaration of laser-aided threats. The system typically consists of four sensor units (depicted in Figure 4) that are oriented around the platform (fore and aft) providing 360° coverage and a controller referred to as a signal comparator module (SCM) located inside the aircraft.

An additional configuration for larger platforms consists of two additional sensor units mounted mid-airframe in order to provide necessary coverage. The system is powered through the platform and integrated as part of the vehicle bus. This interface provides vehicle

Figure 5. AN/VVR-4 Laser Detecting Set for Ground Combat Vehicles

data that enhances system performance, such as reported angle of arrival (AoA) of threat lasers.

UTC Aerospace Systems is introducing a new laser warning system designed to be a common system across the U.S. Army ground combat fleet. The AN/VVR-4 Laser Detecting Set incorporates the lineage of its predecessors with increased functionality (Figure 5).

The system incorporates an additional angle of arrival (AoA) detector which gives the targeted crew enhanced situational awareness.

The AN/VVR-4 can be integrated either as a stand-alone threat warning receiver delivering audio and visual warning through the vehicle's intercom system (AN/VIC-3) and onboard situational awareness displays, or fully integrated within the vehicle's fire control system. The latter option enhances the crew's lethality and survivability in that the system can pass along critical threat information to the fire control system, allowing slew-to-cue of onboard weapon systems to the origin of the laser with high accuracy.

The laser warning system can also serve as a critical sensor within an overall active protection system (APS) construct. The early identification of a laser range finder or beamrider missile can alert the tracking mechanisms of a "hard kill" system of a potential inbound threat, thus reducing overall system response time. The laser warning system can also provide critical laser information of an active designator that can also be used as part of a "soft-kill" countermeasure system designed to spoof an incoming projectile or trigger onboard smoke.

In addition, UTAS is working as part of the U.S. Army Modular Active Protection System (MAPS) community of interest to establish a standard architecture by which this type of sensor can be incorporated into an overall active protection system framework. This open systems architecture will more readily allow systems like the VVR-4 to make software changes as the threat and conditions on the battlefield evolve.

Critical Enabler

As threats evolve on today's and tomorrow's battlefield, laser warning systems continue to be a critical enabler to survivability of our air and ground crews. Integrated with current and future survivability systems, a laser warning system provides valuable warning time and threat information, thus increasing the crew's survivability and lethality toward hostile threats.

This article was written by Brian Gephart, Senior Program Manager, ISR & Space Systems, UTC Aerospace Systems (Charlotte, NC). For more information, visit ***http://info.hotims.com/69505-500.***

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Designing With Plastics for Military Equipment

U.S. soldiers carry loads of equipment and protective gear that can weigh anywhere from 45 to 130 pounds. This is more than enough to quickly tire even the most well-conditioned personnel, contributing to reduced mobility and impaired decision-making that could result in casualties.

Meanwhile, in the skies there has been a proliferation of unmanned aircraft and remotely controlled jet fliers. These aircraft need to travel long distances with limited fuel on board and need materials that make them "invisible" to enemy radar.

To meet the challenges of evolving – often dangerous – circumstances, and to leverage advancing technologies that provide equipment to help the military operate safer, manufacturers need to deliver products that are lighter, stronger and highly functional while simultaneously reducing the total cost of ownership (TCO) associated with their products, including design, production, delivery and maintenance.

Injection-molded plastic parts made from advanced materials are increasingly replacing metal in a variety of military applications, providing a practical solution that accommodates the needs of manufacturers, contractors and users.

Metals vs. Plastics

Metals going back to the Iron Age have been the materials of choice for equipping the military. Metals offer lower thermal expansion and high strength to survive the rugged conditions of combat.

Many metals also offer high electrical conductivity, making them ideal for shielding electronic equipment; others offer high thermal conductivity, so they are well-suited to applications requiring the rapid dissipation of heat, such as engine cooling. Finally, metal parts can be produced to very tight tolerances, though the secondary machining operations required in achieving that precision could be costly.

Today, plastics are replacing metals in military applications due to a growing number of advantages, including the following:

Lower Weight

Plastics are much lighter than metals, making them a better choice for a wide variety of uses, from armor and clothing to equipment, protective gear and vehicles. Not only does plastic significantly reduce equipment carry weights – by as much as 20 pounds in some military situations – it increases vertical and horizontal user agility and safety in accord with the U.S. Department of Defense Joint War Fighting Science and Technology Plan.

Freedom of Design and Assembly

Plastics are subject to fewer assembly constraints, enabling manufacturers to consolidate multiple parts into a single, injection-molded plastic part. The ability to design plastic parts with complex geometries also means multiple parts can be assembled using the method best suited to a particular application – such as welding, heat staking or mechanical snap-fit.

Superior Durability

Today's sophisticated plastics are extremely durable and outperform comparable metals in resistance to heat, chemicals, moisture and impact. (See "Choosing the Best Plastic" and "Additives for Options" sections, below, for discussion about the characteristics of the major plastics families and how complementary materials can be added to further improve strength and durability.)

Ease of Finish

The color of equipment used in the field or in the air can be an important element of its utility – from a matte finish that decreases glare to a camouflage pattern that enables stealth. With plastics, manufacturers and molders can create virtually any color or finish during the production process and eliminate the need for expensive secondary painting or coating operations otherwise required by metal parts. Moreover, the finish color on plastics will not wear off from rugged wear.

Total Cost of Ownership

Taken together, the lower weight, design, assembly, durability and finishing advantages of injection-molded plastic parts result in dramatically lower total costs. Compared with metal, plastic parts do not require expensive secondary operations, such as machining or painting. In addition, because plastic parts can be designed in much more complex shapes, the manufacturer can reduce the total number of parts produced by as much as 70%.

An automated workcell where post-molding operations are performed on a heavy vehicle pneumatic valve body.

Designers are taking body armor beyond Kevlar through the use of additives that include plastic and non-plastic materials.

Similarly, the weight savings created by transitioning to plastic reduces overall fuel and transportation costs. In the case of the military, this is essential since it is the world's single largest consumer of oil at more than 340,000 barrels per day, and the U.S. Department of Defense is requiring its contractors to help improve fuel efficiency.

As explained in a recent blog from Sandvik Coromant, a Sweden-based global tool supplier to the metal cutting industry:

> *In the modern age, the aerospace industry is also looking ahead to tougher, lighter, and more heat-resistant materials that would lessen emissions, cut fuel costs, and enable higher speeds. So far, in the aviation industry, composites have been the go-to material.*
>
> *Per Dr. Eleanor Merson, the company's composite research specialist, "Thirty years ago, five to six percent of an aircraft was made up of composites; now, a plane is made up of about 50% composite material."*

Enhanced Stealth

Remaining undetected gives fighting forces an upper hand, but traditional metal components leave large electromagnetic radar/sonar echo signatures and infrared heat source footprints. A variety of non-conducting and insulating resins have been introduced to increase the stealth capabilities for military applications, including:

- Domes constructed from polymer matrix composites that shield detection equipment and deaden position-revealing vibration on military ships and aircraft.
- Military helicopters outfitted with polymer foam blades and Kevlar-carbon fiber structural materials to enhance multi-spectral stealth capabilities (radar, infrared and acoustic).

Material Name	Material Type	Abbreviation	Trade Names	Description	Applications
Acetal	Crystalline	POM	Celcon, Delrin, Hostaform, Lucel	Strong, rigid, excellent resistance to fatigue, chemicals, moisture, naturally opaque, low/ medium cost	Bearings, cams, gears, handles, plumbing components, rollers, rotors, slide guides, valves
Polyamide 6 (Nylon)	Crystalline	PA6	Akulon, Ultramid, Grilon	High strength, fatigue and chemical resistance, low friction, almost opaque, medium/high cost	Bearings, bushings, gears, rollers, wheels
Polycarbonate	Amorphous	PC	Calibre, Lexan, Makrolon	Very tough, temperature resistance, dimensional stability, transparent, high cost	Panels, lenses, consoles, housings; light covers; reflectors; safety helmets and shields
Polyester	Crystalline	PBT, PET	Celanex, Crastin, Lupox, Rynite, Valox	Rigid, heat resistance, chemical resistance, medium/high cost	Filters, pumps, bearings, cams, electrical components, gears, housings, switches, valves
Polyetherether-ketone	Crystalline	PEEK	Victrex	Strong, thermal stability, chemical and abrasion resistance, low moisture absorption	Aircraft components, electrical connectors, pump impellers, seals
Polyphenylene Sulphide	Crystalline	PPS	Ryton, Fortron	Very high strength, heat resistance, very high cost	Bearings, covers, fuel system components, guides, switches, and shields
Polypropylene	Crystalline	PP	Novolen, Appryl, Escorene	Lightweight, heat resistance, high chemical resistance, scratch resistance, tough and stiff, low cost	Military grade containers, heavy-duty rope and ties
Polyvinyl Chloride	Amorphous	PVC	Welvic, Varlan	Tough, flexible, flame resistance, transparent or opaque, low cost	Electrical insulation, boot soles
Thermoplastic Elastomer	Cross-linked	TPE	Santoprene, Hytrel, Kraton	Good thermal properties, material stability, colorable, soft-touch, medium cost	Overmolding of hand held devices, night vision equipment, protective masks. boot soles, soft touch grips

This chart contains an overview of popular plastics for military applications.

- Flexible, polymer matrix-based coatings used on a number of military vehicles to thwart "normal" and "thermal" visual detection.

Keys to Conversion

There are several considerations that impact successful metal-to-plastic conversion:

Application Requirements

The part design process starts with identifying application requirements in three dimensions: mechanical, thermal and environmental. Will the part or product be dropped? Will it be used in an extremely hot or cold environment? Will it be exposed to harsh chemicals? How long does it have to last? The answers to these and other related questions provide a focal point for the next steps in part development and meeting functional and cost requirements.

Choosing the Best Plastic

Choosing the best plastic for your application requires deep knowledge of the wide range of possible materials. In addition to relying upon an experienced injection-molding partner to guide selection, possessing a basic understanding of the types of plastics is essential. Here's an overview:

- Plastics are made up of polymers, meaning long chains of repeated molecule units. The ways in which the chains intertwine determine the plastic's macroscopic properties.
- Typically the polymer chain orientations are random, giving the plastic an amorphous, structure. Amorphous plastics have good impact strength and toughness. Examples include acrylonitrile-butadiene-styrene (ABS), styrene-acrylonitrile copolymer (SAN), polyvinyl chloride (PVC), polycarbonate (PC) and polystyrene (PS).
- If the polymer chains arrange themselves in an orderly, densely packed way, the plastic is said to be crystalline. Crystalline plastics share many properties with crystals, and generally will have lower elongation and flexibility

Military applications can use a variety of polymers, including pro-colored thermoplastics.

properties than amorphous plastics, but better chemical resistance. Examples of crystalline plastics include acetal (POM), polyamide (PA; nylon), polyethylene (PE), polypropylene (PP), polyester (PET, PBT) and polyphenylene sulfide (PPS).

Additives for Options

Chemists can change plastics' characteristics for military application by mixing in different types of polymers or by adding non-plastic materials. For example, particulate fillers increase the formula's modulus and electrical conductivity, improve resistance to heat or ultraviolet light, and reduce cost. Plasticizers go into the mix to decrease modulus and increase flexibility. Other additives can increase resistance to ultraviolet light and heat or prevent oxidation.

Glass fibers, carbon, stainless steel, and various coated fibers or Kevlar all have high reinforcing properties of tensile strength, increased tensile and flexural modulus, good toughness, and stress/strain behavior similar to that of metals. They can improve mechanical properties provided specific part and tool design is used to position the fibers in areas where the application requires added strength.

Designers are taking plastics beyond Kevlar. A colloid blend of silica nanoparticles and polyethylene glycol (PEG) is being tested as a type of "passive and intelligent" body armor, mean-

ing it is semi-viscous when equipment is not in active use, but hardens immediately upon impact.

A short list of popular additives and their properties includes:

- Glass fibers improve stiffness and increase heat resistance.
- Stainless steel fillers improve conductivity and shielding.
- Lubricant fillers reduce wear and friction.
- Mineral fillers improve electrical performance and sound dampening, reduce cost, and improve dimensional stability.
- Impact modifiers improve toughness.
- Flame retardants increase resistance to burning.

Part Design and Analysis

Part design and analysis is a critical aspect of any metal to plastic conversion. Experienced complex injection molders can identify any potential issues early, modify the design to resolve them, then reevaluate and validate through a process of continuous improvement and tight quality control.

The tools available for part analysis include mold-filling simulation, cooling simulation, predictive shrinkage and warping, and finite element analysis. All provide assurance that the part will perform as intended for lower failure risk, and to safeguard large investments in equipment and tooling.

Plastics Respond to Changing Conditions

The "battlefield" has changed significantly since the beginning of this century, and to meet the new demands our military must possess greater levels of flexibility and agility to respond to new challenges. The availability of myriad plastics and trusted relationships with experienced complex injection molders enable designers for military equipment and aircraft to think more about solutions and less about limitations, with the promise of even more developments in plastics in the future.

This article was written by Al Timm, Business Development Engineer, Kaysun Corporation (Manitowoc, WI). For more information, visit ***http://info.hotims.com/69505-501****.*

Engine Air-Brakes

Paving the Way to Quieter Aircraft

Airplanes, one of humanity's greatest inventions, evoke feelings of awe and amazement for most people, unless you live uncomfortably close to a major airport, in which case the feeling may become annoyance and irritation. Constant aircraft noise causes sleepless nights, stress and other health issues, reducing quality of life.

Airports, airlines and aviation authorities around the world have been in an uphill battle to mitigate noise pollution in their neighboring communities. Neither the airports nor the surrounding communities are moving away from each other anytime soon, necessitating the need for urgent solutions. The Advisory Council for Aeronautics Research in Europe (ACARE) Flightpath 2050 document – Europe's vision for aviation, has set a goal of 65 percent noise reduction at airports by 2050. While mitigation strategies include flying restrictions, soundproofing homes and nighttime curfews, the real solution to meeting such goals lies at the root cause of the problem – reducing the noise airplanes generate and radiate to the surrounding community.

The major source of airport noise comes from engine power during takeoff. During descent and approach to landing, the engines are powered down and the dominant noise is often due to the aerodynamic exposure of structures such as control surfaces, landing gear, high-lift devices and speedbrakes. These structures often provide drag needed to maintain a desired trajectory, but may also become the source of excessive noise. One way to mitigate this noise is through "quiet" drag devices that enable quieter landings through steeper, slower and/or aeroacoustically cleaner approaches.

ATA Engineering, in collaboration with NASA GRC, Williams International and the Massachusetts Institute of Technology (MIT) has developed a novel engine air-brake (EAB) concept that will pave the way for quieter aircraft. The EAB is a unique drag device that was conceived at MIT as a ram air-driven nacelle with a stationary set of turning

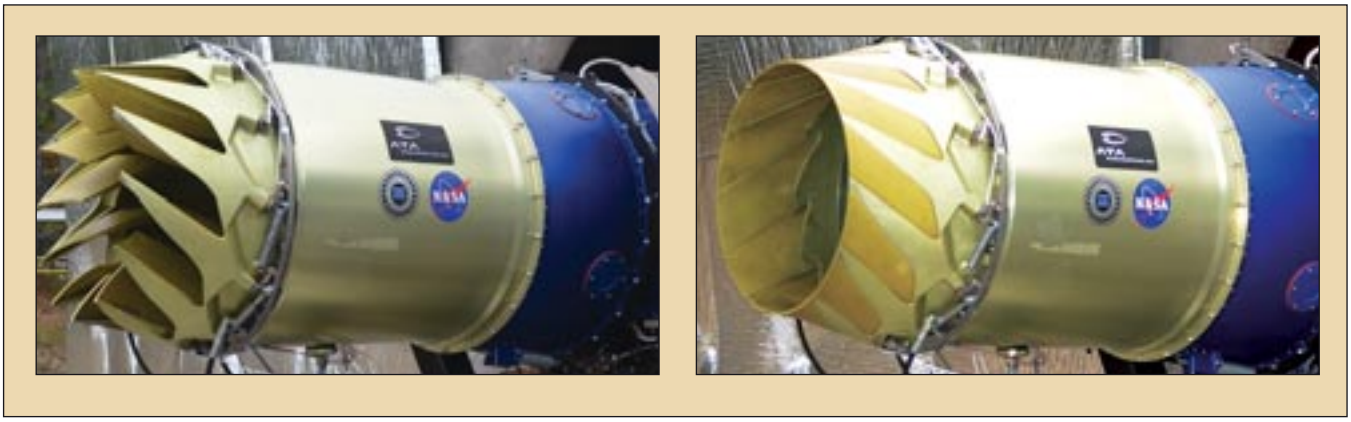

Figure 1. The EAB nozzle configurations on FJ44-4 engine: Fully deployed (left) and stowed (right).

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vanes generating a swirling exhaust flow from the engine. With funding from the NASA Small Business Innovation Research (SBIR) program, ATA Engineering has developed and brought this technology to life in the form of a deployable swirl vane exhaust nozzle. STAR-CCM+® and NX™, tools in the Simcenter™ Portfolio from Siemens PLM Software, played a key role in the design of the EAB, accelerating the readiness of the technology by creating and validating a digital twin before building the prototype.

Using NASA's Technology Readiness Level (TRL), a measurement system to assess the maturity level of a particular technology, ATA has now advanced the EAB concept to TRL level 6 – a fully functional prototype. TRL numbers run from 1-9 with level 1 pertaining to basic principles and conception of the idea and level 9 indicating a flight-proven system through successful mission operations.

What is an Engine Air-Brake (EAB)?

ATA's EAB concept was proposed by Shah et al. [1]–[3] as an evolution of the MIT concept. The EAB is a deployable device for drag management in aircraft. Pressure drag is generated through swirling outflow from the engine's propulsion system by reducing thrust. The EAB is stowed during flight but deploys a swirl vane mechanism (Figure 1) during landing, creating a swirling vortex from the jet engine exhaust flow. The constant flow of swirling air creates additional drag by reducing thrust and is sustained by the radial pressure gradient from the swirl vanes. The system enables a slower, steeper and acoustically cleaner approach/descent when engine thrust cannot be further reduced.

The EAB ground demonstrator consisted of a spool piece, an aluminum nozzle, 12 high-temperature aluminum vanes, 12 stainless steel shafts, 12 dogleg lever arms and adjustable linkages, three hydraulic rams, three extension springs, a stainless steel actuation ring and a string potentiometer (Figure 2). ATA Engineering partnered with Williams International to demonstrate the EAB on a FJ44-4 engine, a 3,600-pound class, medium bypass, twin spool engine.

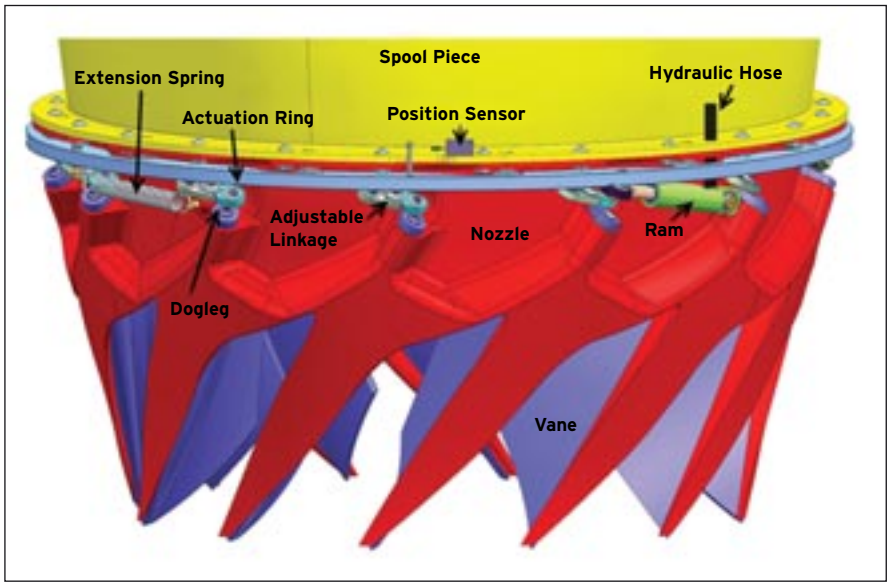

Figure 2. Key components of the EAB assembly modeled in NX.

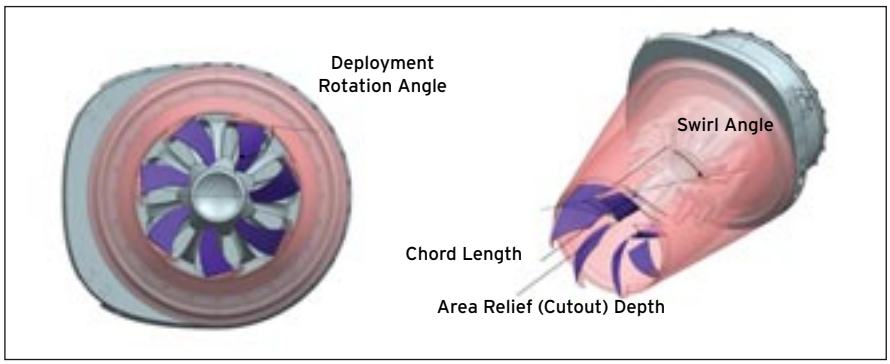

Figure 3. Design parameters studied with STAR-CCM+.

Challenging Design Requirements

As with any design, changes somewhere always result in undesired effects elsewhere and this is more pronounced in the aerospace design space. As part of the TRL program, design requirements and technical objectives for the EAB were identified first. The technical objectives were:

- Design, fabricate and test a realistic flight-weight EAB on a modern turbofan propulsion system;
- Quantify the equivalent drag, effect on operability, noise, cost and weight of the system;
- Perform system-level analysis of the proposed impact in terms of steep approach for noise reduction.

For the aerodynamic design of the EAB, the following requirements were identified:

- No measurable thrust or thrust-specific fuel consumption (TSFC) penalty when stowed;
- A 15-percent net thrust reduction at "dirty approach" fan speed when deployed, measured as a percentage of the stowed nozzle's gross thrust at same condition;
- No measurable fuel consumption penalty or flow reduction when fully deployed;
- Adequate surge margin during all operation, including dynamic deployment and stowing;
- Meet stow/deploy time requirements (0.5 seconds and 3 to 5 seconds, respectively).

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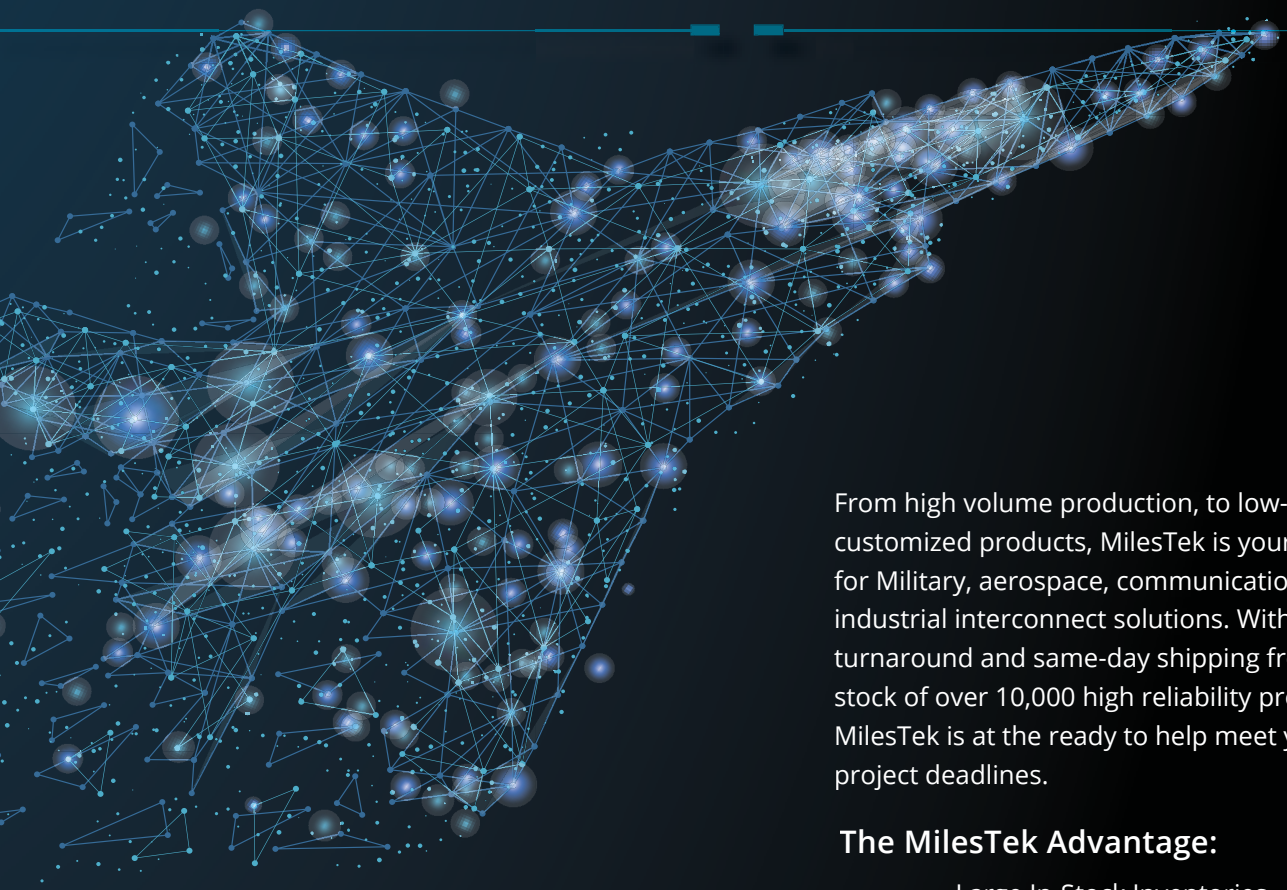

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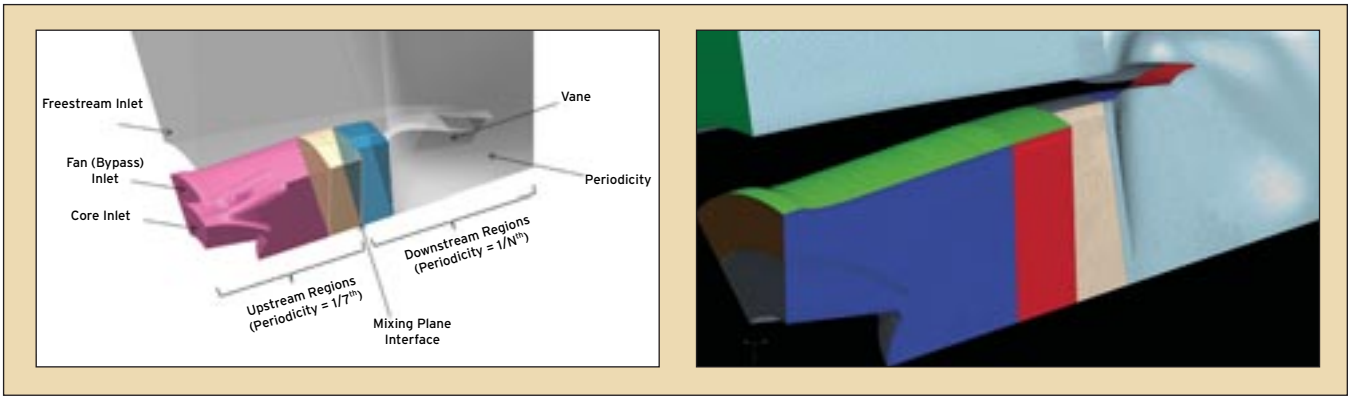

Figure 4. The numerical domain in STAR-CCM+ and the computational mesh

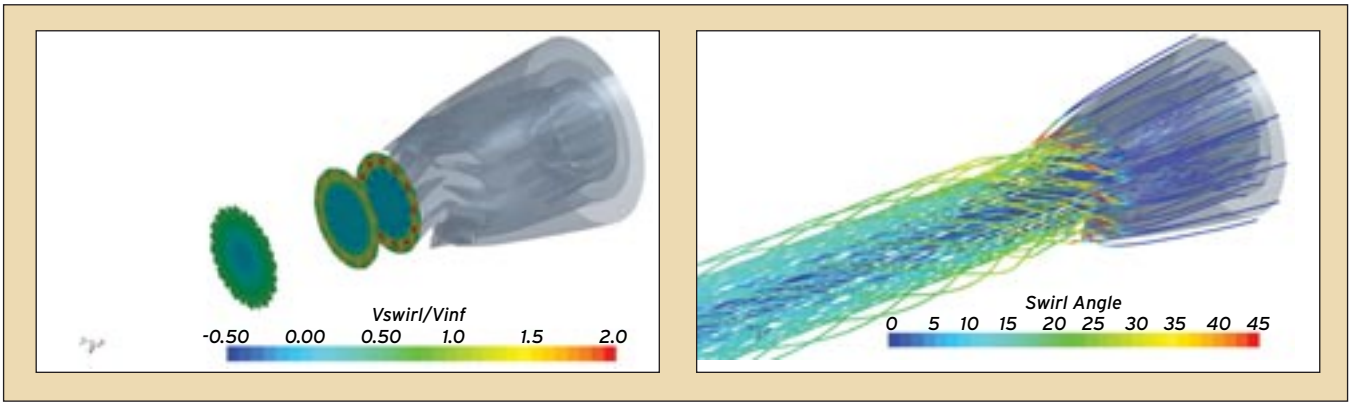

Figure 5. Mixing-plane results for final design in deployed configuration showing (a) Circumferential-to-freestream velocity ratio at downstream exhaust planes and (b) streamlines colored by swirl angle.

Other design requirements included structural and packaging constraints that ensured that the EAB could be integrated into a typical aircraft installation, such as the Cessna CJ4, without performance penalties while providing the noise reduction benefits. The design activity involved performance assessment of various systems, including aerodynamic, mechanical, acoustics, and structures.

Aerodynamic Design With STAR-CCM+

Parametric solid modeling with NX for Design from Siemens PLM Software was used to create the 3D CAD geometry of the EAB. This allowed rapid generation of designs with varying parameters based on aerodynamic performance. The various design parameters (Figure 3) for the numerical simulation were: vane count (N), swirl angle (S), deployment rotation angle (R), chord length (L) and cutout (area relief) depth (C).

Vane count	*12*
Vane swirl angle	*34°*
Vane full deployment rotation angle	*100°*
Leading edge sweep angle	*35°*
Vane chord length at root (OD)	*213 mm (8.39 in.)*
Vane chord length at tip (ID)	*248 mm (9.76 in.)*
Vane area relief cutout depth (percent of local chord)	*70%*

Figure 6. Final design identified from 150 designs using STAR-CCM+.

One of the foundations for the maturation of the EAB technology is the analysis-driven design effort using STAR-CCM+ to quantify flow performance and operability and to predict the thermal operating environments of the design. With the power of computational fluid dynamics (CFD), design optimization and powerful computing hardware, ATA was able to analyze the full aerodynamic design space before identifying the final design that met all the aerodynamic requirements in simulation. The aerodynamic domain is shown in Figure 4.

The domain was discretized with polyhedral cells. Prism layers were used to capture the boundary layer flow. The final designs had a mesh count of 3 to 5 million cells. Total pressure and temperature were specified as boundary conditions at the fan, core and freestream inlet. Steady RANS simulations with ideal gas and k-ω SST turbulence model were carried out. Circumferentially periodic boundary conditions were used, enabling modeling of 1/7th of the upstream region. A mixing plane interface was used to cope with the non-uniformity of the flow emanating from the 14-lobe mixer. The reduction of the computational domain in this way enabled faster exploration of the design space. Full-annulus simulations were carried out on final designs to verify consistency and the performance prediction.

Contours of dimensionless swirl velocity (normalized to approach flight velocity) and streamline patterns for the stowed and deployed final design are shown in Figure 5. From the swirl velocity, it can be seen that the flow becomes axisymmetric

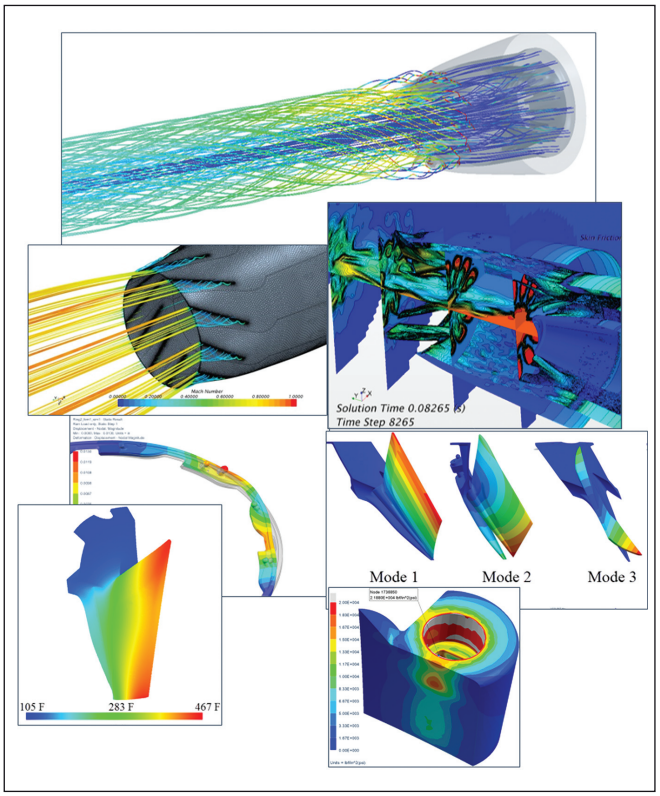

Figure 7. Results from various Siemens PLM Software tools creating the digital twin for the EAB.

about two nozzle diameters downstream of the vanes. The aerodynamic performance results from STAR-CCM+ were used to update the design parameters and iterate on the NX design. Exactly 150 different designs were evaluated and the best performing design was identified, the parameters of which are shown in Figure 6.

An Analysis-Driven Design With Siemens PLM Software

Aside from the aerodynamic analysis detailed above, ATA Engineering used Siemens PLM Software tools throughout this analysis-driven design process to define the final configuration. The multiphysics capabilities of STAR-CCM+ enabled performance and gap leakage analysis with RANS CFD, thermal analysis with Conjugate Heat Transfer (CHT) modeling, unsteady loads calculation with Large Eddy Simulation (LES) capability and flutter assessment. Thus, a digital twin of the EAB was created, which validated the aerodynamic performance of the final design. Structurally, NX™ Nastran from Siemens PLM Software was used for Finite Element Analysis (FEA), fatigue analysis and prediction of thermal/structural deformation.

Figure 7 shows sample results from various simulations used in creating the complete digital twin. The deployment mechanism was challenging to design due to limited space and the challenges in syncing the operation of the 12 vanes. Solid modeling in NX with assembly constraints allowed for visualization of the deployment and checking for interference between parts. Manufacturing of the physical EAB prototype was done through a combination of a 5-axis mill and hand work to bring the nozzle up to specifications.

Technology Maturation to TRL 6 With Ground Testing

Full-scale ground testing of the final EAB design was conducted at Outdoor Test Facility #2 (OTF2) at Williams International's complex in Walled Lake, Michigan. The testing successfully confirmed the performance of the EAB prototype. Results from the test are given below:

- Drag and flow/operability targets were successfully met;
- Noise was favorable compared to analysis;
- Dynamic deployment (<5s) and stow (0.5s) were demonstrated;
- Fuel burn on deployment was reduced;
- Mechanism fits within a notional cowl;
- Thermal performance matched prediction and no structural dynamic concerns were found;
- Quiet steep approach glideslope potential was demonstrated in a system simulation.

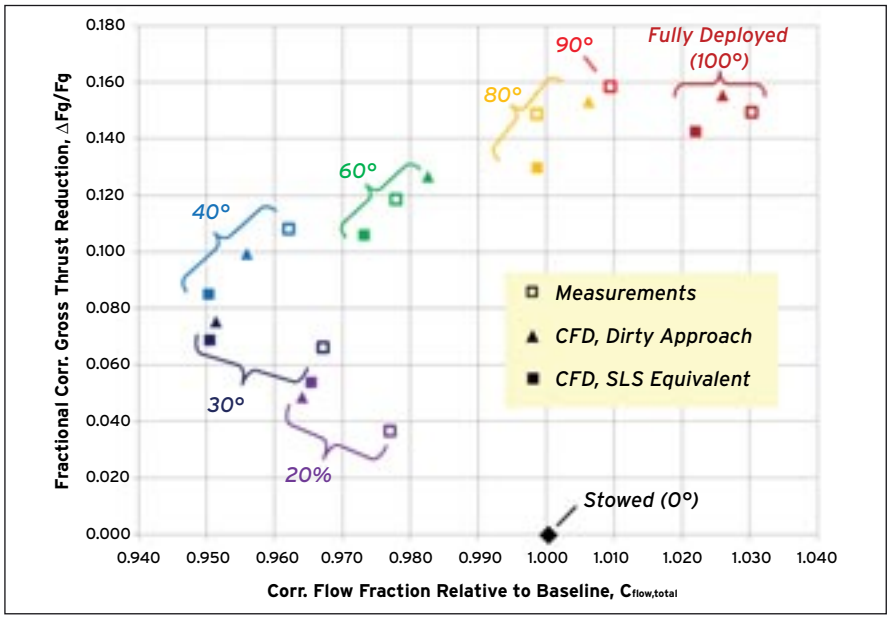

Figure 8. Thrust reduction comparison between ground testing and digital twin predictions (STAR-CCM+)

Testing confirmed the performance of the EAB as a function of the vane rotation angle, which had been predicted with the digital twin. Figure 8 shows dimensionless flow capacity on the X-axis and drag generated on the Y-axis for stowed and various stages in the deployment cycle. STAR-CCM+ predictions agreed well with test results for all configurations, reinforcing the use of STAR-CCM+ as a valuable design tool to bring this new technology to life. A steep approach flyover analysis predicts a 1 to 3 dB reduction in noise on the ground, confirming the performance of the EAB.

A Quieter Future in Aviation Beckons

With the initial success, desired next steps are ground testing to test the reliability and durability of the system and an eventual flight test demonstration. ATA Engineering hopes that future aircraft designs will incorporate the EAB, and that the device may also be retrofitted to existing aircraft. There may yet be a day in the future when the general population is lining up to live in close proximity to airports. Sounds crazy? Maybe not. Now that airplanes and airports can be quieter, very few other balcony views can match the sheer splendor of watching our fantastic flying machines take off and land all day.

This article was written by Parthiv N. Shah, Senior Technical Advisor, ATA Engineering, Inc. (Herndon, VA) and Prashanth S. Shankara, Senior Technical Marketing Engineer, Siemens PLM Software (Plano, TX). For more information, visit ***http://info.hotims.com/69505-502****.*

References

[1] Shah, P.N., et al. "Engine Air-Brakes for Quiet Air Transport." AIAA-2007-1033, 45th AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, Jan. 8–11, 2007.
[2] Shah, P.N., et al. "A Novel Turbomachinery Air-Brake Concept for Quiet Aircraft," Journal of Turbomachinery 132, Oct. 2010.
[3] Shah, P.N. et al. "Aeroacoustics of Drag Generating Swirling Exhaust Flows." AIAA Journal 48, no. 4, Apr. 2010: 719–737.

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Nett Warrior

Enhancing Battlefield Connectivity and Communications

"Sentient data," or information that can feel and perceive things, might one day protect soldiers and their networks, according to a leading scientist at the U.S. Army Training and Doctrine Command's Mad Scientist Conference at Georgetown University. (Photo: Air Force Staff Sgt. DeNoris A. Mickle)

Nett Warrior is the US Army's next generation US integrated soldier system that replaces Land Warrior. It is designed to be an integrated dismounted situational awareness and mission command system for use during combat operations that enables fast and accurate decision-making during tactical operations.

The basic system is comprised of a tactical GPS phone for imaging and texting, various radios for efficient two-way communications, and an optional portable battery pack for power. The End User Device (EUD) — a specially adapted commercial smart phone — graphically displays the location of the squad leader using a digital map image. The EUD uses secure communications channels to transmit and receive information from one Nett Warrior system to another. Armed with advanced navigation, situational awareness and information sharing capabilities, military leaders are able to avoid fratricide and are more effective in the execution of their combat missions.

The electrical interconnect system plays a vital role to the overall performance of the Nett Warrior system. It must be seamlessly integrated into the soldier's vest, pose no serious safety risks to the soldier, and ensure complete functionality throughout the mission.

As the Nett Warrior moved from Low Rate of Initial Production (LRIP) to Full Rate Production (FRP), there were two major issues that the US Army wanted to address: cost and commonality.

Cost and Commonality

The sheer volume of units needed on the battlefield, as well as its associated costs, led the US Government to initiate a Request For Information (RFI) focusing on the development of a universal connector. Potential connector suppliers were given a set of rigid requirements, with an emphasis on three key elements: performance, intermateability, and cost. The down-select process was contingent upon meeting the above criteria. Several rounds of testing were required and completed over a two-year period to ensure the highest degree of reliability.

The US army required the connectors to be lightweight; rugged; operate in harsh environments; provide a safe, reliable, consistent break-away force; and transmit data compatible with USB 2.1 busing architecture.

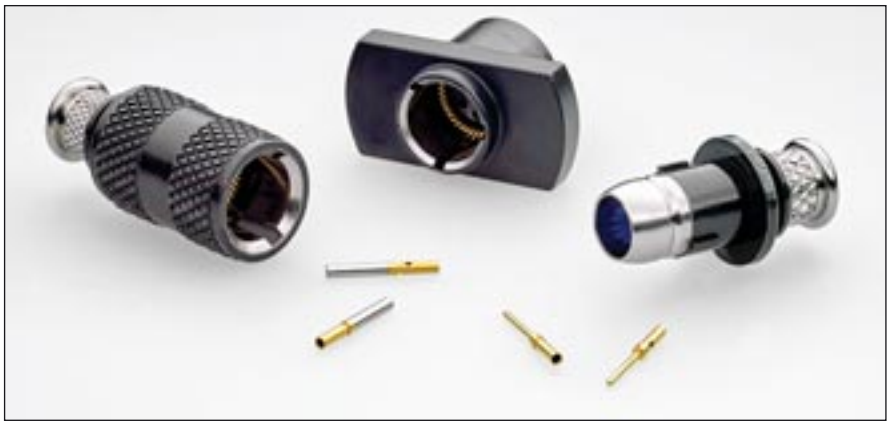
The connectors were tested in accordance with Mil Std 810 G method 516.6 for shock and Mil Standard 810G method 514.7 for vibration. To ensure reliability, the connectors were also subjected to a 2000 mate-de-mate requirement with no loss of signal integrity. A separate test was performed that ensured full backward compatibility with the incumbent design, including a break-away force test that ensured that the connectors de-mated at the specified value of 13 lbs +/- 3lbs.

The electrical requirements included meeting an Insulation Resistance value of 100 MΩ at 500 Volts DC, 5 Amps power rating per contact, and meeting the USB 2.1 signal integrity profile.

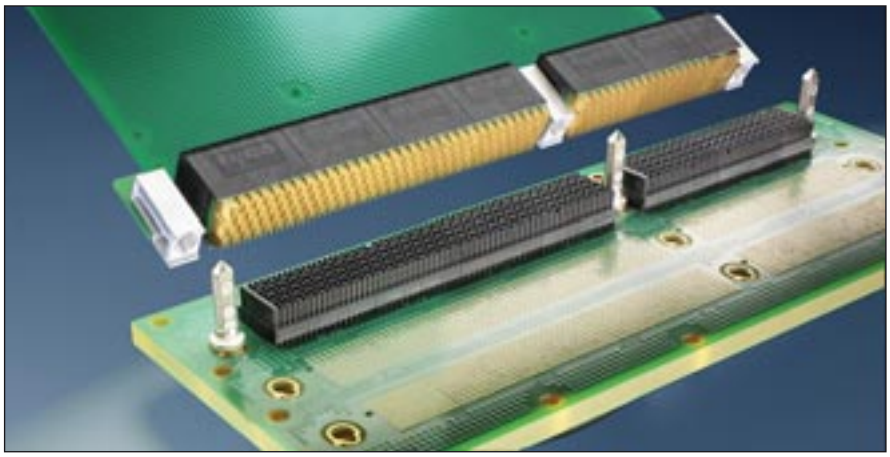
The US Army was ultimately successful in authorizing a second source of supply, which minimized their risk and reduced their overall costs.

Next Generation Soldier Connectivity

In the modern age of increased weaponry and adaptability, soldier technology must constantly evolve to meet the challenges that the warfighter will face in the next decade and beyond. Electrical interconnect will be an in-



TE Connectivity's O.C.H. Micro Circular Connectors



TE Connectivity's MULTIGIG RT2-R Connector

creasingly important part of the overall solution, as the soldier and the battlefield become more connected. To anticipate future electrical system enhancements, it is first important to consider the unique challenges future soldier-systems will face.

Environmental Considerations

One challenge that future soldier-systems will certainly deal with is the harsh environments that soldiers inevitably face. Temperature extremes, rain, mud, dust, sand and even temporary water immersion are and will remain typical battlefield conditions in which soldier-systems must operate. When exposed to these situations, the connectors must not fail.

If a connector is disconnected for any reason, the soldier may need to clean the connector for optimum performance. Traditional pin and socket connectors used in today's Nett Warrior system present a significant challenge related to field cleaning. Thus, a possible area of improvement in next generation soldier system connectors would be a design that uses a "dead face" style of contact system, where the pin is typically spring loaded and the traditional socket contact is replaced by a solid disk of metal. This type of contact interface is inherently more cleanable than other designs.

Water immersion creates unique challenges for connector manufacturers. Essentially, the connector must protect the integrity of the signals from the outside elements. Today, Ingress Protection (IP) standard, IP-67, is the current requirement. However, there is every reason to believe that IP-67 will be replaced by IP-68, meaning it must survive all current conditions with the addition of being immersed in 1.5 meters of water continuously for up to 30 minutes or longer, which may pose some design challenges. Generally speaking, protection in a mated condition is much less of a challenge than when the connectors are unmated. This is another argument for a "dead face" style of connector that can be designed to be IP 67 or 68 compatible, even in an unmated condition.

Ergonomic Considerations

As more electronics are added to the soldier's load, connector manufacturers must continue to find innovative ways to reduce connector weight. Depending on the mission being carried out, a soldier must shoulder loads of up to 100 lbs, which can drastically limit their effectiveness on the battlefield. Developing connectors and assemblies that are smaller, more conformal fitting, and lighter weight can help to improve soldier effectiveness.

As future soldier-systems are introduced, it is expected that the use of composite materials, like LCP, PEEK or ULTEM for connector shells will be expanded. These materials offer higher strength to weight ratios over traditional aluminum-based connectors, resulting in weight savings of 20 to 30% over similar aluminum shell connectors used today.

The use of composite materials does require plating for adequate Electro-Magnetic Interference (EMI) performance. However, unlike aluminum shell connectors used today, composite materials lack a galvanic relationship between the base material and the protective plating. In today's connectors, the aluminum base metal and the nickel-based plating material are at opposite ends of the galvanic scale, requiring very precise and careful surface treatment and plating methods to prevent galvanic corrosion. Since composite connector shell base material is non-metallic, this design concern is virtually eliminated. Salt spray endurance tests of over 2,000 hours have been successfully demonstrated in composite shell connectors.

Finally, composite materials can be molded into almost any imaginable shape in a very cost-effective manner

Nett Warrior could someday lighten the warfighter's load while improving communications and situational awareness.

using modern injection molding techniques. This creates the ability to engineer a connector shell that is low profile and easily integrated into solder vests and protective equipment.

Signaling Considerations

The current Nett Warrior system is built upon a USB 2.0 busing architecture, which is limited to a data transfer rate of 480 Mb/second. As the battlefield becomes more connected, data and video transfer will see a rise within the next 10 years which, most likely, will require USB 3.0 signaling speeds (5 Gb/second) and perhaps beyond. The future soldier-system will invariably require higher pin count density for increased capability while maintaining a similar or smaller footprint. Small form factor connectors like micro D- or nano D-type connectors could form the basis for a new soldier connector by leveraging the higher contact density, smaller size, and lighter weight format. Adapting connectors of this pin density to achieve high speeds would be key to providing a smaller, lighter connector purpose-built for high-speed signaling.

High-speed board level connectors like the TE Connectivity MULTIGIG RT2-R, designed to meet the VITA 46 standard, that utilize small printed circuit board wafers, are modular in design and can handle signal, power and high speed signaling with speeds of up to 12 gigabits of data per second. They interconnect via an industry standard interface and are electrically engaged via a wiping action on the surface of each wafer. This type of connector design could also have some important benefits in a new, low profile soldier connector. The high-speed signaling capability, along with the small size and weight, could form the basis for a future soldier connector that would be a significant deviation from a traditional pin and socket connector.

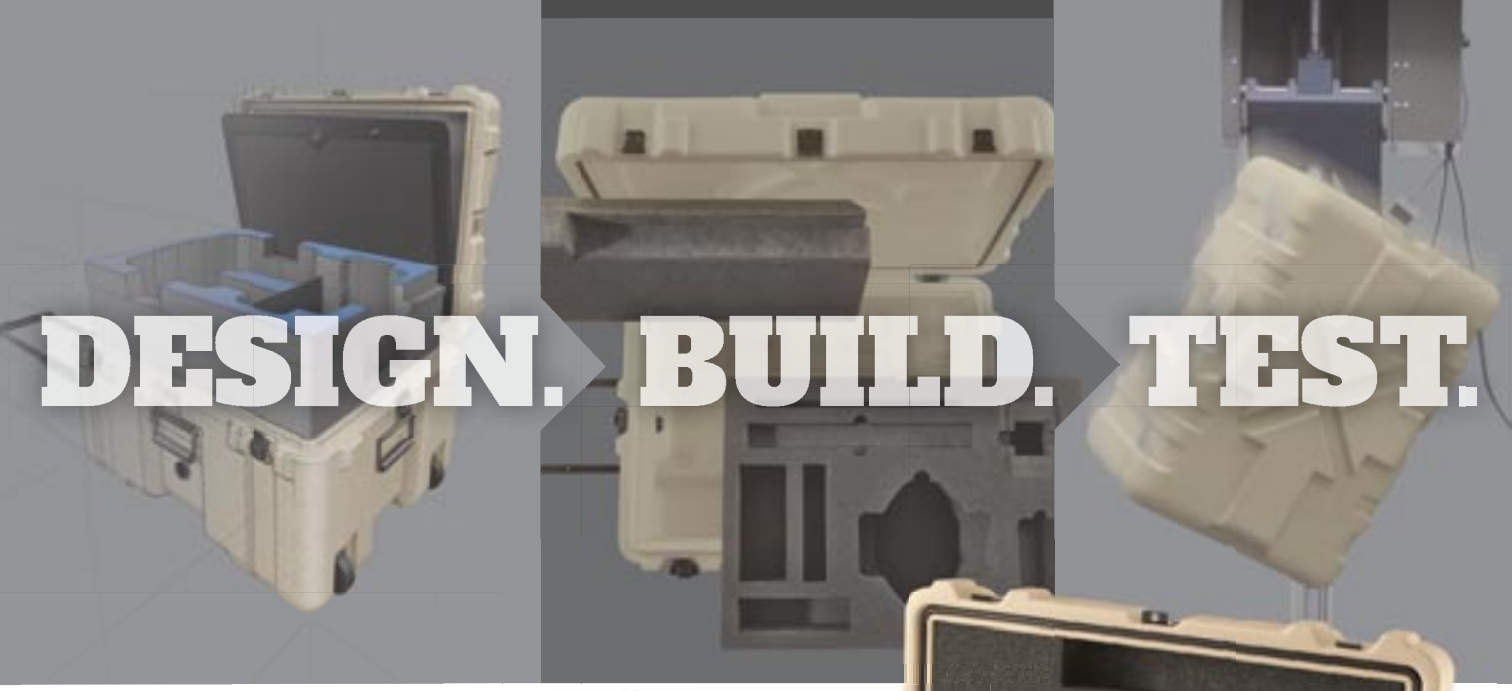
Connector manufacturers today have the engineering resources to develop and construct complete systems so that if initiated at the very onset of a program, a cost effective, optimized interconnect system could be developed. If the connector/cabling solutions are designed as a system, board level style connectors similar to VITA 46 connectors that achieve extremely high data rates could be utilized to achieve data rates previously not possible in traditional systems.

Conclusion

Nett Warrior has revolutionized the battlefield intelligence available to today's fighting soldier. Through it, soldiers are more informed and better connected than ever before. However, future enhancements in technology and capability will drive the next generation of soldier-systems to new levels of capability and efficiency.

Future technologies will require faster data transfer, more power, smaller size, lighter weight, better conformability, improved maintainability, modularity and unfailing reliability. The connector industry is prepared to engineer solutions that meet these needs and is working with the defense industry to develop appropriate solutions.

This article was written by Steve McIntire, Manager, Product Management, (Berwyn, PA). For more information, visit ***http://info.hotims.com/69505-503***



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The Association for Unmanned Vehicle Systems International (AUVSI) is bringing this year's XPONENTIAL 2018 to the Colorado Convention Center in Denver, CO. The event, which runs from April 30 - May 3, will feature more than 200 presentations and panel discussions focused on all aspects of the unmanned vehicle and robotics market. Over 725 exhibitors representing more than 20 different industries will be showcasing their latest technology to an estimated 7,000 attendees from all over the world.

So, what can you expect to find at XPONENTIAL 2018?

The event kicks off on Monday afternoon, April 30, with educational programs and workshops from 1:30 to 5:15 pm, followed by a welcome reception and, if you're an exhibitor, an exhibitor's reception. These social gatherings are a great opportunity for first-time attendees and veterans alike to mingle and network in an informal relaxed atmosphere. And on Wednesday evening, from 6:30 - 9:30 pm, AUVSI will be taking over the Hard Rock Cafe in downtown Denver to host The MIX, a social gathering designed to let attendees mingle, relax, and enjoy live music, food, interactive games, and a beer garden.

Exhibit Hall

The exhibit hall – dubbed XPO Hall, of course – opens for business on Tuesday morning at 10:30, and if past shows are any indication, there will be no shortage of things to see and do. More than 725 exhibitors from around the world will occupy over 370,000 square feet of exhibit space to showcase their latest technology and products covering all aspects of unmanned vehicle and robotics design, manufacturing, and use including

AeroVironment's booth was hard to miss at XPONENTIAL 2017 in Dallas. (Photo: Bruce A. Bennett)

Bluefin Robotics showed off their underwater vehicle technology at XPONENTIAL 2017. (Photo: Bruce A. Bennett)

An attendee checks out some of the drones on display at XPONENTIAL 2017. (Photo: Bruce A. Bennett)

Danielson Aircraft Systems displayed some of their UAV engine technology at XPONENTIAL 2017. (Photo: Bruce A. Bennett)

Former FAA Chief, Michael Huerta (center), visited XPONENTIAL 2017 in Dallas. (Photo: Bruce A. Bennett)

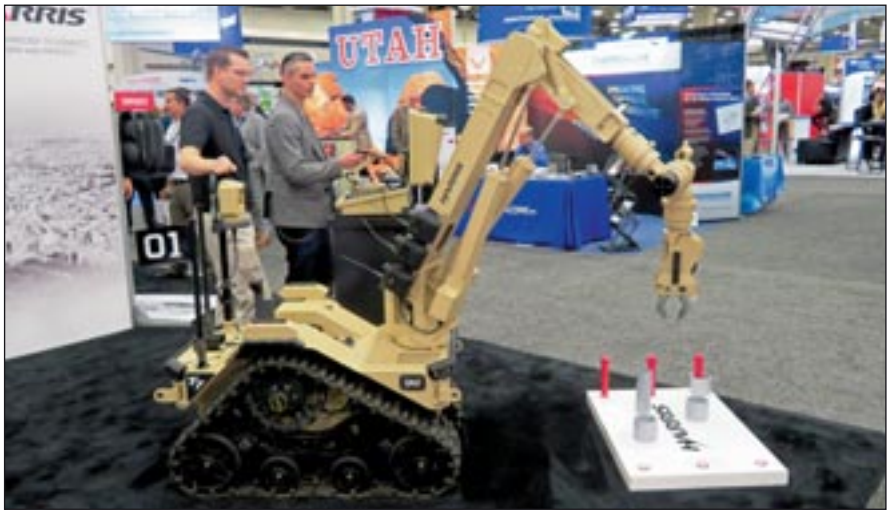
air, ground, surface, subsurface, space systems, weapons systems, security systems, engineering and R&D, propulsion systems, sensors, electronics, fabrication, imaging and communications systems.

In addition to the normal array of exhibitors, this year's event offers a number of features designed to help attendees get the most out of their XPONENTIAL experience. The Starting Point Theater will give entrepreneurs a chance to listen to experts give practical advice on how to start up new businesses or integrate new technology into existing operations. The Solutions Theater will showcase XPONENTIAL exhibitors offering up-close looks at some of their latest advancements and technology solutions. And the always popular Poster Presentation will highlight the cutting-edge research being done by some of the brightest minds in the industry.

Show organizers are touting several "new features" this year that should attract a lot of attention. XBuild will gather some of the best and brightest engineering talent together and turn them loose to come up with new and innovative unmanned systems solutions in a unique buildathon/hackathon. And if competition is your thing, don't miss XPONENTIAL's first-ever drone racing event featuring professional drone operators competing for prizes. There will also be a Talent Acquisition area where attendees can meet with prospective employers and explore career opportunities; a Startup Showdown where five hopeful entrepreneurs will pitch the merits of their companies and products; and the AUVSI XCELLENSE Awards where the industry's leading contributors in 18 categories will be formally recognized.

This year there will be seven international pavilions featuring companies from Alberta, China, Denmark, France, Korea, Quebec, and Spain. On the home front, six State Pavilions will showcase the latest technology being developed in: Colorado, Kansas, Maryland, New York, North Dakota and Virginia.

Pratt & Whitney showed off impressive cutaway models of its engines at XPONENTIAL 2017. (Photo: Bruce A. Bennett)



Harris had an interactive exhibit demonstrating the manual dexterity of its robots. (Photo: Bruce A. Bennett)

The Wave Glider autonomous unmanned surface vehicle from Liquid Robotics. (Photo: Bruce A. Bennett)

Educational Program

Those seeking the latest cutting-edge information about unmanned vehicles and robotics technology can attend a variety of stimulating courses and seminars at XPONENTIAL 2018. Like last year, the courses have been broken down into four program tracks: Policy, Technology, Business Solutions and Trending Topics. Although parts of the program were still being finalized as we went to press, here are some of the educational programs being offered:

Policy Track

The Policy Track is designed to give attendees access to the latest information on policies and regulations impacting the unmanned vehicle and robotics industries straight from the people formulating them. Some of the panel sessions being offered are:

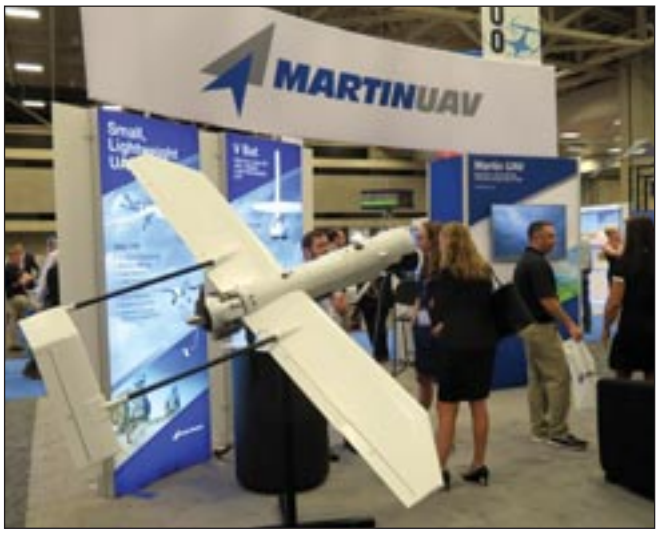
- Addressing State and Local Issues Impacting UAS Regulation
- Implementation of the Low Altitude Authorization and Notification Capability
- Unlocking the National Infrastructure for Air and Ground Cargo Transport
- Cooperatively Managed Airspace: Structuring E Above A for Balloons, Fixed Wing Aircraft, Border Patrol Supersonic Jets, and Others
- Integrating UAS Technologies Within State and Local Government Agency Operators

Technology Track

The Technology Track, as its name implies, will keep you up to speed on the latest technological developments affecting areas like robotics, artificial intelligence, machine learning, software, and payload advancements. Some of the panel sessions being offered are:

- Measuring Vehicle Intelligence in Human Transport: What is Your Car's IQ?
- Cutting the Tether: Performing ROV Style, Complex Manipulation Without a Tether
- Hardware-in-the-Loop (HIL) Implementation and Validation of a SAE Level 2 Autonomous Vehicle
- Swarm Development for Maritime Search and Rescue Using Genetic Algorithms

Among the international contingent at XPONENTIAL 2017 was Japanese specialty commercial drone manufacturer, Prodrone. (Photo: Bruce A. Bennett)



The Martin UAV booth was busy during XPONENTIAL 2017. (Photo: Bruce A. Bennett)

- The Dark Arts of Jamming or Spoofing GPS to Disrupt Drone Flights

Business Solutions

Unmanned vehicles and robotics technology is opening up all kinds of new business opportunities, and this track is designed to help you learn how to take advantage of them. Some of the panel sessions being offered are:

- 60 Tips Your UAS Service Business Needs to Succeed
- Selling UAS Outside the U.S. Without Breaking the Law
- Market Sizing: Turning Guesses into Data
- Transitioning from Manned to Unmanned Aircraft...When is the Right Time?

- Market Insights: Where We've Been, Where We Are and Where We're Headed

Trending Topics

This track, which is new this year, is designed to give participants insight into the industry's biggest growth markets and hottest technology trends from BVLOS drone operations to new developments in artificial intelligence. Some of the panel sessions being offered are:

- Achieving Commercial Beyond Line of Sight Operations
- Countering the Threat: Combatting Nefarious Drone Activity Domestically and Abroad
- Whose Drone is That? Achieving a Balanced and Fair UAS Remote Identification Policy
- Lessons Learned During the Development and Testing of the Vahana Urban Air Mobility Technology Demonstrator

The Naval Research Laboratory distributed information on their programs at XPONENTIAL 2017. (Photo: Bruce A. Bennett)

After Hours

There is certainly no shortage of things to see and do in Denver, assuming you're not too tired after walking the show floor for hours or participating in the educational sessions. Check out downtown Denver; marvel at the Colorado State Capital building where you can stand exactly 5,280 feet (1-mile) above sea level; visit the U.S. Mint where you can literally watch them make money; or check out the Buffalo Bill Museum & Grave high atop Lookout Mountain. If you can't get your fill of technology at XPONENTIAL (hard to imagine), tour the Denver Museum of Nature & Science; or get back to nature at the Denver Zoo or Botanic Gardens. However you choose to spend your free time, it's sure to be a fitting compliment to all there is to see and learn at this year's XPONENTIAL 2018.

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Communications in Space: *A Deep Subject*

Transmitting and receiving radio signals between spacecraft in deep space is a snap compared with getting those signals back to Earth, especially when the spacecraft is 120 billion miles away.

Even though we've sent spacecraft hundreds of billions of miles into space, and rovers are gathering enlightening information about planets, moons, and even asteroids, radio communication in space still remains the new frontier. While the missions themselves are a marvel of technical wizardry, so too is the Herculean feat of not just communicating between spacecraft, but sending signals back to Earth.

Man's greatest achievement in this regard is the Voyager spacecraft launched in 1977; 38 years later, it is still communicating with Earth from more than 120 billion miles away, and has far outlived even the most optimistic projections of longevity. NASA recently celebrated the 25th anniversary of the last time Voyager sent images to Earth in 1990. The decision to take one last glimpse as Voyager left the solar system was made by Carl Sagan, who was a member of the Voyager team. The image (Figure 1) was called "The Pale Blue Dot" and became the title of Sagan's 1994 book.

Voyager has remained operational for nearly four decades, which is hard enough for Earth-bound electronic systems. It's a true engineering marvel considering that Voyager technology was state-of-the-art when "All in the Family" was the TV top sitcom in the U.S. It's also testament to the incredible capabilities of the NASA Deep Space Network (DSN), which captures Voyager's incredibly faint radio signal after being weakened by passage through the Earth's attenuating atmosphere.

The space communications challenge is great today, even with technology that is orders of magnitude more advanced. It becomes even more vexing as the resolution of still images and video is far greater, which translates into huge amounts of data from cameras, telescopes, and scientific equipment.

The Deep Space Network

In the U.S., the bulk of the development in deep space communications has been conducted at NASA's Jet Propulsion Laboratory (JPL) located in Pasadena, CA, which is managed for NASA by the California Institute of Technology. The list of advancements achieved by JPL is massive, thanks in no small measure to the many scientists who have made contributions there, including Erwin Schrödinger, Werner Heisenberg, Hendrik Lorentz, Niels Bohr, and Albert Einstein. JPL has been a major participant in every NASA space mission, from construction and operation of robotic planetary spacecraft, through Earth-orbit and astronomy missions, and operation of the DSN that is the terrestrial portion of U.S. deep space mission communications.

The DSN consists of three transmission and reception facilities: the Goldstone Deep Space Communications Complex near Barstow, CA (Figure 2); the Madrid (Spain) Deep Space Communication Complex; and the Canberra (Australia) Deep Space Communication Complex.

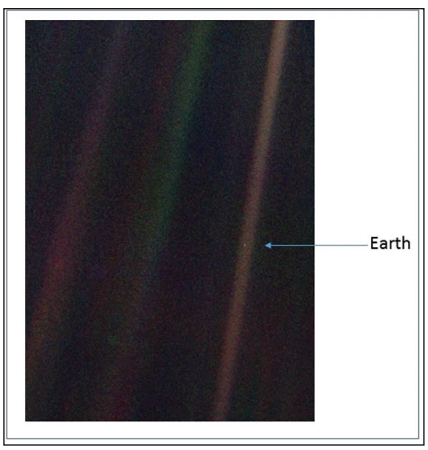


Figure 1. The Pale Blue Dot is part of the first-ever "portrait" of the solar system taken by Voyager 1. The spacecraft acquired 60 frames to create a mosaic of the solar system from more than 4 billion miles from Earth. At that distance, Earth is just a speck of light less than a pixel in size.

They are spaced about 120 degrees apart on the globe in order to provide continuous coverage (Figure 3). To continue meeting the increasing demand on deep space communications systems, NASA believes the DSN must increase its capability by more than a factor of 10 during each of the coming three decades, with a goal of achieving data rates of 200 Mb/s by 2022 and 20 Gb/s by 2030.

Getting Down to Earth

There are basically two elements that comprise deep space communications: transmitting and receiving signals, first in space and then through the ionosphere and troposphere that surround Earth. Space is a vacuum, so signals within it are not reduced in strength, and once transmitted, will theoretically continue to propagate to whomever (or whatever) might be listening.

This makes it possible to use transmitters that need only generate relatively low RF power, aided immeasurably by very-high-gain antennas on Earth, and terminals like those of the DSN that increase strength of the received signal and amplify the signal transmitted from Earth to the spacecraft. The lack of signal attenuation in space is an enormous benefit, as the small transmitters on spacecraft need to produce much less RF power (boosted again by their high-gain antennas) so they consume little DC power, of which there is little to spare on a spacecraft powered by solar cells.

Unlike communication in space, communicating between deep space and Earth is far more difficult, as Earth is surrounded by an atmosphere that consists of five layers, each with different characteristics, but all forming an impediment to radio and optical communications. The atmospheric layers absorb and scatter signals within them, reducing signal strength

and limiting the specific portions of the electromagnetic spectrum that can be used for communication. Below 30 MHz, the ionosphere layer of the atmosphere absorbs and reflects signals, and above 30 GHz, the lower atmosphere or troposphere absorbs them. As a result, the region between (roughly) 30 MHz and 30 GHz is chosen for communications from deep space to Earth.

Having passed through the atmosphere, these signals are invariably reduced in strength and are so weak that they can only be received by huge parabolic antennas that generate very high levels of gain, along with receivers with exceptionally low system noise levels. To increase sensitivity even further, these antennas can be combined to produce a single, huge aperture that increases the likelihood of reception. Without them, communications from deep space would be impossible.

Figure 2. The 70-m antenna at the Goldstone Deep Space Communications Complex in the Mojave Desert. (Source: Goldstone DSN antenna. Licensed under Public Domain via Wikimedia Commons)

The Data Dilemma

Deep space missions generate lots of publicity, possibly due to the stunning, high-resolution still images and video. And as all of us who have data-limited wireless plans know, high resolution means high data rates and "big data." The imagers, along with scientific instruments, produce more and more data with each mission; thus, deep space communications networks must continually be enhanced to accommodate it.

For example, as of 2013, the Mars Reconnaissance Orbiter (MRO) sent about 25 Tbytes of data back to Earth, but NASA estimates this must dramatically increase, and along with it, the ability to download it to Earth. According to JPL, at its data rate of 5.2 Mb/s, MRO requires 7.5 hours to transmit scientific data stored on its recorder, and 1.5 hours to send a single High Resolution Imaging Science Experiment (HiRISE) image to Earth. HiRISE is the largest camera ever used on any deep space mission, and is mounted on the MRO that was built under the direction of the University of Arizona by Ball Aerospace. As it photographs Mars, it can resolve objects of about 1 foot in size (at 0.3

m/pixel) on the planet surface from its place in orbit. HiRISE has imaged Mars landers on the surface, including Curiosity and Opportunity.

High-resolution hyperspectral imagers are one of the greatest contributors to this glut of data as they can image at hundreds or thousands of wavelengths simultaneously, revealing mineral content or other characteristics that cannot be revealed from a single visible-wavelength image. A hyperspectral image is hundreds or thousands of times larger. New image compression technology is being developed to reduce this data to a more manageable size.

The Future Is Optical

The channel capacity of interplanetary RF communications systems has expanded by eight orders of magnitude since 1960, and the resolution that can be achieved in tracking a spacecraft has been improved by a factor of 105. This has been achieved by increasing the efficiency and gain of the transmitters and antennas, and by reducing the loss introduced by various RF and microwave components. However, there are limits to what microwave communications systems can achieve in terms of data rate increases within the constraints of mass, power, and volume dictated by the spacecraft.

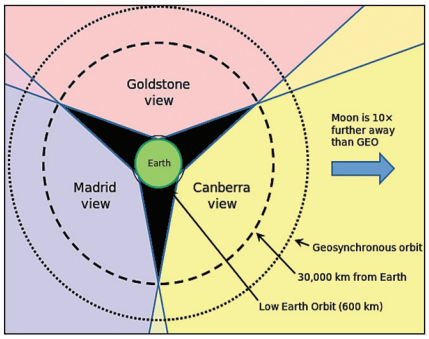


Figure 3. View from the North Pole showing the field of view of the main DSN antenna locations. Once a mission gets more than 18,600 miles from Earth, it is always in view of at least one of the stations.

Nevertheless, NASA has been developing a system called the Reconfigurable Wideband Ground Receiver (RWGR) that will leapfrog the performance of the existing DSN receiver. It is a variable-data-rate, reprogrammable, software-defined radio using an intermediate frequency (IF) sampling receiver that operates at a fixed sampling rate of 1.28 GHz with a 500-MHz instantaneous receive bandwidth. The current receiver samples at a 160-MHz rate and has a bandwidth of 72 MHz. NASA ultimately hopes to achieve telemetry data rates in excess of 1 Gb/s using this system.

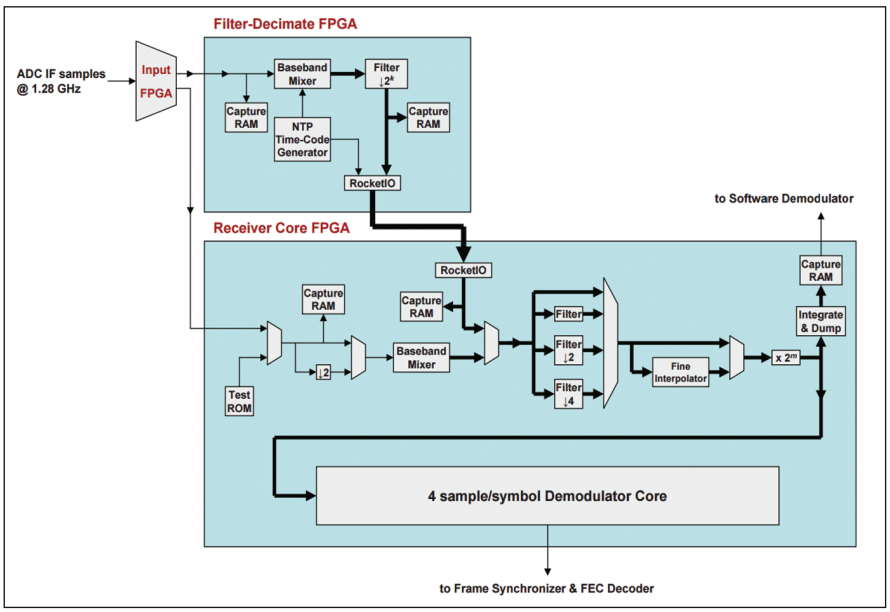


Figure 4. Block diagram of NASA's Reconfigurable Wideband Ground Receiver.

Even with such advances, JPL predicts that in the future, there will be a need to transition from microwave to optical communications, as orders-of-magnitude increases in performance can be achieved within the same levels of power consumption and equipment size. The equipment designed for this purpose is being developed now in order to enable streaming video and data communications over immense distances. By using the narrow beam of an optical carrier frequency near 200 THz (1,550 nm) for transmission, optical communications has the potential to increase the achievable data rate from spacecraft at planetary distances by orders of magnitude with a spacecraft transceiver that is of similar mass and power consumption to a wide-beamwidth 32-GHz (Ka band) spacecraft transceiver.

The beamwidth of a microwave communications signal transmitted from Mars is also 100 to 200 times the diameter of the Earth, while an optical communication systems beamwidth is 1/10th to 1/20th of our planet's diameter, so it is inherently narrower when it reaches Earth; however, with a beamwidth this narrow, the laser beam must target a point with exceptional precision. A narrower beamwidth translates to a 10× to 100× increase in the power transmitted by the spacecraft to the Earth terminal than is possible with today's microwave antennas, with additional benefit of a significant reduction in weight and a 99% reduction in the amount of space occupied. And as is presently accomplished with optical communications over fiber optics, there is virtually no limit to the amount of available bandwidth, so almost any amount of data can be accommodated. Development of such systems is far from trivial, and will require laser transmitters that are exceptionally efficient, can withstand the hostile environment of space, are reliable enough to perform over a system's operational life of a decade or more, are sensitive enough to receive the faint signals visible during daylight hours, and can function reliably in deep space.

Making Do with Technology We Already Have

JPL as well as other space science organizations throughout the world is

working on ways to meet the needs of high-data-rate deep space communications and ultimately the needs of manned spacecraft once they are capable of leaving the solar system. JPL has already spent decades developing power-efficient channel codes that achieve reliable transmission from deep space to Earth, and they are currently so effective, they can achieve data rates near the theoretical (Shannon) limit. Technologies in development include channel coding that makes communication possible over otherwise unusable channels by adding redundancy. This could make the transmitted message 100% recoverable even in the presence of massive levels of noise and data corruption.

Low-density parity-check (LDPC) codes have been created that have maximum data rates above 1 Gb/s using current FPGA technology. For the most distant missions to outer planets or beyond the solar system, JPL has designed "turbo codes" that can operate on channels whose noise power is more than five times higher than the signal power. LDPC and turbo codes, along with protocols for variable-coded modulation (VCM) that vary the channel codes and modulation from code block to code block, may be able to double the data return of a mission without any hardware changes.

While increasing data rates is exceptionally important, it is also necessary to compress data as much as possible to reduce volume. Standard compression algorithms such as JPEG take too much computing horsepower to be suitable for use on a spacecraft, so JPL is using a technique called ICER image compression. It achieves the same result, but is much less complex and requires less formidable signal processing hardware. It has already been used on the Spirit and Opportunity Mars rovers to return images of high quality using a compression ratio of 10:1.

The Major Challenges Ahead

If one thing of certainty can be said of future space exploration, it is that we will reach further and further from Earth. Among the hundreds of other challenges posed by this adventure are those associated with communicating with, and receiving images and other data from spacecraft. That will require exploring new approaches such as the use of free-space optical communications, greater data compression and new data coding schemes, and others that together will propel us to where no man has gone before.

This article was written by Barry Manz for Mouser Electronics, Mansfield, TX. Originally published by Mouser Electronics, it is reprinted with permission. For more information, visit ***http://info.hotims.com/69505-541****.*

First Air-Worthy Metal-Printed RF Filter Ready for Takeoff

Within the aerospace industry, 2016 and onwards could be looked upon as the tipping point for direct metal printing (DMP), as the technology increasingly made the jump beyond prototyping to production parts and assemblies ready for flight.

During that time frame, Airbus Defense and Space worked with 3D Systems (Rock Hill, SC) to achieve a major breakthrough: The first 3D-printed radio frequency (RF) filter tested and validated for use in commercial telecommunications satellites. The project built upon research funded by the European Space Agency.

Metal RF or waveguide filters date back to the first space communication systems nearly 50 years ago. The filters act like traffic cops, allowing frequencies from selected channels to pass through, and rejecting those from signals outside those channels.

A major industry trend is to increase the capacity for multiple beams within a single satellite. A high-capacity satellite such as the Eutelstat KA-SAT, manufactured by Airbus Defense and Space, carries nearly 500 RF filters and more than 600 waveguides. Many of these are custom-designed to handle specific frequencies.

Meeting Critical Mandates

Telecommunications satellites exemplify the aerospace industry's relentless emphasis on reducing weight — sending a vehicle into a geostationary orbit can cost as much as $20,000 per kilogram. Continuing design innovation and reduced production time are also major priorities, as most satellites are designed for a lifetime of 10 to 15 years.

These priorities make telecommunications satellites the ideal candidate for direct metal printing. The 3D Systems ProX® DMP 320 used in the Airbus RF filter project enables manufacturers to consolidate parts, improve functionality with shapes and surfaces not possible to manufacture via traditional means, reduce production time and lower costs for customized designs, and decrease weight while maintaining or improving material strength.

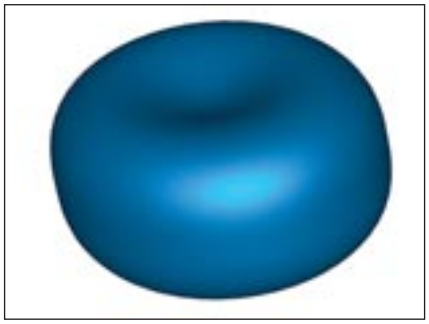
3D Systems' facility in Leuven, Belgium has been using the 3D Systems ProX DMP 320 since the machine was in its beta stages. Successful projects include topological optimization, weight reduction, and parts consolidation for spaceflight-validated parts such as brackets and strut end fittings for telecommunications satellites. The Airbus Defense and Space project was 3D Systems Leuven's first foray into RF filters.

The ProX DMP 320 is designed for heavy-duty metal parts production. It uses a totally new architecture that simplifies setup and provides the versatility to produce all types of part geometries in titanium, stainless steel, aluminum, nickel-chromium, and other alloys. Exchangeable manufacturing modules deliver increased applications versatility and less downtime when moving among different part materials. A controlled vacuum build chamber ensures that every part is printed with proven material properties, density, and chemical purity.

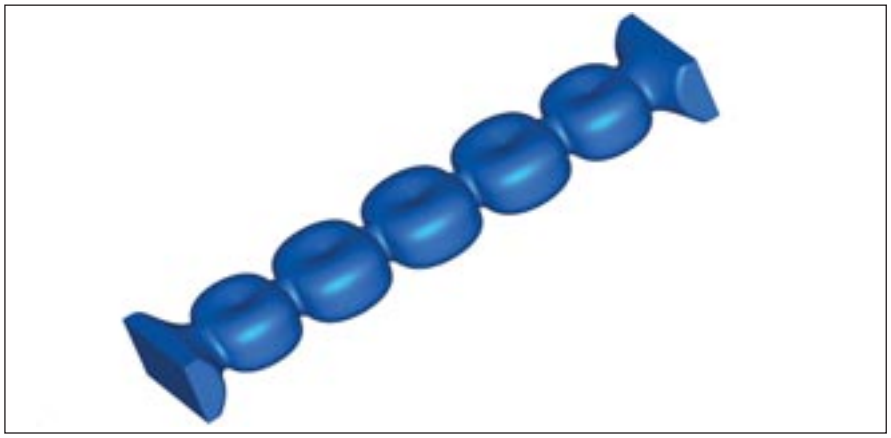
Disruptive Design Innovation

The Airbus Defense and Space RF filter project demonstrated the ability of 3D printing to enable new design innovation for aerospace parts that haven't changed appreciably in decades. RF filters have been traditionally designed based on libraries of standardized elements, such as rectangular cavities and waveguide cross-sections with perpendicular bends. Shapes and connections are dictated by typical manufacturing processes such as milling and spark eroding. As a result, cavities for RF filters typically need to be machined from two halves bolted together. This increases weight, adds an assembly step to production time, and requires extra quality assessment. Designing the parts for 3D printing enabled Airbus Defense and Space to explore complex geometries at no additional manufacturing cost.

CST MWS, a standard 3D electromagnetic simulation software tool, was used to design the 3D-printed RF filters, with little time spent on optimization. The increased manufacturing flexibility enabled by 3D printing led to a design using a depressed super-ellipsoidal cavity. The unique shaping helped to channel RF currents and deliver the required tradeoffs between Q factor — a measure of a waveguide's ef-



Metal 3D printing enabled Airbus Defense and Space to design and build a new RF filter based on a super-ellipsoidal cavity that efficiently channels RF currents.



The unique internal structure of the 3D-printed RF filter based on depressed super-ellipsoidal cavities.

ficiency based on energy lost — and rejection of out-of-band signals.

"The disruptive innovation lies in the fact that pure functionality, not manufacturability, now determines how the hardware will be designed," said Koen Huybrechts, project engineer for 3D Systems in Leuven. "This project is a classic example of 'form follows function.'"

"The main benefits of a monolithic design enabled by 3D printing are mass, cost, and time," said Paul Booth, RF engineer for Airbus Defense and Space in Stevenage, United Kingdom. "The mass is reduced because there is no longer the requirement to have fasteners. With direct metal printing, there is also the no-cost bonus to have the outer profile more closely follow the inner profile, so only the really necessary metal needs to be used. The cost/time benefit comes from the reduction in assembly and post-processing."

Eliminating Surface Concerns

Initially, the different surface topology in 3D-printed metal parts was thought to be an issue, but extensive testing by Airbus Defense and Space eliminated those concerns.

"The microscopic topology is different in the 3D-printed part than in a machined part," said Booth. "Machined surfaces have sharp peaks and troughs, while the 3D-printed surface is spheroids melted together so there is less sharpness."

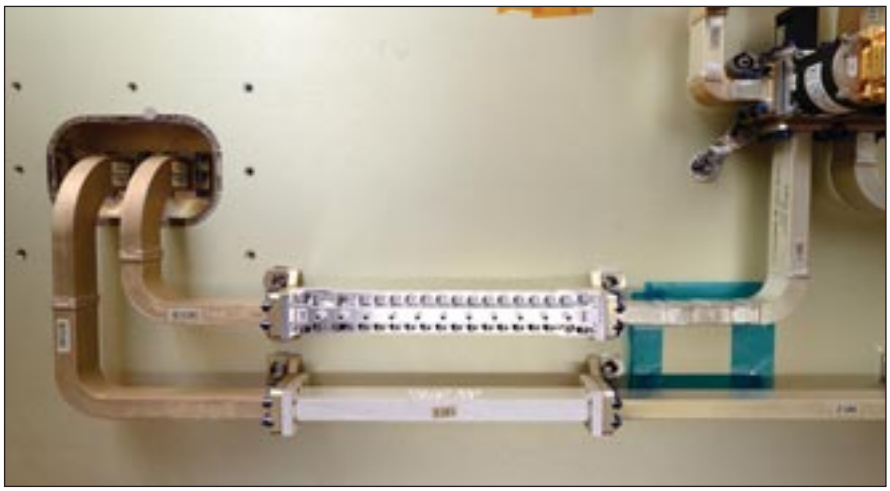
"The spherical shape of the powder particles used in 3D metal printing leads to a certain waviness rather than steep transitions," said Huybrechts, "but the ability to shape a part for more effective signal filtering more than overcomes any concerns with surface topology."

"We were very pleased with the work that 3D Systems did for us, and many inside Airbus have commented on how good the surface finish is," said Booth. "We did some X-ray CT scans and have been impressed with the density of the part and the general surface quality."

Passing Rigorous Tests

Three aluminum samples printed on the ProX DMP 320 using different processing paths were tested by Airbus Defense and Space at its Stevenage facilities. Tests mimicked conditions the parts would face during launch and orbit, including vibration, shock, and thermal situations such as temperature extremes and vacuum conditions. All three samples met or exceeded requirements, with the best performance coming from a filter that was silver-plated via an electrolytic process.

Beyond 3D printing, 3D Systems delivered added value that is critical to this kind of project, including certified powder handling, process control for superior material density, proven post-processing, and reliable quality control.



The metal 3D-printed RF filter designed by Airbus Defense and Space integrated into the satellite payload. The new filter reduces weight by 50% over the previous design.

The metal 3D-printed RF filter designed by Airbus Defense and Space consolidates two parts into one and reduces overall mass. 3D printing enables faster production and lower costs.

Booth recognizes that this added expertise played a key role in the project's success. "We realize that this is not just down to using a good machine to manufacture the part, but also the result of a good understanding by 3D Systems of the manufacturing process."

ROI Potential

Now that the process has been validated and the parts have met the highest spaceflight standards Airbus Defense and Space has in place, the company can begin to consider the return on investment (ROI) potential for 3D metal printing. The project delivered faster turnaround time, reduced production costs, and a weight reduction of 50 percent.

"Mass was reduced without spending any time on optimization," said Booth, "and it can be reduced further with more aggressive mechanical design. The reduced mass saves costs by requiring less propellant in the rocket, and puts fewer demands on support structures, allowing further mass reduction.

"The success of this project opens up the possibility of much greater integration of RF filters with mechanical and thermal components to reduce part count and overall mass," Booth added. "We will also look at integrating more functionality such as test-couplers as part of the filter, or directly integrated into waveguide runs. There is a huge potential for reducing mass while cutting production time and costs."

This article was contributed by 3D Systems, Rock Hill, SC. For more information, visit ***http://info.hotims.com/69505-542****.*

Validation of Automated Prediction of Blood Product Needs Algorithm Processing Continuous Non-Invasive Vital Signs Streams (ONPOINT4)

Using a combination of non-invasive sensors, advanced algorithms, and instruments built for combat medics could reduce hemorrhaging and improve survival rates.

Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio

Hemorrhagic shock occurs frequently in natural and man-made disaster scenarios. To control bleeding and to provide necessary resuscitation, swift and accurate diagnosis and decision-making are required. Early recognition of bleeding and the need for targeted interventions could improve both survival and resource management, allowing the receiving hospital to prepare required blood, surgeons, or other resources in advance of patient arrival and to conserve valuable resources in those patients who are not bleeding. Resources can be saved through avoidance of over-triage, thereby reducing unnecessary air transport, unnecessary blood transfusions, and unnecessary evaluation with labs, X-rays, and computed tomography scans, which is important in all resource-constrained and austere environments.

To achieve the above goals, many diagnostic and predictive models have been proposed. These models use information collected from patients, such as pre-hospital vital signs (VS), injury mechanism, or information measured from other devices. They are useful and some of them have been used in practice. However, those methods have their drawbacks. First, they are mostly based on a paper-pencil type scoring system. Users need to collect all variables and either do manual calculation or input the numbers to a calculator, costing valuable time. Second, alternative methods require specially trained experts to use certain devices, such as ultrasound machines. Third, other methods depend on blood sampling and laboratory testing; such requirement increases the logistics for in-the-field deployment. Moreover, there is no systematic validation of those models in military-specific populations.

A working prototype device that runs the prediction algorithm. It uses an oximetry sensor as input, and outputs BRI as an indicator for future use of blood transfusion.

Advances in computing and sensoring techniques allow real-time high-fidelity VS data collection and processing. Non-expensive and non-invasive sensors with built-in computing processors could fully automate data collection and calculation without user input during the multi-tasking trauma patient resuscitation period. Transfusion prediction algorithms use the non-invasive sensor signals to convert these data into clinically relevant quantities that can be used for identifying patients with life-threatening bleeding.

To derive such algorithms, a feasible and practical approach was to use a subset of >22,000 trauma patient datasets to train an algorithmic "learner." By "observing" and "inferring" from the dataset, the association between input variables and the outcomes could be learned. This machine learning approach is called supervised learning. Moreover, the trained algorithms need to be thoroughly tested in testing datasets that the algorithms have never seen before. In this way, what performance to expect when the algorithms are applied in the future would be known. Therefore, it is important to use these validation methods to train and test the algorithms or models, e.g., for transfusion prediction, before deploying them for healthcare.

This has particular relevance for military applications. Hemorrhage is the greatest threat to survival, the leading cause of death, and the most common cause of potentially preventable combat-related mortality. The Department of Defense has invested many resources into developing reliable transfusion prediction models andpractical usable tools based on intensive analysis of large data collections. Military medicine considers these approaches as the future way to develop combat casualty autonomous resuscitation and enhance real-time field decision-making.

Past work has focused on the assessment and treatment of major bleeding in the pre-hospital environment, typically in the form of field severity scoring systems. On the other hand, using new sensors that are non-expensive and non-invasive, advanced field-ready algorithms and instruments that can be built for combat medics offers advantages. Such study can enhance the ability to rapidly assess fluid resuscitation needs. Through large-scale big data modeling, evidence-based physiologic criteria for validation of transfusion use in a combat casualty can be identified and thoroughly tested.

This work was done by Peter Hu, PhD; Shiming Yang, PhD; and Colin Mackenzie, MD; University of Maryland School of Medicine for the Air Force Research Laboratory. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Sensors category.*** *AFRL-0261*

Calculation of Weapon Platform Attitude and Cant Using Available Sensor Feedback

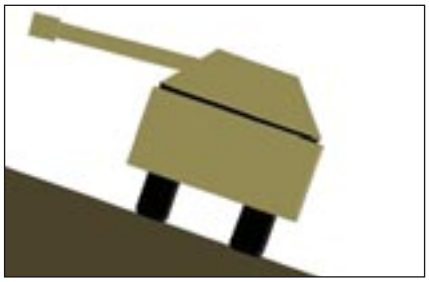
Successful development of mobile weapon systems must incorporate operation on sloped terrain.

Army Armament Research, Development and Engineering Center, Picatinny Arsenal, New Jersey

When firing artillery, there is typically a maximum angle that the platform cannot exceed relative to the Earth plane. This is due to the large recoil forces involved and the risk of destabilizing the platform the weapon is mounted to. Mobile systems are particularly sensitive to this as the attitude of the platform relative to Earth is constantly changing. A simple solution is to add pitch and roll sensors directly to the platform. However, many mobile systems already have an assortment of sensors that can be used to calculate the platform attitude.

U.S. Army weapon systems are designed to be deployed and operated wherever a need arises. This design requirement necessitates operation on a myriad of terrain types. This includes hills, mountains and ravines — locations where level ground is rare or unavailable. It follows that successful development of mobile weapon systems must incorporate operation on sloped terrain.

Sloped terrain presents challenges for firing large caliber weapons. When a weapon is fired, the forward momentum of the discharge is equally reflected to the weapon in the form of a recoiling impulse. That recoiling force can be minimized via a recoil system, which applies a lesser counter force over a calculated distance to spread the impulse over a greater period of time. However, even with sophisticated recoil systems, large caliber guns can impart significant forces into the weapon mount and, subsequently, the weapon platform. The figure below illustrates a large platform cant combined with a low firing angle tangential to that cant. Firing in this configuration could destabilize the platform, resulting in a vehicle rollover.



Excessive cant

Sloped terrain can also impact non-firing operations. Traversing on a level platform requires force to accelerate the inertia of the mass and overcome any frictional losses. When canted, a gravitational component is added. That additional load increases with the cant angle and is reflected to the traversing mechanism requiring additional force to overcome. There are also instances when cant must be minimized in order to perform certain maintenance procedures, such as boresighting the gun tube.

Due to the challenges presented by operation on uneven terrain, determination of the weapon cant is essential. Computer controlled indirect weapon systems typically have an attitude sensing device that is aligned to the gun tube and enables precise pointing of the weapon. This device provides the attitude of the gun tube relative to Earth using a series of rotations (yaw, pitch, and roll) called Euler angles. In addition, these systems often incorporate sensors to indicate the angles of the traversing and elevating actuators relative to the platform. The weapon attitude and actuator sensor data can be used to calculate the attitude of the platform relative to Earth, as well as the maximum cant and heading values.

This work was done by Joshua Stapp for the Army Armament Research, Development and Engineering Center. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Sensors category****. ARDEC-0001*

Designing for Compressive Sensing: Compressive Art, Camouflage, Fonts, and Quick Response Codes

Achieving optimal CS performance requires a balance between object sparsity and distortion.

Army Research Laboratory, Aberdeen Proving Ground, MD

Compressive sensing (CS) is a relatively new field that has caused a lot of excitement in the signal processing community. It has superseded Shannon's time-honored sampling theorem, which states that the sampling rate of a signal must be at least twice its highest frequency. In CS, the necessary sampling rate depends on the sparsity of signal, not its highest frequency, reducing sampling requirements for many signals that exhibit natural sparsity. This compression happens on the hardware level, allowing systems to be designed with benefits ranging from increased resolution and frame rates to decreased power consumption and memory usage. Despite this enthusiasm for CS and the large quantity of research being performed, the number of commercial systems that use CS is relatively few. The problem of designing a CS strategy that increases functionality while actually reducing overall system cost has not been solved in many areas. This is a developing field where not only are new applications for CS still being developed, but also fundamental aspects of CS theory are still evolving.

Even though CS has not become ubiquitous at this early date, one can look forward to a time in which it plays an important role in many sensing systems. Considering this possible future, it is important not only to properly design the CS sensor, but to also consider how the objects being sensed can be designed to increase overall system performance.

This idea is not unique to CS; examples of designing objects to improve the performance of specific technologies can be found in other areas as well. The image on the left of Figure 1 shows a moire pattern caused by interference between the shirt's stripes and the pattern of the imaging array. When television (TV) newscasters are told to avoid clothes that could cause these patterns, the objects being sensed (the newscasters) are effectively being designed to increase the performance of the sensing system (the TV cameras). Another example is the magnetic ink character recognition (MICR) font shown in Figure 2. This font is used on checks and was designed not only to be readable by humans but also to increase the character recognition performance of MICR readers.

Figure 1. Moire pattern example

Before exploring how objects can be designed for CS, a short review of CS theory is presented

and simple examples are shown demonstrating the advantage of modifying an object's sparsity to increase or decrease CS performance. In more complex object recognition applications, an object's sparsity must be balanced against other factors. Increasing an object's sparsity improves CS performance, resulting in higher reconstruction quality and improved object recognition. But the very act of increasing sparsity distorts the object, which can impair recognition. Simulation results show that by balancing these competing factors, an optimal design can be achieved.

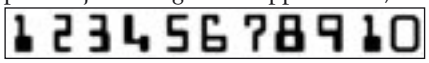


Figure 2. MICR font

This work was done by Michael L Don for the Army Research Laboratory. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Sensors category.*** *ARL-0209*

Phonon Confinement Effect in TiO_2 Nanoparticles as Thermosensor Materials

Thermal sensors have the unique ability to forensically retain the complete thermal history (spatial and temporal variation) of an event under extreme conditions.

Defense Threat Reduction Agency, Fort Belvoir, Virginia

TiO_2 or ZnO nanoparticles (NPs) have a very strong finite-size dependency in their Raman spectra or photoluminescence (PL) spectra due to the phonon confinement effect or the quantum confinement effect. Together with a fast grain growth kinetics and a high stability under high temperature and pressure, they can forensically retain the complete thermal history of an event. By spatially distributing these NPs during thermal events such as blasts or weapon tests, a spatially and temporally non-uniform thermal environment can be determined by a direct read off their Raman or PL spectra at various locations.

These thermosensors can also be used in non-defense applications such as for detecting the transient heating in electronics and measuring the rapid energy release during catastrophic fractures. The protocols developed in this research can be easily extended to the design of other thermosensors where a grain growth or phase transition at lower temperatures is needed to characterize the thermal environment on the biological or cellular level.

Therefore, the objective of this research was to utilize the phonon/quantum confinement effect in Raman/PL spectra and grain growth kinetics in NPs to create thermosensor materials with the ability to forensically retain the complete thermal history (spatial and temporal variation) of a thermal event under extreme conditions.

Ribbon pyroprobe microheater from CDS Analytical, Inc., which can be heated from room temperature to 1400°C with heating rates from 0.01°C/min to 20,000°C/s.

NPs and substrates chosen for use as thermosensor materials had to meet the following requirements:

NPs:

1. Strong phonon/quantum confinement effect;
2. Fast growth kinetics;
3. Easy synthesis to get spherical NPs;
4. High thermal and mechanical stability.

Substrates as NPs' carrier and protector:

1. High thermal and mechanical stability;
2. High thermal conductivity.

Small and monodisperse TiO_2 and ZnO NPs of 5-6 nm in size were synthesized and loaded onto SBA-15 or graphite nanoplatelets (GNPs) substrates. Raman and PL spectrometers were used to establish the particle size versus the Raman/PL peak position master curves. Systematic isothermal and temperature-dependent heat treatments of NPs using a ribbon pyroprobe microheater (see figures) were carried out to study their grain growth kinetics.

This work was done by Liping Huang, Rensselaer Polytechnic Institute, for the Defense Threat Reduction Agency. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com under the Sensors category****. DTRA-0008*

Application Briefs

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(636) 296-5417
www.arnolddefense.com

Arnold Defense, an international manufacturer and supplier of 2.75-inch rocket launchers, has been generating considerable interest in its new, ultra-light LWL-XII and M260 2.75-inch/70mm Weapon Systems.

Arnold Defense is the world's largest supplier of rocket launchers with more than 1.1 million 2.75-inch rocket launchers manufactured since 1961 for the U.S. Army, U.S. Navy, U.S. Air Force and many NATO customers. Traditionally, 2.75-inch rocket systems have been used as an area suppression weapon, ordinarily deployed by aviation assets. The Arnold Defense team is currently developing the FLETCHER smart, laser-guided 4 round launcher, which will be available in 2018. A special forces vehicle- mounted FLETCHER prototype utilizes the advancement of laser guided rocket technology to meet the modern demands of air, land and marine-based, mounted and dismounted asymmetric warfare, for special and conventional forces.

The company designs and manufactures rocket launchers that can be customized for any size, weight, capacity or form factor for platforms in the air, on the ground or at sea. Their products include the new, ultra-light LWL-XII that weighs just over 60 pounds (27 kg) empty. Other core products include the 7-round M260 and 19-round M261 commonly used by U.S. Army helicopters; the thermal coated 7-round LAU-68 variants and LAU-61 Digital Rocket Launcher used by the U.S. Navy; and the 7-round LAU-131 and SUU-25 flare dispenser used by the U.S. Air Force.

Apaches heading out on a support mission, equipped with Arnold Defense's M261 rocket launchers (image courtesy of Arnold Defense)

For Free Info Visit ***http://info.hotims.com/69505-550***

Control Platform Toolkit

Charles River Analytics
Cambridge, MA
(617) 491-3474
www.cra.com

Charles River Analytics Inc., a developer of intelligent systems solutions, recently partnered with Sensics, Inc., creators of the OSVR software stack; Technology, Modeling & Simulation, and Training Consultants (TMST), who provide consulting expertise across the spectrum of live, virtual and constructive training of emerging technologies; and the Virtual Reality Medical Center (VRMC), which provides virtual reality exposure therapy. Together, the team designed and developed the VIRTUOSO interface for the US Army Research Laboratory. VIRTUOSO supports natural human interactions in mixed reality/virtual reality/augmented reality (MR/VR/AR) environments.

The military's shift towards mixed MR/VR/AR training in recent years has yielded safer training at a lower cost than live operations, as well as a more immersive experience than traditional, two-dimensional displays and partial dome environments.

According to Dr. Michael Jenkins, Senior Scientist at Charles River, "During live training, trainees develop learned muscle memory for critical physical tasks. We must support natural interactions so they can develop that same muscle memory in virtual environments."

Toward that end, VIRTUOSO is designed to unobtrusively acquire fine- and gross-motor movements using commercial, off-the-shelf (COTS) peripherals. It is also designed to perform automated skills proficiency assessment by implementing task-tailored skill models with data fusion and probabilistic modeling techniques to infer indicators of skill proficiency.

While the VIRTUOSO toolkit can be applied to any virtual environment simulation, it will initially improve military medical training and education by advancing medical simula-

tion systems, such as those that address combat casualty training. It can automatically assess skill performance and integrates hierarchical models of the abilities and techniques that contribute to overall skill proficiency, allowing users to conduct self-guided training and receive individualized performance feedback to drive improvement. At the same time, expert trainers have the ability to remotely observe these training sessions to provide additional guidance to trainees based on their real-time training performance.

Because VIRTUOSO incorporates so many leading commercial control and display peripherals, it can support training with the equipment best suited to a training task, or support training with the equipment available to an individual when they wish to train. This training robustness means simulations that incorporate the VIRTUOSO framework are resilient to future technology advances.

For Free Info Visit ***http://info.hotims.com/69505-551***

Radar Sensor Systems

Kelvin Hughes
London, UK
+44 19 9280 5200
www.kelvinhughes.com

Kelvin Hughes recently announced a number of new coastal surveillance / Vessel Traffic Service (VTS) radar sensor sales references in Australia including installations in the Port of Melbourne and contracts awarded for Chevron (Barrow Island) and Port Hedland.

At Barrow Island off the coast of Western Australia, AMS Group (previously known as Australian Maritime Systems) won an order to upgrade the VTS system for Chevron's Oil and Gas production activities. Barrow Island is situated 30NM Northwest off the Pilbara coast of Western Australia between Point Samson and Onslow. Despite being Australia's leading site for oil production and one of its largest sites for gas production, Barrow Island retains Class A status as one of Australia's finest nature reserves.

The radar selected for the Barrow Island project is the Kelvin Hughes SharpEye™ SBS-800 series, for a number of reasons. First, the need to conduct maintenance is a costly and logistical burden, and the previous magnetron systems would require frequent maintenance routines. Not only is the island remote, it also requires complete self-sufficiency. SharpEye™ is a solid-state radar, meaning there is no magnetron and regular maintenance routines are not needed. What's more the reliability and MTBF is greatly improved.

Second, the SBS-800 series features Doppler processing and enhanced pulse compression, bringing sea clutter removal without removing the targets of interest, such as shipping and smaller vessels in the area. This capability extends to all ranges, and with tanker mooring for loading of oil via a submarine pipeline from the Island storage tanks to the mooring 10 kilometers east of the Island, this greatly enhances the safety of vessel traffic operating in the area.

Free Info at http://info.hotims.com/69505-861

At the Port of Melbourne in Victoria, a similar requirement led to the successful completion of a project involving the SBS-900 series featuring 2 dual redundant X-Band SharpEye™ transceivers. The difference between the SBS-800 and 900 is that the former locates the SharpEye™ upmast in the antenna rotator housing and the latter places it a few meters downmast on the tower in a self-contained environmentally isolated enclosure. The key benefit here is that both systems — unlike magnetron-based units — do not require the usual additional infrastructure such as a hut at the foot of the radar tower that requires air conditioning, lighting etc.

In addition to the Doppler processing and enhanced pulse compression capability, the SharpEye™ receiver in the SBS-900 system supplied to the Port of Melbourne VTS includes frequency diversity, bringing additional target detection performance along with excellent small target detection and separation benefits. This brings the most state of the art VTS sensor technology to one of Australia's busiest ports for containerised and general cargo shipping. In total two SBS-900 systems have been installed by AMS and Kelvin Hughes in the Port of Melbourne.

Finally, Port Hedland, located in the Pilbara region of Western Australia, chose the SharpEye™ SBS-900 X-Band radar system to be installed as part of a complete VTS system by AMS.

Port Hedland is reported to be the highest tonnage port in Australia, supporting iron ore exports and other mining commodities as well as offshore natural gas field activities. This northern edge of Australia sees inclement sea conditions all year round, producing very high clutter conditions in which radars typically find it difficult to reliably detect targets of interest. The port itself experiences significant tidal conditions, which constrains vessel movements to a four-hour window.

For Free Info Visit ***http://info.hotims.com/69505-553***

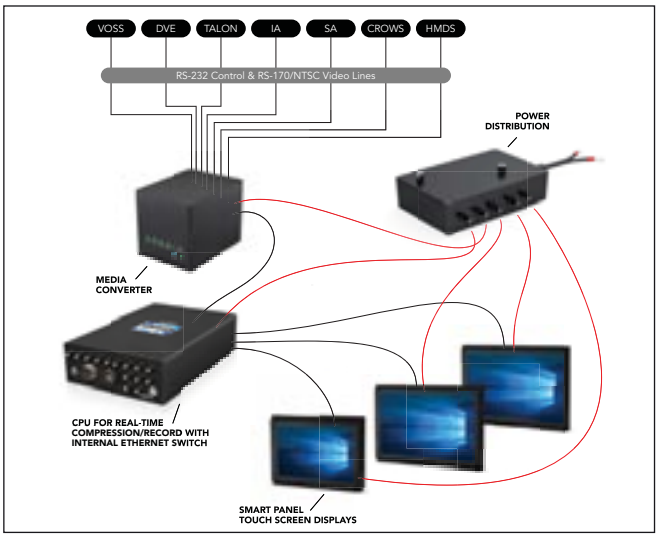
Rugged Server and Display System

General Micro Systems
Rancho Cucamonga, CA
(800) 307-4863
www.gms4sbc.com

General Micro Systems Inc. (GMS) recently announced that the U.S. Army will exclusively deploy powerful rugged server and display systems from GMS to run the multifunction video display (MVD) software within Type II medium mine protection vehicles (MMPV). The GMS system comprises four components – two chassis and two displays. It also includes an enterprise-class, ultra-rugged, secure server with an intelligent 12-port 1/10 Gigabit Ethernet switch, a router, mass-media storage, CITV/DVR, video-over-IP, and two ultra-thin, rugged smart-panel PCs. When coupled with a video encoder, the system is a complete full motion video and control system with storage.

A program of record for the U.S. Army's Product Manager Mine Resistant Ambush Protected Vehicle Systems (PdM MRAP VS) and co-developed directly with the Army's Night Vision and Electronic Sensors Directorate (NVESD), the GMS rugged server and display system gives the MRAP mine-clearing vehicles a distributed platform with smart displays that run the Army's portable MVD software. The system's hardware and software enable the seamless distribution of full motion video and control in real time with low latency from all sensor systems mounted on the MMPV Type II trucks to each crew station.

Compared to the traditional system used on the mine-clearing MRAP, the U.S. Army needed a combined hardware/software system that could provide full situational awareness at all times while also improving crew efficiencies. According to the contract synopsis from the Army Contracting Command - Warren (ACC-Warren), the MVD system "integrates full-motion video from all sources at all vehicle crew stations. The MVD system efficiently distributes images and sensor control to all crew stations within a vehicle, resulting in a single touchscreen display for each crew station capable of viewing



and controlling all vehicle enablers, and creating a seamless common interface across all enablers."

With the MVD system, each networked crew station operates independently such that one crew member can control one sensor system while another crew member simultaneously controls or views another. The ultra-low latency system enables warfighters to drive "head down" in the vehicle, using only cameras and sensors without inducing motion sickness. The MVD system is integrated with the truck's radio so that it too can be controlled from any crew station or set up during pre-mission checks. Because the system is designed to enable soldiers to navigate without direct sight, it can be used in other programs as well.

The key to the system's anticipated success is a combination of low-latency networked video and data processing coupled with NVSED-created modular software. The software presents a standardized view of sensor feedback that is common across all workstation consoles. This gives operators immediate familiarity with different sensors and enables cross-training and cross-operation should the need arise. Moreover, new sensors and counter-IED payload processing can be added while the user interface remains consistent.

For Free Info Visit ***http://info.hotims.com/69505-552***

Counter UAV System

SteekRock UAV
London, UK
+44 (0) 20 7491 8186
www.sruav.co.uk

The use of unmanned aerial vehicles (UAVs) is one of the most significant technological developments in the last decade. However, where once such equipment was unique to military operations, the use of a new generation of small and cheap to buy UAVs has spread exponentially. This brings a new dimension to contemporary terrorism, with those determined to do harm, seeking different ways of carrying out attacks on civilians.

Easily purchased and simple to fly, these UAVs can carry a payload of several kilograms, but are sized to evade traditional security surveillance. Thus, a recreational UAV, which costs no more than a few hundred dollars, can be deployed as an aerial improvised explosive device (IED) or aerial substance disperser.

Many solutions have been designed to help combat this new threat, from Radio Frequency (RF) technologies to physical interceptors. While RF technologies can be used to great effect to disable UAVs, the safety implications of using powerful RF technology, particularly in built-up civilian areas, are serious but rarely talked about.

For SteelRock UAV, the safety of both the counter-UAV system operator and the surrounding human environment have always been a key concern. To address this serious RF technology safety issue, SteelRock UAV has created the NightFighter Counter-UAV System — a highly focussed, directional antenna system, for use in military and civil protection applications that can override, repel, capture and/or take-down UAVs.

Having analysed the problems posed by existing Counter-UAV technology, the NightFighter was designed and manufactured to maximise the safety of the system's operator, as well as the immediate infrastructure and surroundings. If not directed properly, items such as hospital health monitoring systems, security and police communications, telecoms infrastructure (mobile phone masts), vehicle navigation systems and life-saving medical devices (such as pace-makers), which all rely on RF, can be materially affected by Counter-UAV RF devices. The NightFighter has been carefully developed to avoid any levels of interference with such critical national infrastructure, while still delivering precisely and safely on specific targets.

By using a highly directional antenna, the NightFighter minimises the surrounding environment's exposure to RF and, as importantly, shields the operator from the dangerous RF exposure levels that are experienced with other Counter-UAV RF systems.

The NightFighter has undergone rigorous safety and Radiation Hazard testing to ensure that all the steps taken have created the safest Counter-UAV system on the market. Not only has the NightFighter passed all these tests, but in a recent controlled UAV 'take-down' at range, the RF exposure to the operator was measured at 10 per cent of the permitted EU limits — far exceeding design safety expectations.

For Free Info Visit ***http://info.hotims.com/69505-554***

RF Cable

PIC Wire & Cable® (Sussex, WI), a Division of The Angelus Corporation, recently announced the launch of its new RF-MATES® ULTRALITE UH25107 cable. UH25107 is a 50 ohm RF aerospace cable that is highly shielded, light and flexible. The cable's sophisticated design yields low loss characteristics that make it a robust solution for systems requiring a low dB loss budget for antenna runs, like SATCOM and Iridium systems.

In conjunction with the UH25107 release, several new RF-MATES® ULTRALITE connectors have been released to better serve the market's needs.

For Free Info Visit http://info.hotims.com/69505-537

Linear Bearings

LM76 (E. Longmeadow, MA) has developed new corrosion resistant linear bearings called Pegasus Series 1 Linear Ball Bearings. Pegasus Series 1 Linear Bearings feature silicon nitride (SiNi) ceramic balls in a shell with retainer and end caps all made from 440 stainless steel and then Armorloy™ coated. Silicon Nitride was selected for the balls because it is: 40% lighter than steel, inert to chemicals, capable of higher speeds and higher loads (RC78 hardness), FDA compliant, and does not corrode or support electrolysis.

Pegasus Linear Bearings are available in two series (closed and open), and in four sizes (1.000", 1.250", 1.500" and 2.000"). Dynamic load rating for these bearings are: 220 lbs (1.000"), 352 lbs (1.250"), 490 lbs (1.500"), and 858 lbs (2.000"). Bearings are designed for zero clearance on Class L linear shafting. For maximum performance, LM76 Case Hardened 440 Stainless Steel shafting with Armoloy™ coating is recommended.

For Free Info Visit http://info.hotims.com/69505-516

20-Bit Resolution Absolute Encoders

Netzer Precision Motion Sensors (Misgav, Israel) has taken a position sensing technology originally developed for harsh environment specialized applications and made it available for today's broader range of defense, homeland security, aerospace, and instrumentation motion control requirements.

Netzer's Rotary Electric Encoders™ provide exceptionally accurate, high resolution, absolute position with miniature to wide diameter hollow shaft. Available with Analog Sin/Cos, Digital SSi, Digital AqB+I outputs, these rotary encoders feature up to 20 Bit Resolution (with 12 bit A/D) and accuracy to <0.01° .

The Electric Encoder™ non-contact technology relies on interaction between the measured displacement and a space/time modulated electric field. Absolute position output over 360° rotation range. Precision to 0.001° in selected models. Default operation range from -55°C to +125°C.

For Free Info Visit http://info.hotims.com/69505-511

PC/104 Embedded Processing Module

Sundance Multiprocessor Technology Ltd. (Chesham, UK) has announced the SMT6657, an embedded processing module manufactured on the PC/104 small form factor of 90 mm × 96 mm. The SMT6657 features two onboard, dual-core TMS320C6657 floating-point DSPs from Texas Instruments based on the

TI Keystone multicore architecture. It clocks at 1.25 GHz and generates a raw floating-point performance of 40 GFLOPS (20 GFLOPS per core). The DSPs are closely coupled to an on-board Xilinx Kintex Ultrascale KU35 FPGA used for filtering and post-processing. It also provides the I/O brain of the board, controlling a PC/104 interface, the new PCIe/104 OneBank™ for high-speed connection to a growing range of compatible boards.

For Free Info Visit
http://info.hotims.com/69505-512

IP65-Rated Panel PCs

WinSystems (Arlington, TX) has released an advanced IP65-rated panel PC delivering high reliability and an extended operating temperature range in a thin, fanless design. These new panel PCs, which support Linux and Windows 10 operating systems, use the 1.9 GHz Quad-Core Intel® Atom™ processor and include up to 8 GB of RAM. They deliver fast graphics at high resolutions – 1024 × 768 and 1280 × 1024 – accessed via a five-wire resistive touchscreen. The rugged design also incorporates a SATA controller with 2.5-inch HDD/SSD and wide input power: 12-24V DC.

Optimal connectivity and I/O for embedded systems is achieved through 2× Gigabit Ethernet ports, a 1× USB 2.0 port (accommodating up to 3× with expansion) and 1× USB 3.0 port. A watchdog timer is included.

For Free Info Visit
http://info.hotims.com/69505-520

PLL Synthesizers

Fairview Microwave's (Lewisville, TX) six new PLL frequency synthesizer models are compact, rugged, SMA-connectorized designs that support USB 2.0 interface with a PC computer supplying DC power and GUI command control. They cover a broad range of frequency bands from 25 MHz to 27 GHz. These models deliver output attenuation that is adjustable up to 50 dB in 1 dB steps and high output power levels ranging from +10 dBm to +19 dBm typical. Phase noise is as low as -108 dBc/Hz at 100 MHz offset and phase locked speed is 1 msec typical.

These synthesizer models also feature a 50 MHz internal frequency source and optional external reference with supplied cable. Frequency resolution can be adjusted using either integer (default) or fractional modes with resolution to a step size down to 1 MHz.

For Free Info Visit http://info.hotims.com/69505-531

Battlefield Navigation System

Orolia (Valbonne, France), through its Spectracom brand, recently released VersaPNT™, which provides virtually failsafe battlefield navigation, even in GPS-denied environments, to protect critical networks with Assured PNT technology.

The VersaPNT combines a GNSS receiver, inertial measurement technology, and high-performance timing oscillators to provide Assured PNT in GNSS degraded and denied environments. The rugged and highly customizable device serves as a navigation system, master clock, and network time server for mobile applications in harsh environmental conditions.

For Free Info Visit http://info.hotims.com/69505-532

Rugged Tablet Computer

Dell (Round Rock, TX) announced the launch of the Latitude 7212 Rugged Extreme Tablet, designed to perform in the world's toughest jobs and harshest environments. Weighing just over 2.8 lbs. for base configurations and built with the latest Intel 6th and 7th Generation Core I-series 15-watt processors, the Latitude 7212 delivers up to 19 hours of battery life with dual, hot-swappable batteries.

Features include: Scalable performance with 6th and 7th generation Intel Core i-series CPUs for both Windows 7 and Windows 10 support; up to 16GB of memory; up to 1TB of removable PCI-Express NVMe SSD storage; sophisticated 4th generation Dell Quad-Cool passive and active thermal management system that uses a sealed fan assembly to dissipate heat while preventing water and dust particles from entering the device; and a multi-touch glove capable 11.6" FHD display that features a Gorilla Glass cover.

For Free Info Visit http://info.hotims.com/69505-517

Multi-Axis Robotic Controller

Aerotech's (Pittsburgh, PA) HEX RC is a 6-axis motion controller designed for controlling robotic systems like hexapods. The HEX RC is 4U rack-mountable and compatible with the Automation 3200 (A3200) motion platform. A high-performance processor provides the intense computing power needed to run up to 32 axes; perform complex, synchronized motion trajectories; manipulate I/O; and collect data at high speeds.

The HEX RC features 6-axes of drives capable of controlling any combination of brush, brushless, or stepper motors. It digitally performs both current loop and servo loop closures to ensure the highest level of positioning accuracy and performance. The HEX RC connects and controls up to 26 additional axes of servo, stepper, or piezo-driven stages using the A3200 distributed control architecture. The HEX RC is designed with an ASCII command interface over TCP/IP for control in applications such as beamlines. Alternatively, it can act as a master controller to control other A3200 external drives via the FireWire® interface.

For Free Info Visit http://info.hotims.com/69505-530

LAN Modules for Power Supplies

TDK-Lambda Americas, Inc. (National City, CA) has introduced LAN (Local Area Network) modules for the popular HFE series of 1600W and 2500W rack mounted, hot swap power supplies. These optional modules allow remote monitoring, status check and programming through a number of standard protocols, supporting VISA (Virtual Instrument Software Architecture). The LAN option is suitable for computer networking, telecommunications, test and measurement and industrial equipment.

The modules plug into any open slot on the standard HFE1600 or HFE2500 19" racks, measuring the same size as the HFE1600 or HFE2500 I^2C / PMBus™ equipped power supplies. Removal or insertion of the modules can be made with the AC input applied (to the HFE rack housing, HFE1600-S1U or HFE2500-S1U) without causing any disruption to the power supply output voltage. The HFE1600-LAN and HFE2500-LAN can be used with any of the available HFE output voltages and can support up to two racks, or their individual power supplies. The LAN modules are certified to IEC/EN/UL/CSA 60950-1 with CE marking for the Low Voltage and RoHS2 Directives.

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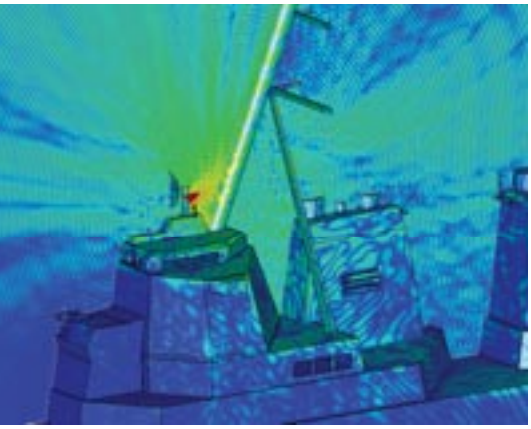
April 2018, Volume 3, Number 2

Make the Connection

Find the simple way through complex EM systems with CST STUDIO SUITE



Components don't exist in electromagnetic isolation. They influence their neighbors' performance. They are affected by the enclosure or structure around them. They are susceptible to outside influences. With System Assembly and Modeling, CST STUDIO SUITE helps optimize component and system performance.

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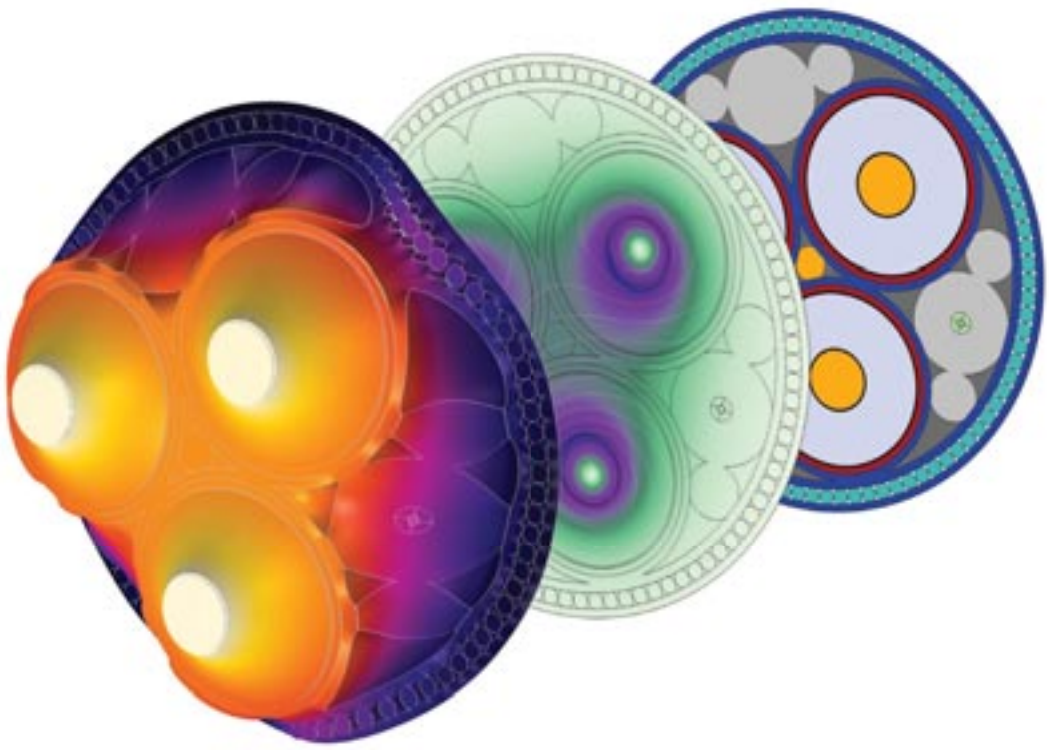

Visualization of temperature (left) and magnetic flux density norm (center) in the cross section (right) of an industrial-scale cable.

In cable design, it's important to account for capacitive, inductive, and thermal effects in the cable parts. For example, different bonding types result in different current buildup and losses. Similarly, phase conductor and armor twist affect current distribution in the cable. Knowing this up front will help you make informed design decisions. This is where electromagnetics simulation comes in.

The COMSOL Multiphysics® software is used for simulating designs, devices, and processes in all fields of engineering, manufacturing, and scientific research. See how you can apply it to cable design.

comsol.blog/cable-tutorials

COMSOL