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# Applications of Nanotechnology in Military Medicine

## From the Battlefield to the Hospital and Beyond

Homeland Defense & Security Information Analysis Center

# JOURNAL

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Department of Defense Information Analysis Centers

# Contents



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# HDIAC Welcomes:

**Joseph Cole**
**Deputy Director**

HDIAC is pleased to introduce Joseph "Joe" A. Cole as HDIAC's deputy director. Cole will interface with HDIAC clientele and personnel and lead day-to-day operations.

Cole joins HDIAC after 22 years with the U.S. Environmental Protection Agency-Criminal Investigation Division, where he recently retired as the resident agent-in-charge.

In addition to his daily duties as deputy director, Cole will continue his service to the nation as a lieutenant colonel in the United States Army Reserve focusing on environmental science and engineering; chemical, biological, radiological, nuclear and explosives support; and consequence management matters.

Cole possesses a breadth of knowledge, training and experience in many of HDIAC's core focus areas and will significantly contribute to HDIAC's scientific and technical research capabilities.

Cole also brings tangible homeland defense response through his participation as an EPA-CID National Counterterrorism Evidence Response Team member during the Sept. 11, 2001 terrorist and the 2001 Amerithrax attacks.

Cole has a bachelor's degree in environmental health. In addition, he completed graduate work in national security and emergency management. Cole also passed the Certified Hazardous Materials Manager, Certified Safety Management Practitioner and Registered Sanitarian board exams.

Also joining HDIAC is R. Brandon Hulette. HDIAC welcomes Hulette as the scientific and technical advisor. Hulette will interface with HDIAC clientele, serving as a program manager on all projects involving research, development and demonstration.

Hulette comes to HDIAC from the Tennessee Department of Environment Conservation, where he was the director of the Fleming Training Center. Hulette is also a seated member of the Tennessee Governors Board of Homeland Security.

In addition to his civilian duties, Hulette is a major in the United States Army Reserve, where he focuses his efforts in environmental science and engineering, CBRNE support and consequence management. He is a distinguished and sought after subject matter expert in several of HDIAC's focus areas.

Hulette holds bachelor's degrees in microbiology and environmental policy; an advanced degree in epidemiology; and a current Emergency Medical Technician license. Hulette also maintains Registered Sanitarian and Microbiologist certifications.

Hulette is a national lecturer and adjunct professor at the Meharry Medical College where he has authored numerous scientific publications.

In his role with HDIAC, Hulette will function as the subject matter expert on all Core Analysis Tasks. He will continue his professional research in the scientific and technical field and represent HDIAC at symposia.

**Brandon Hulette**
**Scientific and Technical Advisor**

# Message from the Director:
## Better Buying Power 3.0

The Homeland Defense and Security Information Analysis Center supports Better Buying Power 3.0, a Department of Defense initiative to achieve dominant capabilities through technical excellence and innovation. HDIAC supports BBP 3.0 by improving affordability, productivity and standardization within defense acquisition. This highlight focuses on two components of BBP 3.0: Achieve Affordable Programs and Eliminate Unproductive Processes and Bureaucracy.

The BBP 3.0 element, achieve affordable programs, looks at prioritizing requirements and ensuring programs remain within affordability caps. By researching work conducted in industry and academia and matching it with government requirements, HDIAC provides the government with information needed to prioritize requirements based on current and ongoing research in the needed field.

The eliminate unproductive processes and bureaucracy element of BBP 3.0 focuses on removing numerous inefficiencies to further strengthen the DoD's buying power. The Pentagon recognizes the Information Analysis Center Program as, "a proven resource for maximizing the value of each dollar the Department spends."

According to the DoD's Better Buying Power mandate, "Unnecessary and low-value added processes and document requirements are a significant drag on acquisition productivity and must be aggressively identified and eliminated."

Through the technical inquiry process, HDIAC analysts and subject matter experts answer questions and help identify technologies of interest to the government, as well as gaps that need to be addressed.

### Better Buying Power Focus Areas

1. **Achieve Affordable Programs**
2. **Control Costs Throughout the Product Lifecycle**
3. **Incentivize Productivity and Innovation in Industry and Government**
4. **Eliminate Unproductive Processes and Bureaucracy**
5. **Promote Effective Competition**
6. **Improve Tradecraft in Acquisition of Services**
7. **Improve the Professionalism of the Total Acquisition Workforce**

Recently, HDIAC received an inquiry from a DoD agency, requesting research and analysis on next generation bandage options. This inquiry, in which HDIAC reviewed and analyzed emerging technologies in wound care, showcases HDIAC's efforts in addressing the BBP 3.0 initiative, "Reduce cycle times while ensuring sound investment decisions."

Under this initiative, the government is encouraged to mitigate long development cycles and reduce the time and cost to field a product. By researching and analyzing concepts under development, HDIAC provides information to assist the government in lessening development costs and cycle times.

Upon receiving the inquiry, HDIAC analyzed research trials and studies supporting current and ongoing next generation wound dressing research. HDIAC's research led to options in the academic and industry sectors. Members of HDIAC's Scientific and Technical Analysis Team spoke to the researchers working in wound care to determine if and how their research and products meet the DoD organization's requirements for the next generation bandage.

After analyzing and reviewing capabilities, HDIAC discovered various prospects that met the requirements. Specifically, HDIAC found fully customizable wound care options, made of novel materials, which could incorporate needed medications as well as stop bleeding and encourage tissue growth. HDIAC also presented options to combine research efforts from various organizations to develop one all-inclusive product.

Additionally, HDIAC included external developments, specifically wound monitoring, that would provide further advancements in next generation wound dressings. As the DoD continues to refine its requirements, a combination of approaches may prove beneficial in meeting all of its needs.

An agile approach is key to providing the most comprehensive and reliable solution. Even after completing the inquiry response, HDIAC continues to engage various medical research and development prospects regarding emerging wound care technologies in order support and sustain the warfighter.

Technologies developed by industry and academia drive innovation. BBP 3.0 initiatives promote innovation in research and development in academia and industry to better enable and equip the warfighter.

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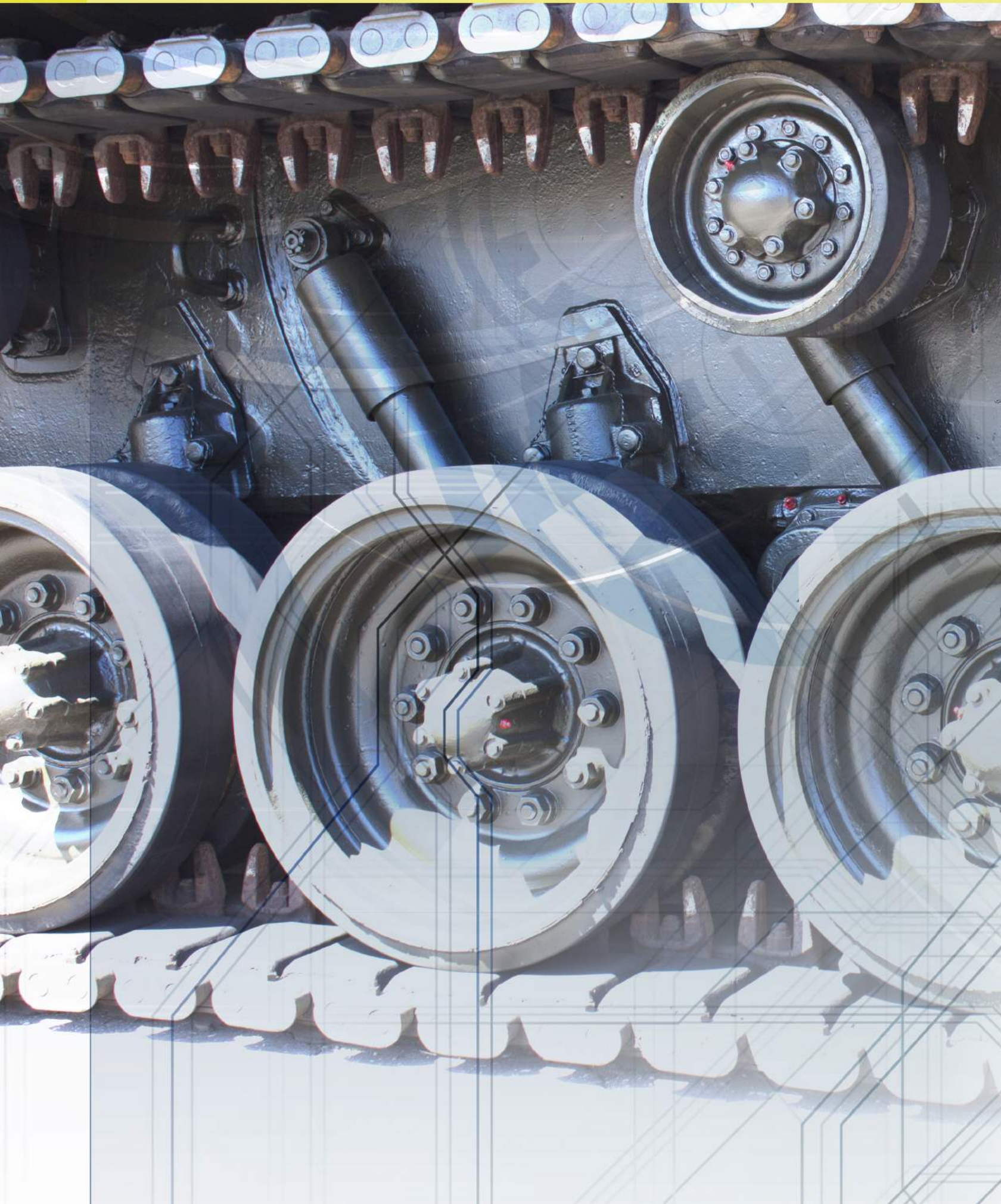

# Partial Hybridization for Military Power Applications

By: Daniel Carder, Ph.D. & Ross Ryskamp

The U.S. Department of Defense is a significant consumer of petroleum fuel. In Fiscal Year 2014, the DoD consumed 87.4 million barrels of fuel. [1] "This fuel supported operations in Afghanistan, Africa, and Iraq, as well as the Department's global presence, training at home and overseas, and logistical resupply." [1]

Since Fiscal Year 2000, fuel consumption by the DoD increased, peaking in 2007 and subsequently declining by 30 percent in Fiscal Year 2014. [1] In 2008, approximately 68 million gallons of fuel were supplied per month to support U.S. military operations in Iraq and Afghanistan. [2] Although aircraft used significant portions, the DoD reports the single largest battlefield fuel consumer was generators. A 2008 Defense Science Board Task Force report concluded Army generators consume approximately 26 million gallons of fuel annually in peacetime and 357 million gallons annually during wartime. [2] Furthermore, delivering this fuel to forward operating bases in wartime is hazardous and costly. Cost estimates to ship JP-8, the cho-

sen fuel of the U.S. military based on its one fuel forward policy developed in the late 1980s, [3] to theaters of war in the Middle East are as high as $400 to $600 per gallon. [4]

In June 2008, DoD officials reported 44 trucks and 220,000 gallons of fuel were lost due to attacks or other events during delivery to forward-deployed locations in Afghanistan. [2] A 2010 study found Marine and Army units in Afghanistan averaged one casualty for every 50 fuel and water convoys. [5] Reducing fuel consumption by military vehicles and generators, as well as developing other technologies to provide electricity at forward-deployed locations, would provide financial benefits and reduce casualties.

One proven method to reduce vehicle fuel consumption is electrical hybridization. Several commercially available hybrid electric architectures exist today. These include micro or mild electric hybrids, parallel electric hybrids and series electric hybrids. Development of each of these fields originally concentrated on non DoD-specific applications; however, system design attributes of each provide performance characteristics that tailor nicely to the needs of future military vehicle designs.

Micro or mild hybrids offer the least fuel economy and performance benefit, but also the least added complexity and deviation from conventional internal combustion engine powered platform designs. Hence, they provide a distinct retrofit pathway to impact performance characteristics of existing fleets. Mild hybrids are characterized by a motor/generator that is coupled to the ICE often by a belt or in the form of an integrated starter generator, displayed in Figure 1. This motor/generator can start the ICE and generate electricity to charge a battery or capacitor based energy storage system.

With proper sizing and drive system design, these systems can also take limited advantage of regenerative braking energy availability. In conjunction with an energy storage system, the integrated starter generator allows for the electrification of mechanical accessories, such as the coolant pump, oil pump, cooling fan, air conditioning compressor and power steering pump. Electrification of these accessories allows them to operate when needed, rather than constantly through mechanical power, therefore reducing parasitic loads on the ICE.

Micro or mild hybrids with electrification of accessories also allow implementation of start-stop technology, where the ICE shuts off when the vehicle is stationary, yet systems such as air conditioning can continue operation. The ICE quickly starts again when movement is demanded.

One obvious benefit of this type of system is silent watch support, where the vehicle is stationary and the ICE can be shut off while an energy storage system supplies electricity to mission-critical equipment. Based on simulations performed at Argonne National Laboratory, such a system installed on a class 8 line-hall truck can provide up to 10 percent fuel economy benefit in urban driving. [6]

Parallel electric hybrids often employ an integrated starter generator, but also utilize another electrical motor(s) (integrated into the drivetrain) to aid in vehicle propulsion, in addition to a direct connection of the ICE to the road (ICE to transmission to differential), as demonstrated in Figure 2.

The advantages of this system over a micro/mild hybrid is the enhanced recovery capability during regenerative braking, resultant of larger motor power capacity, and propulsion from the electric motor that is connected to the drivetrain directly or through the road. If the typical operation of a vehicle includes significant brake usage and urban driving, the energy recovered and fuel economy benefits can be more substantial from this type of hybrid-electric system versus a micro/mild hybrid. However, the system includes

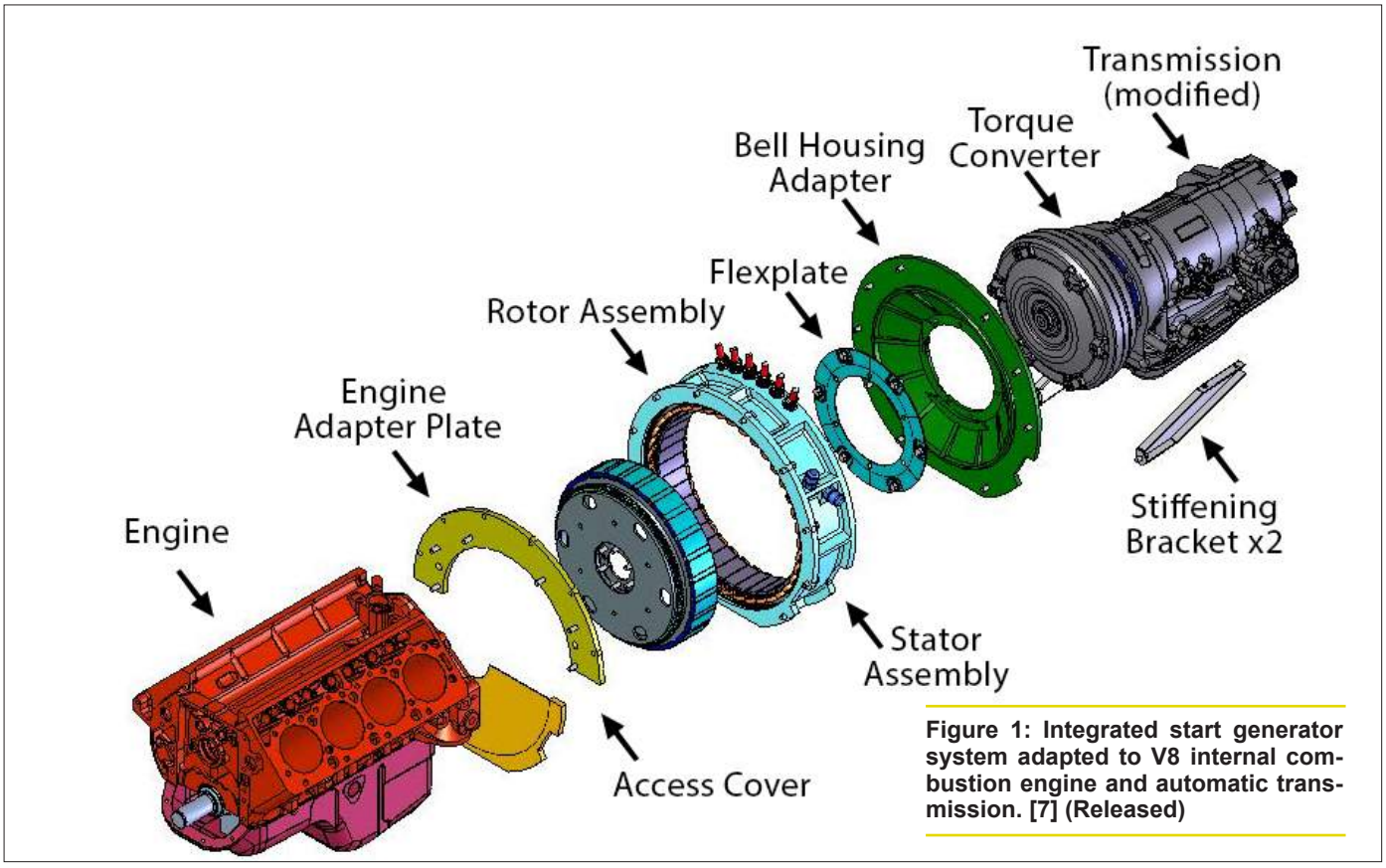


**Figure 1: Integrated start generator system adapted to V8 internal combustion engine and automatic transmission. [7] (Released)**

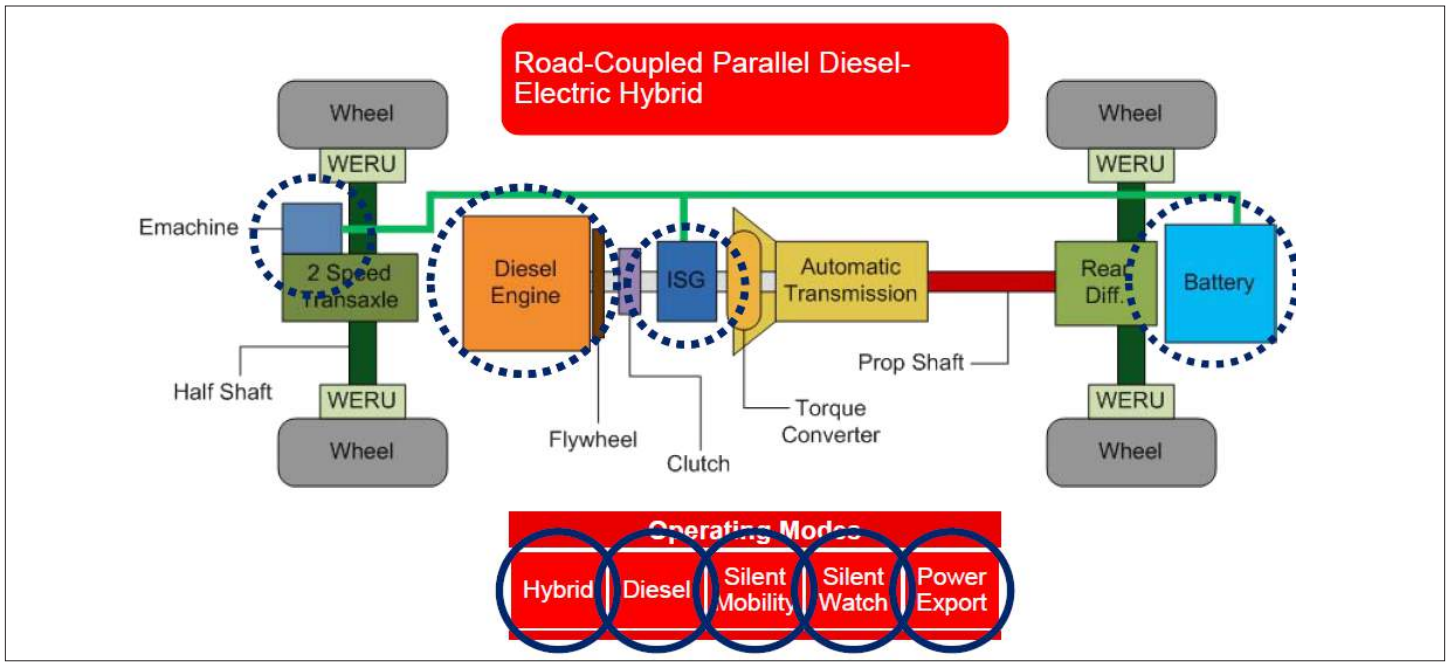


**Figure 2: Parallel hybrid-electical architecture. [7] (Released)**

more components and its integration is more complex.

Engine downsizing can also provide additional fuel economy benefits with performance levels maintained by the additional power of an electric motor. Another benefit of a parallel hybrid system is, in addition to silent watch support, the vehicle can operate at low speeds with the electric motor and without the ICE, to reduce noise. Simulations of such systems have demonstrated 20 to 40 percent improvement in fuel efficiency over conventional vehicles, depending on operation characteristics. [6]

A series hybrid mechanically decouples the ICE completely from the drivetrain of the vehicle. The ICE connects to a generator, which supplies energy to electric motors. In a similar fashion as the parallel hybrid architecture, an energy storage system can integrate into the system to provide low speed operation without the ICE and regenerative braking capabilities.

Figure 3 provides a comparison of the energy losses from conventional, parallel hybrid and series hybrid vehicles over the urban dynamometer driving schedule and the freeway-dominate heavy duty truck cycle. Note that the magnitude of improvement in fuel consumption is dependent on the operation of the vehicle, among other factors.

In urban driving, represented by the urban dynamometer driving schedule, both the parallel and series hybrid offer more than 20 percent improvement in energy loss, which correlates directly to reduced fuel consumption. However, this improvement in energy loss over a conventional vehicle does not translate to predominantly high speed operation, represented by the freeway-dominate heavy duty truck cycle.

More than 10 percent of the energy loss improvement during urban driving came from the energy capture during braking for both hybrids, but when this mode of operation is reduced (freeway-dominate heavy duty truck cycle), the series hybrid encountered 8.4 percent more energy loss than the conventional vehicle. This additional energy loss can be attributed to increased losses by the ICE and the motor/generator, and minimal regenerative braking energy available to offset them.

The U.S. military, specifically the Army's Tank Automotive Research, Development and Engineering Center has been conducting research on hybrid electric military vehicles for more than 20 years. [9] In the second quarter of 2011, TARDEC demonstrated and tested a hybrid-electric Joint Light Tactical Vehicle. [7] This vehicle featured a road-coupled parallel diesel-electric hybrid architecture displayed in Figure 2.

It also utilized a 4.4 liter high efficiency Ford diesel engine, a 145 kilowatt electric motor positioned between the front wheels, and an integrated starter generator between the diesel engine and transmission. Compared to its predecessor, the M1114 Humvee, modeling and simulation results demonstrated that it could improve fuel economy from 5.19 mpg to 8.15 mpg in wartime conditions, with further gains expected. [7]

Oshkosh Defense also developed series electric hybrid technology in its Heavy Expanded Mobility Tactical Truck and Medium Tactical Vehicle Replacement platforms. [10] These vehicles utilize a diesel engine coupled to a generator to produce electric power for motors located at the axles.

The HEMTT vehicles also incorporated an ultracapacitor-based energy storage system. An option for these vehicles was developed to provide export power, up to 100 kW from the HEMTT vehicle and 120 kW from the MTVR when stationary.

BAE Systems developed a hybrid electric drivetrain option for the Ground Combat Vehicle. Compared to the conventional mechanical propulsion system, the hybrid electric system is capable of 10 to 20 percent better fuel economy. [11]

Another method of improving the fuel efficiency of ICEs is through capturing a portion of the heat rejected from the ICE with the use of thermoelectric generators and other waste heat recovery systems. In general, a large amount of exergy is available from an ICE in the form of its exhaust gas and cooling systems.

Engine dynamometer results have shown, for a modern heavy-duty diesel engine operating at approximately 40 percent thermal efficiency, nearly 25 percent and 10 percent of the fuel energy input to the engine is lost through the exhaust and cooling systems, respectively. [12]

Obtaining useful energy from these sourc-

es, although feasible, has it challenges. Thermoelectric generators are generally associated with less than 10 percent thermal efficiency. During normal operation of a 100 kW engine, for example, this theoretically only allows for less than 7 kW of recoverable energy from the exhaust. In practice, it is found to be even less, generally less than 1 kW. This is because placing a thermoelectric generator directly in the exhaust stream is not necessarily feasible, and heat exchangers or other methods to extract the energy can often impose additional backpressure on the engine causing it to become more inefficient.

Organic Rankine Cycles, developed to recover energy from ICE exhaust, have been calculated to provide up to a 20 percent power increase from the ICE. [13] In practice, these systems are generally only capable of less than 10 percent power increase. In commercial vehicles, which adhere to strict federal emissions standards, their applicability is also limited because modern exhaust aftertreatment systems must be thermally maintained to be effective. This limits where and how much energy can be extracted from the exhaust by waste heat recovery systems.

Military vehicles, however, have the benefit of a lack of exhaust aftertreatment systems because of their incompatibility with world fuels (high sulfur content) and durability concerns due to harsh operating environments. This makes the applicability of waste heat recovery devices more feasible for military vehicles.

Integrating any of these hybrid systems or waste heat recovery systems with electrical storage systems has potential to be useful for supplying enough power for onboard systems and other external applications needed in the battlefield.

These important applications include charging individual soldier equipment, powering weapons, targeting systems, tactical unmanned aerial systems and emergency power. In addition to wartime power requirements, export power from hybrid vehicles and energy storage systems is useful for disaster relief activities.

Military applications provide common and unique challenges for energy storage systems. Energy density with regard to mass and volume are critical challenges for commercial and military energy storage systems. However, energy storage systems for military applications must be able to operate safely at low and high temperatures (-46 °C to 71°C [14]), be stored at low and high temperatures (-54 °C to 88°C [14]), and under greater shock and vibration conditions than commercial systems.

Cooling systems for military energy storage and export power solutions are complicated by the harsh environmental conditions they must withstand. For example, forced air-cooling systems offer a simple cost effective method of cooling electronic components, but the air must be relatively clean. Dust and dirt buildup on components reduces the amount of heat transferred, which can precipitate failures. [15]

Liquid cooling systems are a solution to this problem, but have their own drawbacks, such as added complexity and cost. To keep electronic components in contact with the cold plate of many liquid cooling systems, compact packaging and space must be sacrificed. [15] Non-conventional liquid cooling technologies, such as immersion in oil, can provide additional heat transfer capability. Circulating cooling oil that immerses components is a technology already in use on commercial hybrid vehicles for battery chargers and transformers. [15]

In addition to temperature requirements, numerous other requirements exist for military energy storage and power export systems such as electromagnetic interference (MIL-STD-461-F), ballistic shock (MIL-STD-810G), live fire (MIL-STD-810G), explosive environment (MIL-STD-810G), altitude to 60,000 feet (MIL-STD-29595), Explosive Decompression (MIL-STD-810G), salt fog (MIL-STD-810G) and sand and dust requirements (MIL-STD-810G). [14]

As a result, some of the important milestones in energy storage are developing energy storage systems with higher energy and power densities; delivering durable battery solutions in standardized military form factor (e.g. 6T); and solving the low temperature operation resulting in reduced power from increased impedance, discharge current and capacitance, high temperature operation triggering reduction in battery life span, and increasing corrosion and safety hazard. [16]

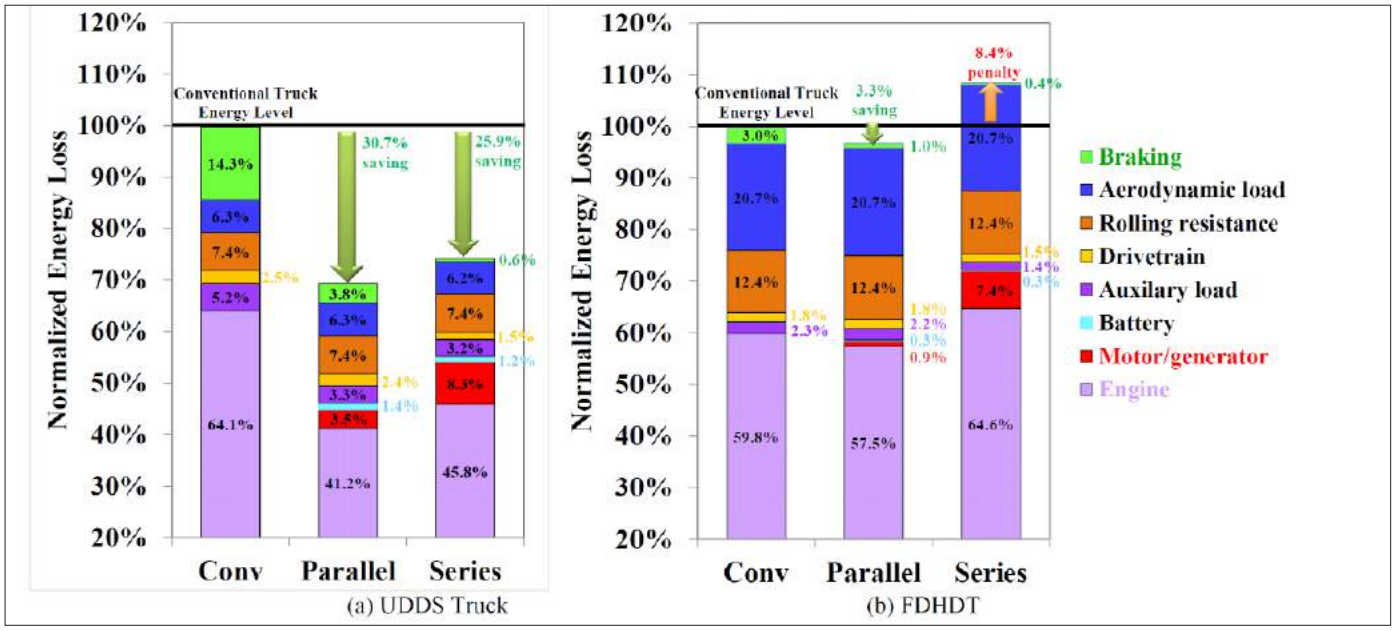


**Figure 3: Normalized energy loss comparing conventional, parallel hybrid and series hybrid vehicles over urban dynanometer driving schedule and freeway-domanant heavy duty truck test cycles. [8] (Released)**

Other sources of energy generation have been considered and even exist for military applications, especially combat outposts. These include photovoltaic solar panels, waste-to-energy systems, micro-hydro turbines and wind turbines. [17]

These technologies are part of a micro-grid approach, where multiple power generation sources are used to provide electricity to a military installations. Photovoltaic power systems are an attractive solution for energy generation based on their minimal maintenance and environmental impact. Photovoltaic-integrated military shelters are available and offer reduced electrical demand by cooling loads while generating low kilowatt level power. [17]

INI Power Systems, a manufacturer of man portable generators and power systems, offers 360 watt and 180 watt flexible photovoltaic kits for use in conjunction with their power systems. [18] Larger photovoltaic installations could be seen on tactical vehicles, in the form of deployable panels, when the vehicles are stationary. Although photovoltaic technology is not a full replacement for conventional power generation, as a supplement, and when combined with other technologies discussed, substantial reductions in the U.S. military's fuel consumption could be realized.

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**Daniel Carder, Ph.D., is the director of the Center for Alternative Fuels, Engines and Emissions at West Virginia University. For more than 20 years Carder has specialized in the measurement and control of heavy-duty mobile source exhaust emissions and alternative fuels research. His interests include design and development of exhaust emissions control systems, gaseous and particulate matter measurement and characterization, as well as in-use emissions measurement. His research has spanned most of the transportation sector, including medium- and heavy-duty on-highway, transit bus, locomotive and marine vessels, while his diesel engine research endeavors have covered on-highway, off-highway, mining and portable/stationary applications of both conventional and hybrid designs.**

**Ross Ryskamp is a graduate research assistant with the Center for Alternative Fuels, Engines and Emissions at West Virginia University. Ryskamp is actively researching the effects of fuel properties on advanced combustion regimes, studying dual-fuel diesel and compressed natural gas combustion, bi-fuel gasoline natural gas and liquefied petroleum gas. He was part of a research team that investigated diesel fuel property effects on advanced combustion regimes for the Coordinating Research Council. His dissertation focuses on a reactivity controlled compression ignition, using dual-fuel diesel-natural gas combustion to reduce oxides of nitrogen and soot exhaust emissions, yet retain or exceed the fuel efficiency of conventional diesel combustion.**

# Operational Energy

**By: HDIAC Scientific and Technical Analysis Team**

Energy security and forward operating base self-sufficiency are not solely logistics issues; they also affect the safety of the warfighter. Self-sufficient FOBs require fewer resupply convoys, which are vulnerable to insurgent attacks and put warfighters in harm's way. [1] To mitigate these dangers, the Department of Defense's 2025 energy security goals include reducing energy consumption at military instillations, while also increasing on-site energy generation and utilizing alternative energy sources. [2]

The Homeland Defense and Security Information Analysis Center received a request to analyze emerging technologies capable of assisting in meeting operational energy requirements.

Many alternative energy systems, such as solar panels and wind turbines, rely on consistent weather conditions, which may hinder their use in military installations. All FOBs, however, generate waste during day-to-day operations, which provides an untapped opportunity for on-site energy generation as 90 pounds of mixed waste possesses the same energy content as five gallons of JP-8 jet fuel. [3] Using waste to create energy can improve FOB self-sufficiency and energy security by diversifying energy generation options while reducing the amount of waste requiring removal, including food and animal waste, grass, and waste paper. [4,5]

The DoD previously tested waste-to-energy systems, employing the Tactical Garbage to Energy Refinery to reduce the need for fuel and waste convoys during operations in Iraq. [6] TGER employs a biocatalytic system to break down organic materials and a thermochemical system to process "solid wastes such as paper, plastic and Styrofoam." [7]

TGER decomposes the waste, creating a slurry, and ferments it to create a 5 percent hydrous ethanol. [7,8] The system converts the remaining material into fuel pellets, [7] and heats the pellets within a gasifier to break them down into a synthetic gas. [8]

After adding a diesel drip to the synthetic gas and ethanol blend, the mixture powers a standard diesel generator. [7,8] Byproducts from this procedure include ash, carbon dioxide and heat usable for "field sanitation, shower, laundry, or cooling devices." [7] During TGER's use at Camp Victory, the unit processed an average of 54 pounds of solid waste and 13 pounds of liquid waste per hour, while saving 2.6 gallons of diesel fuel each hour. [7]

Wastewater treatment offers another process for waste-to-energy generation for FOBs. Transitioning military installations to anaerobic wastewater treatment systems allows processing wastewater while producing biogas, all at a lower energy cost than aerobic wastewater treatment. [4,9] During anaerobic wastewater treatment, matter is broken down through chemical reactions. The process creates compounds used to fuel subsequent reactions, culminating in the creation of biofuel. [10,11]

In the first step, hydrolysis reactions convert large and complex molecules into smaller, more easily metabolized molecules. [10] Hydrolysis is especially important when large amounts of suspended solids and large molecules are present. [10] Using the products created at the end of hydrolysis, acidogenesis uses microorganisms to further break down organic matter while creating additional compounds, most notably

hydrogen and carbon dioxide. [11]

In the next step, acetogenesis, bacteria transforms the products resulting from acidogenesis into acetic acid and additional hydrogen and carbon dioxide. [11]

The final step, methanogenesis, converts hydrogen and carbon dioxide formed during acidogenesis and acetogenesis into methane and water through a chemical reaction. [11] The final biogas product following methanogenesis possesses an energy content of 22-26 MJ/$m^3$ and consists of 60 to 70 percent methane and 30 to 40 percent carbon dioxide with traces of other compounds and gases. [10]

Further modification of waste-to-energy systems to use non-organic materials not currently supported, such as metal and glass, [8] would increase usability by offering additional fuel sources otherwise discarded.

Recent research may prove beneficial toward incorporating metal wastes by utilizing metal particles such as iron, which possesses high energy densities and low emissions, heated in a metal-fueled combustor. [12] This process creates thermal energy used to power heat and steam engines as well as provide heating. [12]

In an ideal system, alternative energy sources such as waste-to-energy systems deliver on-site power generation to run energy efficient technologies. While many commercial off-the-shelf products offer the DoD technology needed to meet its energy security mission, the technology requires additional research and development to ensure the products meet military standards of ruggedness, portability and cost.

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Leveraging
Smartphones
& Biometrics
in
Disasters
STATUS:
FOUND SAFE_

By: Jonathan Hayes & David Lohman

## Introduction

How ready is the government for the aftermath of natural disasters or terrorist attacks? While significant work is underway to prevent, deter and respond to the initial event, less emphasis is placed on managing the days and weeks after a disaster or terrorist event. This is where lasting success or failure may be determined. Biometrics offers some unique applications ideally suited in that scenario.

Terrorist and disaster event numbers in the United States are relatively low considering its population and compared to the number of events in other countries. The Washington Post, however, reported that Hurricane Katrina displaced more than 400,000 people. [1]

Is the government prepared for another Katrina-scale event? What about the public? One technical solution lies just outside execution's grasp, based in some of today's emerging technological advancements. A properly designed solution would equally prepare the public and the government for any number of crises that might occur, turning a disaster with lasting random impacts into an event with a course of action to overcome its chaos.

Depending on the scale of the disaster, evacuating and tracking people can be messy and chaotic. Panicked people, concerned about their family, may not heed directions, such as shelter-in-place instructions. People in different locations will likely evacuate to separate shelters. Social media may help, but it is also unorganized and often full of misinformation.

In the case of immediate emergency evacuations, how does a family know who is safe or unaccounted for? How do they rejoin? How does one determine who is impacted?

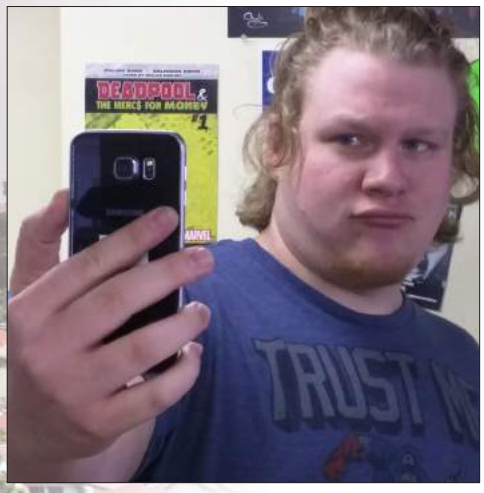


**Figure 1: James Spitznogle demonstrates taking a "selfie" with a smartphone. (Image courtesy of Jonathan Hayes/Released)**

The Senate Bipartisan Committee's report on Hurricane Katrina outlined numerous specific problems that occurred before, during and after Katrina. [2] Potential solutions include implementing biometrics and technology reuse to provide a scalable solution viable from community to state and even national levels. In a time of cost-cutting measures and government budget overruns, developing a system that does not recreate the wheel, but creates its efficiency would be the ultimate goal of any new systems. Consideration would be on technology that the government already has and technology that a majority of the general population possesses.

## The Solution

*"Joint Task Force Katrina, the National Guard, Louisiana, and Mississippi lacked needed communications equipment and the interoperability required for seamless on-the-ground coordination."* - Senate Bipartisan Committee's report on Hurricane Katrina. [2]

There are approximately 600 million smartphones with biometric sensors in use, a mere 28 percent of smartphones worldwide. [3] These smartphones include different types of fingerprint sensors involving either placing the finger on or swiping a sensor. For those phones missing fingerprint sensors, capturing a face with the embedded megapixel camera is an option.

Both types of biometrics are of sufficient quality that financial and other institutions use them for verification purposes.

Facial verification in smartphones can be done through self-enrollment using the front-facing or "selfie" camera. A person captures a face image which is processed and converted into a mathematical representation or template of the image. This template is basically a geographic roadmap of the face. The method employed to create the template is determined by the algorithm used and will vary from company to company. A person verifies themselves in order to access functions of the app at a later time. Verification is the process of capturing a facial image and comparing it to the earlier captured image.

Increased security can be achieved through two-factor authentication, a process of layering a pin or password with a biometric. This process can be used to register a specific smartphone device to a person. Smartphone applications are numerous and increasing daily. They have various applications from games to health monitoring to work tools.

A solution involves creating a biometrically-enabled smartphone application targeted for use on any number of general population or first responder devices, combined with a back-end national emergency management system, managed by the proper emergency service group or agency. The general population's and first responder's app would differ greatly in function, but both would serve the larger purpose of emergency preparedness. Once developed, an emergency management system could be used by the military in any number of global humanitarian situations.

The concept of the app centers in downloading and self-registering. To do so, one would enroll in the emergency management system by providing basic personal contextual information: name, address, immediate family information and a biometric to register or link to the identity. After registering, the app would require biometric verification of a person's identity to the registered information in order to submit reports or access other functions offered by the emergency management system.

For a system with two-factor authentication, a person enters a pin or password and then presents a biometric image. These "factors" are compared to the registered items stored locally on the smartphone. This process is called verification or the one-to-one comparison of a presented to a registered factor. In this case, the biometric is a physical token and the pin or password is a memorized item.

For emergency management purposes, a facial image is the preferred biometric as it could easily be presented visually when necessary to first responders or others for verification. This type of personal verification could be used by the U.S. military for any number of applications including school course test taking or base access control.

Four phases are covered by emergency management: mitigation, preparedness, response and recovery. [4] Past emphasis has been on preparedness and mitigation, versus response and recovery. Any new system built should equally support all as-

pects of a disaster.

## Emergency Management Capabilities

Mitigation is the process of trying to prevent or minimize a disaster or emergency. Mitigation can begin before, during or even after a disaster occurs.

A broader emergency management system would need to create a plan of action to pre-deploy and implement the smartphone app throughout schools and other community-based programs, allowing families to pre-register and associate their records within the back-end emergency management database.

*"The lack of a warning system for breaches and other factors delayed repairs to the levees."* - Senate Bipartisan Committee's report on Hurricane Katrina. [2]

Creating a problem reporting mechanism is a perfect example of how a smartphone app is applicable to all users. The general population or first responders' ability to report observed issues, such as a fire, structural concern or other hazardous situation or event in a near real-time manner to police, fire or other departments is an absolute necessity.

Leveraging additional smartphone features such as GPS, a geolocation feature, can enable the app to record a person's exact location when capturing an issue. Additionally, allowing the attachment of photos of an incident or problem can only serve to help in the reporting process. Submission of the report is linked to biometric verification and will serve to reduce false reports.

**Figure 2: Flooded roadways can be seen as the Coast Guard conducts initial Hurricane Katrina damage assessment overflights. (U.S. Coast Guard photograph by Petty Officer 2nd Class Kyle Niemi/Released)**

Preparedness is the process of preparing for a disaster or emergency. Preparedness includes all items that help to save lives, improve response times and support all general operations. These items occur before an event.

*"[The Department of Homeland Security] and [the Federal Emergency Management Agency] lacked adequate trained and experienced staff for the Katrina response."* - Senate Bipartisan Committee's report on Hurricane Katrina. [2]

Any first responder education and preparedness training could use the smartphone app and/or other system infrastructure to create a comprehensive course and reoccurring training regimen tailored for the specific skills of the trainee and disaster.

The smartphone app would automatically notify a person when there are new, annual or required trainings and would biometrically verify upon completion. Many resources in this category are found at the Emergency Management Institute website. [5] Additionally, general population training, business and industry workers preparedness training, and volunteer organization preparedness training could serve to educate people of potential targets, risks and the types of support provided during and post event.

Using the app for first responder credentialing and access control capability would be explored. Much like the current efforts to digitize driver's licenses and insurance cards, a smartphone app could note the level of training discussed above, but also serve to verify who is a doctor, nurse, versus an imposter. Additional exposure to or inclusion of other government initiatives would be considered. Initiatives such as Child ID Kits used in the case of Amber Alerts could easily integrate into the smartphone app. [6]

# HOW FACIAL RECOGNITIO

**By: Jonathan Hayes**

Fingerprints are by far the oldest and most widely used biometric; however, facial recognition has made great strides since it was first explored as a biometric in the 1960s. Early facial recognition techniques required system operators to support matching by locating features (eyes or the nose). Once marked, computer systems were able to measure relative distances between points on the face and thus try to match one face to another. Techniques continued to progress through the decades, with the 1990s giving way to the automated extraction of facial images from existing images and in turn lead to real time facial recognition.

Progress has continued with facial recognition, which was recently utilized to identify the Boston Marathon bombing attackers. New pushes for use of face matching are coming from one of the most recognized companies in the world, Microsoft, which has enabled facial recognition within Windows 10. [1] Other companies, such as Confirm.io, are utilizing smartphones to authenticate whether a person is of drinking age prior to ordering alcohol from a delivery service via their driver's license. They are partnering with MorphoTrust, a leader in biometric matching systems and algorithms. [2]

Facial verification for smartphones is a fairly new and simple concept. A person self-enrolls into the smartphone by using the front-facing or "selfie" camera. During capture a person is required to wink or blink in order to prove liveness to the capture software. The enrolled image is processed and converted into a mathematical representation or template of the image by an algorithm, which creates a geographic roadmap of points of interest on the face. Exactly how is determined by the specific algorithm and varies from company to company in method.

Verification is done by a new facial image being captured and processed in the same method as the enrollment image. A match is performed by matching the image template in a one-to-one method to verify the identity of a person. Algorithms, and therefore templates, are unique to each developer, thus a template created by one algorithm cannot generally be compared to another.

Responses are the events that occur during a disaster or emergency. Response efforts help minimize further damages by putting into action preparedness plans.

*"The failure of complete evacuations led to preventable deaths, great suffering, and further delays in relief."* - Senate Bipartisan Committee's report on Hurricane Katrina. [2]

Shelters, and their locations, are of vital importance during a disaster. The smartphone app would provide a list of local shelters based on a person's GPS location. The app could educate the public to their closest shelter location, and could serve for self-registering of the general population when entering a shelter location. This allows first responders and emergency staff to track registered people who have checked in to a shelter with their app in real-time.

The app can allow for registering a shelter-in-place with the GPS function so the emergency management system can track other people in potential problem locations. The app would keep families updated regarding safety status and shelter location. Evacuation planners can use the information provided to unite families during further evacuations, or to rescue people in troubled areas. The app could inform users as to when their home or other areas of interest are cleared for travel.

The current global positioning system used by persons worldwide was originally created by the U.S. government for military purposes. Operation is based in low-power radio waves, sent from satellites and received by a GPS chip, which are interpreted by the processor within a smartphone. This information is linked to source maps to determine position and relative movement. [7]

*"A proactive federal response, or push system, is not a new concept, but it is rarely utilized. ... DHS and FEMA lacked adequate trained and experienced staff for the Katrina response."* - Senate Bipartisan Committee's report on Hurricane Katrina. [2]

The Senate Bipartisan Committee's report on Hurricane Katrina noted "information gaps" created failures to act in a timely manner. [2] Information was also being reported incorrectly. Developing an internal system of passing only verified information, supplied by a person in a leadership role within FEMA or another lead organization is essential, specifically regarding information needed to move between departments, areas and government groups.

Emergency managers would be equipped with an enhanced version of the app, which could be used by first responders and responding agencies to provide question and answer capabilities to pass real-time information back and forth to the boots on the ground encountering the issues, as opposed to the news organizations not involved with rescue operations.

As always with this application, the submission links to a specific reporter. The general population's app would also benefit from this communication method by receiving during-event notifications and providing relevant information such as shelter locations, family member status, food and blanket distribution time and locations, and generally staying informed with current FEMA news and updates.

*"FEMA logistics and contracting systems did not support a targeted, massive, and sustained provision of commodities."* - Senate Bipartisan Committee's report on Hurricane Katrina. [2]

Emergency managers would be equipped with an enhanced version of the app, which would allow state and local governments to identify needs and request resources. First responders would use this version to offer registration to people entering a shelter location without smartphones.

The smartphone app would keep track of who received provisions and amount received. The app could also record ambulatory transport, shelter occupancy, hospital admittance and mortuary services, and link with other organizations, like the Red Cross. The app would keep vital information current on evacuation and shelter status and food, water and medical supply levels.

Recovery includes the post-event processes executed to return to a normal state following an emergency or disaster.

*"Procedures for requesting federal assistance raised numerous concerns."* - Senate Bipartisan Committee's report on Hurricane Katrina. [2]

This app would provide for implementation of programs such as the Disaster Assistance Improvement Program, whose "mission is to provide disaster survivors with information, support, services, and a means to access and apply for disaster assistance through joint data-sharing efforts between

**Article continues on page 18**

# TION TECHNOLOGY WORKS

Liveness detection and other anti-spoofing techniques are embedded into the process to stop a person from registering a photograph of a person by asking for blinking to occur during enrollment. These types of technology advances stop criminals or even terrorists from hacking or manipulating the systems to their advantage. Other variables such as what is in the background and off angle facial image captures can pose a problem to capture and process algorithms.

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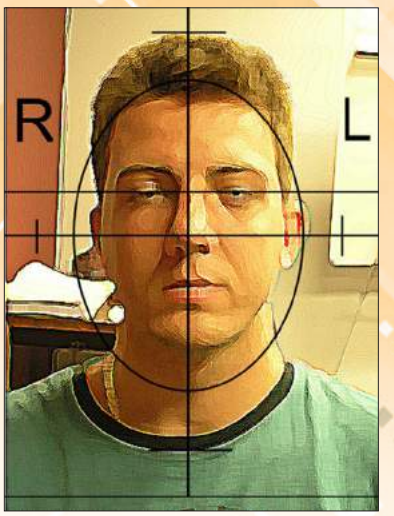



**Image 1: A graphical overlay can improve the quality of facial images obtained by facial recognition systems. (Image courtesy of the National Institute of Standards and Technology/Released)**

Article continued from page 17

federal, tribal, state, local, and private sector partners." [8]

*"There was inappropriate delay in getting people out of shelters and into temporary housing – delays that officials should have foreseen due to manufacturing limitations."* - Senate Bipartisan Committee's report on Hurricane Katrina. [2]

This app would be beneficial for days and months following a disaster event. The app could track the number of people affected and log healthcare or benefits provided to impacted people. Later on, the log of impacted people could confirm someone's presence, or to enable follow-up questionnaires, care or applications for aid or reporting of damages.

Implemented correctly, the app would allow online applications for assistance, uploading supporting documents and checking the status of an existing application in a simple process. All of these link to registered individuals, verifying identity via the app, thus reducing false information. With proper permissions, the app may prove helpful in longitudinal studies. This would have been helpful after the Sept. 11, 2001 attacks had such a system been available.

*There was "[l]ack of coordination led to delays in recovering dead bodies"* - Senate Bipartisan Committee's report on Hurricane Katrina. [2]

A properly developed app could allow first responders to gather fingerprints or facial images of deceased persons, in support of quicker identification and thus family notifications. This portion of the app could integrate with any number of existing systems that identify persons for U.S. interests. The FBI Next Generation Identification system houses criminal and civilian records. The Office of Biometric Identity Management is responsible for border and homeland protection, and even utilizes the DoD's Automated Biometric Identification System, which houses biometrics of persons of interest from across the globe.

## Additional Considerations

*"The National Communication System met many of the challenges posed by Hurricane Katrina, enabling critical communication during the response, but gaps in the system did result in delayed response and inadequate delivery of relief supplies."* - Senate Bipartisan Committee's report on Hurricane Katrina. [2]

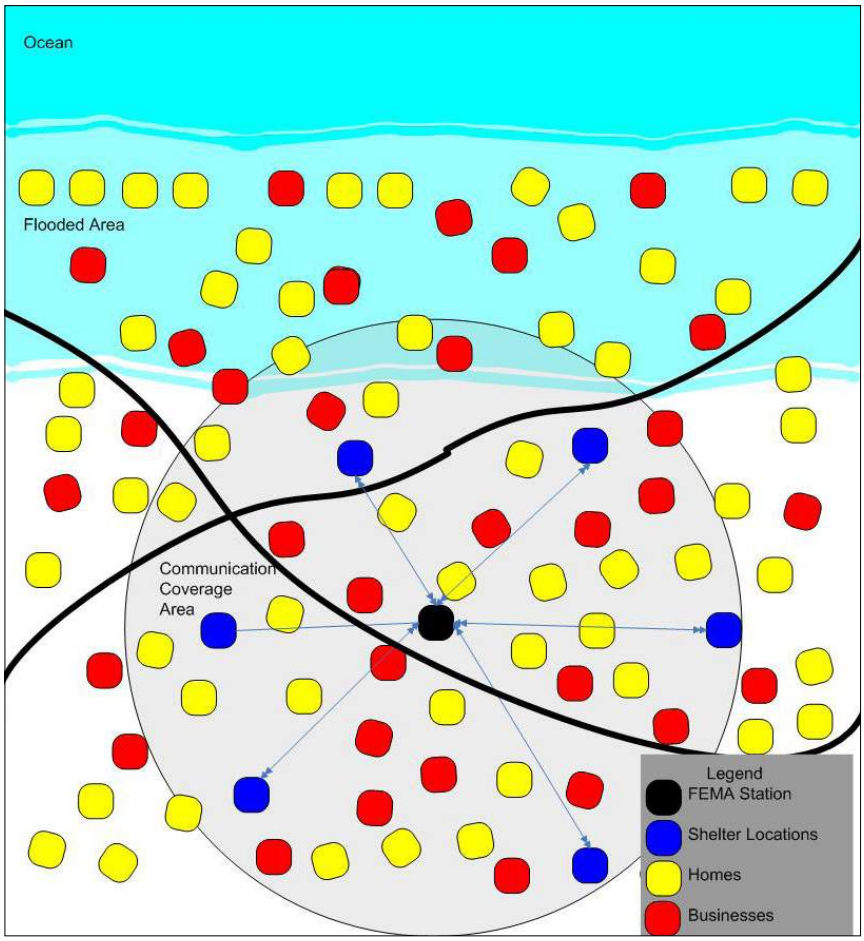



**Figure 3: Operational overview: network coverage of shelter locations. (Image courtesy of Jonathan Hayes/Released)**

The app would be designed to operate on whatever communication method is available, including data bands and local Wi-Fi already promoted by most local businesses and community facilities. Contrast this with frantic phone calls ending in trunk-busy signals, leading loved ones to try to make their way to evacuation sites, or worse to the disaster sites. Therefore allowing for the proliferation of information and thus leading to reduced confusion and panic, first responders could focus more on the problem at hand.

The focus of discussion has been disasters, but the system would support all types of emergency incidents occurring today, including events such as attacks in Sandy Hook, San Bernardino, Paris and Brussels. Concepts outlined are global, thus containing DoD applications in humanitarian aid, UN peacekeeping and Non-combat Emergency Operations. With some small system and app modifications, one could foresee the use in routine military operations.

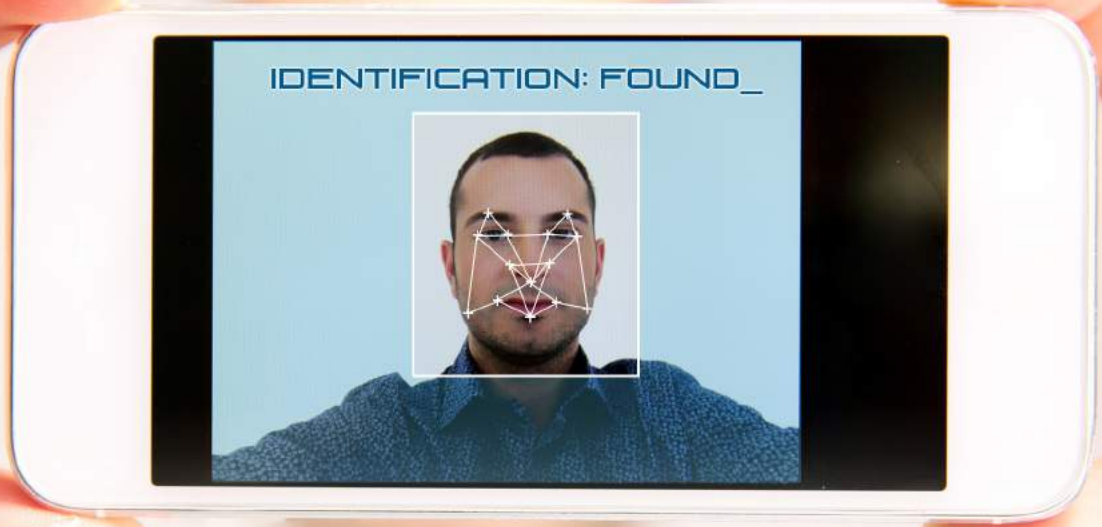
## Summary

One of the problems with emergency management over the years has been that it is approached by federal, state and local governments in fundamentally different ways, which are often incompatible as well as in conflict. An emergency management system needs to cover the spectrum of capabilities that all groups and agencies like FEMA and the National Guard would need before, during and after a disaster.

Generally speaking, most preparedness is focused on first responders but with the system presented, the general population takes an active role thus reducing the amount of workload on the emergency management teams. This system would place a larger role in all domains of homeland security, because domestic homeland security has a larger than ever role in military and national security compared to that of emergency management of the 1990s. Emergency management would need to rebuild and rediscover disaster management and establish new working

relationships with disaster response groups to include active military, National Guard and local first responder assets.

An emergency management system built utilizing existing infrastructure and a new smartphone app could fundamentally rebuild emergency management processes. Such a system would need to take into account that first responders and managers will need to be educated, tested and certified to new qualifications in homeland security and emergency management. Training would need to account for and be designed in a manner that would absorb responsibilities beyond the skill sets of current, conventional first responders and emergency managers. Any technologies that would simplify the "normal" operations occurring during a disaster would be a game changer. ■

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**Mr. David Lohman is a graduate of Shippensburg University of Pennsylvania, and a former U.S. Army Signal Corps officer with 10 years of active duty service. His experiences include strategic and tactical units, and combat during Operation Desert Storm. He spent time doing operational testing with the U.S. Army Test and Evaluation Command before coming to work biometrics with the Biometrics Fusion Center, now a part of the Defense Forensics & Biometrics Agency. Currently the executive officer for the agency, Lohman has held a number of positions including director of biometric operations, technical advisor and lead for concepts and technologies. Lohman is a life member of the Armed Forces Communications-Electronics Association, the Signal Corps Regimental Association and the Veterans of Foreign Wars.**

# Identifying CBRN Agents to Stop Disease in its Tracks

By: Lt. Col. David G. Watson, Ph.D. & Richard Schoske, Ph.D.

Consider the work of a military medic in the field when a warfighter comes on sick call complaining of a sore throat, cough or fever. Aside from suggesting an analgesic and fluids, should the medic return the warfighter to the unit where he or she may spread illness and endanger others? At present, options can be that limited. The medic might take a nasopharyngeal swab and hope a supporting Clinical Laboratory Improvement Amendments-certified lab gets back with a diagnosis in two to three days; but in that time members of the unit are put at risk of catching an infectious disease and the unit may lose effectiveness.

From 1918 to 1919, the U.S. military faced that very problem, when an illness known as Spanish Flu spread worldwide, causing an estimated 20 to 50 million deaths. [1] U.S. Naval estimates put infection rates among its members at 40 percent. In one particularly serious outbreak, the USS Pittsburgh suffered an 80 percent attack rate among its crew when the ship's captain allowed his crew to go ashore while Spanish Flu raged in Rio De Janeiro. [2]

The obvious problem is that military medical personnel and commanders need to know when unit members catch a contagious illness, but current diagnosis often takes too long to report back disease status. Using BioFire's FilmArray® Respiratory Panel, detection of multiple respiratory pathogens takes only one hour. However, U.S. regulation under the CLIA of 1988 [3] requires laboratories conducting moderate to high complexity human diagnostic testing must receive certificates of compliance or accreditation that require highly trained professional laboratory staff. Settings in which medics, pharmacist's mates, nurses and even physicians may perform testing generally cannot qualify for these levels of certification because they lack education and experience.

In order to get the diagnostic capability closer to the warfighter, the Defense Threat Reduction Agency contracted with BioFire Defense/BioFire Diagnostics to conduct clinical studies that can allow the U.S. Food and Drug Administration to grant CLIA-waiver for a simplified version of the FilmArray® RP. In Summer 2015 those studies concluded, and the BioFire team submitted its application in October 2015 to FDA's Center for Devices and Radiological Health. If the CLIA-waiver is granted, DoD can deploy the simpler FilmArray™ RP EZ

**Film Array™ Respiratory Panel EZ Detects:**

- Adenovirus
- Coronavirus
- Human metapneumovirus
- Human rhinovirus/enterovirus
- Parainfluenza Virus
- Influenza A
- Influenza A H1
- Influenza A H1 – 2009
- Influenza A H3
- Influenza B
- Respiratory Syncytial Virus
- Bordetella pertussis(the etiologic agent for whooping cough)
- Chlamidophila pneumonia(an etiologic agent for pneumonia)
- Mycoplasma pneumonia(the etiologic agent for mycoplasma pneumonia)

**Film Array™ WARRIOR is Designed to Detect:**

- Bacillus anthracis (etiologic cause for anthrax)
- Coxiella burnetii (etiologic cause for Q fever)
- Ebola Virus
- Francisella tularensis (etiologic cause for tularemia)
- Marburg Virus
- Yersinia pestis (etiologic cause for human plague)

into less specialized settings (e.g., clinics, ships or aid stations) where sick warfighters can receive diagnosis and begin treatment in an hour. All the while, the unit overall is spared the risk of infectious disease.

## FilmArray™ Respiratory Panel EZ

With the RP EZ, medics and pharmacist's mates undergo simple video-based training lasting only minutes. [4] The training enables users to collect patient samples, run the diagnostic test, interpret results and even perform routine system maintenance. The FilmArray® itself consists of a laptop computer, disposables (reagent vials, plastic transfer pipettes and diagnostic pouches), a pouch loading station and a testing instrument.

Only the laptop and instrument require power, and nothing in the system needs refrigeration. Requiring less than five minutes of hands on use, the FilmArray® is a load and go system.

Using Polymerase Chain Reaction technology, RP EZ reliably detects 14 common respiratory pathogens.

## FilmArray® WARRIOR

In partnership with the Joint Program Management Office for Medical Countermeasure Systems, BioFire Defense is also developing a panel to detect some of the most feared pathogens for its WARRIOR panel, which is intended for military use. Under separate contract with DTRA, BioFire, JPM MCS and DTRA representatives took the WARRIOR system to FDA's Center for Devices and Radiological Health early in 2016 and entered into pre-submission discussions on whether the WARRIOR panel could also be made eligible for a CLIA waiver.

## Future Developments

While the WARRIOR panel is probably years away from FDA clearance, military users can begin using the FIlmArray® RP EZ system more quickly if it receives CLIA waiver. Also, BioFire Defense is working with JPM MCS to tie the FilmArray® laptop into the DoD's Global Information Grid, so that commanders can eventually gain insight into unit effectiveness in near real time. Lastly, depending on BioFire's company strategy the FilmArray® RP EZ could also become available at civilian locations, so that all Americans may one day hope for one hour diagnosis of colds, influenza and other respiratory illness.

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# Disaster Prevention for

**By: Col. Barrett K. Parker**

On the morning of April 28, 1986, the alarm sounded at the Forsmark Nuclear Power Plant, about an hour north of Stockholm, Sweden. The plant chemist, Cliff Robinson, had just finished breakfast and was returning to work when he walked through and set off the personnel detector alarm. This was a very odd situation, as Robinson had not been in the controlled areas yet that day.

Soon, other workers started setting off the alarms as well. Forsmark immediately initiated its protocols to determine the source of the radiation, but found no faults at the facility. Next, the alarm to evacuate the plant sounded. Plant management retained control of the situation, and within hours other NPPs in the region were calling in with similar detections. This was, of course, how the world first learned of the Chernobyl disaster.

Thirty years after Chernobyl, the U.S. operates 99 nuclear reactors at 61 separate NPP sites. How likely would it be that one of the U.S. NPPs would be 'caught in the crossfire' and find itself downwind and in the fallout plume of a terrorist-caused nuclear burst? NPPs are typically located on the outskirts of the urban areas they support; however, a fallout pattern from a ground burst nuclear device could go much farther. This situation has, in fact, occurred during exercises such as Vibrant Response. The detailed response at the NPP, however, has always been a 'second-order effect' and outside the exercise.

Could a U.S. NPP continue to operate if located in a fallout hazard area? The implications of a power plant shutdown in a region trying to recover from a major disaster cannot be overstated. Hospitals and command posts may have back-up generators that could last days, however, the population of an area without power for an extended period of time would quickly require relief water, food, security and possible relocation. If overlaid on a nuclear weapon detonation scenario, a major power outage situation could become untenable. Communities surrounding the nuclear burst, which could usually be expected to assist with relief operations would, themselves, need assistance.

How might a U.S. NPP react today if faced with a situation similar to the situation the Forsmark NPP faced three decades ago so far away? If NPP alarms are sounding due to external contamination, then they cannot do what they were installed for – detecting a fault or radiation release at the NPP. Given both degraded sensors, but also a time of public need, would the plant be allowed to continue operation? Who would make the decision to continue operations or begin to shut down the plant? Who would take responsibility for operating an NPP with degraded sensors… the plant owners? The NRC? The governor? Or are shutdowns now automatic in the 21st century? Would the plant react differently to a warned, known event (a nuclear detonation in a U.S. city would immediately become public knowledge) as compared to an unwarned, unknown event (a Radiation Distribution Device, or RDD, could be operated subtly outside an NPP)?

These were some of the questions raised in informal discussions around FEMA Region VII. The hardest of these questions were sent to the Homeland Defense & Security Information Analysis Center for evaluation. In response, HDIAC produced Technical Inquiry 2016-0596 Nuclear Power Plant Response Protocol, succinctly answering these and related questions.

Key points made in the HDIAC report include that each NPP operates under individual sets of specific and highly controlled guidelines and the decision to shut down NPP operations lies with the NPP's responsible party. The decision to continue or cease power generation is predicated on the potential detriment to human health, environmental harm and operational criticality. Upon detection of an external radioactive plume, NPP health physicists begin their assessment with the ends of determining

# Nuclear Power Plants

whether the plume was generated by the NPP. However, many radioactive effluent monitors are located within NPP structures, thereby rendering accurate location discernment ineffective.

For example, an event such as an RDD would not impact the stack gas monitors, and most likely the monitors would not even detect plume passage, nor alert the interior building or containment monitors.

When an external alarm is triggered, operators are the first line in the decision making process. From there, protocol depends on the managing agency. There is no standard protocol to guide all NPPs. After an external alarm is triggered, law enforcement agencies and members of the Nuclear Regulatory Commission arrive to determine the source of radiation and how to proceed.

While the gold standard of such evaluations is seeing them applied successfully to a real world event – something nobody wants to do – the silver standard is having the report reviewed by an actual representative NPP plant operator.

To that end, Mr. Dennis Branson, site specialist for Radiological Emergency Preparedness for FEMA Region VII provided a copy of HDIAC's inquiry response report to Exelon Corporation, the largest operator of NPPs in the United States, for review.

While they are still reviewing the document, initial impressions are that the HDIAC report is 'correct on most parts' when applied to their facilities and emphasized that the 'shift manager would maintain control of the plant as the senior license holder.' The report can serve as a cornerstone for discussions with Exelon and other companies operating in Region VII and beyond.

## Conclusion

Looking beyond the immediate questions answered, this unclassified, publicly releasable report is a superb tool to help us initiate and facilitate discussions with the private sector. Our hope and intent is to use this HDIAC report, and ones like it, to increase collaboration and interoperability between industry and government partners.

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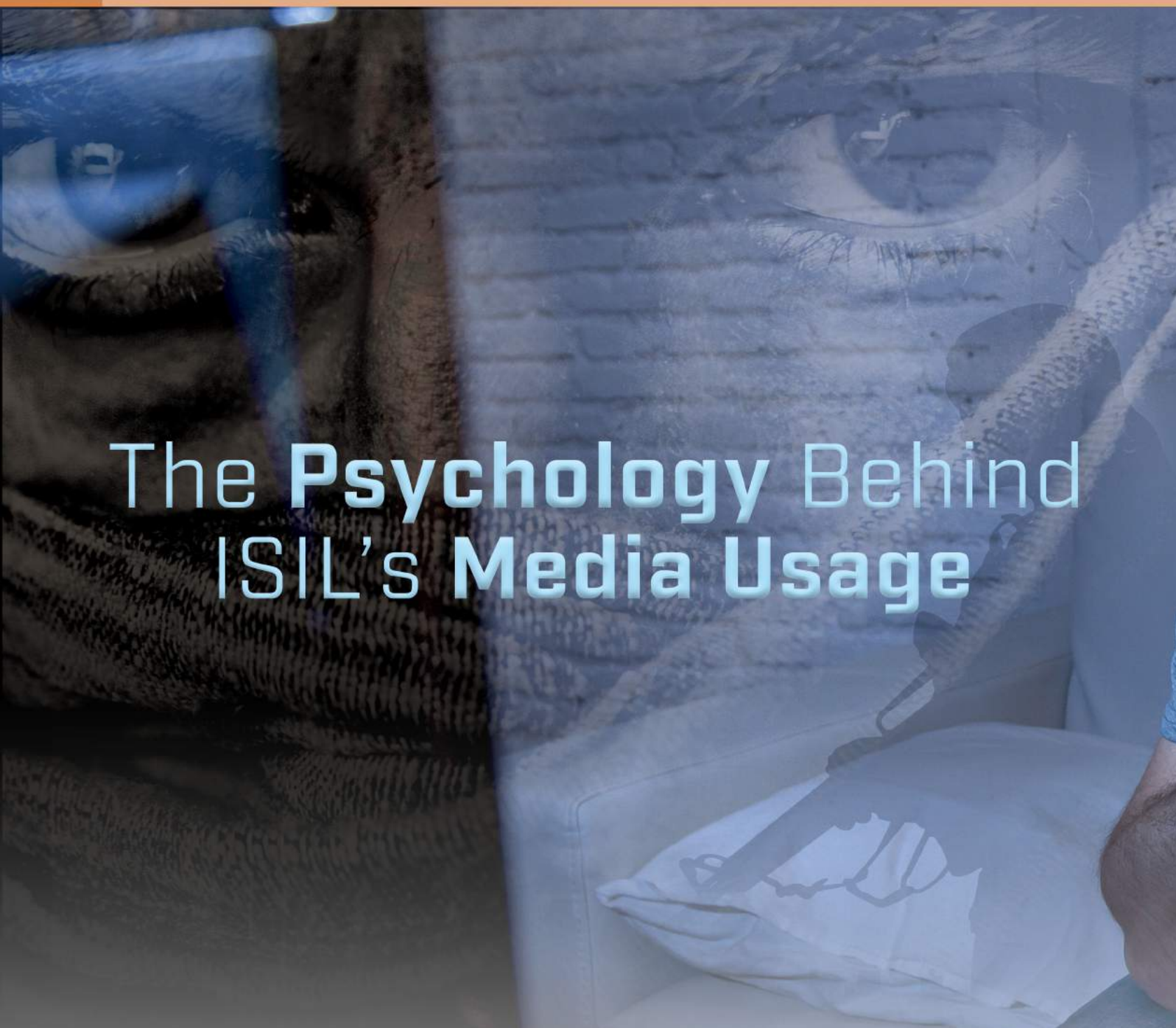

# The Psychology Behind ISIL's Media Usage

By: Matthew Grizzard, Ph.D.

## Introduction

The 21st century brought with it a democratization of media production and distribution. The ability to capture events on video and distribute them to mass audiences was once limited by news reporters' proximity to events, as well as access to professional video production and distribution equipment. Today, the ubiquity of high quality cameras in the form of cell phones and the ease of video production and distribution through personal computers and the internet allows visual documentation of events to diffuse across the globe nearly instantaneously.

Terrorist organizations, such as the Islamic State of Iraq and the Levant, utilize these technologies to create and disseminate propaganda videos documenting the groups' various atrocities and crimes against humanity in an effort to increase their status as an Islamic extremist organization, to intimidate potential adversaries and to terrorize populations. Although the extreme violence present in these videos may be useful for spreading fear and terror, leadership within ISIL has expressed concern that such violent content might alienate potential sympathizers. [1] For example, Abu Bakr al-Baghdadi, the leader of ISIL, commanded the group's media wing to cease using gruesome imagery in its videos because such images may be offensive to Muslims and children. [1]

Theory and evidence from media effects and psychological research may explain why inclusion of such graphic violence could decrease support for ISIL and increase support for U.S. military interventions targeting the group. At the same time, current

standards regarding the display of such violent content in news media may be inhibiting these proposed effects. This paper describes these processes, and points to psychological and communication research that may serve as a building block for leveraging violence-exalting propaganda videos against the groups producing them.

## Limitations of Human Cognition and the Power of Visual Information

Humans are notoriously bad at abstract thinking. Judgments and evaluations are easily biased by perceptions and reliance on heuristic decision-making. [2] Such biasing can be revealed by simple thought experiments. For example, consider the following:

*A baseball bat and a ball cost $1.10 total. The bat costs $1 more than the ball. How much does the ball cost?*

The correct answer is that the ball costs $.05, with the bat costing $1.05. However, many intelligent people, including 50 percent of Princeton and 56 percent of University of Michigan undergraduates, [2] respond incorrectly to this question with the intuitive, but wrong, "the ball costs $.10."

This type of question, along with a host of research in psychology, economics and computer science (see for example the work of John Bargh, Amos Tversky, Daniel Kahneman, Gerd Gigerenzer and Herbert Simon), has focused social psychologists and cognitive scientists' attention on the potential that human cognition, including judgments and decision-making, is the result of two cognitive systems interacting with each other. These are a faster, less effortful intuitive system based on perceptual cues (Sys-


**Figure 1. Depictions of various warning labels on cigarette packs. (Image courtesy of the Food and Drug Administration/Released)**

tem 1) and a slower, more effortful deliberative system based on applying rules and logic (System 2). [3,4,2]

System 1, the intuitive system, is thought to be primary to System 2 and operating continuously. This means that individuals process incoming information through System 1 first, and if System 1 provides an answer that makes sense perceptually, the individual is unlikely to engage System 2 to further process the information.

With regard to the bat-and-ball problem, the intuitive System 1 drives individuals toward the $.10 response, because it feels right (i.e., it is about the right amount and it results in the remainder equaling $1.00) and because this intuitive response occurs nearly instantaneously without conscious awareness or effort. The individual thus did not have to engage careful decision rules or the effort associated with these rules.

System 2 would involve algebraic logic (i.e., Bat + Ball = $1.10, where Bat = Ball + $1.00), and although this type of logic may be the most correct way to determine the answer, unless the individual has some reason to believe that the "gut" response is wrong, System 2 is unlikely to be engaged. [5]

Within this dual-process perspective, emotional responses would be considered a byproduct of System 1; and when such emotional responses occur, they can again bias individuals' judgments against rational answers just as the intuitive response in the bat-and-ball problem biased individuals against the correct answer.

In fact, certain statistically unsupported perceptions are thought to be the result of such emotional biasing (e.g., the fear of being the victim of a terrorist attack outweighing the fear of being the victim of a car accident).

Findings regarding the manner in which emotional responses can suppress rational thought [6] have led to important breakthroughs with regard to media effects research and the conceptualization of exemplification theory. [7] Exemplification theory makes several key predictions that are useful when considering emotion-inducing media content, such as that found in the propaganda videos of ISIL.

First, the theory proposes that concrete events are superior to abstract events in terms of comprehension and memory. For example, a case study is easier to understand than an abstract account using statistics, although the statistical description is likely to be more complete and more accurate. Second, the theory proposes that iconic stimuli (such as pictures and video) are superior to symbolic stimuli (such as written descriptions) in terms of the effects they elicit. For example, a video of the aftermath of a suicide bombing is likely to elicit more anger and disgust than a text description. Finally, the emotional nature of stimuli is thought to magnify psychological responses such that a highly emotional stimulus will be superior to a lowly emotional stimulus. [7]

These propositions explain why warnings on cigarette packs are more effective if they include graphic imagery of the effects of smoking rather than simple text [8] and the reason why the Food and Drug Administration sought to include such images on cigarette packs sold in the United States [9] (see Figure 1 for a visual depiction of such labels).

These findings also support ISIL's decision to include extremely graphic images in their propaganda videos. Visual evidence of the extreme acts of violence they commit is likely to elicit high levels of fear and perceptions of ISIL as a dangerous and powerful organization. Thus, ISIL's videos are likely very effective at eliciting the intended intimidation responses. However, there are reasons to believe such videos could backfire on the group, particularly in the form of consolidating and intensifying negative attitudes toward the group. Such videos are likely to elicit other condemning emotions, such as contempt, anger and disgust. [10,11] There is some evidence suggesting that this might indeed be happening.

Research by Pew indicates ISIL is disliked by substantial majorities in countries with large Muslim populations. [12] Moreover, this negative sentiment appears more widespread and consistent than dislike for other Muslim-extremist groups. [13] There is also some temporal evidence that extreme terroristic tactics can be the cause of such negative views. Pew Research Center data from Jordan indicated sharp drops in "confidence for Osama bin Laden" and the view that "suicide bombings were often/sometimes justified" among Jordanians following the 2005 Amman bombings. [14] Prior to the Amman bombings, Jordanians may have been able to view the tactics utilized by al Qaeda and bin Laden from a psychologically safe distance. Jordanians were obviously aware of the negative outcomes related to such attacks (e.g., civilian casualties), but as the old adage goes: seeing is believing.

The 2005 Amman bombings brought the violence committed by al Qaeda much closer psychologically to Jordanians. As such, there were enormous shifts in public sentiment related to these attacks. Prior to the bombings 61 percent of the population had confidence in bin Laden and 57 percent viewed suicide bombings as often or sometimes justified. After the bombing, these dropped to 24 percent and 29 percent, respectively. [14]

Although attacks on a nation or its allies may reduce psychological distance and galvanize the public against the perpetrators of the attack, media images may be an effective means for achieving these goals absent horrific, local outcomes. Moreover, media images may be able to cross geographical distance and bring the reality of such terroristic acts into the purview of populaces that rarely experience them firsthand. At the same time, current standards regarding journalism in the United States may be thwarting these objectives.

## Journalism Standards Regarding Displays of Graphic Violence and Their Consequences

The Society of Professional Journalists is the largest professional organization for journalists in the United States. One of its missions is "to stimulate high standards and ethical behavior in the practice

of journalism." [15] To this end, the SPJ adopted the SPJ Code of Ethics and commissioned several white papers to describe standards that journalists should adhere to regarding various ethical dilemmas, including guidelines for transparency, the protection of sources and displays of violence. [15] Particularly relevant to the current discussion regarding violence is a position paper written by the SPJ Ethics Committee on victims of tragedy or violence. [16] The article suggests that reporters and journalists "show good taste" and "avoid pandering to lurid curiosity." The committee also cautioned reporters about avoiding sensationalism in photos:

> Journalists also should recognize that news of grief and tragedy circulates quickly. The news will draw attention no matter the presentation. In other words, media will receive higher marks if they present the stories in responsible fashion without resorting to sensationalism in words or photos. [16]

Thus, current SPJ standards explicitly tell reporters to avoid displaying graphic images. Moreover, the assumption that tragic news "will draw attention no matter the presentation" ignores much social scientific evidence that news with graphic displays draw more attention and elicit stronger responses than news lacking these displays. [7]

The SPJ likely made these suggestions in good faith. After all, common wisdom says violence, and especially graphic violence, are bad things. Broadcasting such images could upset viewers and cause discomfort. Moreover, it is a widely-held belief that responsible journalists are not sensationalists. However, psychology has shown repeatedly that common wisdom is not always so wise, and that adhering to the standards of good taste can result in highly problematic effects. In fact, there is some notable disagreement even among journalists regarding how these standards of good taste govern reporting. These disagreements flared following the on-air killing of two reporters in Virginia.

On Aug. 26, 2015, Vester Lee Flanagan II, a former employee of WDBJ in Roanoke, Virginia, shot and killed two of his former co-workers during a live TV news report. He filmed the attack on a cell phone and posted the video to Twitter before committing suicide. The next day, the front page of New York's The Daily News featured images of the moment Flanagan shot and killed Alison Parker under the headline "Executed on Live TV."

The decision to feature such graphic images on the front page of a newspaper set off a firestorm of debate, with some arguing that The Daily News was sensationalist and cashing in on tragedy. [17] However, The Daily News defended its decision by stating that the images were "a definitive part of the story, however distributing and horrific" and that their publication might give the issue of gun violence more visibility "at a time when it is so easy for the public to become inured to such senseless violence." [17] This sentiment was echoed by David Rhodes (president of CBS News), who also broadcast some of the video; he defended his decision stating:

> I think we are harder in our approach, and that's why we showed what we did. The softer approach is to take additional steps to protect the audience from some of this material. I'm not sure that's helping their understanding of what happened. [17]

Thus, there is some sentiment even within journalism organizations themselves that more graphic displays of such events might decrease the apathy of the public. However, the current standards of sanitizing violent acts within media, such as censoring graphically-violent images, is likely to minimize anger from the public, especially when the violence is committed in areas that are geographically and psychological distanced from the United States. This minimization can lead to a lack of awareness of and attention to events when they are beginning—the time when interventions would be most effective.

## A Stitch in Time

A lack of public support for military and humanitarian actions can doom operations. [18] Dwindling support among the population can trickle up into policy decisions of publicly-elected officials as U.S. representatives and senators become sensitive to their constituents' opinions during election cycles. [19]

Although dissent introduced into the political process is unlikely to sway the course of action proposed by unelected advisors, this type of dissent can decrease the chances of success of operations. Elected officials may choose to play it safe and move toward the opinion of their constituents, thus reducing support in Congress for funding of such operations or altering the objectives that receive public commitment from political officials (e.g., offensive strategies move toward defensive strategies).

In addition, past research has indicated that these decreases are less tied to the success or failure of operations, and more so with the framing of conflicts. Some researchers have even argued that moral frames for military operations (e.g., "military actions are a necessary response to a moral violation by the enemy") can overcome substantial strategic losses. [18]

There are times when the American public fully supports military and humanitarian intervention, especially times when the United States or its allies have been attacked (e.g., following the attacks of Pearl Harbor and Sept. 11, 2001) or, as previously alluded to, when the intervention seems a moral necessity (e.g., the invasion of Iraq).

**Figure 2. New York City the afternoon of Sept. 11, 2001. (Photo by Master Sgt. Mark Olsen, 177th Fighter Wing -- NJ Air National Guard/ Released)**


**Figure 3. Junaid Hussein, under the screen name of CyberCaliphate, claimed responsibility for defacing the U.S. Central Command's Twitter account in January 2015. (Image courtesy of Maryland Coordination and Analysis Center/Released)**

Other times, the American public is either not in favor of intervening or unaware that intervention might be necessary (e.g., the Rwandan and Bosnian genocides). In addition to differences in framing, the lack of awareness may be attributable to lack of news coverage of events or rather incomplete coverage of the atrocities occurring during such events (e.g., sanitization of violence).

Although many news networks reported on ISIL's mass executions, such as the Camp Speicher massacre in Tikrit, which resulted in the deaths of more than 1,000 people, news reports in the United States typically sanitized images of such attacks. In fact, Scott Pelley of CBS Evening News reported on the Camp Speicher Massacre and described it as an ongoing genocide displaying some images from ISIL's own videos of the massacre in his report. The images displayed were censored by using a freeze frame. [20] Rather than seeing the victims of the executions being shot and killed, the image freezes before the killing takes place.

Based on the previously discussed psychological literature, this article argues that such censorship can decrease the amount of anger and disgust elicited by such clips, which can consequently decrease willingness to support intervention. This logic was tested in an experimental study and presented the results recently at an academic conference. [21]

The study manipulated a CBS News clip covering the Camp Speicher Massacre to create three levels of graphicness. [20] CBS's clip served as the control version. The clip was edited to create a more sanitized version, by removing all images of the executions themselves, replacing such images with video footage of the victims being carted off to the execution site in the back of cattle trucks.

Another edited clip created a more graphic version, replacing CBS's freeze frame with the unaltered video footage from ISIL's video released online. Importantly, all elements of the final product were identical in audio elements. Thus, the informational value of the clips was identical and the only alteration occurred in the visual elements of the clip.

Results from the study showed high levels of anger and disgust were elicited by all three versions of the clip. However, the highly graphic version of the clip led to the highest levels of anger and disgust and these responses were polarized. That is, 53.3 percent of the participants who watched the highly graphic version were within one point of the maximum score on our anger-disgust index, compared with 35.9 percent in the unedited clips and only 27.3 percent in the highly sanitized clip.

Thus, this study seems to suggest that highly graphic violence causes viewers to think alike, galvanizing support. The study also examined whether anger and disgust affected support for U.S. military intervention targeting ISIL and more support for humanitarian intervention to support ISIL's victims. Results suggested that higher levels of anger and disgust led to greater willingness to support military and humanitarian intervention. Moreover those effects linked to the video clips through statistical path analysis.

Today, ISIL is a key concern for the U.S. public, and increases in concern about the group have occurred since the Paris attacks. [22] However, the level of concern seen now among the public may have been possible earlier and prior to the Paris attacks had the news media presented rawer, more graphic images of ISIL's terroristic tactics to the general population. These types of images might have galvanized the public against the group leading to increased willingness among politicians to support more robust interventions against the group earlier in their rise to power.

## Concluding Thoughts

Current journalism standards regarding displays of graphic violence suggest that news outlets should sanitize and censor these types of images in order to protect public sensitivities. There is reason to believe; however, that such sanitization can foster apathy and indifference to international crises by failing to elicit strong emotional responses to such events. Because crises unfold over time and a lack of intervention early in the timeline of such crises can exacerbate their effects, earlier interventions into such crises may prevent escalation.

In this manner, news media might serve a functional role for increasing public support of interventions by incorporating highly graphic images in their content. Similar methods might further be used by the military and non-governmental organizations when it comes to recruiting local populations to rally against local extremists. Displaying the cruelty and brutality of local militias—especially if it is contrasted with humanitarian efforts by non-governmental organizations or U.S. military interventions—might help to reduce sympathies for those groups and decrease antipathy toward Western aid.

At the same time, it is possible that such graphic images could exaggerate threats posed by such groups. After all, emotional responses lead to illogical fears and poor rational decision-making, [23] as discussed earlier. Thus, focusing on the graphic outcomes of terrorist groups can elevate concerns among the public above and beyond what might be warranted. President Barack Obama argued something similar during his 2016 State of the Union Address, where he downplayed the threat of ISIL:

> As we focus on destroying ISIL, over-the-top claims that this is

World War III just play into their hands. Masses of fighters on the back of pickup trucks and twisted souls plotting in apartments or garages—they pose an enormous danger to civilians and must be stopped. But they do not threaten our national existence. That is the story ISIL wants to tell. [24]

The fact of the matter is that far more research must be done in this area. The standards of professional journalists are based on good taste and common sense rather than social scientific evidence.

Moreover, understandings of the effects of graphic violence on emotional responses, and the motivating effects of those emotional responses on behaviors and attitudes are incomplete. Although it may appear obvious how these types of images work on psychological processes, great advances can be made by testing such obvious explanations to determine where and why they might be wrong.

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# Real-Time Biological Target Detection in Operation Enviroments by Dogs

By: Craig Angle, Ph.D., Paul L. Waggoner, Ph.D., Thomas Passler, Ph.D., & Robert Norton, Ph.D.

## The Need

Dogs are a deployable and mobile sensor that can be used in a wide variety of environmental conditions and operational settings, humanitarian assistance, stability operations, natural disasters and other emergency response needs by conventional forces and Special Operations. The DoD's use of dogs is perhaps best known as explosive-sniffing canines deployed to detect improvised explosive devices buried in the field. [1] However, utilizing dogs in other roles, such as for mobile real-time detection of biological targets, would benefit the DoD in a variety of other missions, including CBRNE detection, industrial chemicals, pollution, and illicit substances, as well as acting as a medical sensor for human and animal diseases. This article highlights the use of dogs in operational environments.

## The Target

Pathogen infection by natural disease outbreak is the leading cause of death worldwide in plants, animals and humans. In addition, bioterrorism is a serious threat to world populations and food sources. Scientists have been investigating technologies that aid in early detection of pathogens to prevent the spread of natural disease outbreak and bioterrorism activities. Recent advancements in analytical chemistry demonstrate that pathogen infections produce unique volatile organic profiles or odors.

Production of cellular volatile organic compounds occurs in millions of cells simultaneously, thus releasing extracellular VOC on a detectable scale. These VOC enter the blood stream and release into the air around a human, animal or plant. The mechanism of the release is through breath, urine, feces, skin emanations and blood. [2] The VOC profile of an individual reflects their health status and provides a sample to use for diagnostic purposes.

## The Concept

One overlooked, but highly capable, technology for the real-time detection of unique pathogen VOC profiles is detection dogs. Dogs are a mobile real-time detection technology that are the gold standard in operational environments for detection of explosives, narcotics, accelerants, people, animals and other targets of interest.

Dogs possess five essential qualities for biological detection in operational environments: (1) extreme analytical sensitivity in the parts per trillion range; (2) real-time discrimination of complex odor profiles; (3) ability to trace an odor to its source; (4) the ability to efficiently search large areas and populations for a biological target; and (5) the ability to sample in environmental extremes, including high particulate densities in the air.

Dogs possess 220-300 million sensory receptors which allow them a lower limit of detection at concentrations of one part per trillion. [3] A sensitivity of one part per trillion is three orders of magnitude more sensitive than today's available instruments. In addition, the dog has tremendous mobility and capabilities to efficiently search large areas and trace odor to its source. This capability could increase an operational team's ability to quickly find biological targets in crops, livestock and human populations.

Operationally, dogs should be considered a supportive technology to other sensory platforms and instruments, where dogs are used in a queuing process, enabling initial detection of target substances, or when scanning of large numbers of humans, animals or inanimate objects is necessary.

Strategically, the dogs would be used in conjunction with existing or future developed electronic devices that may be mandated by regulation, or used as stand-alone real-time mobile sensors, where detection limits exceed the sensitivity of current technology or the stand-off distances prohibit the use of currently available detection technology. Researchers at Auburn University are currently working to develop the strategies and techniques of using dogs in combination with existing detection equipment, labeling the process, "Dog Assisted Detection."

## The Hurdle

A current hurdle in the use of dogs to detect highly virulent pathogens is the manufacturing of safe training aids. Dogs need to

train on pathogen-associated odors, which means that these odors need to be safely trapped and released for training purposes. Such as technology would be especially important for highly contagious pathogens capable of infecting humans and dogs. For other pathogens, cell cultures and other methodologies could be utilized.

## The Capability

Detection dogs have previously been demonstrated to successfully detect a variety of biological targets with relatively high diagnostic accuracy. Dogs have demonstrated the ability to detect cancer by sampling breath, feces, urine, blood, and tissue. Researchers trained a dog to detect colon cancer using samples of exhaled breath (sensitivity, 91 percent; specificity, 99 percent) and watery stool (sensitivity, 97 percent; specificity, 99 percent). [4]

Another study demonstrated the overall sensitivity of canine scent detection of lung cancer and breast cancer utilizing exhaled breath samples was 99 percent, with a specificity of 99 percent for lung cancer and 88 percent and specificity was 98 percent for breast cancer. [5] A dog was trained to detect C. difficile with high diagnostic sensitivity and specificity in stool samples and hospitalized patients, correctly identifying 25 of the 30 C. difficile cases and 265 of 270 control cases. [6]

A recent study demonstrated that dogs could detect bovine viral diarrhea virus and discriminate it from bovine herpes virus 1 and bovine parainfluenza virus 3. [7] The diagnostic sensitivity and specificity in that study was 85 percent and 96 percent and 98 percent and 99 percent, for each of the two dogs respectively. The above studies illustrate that dogs have the sensory capability to detect pathogens in real-time. Future research needs to evaluate whether dogs can detect pathogen-associated VOC in operational environments just like they have done for decades in explosives, narcotics, human tracking, search and rescue, arson and other targets of interest. If dogs can prove to be real-time mobile pathogen sensors in operational environments then there are many force-multiplier roles they can play for a variety of operational missions.

**Auburn University's Canine Performance Sciences Program is training dogs such as this one to detect explosives, narcotics and other targets of interest. (Released)**

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# Applications of Nanotechnology in Military Medicine:

## From the Battlefield to the Hospital and Beyond

**By: Gregory Nichols, MPH, CPH**

It is not enough for a nation to have a strong military force. It is equally important to ensure that the fighting force has the best possible medical equipment and techniques before, during and after combat. Battlefield medicine has been evolving over the course of millennia. The more advanced a military's wartime medical capabilities, the more likely the combatants are to survive, recover faster and more completely, and return to duty sooner. Emerging technologies always play a fundamental role in bolstering the firepower and strength of a nation, but also the survivability of military personnel through medical improvements for the warfighter, both on and off the battlefield.

Innovations, such as the tourniquet, ambulance, antibiotics, fluid replacement therapy and field hospitals, dramatically increased survival rates during combat and helped return personnel to active duty more quickly. Medical improvements during the critical initial period of injury increase the chances of survival and minimize the long-term impact of injury. Improved medical technologies during rehabilitation can shorten recovery time and improve the quality of life for service members who either return to active duty or return to their civilian lives. One technology proving multiple applications to medical care during and after combat is nanotechnology.

Nanotechnology involves creating and using materials and devices on a scale of nanometers, one-billionth of a meter. Several advantages to having access to materials on this scale include a drastic increase in surface area to volume ratio, the ability to directly target specific tissues and the ability to create new and novel shapes of particles. These advantages are critical in nanotechnology's medical possibilities.

Military medical practice spans every aspect of health care from preventive services such as vaccinations, to combat casualty care, to long-term convalescence. Military medicine presents unique challenges, especially concerning combat injuries in terms of epidemiology, mechanism of wounding, pathophysiologic trajectory after injury and outcome. [1] Medical advancements are applied to troop health when possible and practical; and in some instances, technological innovations in medical delivery originated in military practice and spread to civilian use.

Discussions began as early as 2002 regarding nanotechnology's use in military medicine. The 15th Conference on Military Medicine outlined practice changes, such as remote monitoring of patients, faster diagnoses, less invasive procedures and sustained pharmaceutical release, which might result from nanotechnology applications. [2]

Medical applications of nanotechnology span a range of possibilities, but they generally fall into four categories:

1. Diagnostics and imaging
2. Pharmaceuticals and drug-delivery systems
3. Tissue engineering/surgery
4. Devices

Each category has direct applications to military medical practice, but some of the most promising medical applications of nanotechnology for military medical use fall under pharmaceuticals and drug delivery

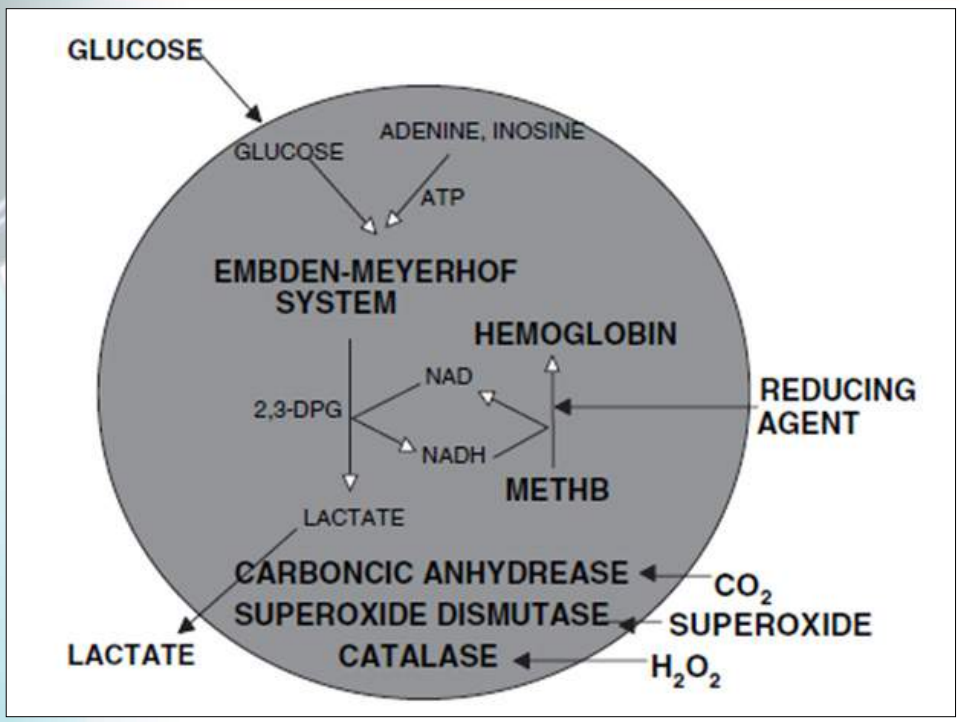


**Figure 1. Structure of an artificial red blood cell. [26] (Released)**

systems and tissue engineering/surgery and include solutions for hemorrhage control, wound management, tissue regeneration and drug delivery.

The majority of combat injuries (70-80 percent) in today's military operations are penetrating, mostly caused by explosive munition fragments. [1] These types of wounds offer unique challenges to medical providers both on the battlefield and during long-term care.

Using dressings and bandages to manage combat injuries dates back to time immemorial. However, recent advances in field dressings, including the use of chitosan, silver nanoparticles and copper, may offer improved outcomes following battlefield injuries. Chitosan is a biodegradable, nontoxic, complex carbohydrate derivative of chitin, which is a naturally occurring substance primarily found in the exoskeletons of insects. [3] Several products contain chitosan, including HemCon ChitoFlex and CELOX Chitosan Gauze. A recent development using nanoparticles of chitosan, pectin and titanium dioxide shows a significant wound closure rate compared with conventional gauze and chitosan alone. [4] Another development found that using a nonwoven mat coated with nanoscale chitosan and tea tree oil significantly reduced bacterial activity after seven days compared with controls. [5]

Wound treatment in long-term care settings can be quite different than treatment on the battlefield. Nanofiber scaffolding using fibrin and other naturally-derived products with blood-derived growth factors has been used to encourage new tissue growth and improve wound healing with promising results, [6,7] and nanostructured silk fibroin could lead to next generation skin grafts. [8] Another promising product in wound treatment is Nanoflex powder, which is a mixture of two different types of nanoscale materials. [9] When applied to a moist wound, the powder expands and fills dead space in the wound and seals the wound margins, thus protecting the wound during healing.

Silver, long used to fight infection due to its antimicrobial properties, and silver nanoparticles show great promise in reducing infection rates. Acticoat is one such product that uses silver nanocrystals applied to either a rayon or polyester core. [10] Nanoscale copper is another promising antimicrobial agent shown to improve wound healing. [11] However, both silver and copper nanoparticles have the potential to be toxic to cells, and further evaluation of their long-term health effects must be studied.

Uncontrollable hemorrhage is the largest single cause of combat deaths and accounts for more than 80 percent of deaths on the battlefield. [12] Although the tourniquet still remains the most effective first-line method to control hemorrhage in extremity wounds, the use of homeostatic agents and fluid resuscitation play an extremely important role in preventing death from blood loss. The amount of blood volume lost directly impacts blood pressure, and the risk of death drastically increases as blood pressure falls. [1] Nanotechnology may play an important role in improving coagulation and enhancing fluid replacement therapy.

One of the body's primary components in preventing blood loss are platelets, tiny blood cells that bind together to form a clot. A platelet-like nanoparticle was developed using spherical polystyrene nanoparticles coated with poly (allylamine hydrochloride) and bovine serum albumin. [13] The platelet-like nanoparticles mimic four key attributes of platelets: (1) they were disc-shaped; (2) they had mechanical flexibility; (3) they aggregated through similar mechanisms demonstrated in biologically real platelets; and (4) they had the presence of ligands that facilitated adhesion. When introduced to a wound, these particles accumulated at the site and reduced bleeding time by 65 percent. Applications in the field could potentially include the development of an injectable form of these particles.

One study also demonstrated the effectiveness of using intravenous hemostatic nanoparticles (i.e. synthetic platelets) to reduce bleeding following blast injury in mice. [14] In addition, a recent study demonstrated the effectiveness of silica nanoparticles in assisting coagulation. [15] The introduction of silica nanoparticles shortened coagulation time and increased the activation of factor X, which is another important component of clotting. A similar effect to mitigate internal bleeding was noted using hemostatic dexamethasone nanoparticles to treat lung injury after blast trauma. [16] Also demonstrated was a novel wound closure method using a combination of gold nanorods coated with hyaluronic acid and a laser to seal lacerations in the carotid arteries of rabbits. [17] This application could lead to more effective wound closure at earlier stages in the medical evacuation process.

Red blood cells are a primary volume expander used to control massive blood loss. Some difficulties with using blood replacement on the battlefield are gaining access to enough blood and storing it effectively. One solution would be to use artificial red blood cells. While first reported in 1957, recent advances in nanomaterials allow creation of much smaller particles. A red blood cell substitute can be created using nanocapsules made of biodegradable polymers containing enzymes and hemoglobin as illustrated in Figure 1.

Nervous system injuries are some of the most severe and complicated injuries to manage. Nerve cells, including neurons, do

| Technology Attribute | Description |
|---|---|
| **Risk/safety** | The technology has been proven safe by a government regulatory body |
| **Efficacy/effectiveness** | How well the technology has been proven to work in the relevant patient population |
| **Feasibility** | How easily the technology can be used in current clinical settings (e.g., is any special training required?) |
| **Cost** | How much it costs to use the technology in clinical practice |
| **Certainty of benefit** | How sure we are that the technology does what it is supposed to do |
| **Budget impact** | How much the technology will affect the budget of the organization (i.e., what the organization might need to take away from other services to provide this technology) |
| **Return to daily activities quickly** | Patients are able to return to work or their normal routines more quickly with this technology than with current standard care |
| **Seriousness of the condition or disease** | The condition for which the technology is used affects either a large number of patients or a small number of patients in an extreme way |
| **Convenience** | The technology is more convenient to use than is the current standard of practice for patients and health care providers |
| **Newness** | Nothing like this technology is currently available in the marketplace |
| **Feel-good factor** | The care and attention a patient receives as a result of using the technology makes him or her feel better |
| **Price** | How much it costs to purchase the technology |
| **Immediacy** | The benefits of the technology can be realized quickly |

**Table 1: Technology adoption considerations in healthcare. [29] (Released)**

not divide and regenerate like many other cells do. Typically, nerve injuries result in permanent loss of function or mobility. Recent work describes the use of silk protein in a hydrogel scaffold to repair peripheral nerve injury, which resulted in a significant improvement of the nerve cells. [18] Other fibers, such as carbon nanotubes coated with various naturally occurring materials show similar effects. [19] Carbon nanotubes have also been explored for use in bone tissue engineering. [20] Another paper provides an excellent review of nanofiber technology used in tissue engineering. [21]

One of the most anticipated uses of nanotechnology in medicine is for the development of new classes of pharmaceuticals and drug delivery systems, especially for targeted therapies. Targeted drug delivery systems offer several advantages versus traditional drug administration routes including:

- Increased treatment efficacy
- Increased specific localization
- Decreased toxic side effects
- Improved patient compliance
- Reduced dose
- Controlled biodistribution
- Anodulated pharmacokinetics [22]

Table 1 shows a list of some nanoparticles and their applications in drug delivery. A new generation of anti-infectives are being developed using antibacterial nanoparticles. These alternatives offer new options to fight disease, especially with the existence of antibiotic-resistant strains of bacteria. These new medications may also prove to be more effective countermeasures to biological warfare agents.

Nanomedical techniques using liposomes, emulsions, polymer-based nanoparticles or carbon nanoparticles could be used to create needleless vaccine delivery systems that can be delivered directly to target tissues. [23] Nano-enabled techniques like this can increase the number of different types of vaccines that would be available leading to a reduction in the volume of vaccine required for individual administration, less discomfort for patients, easier transport to remote locations and greater efficacy of the vaccine to produce an immunologic response. [24] More effective vaccines, produced more rapidly, would offer a tactical advantage to troops deployed to areas with emerging diseases or to hostile territory where the use of biological weapons is a threat.

When evaluating the implementation of any new technology in healthcare, 13 attributes must be assessed, and the effective use of nanotechnology for military medicine is no exception. It is also important not to discount an innovative technology because it may fall into one of these common criticisms:

- Customer has not expressed a need for this
- There is no military requirement
- This has never been tried before Investigator is new to the field
- Not in the pre-established research plan
- Insufficient data to demonstrate feasibility [25]

Not unlike its cousins in innovation that have come before, nanotechnology has serious potential to radicalize the treatment of military personnel before, during, and after combat operations. Applications of nanoscale powders and solutions, such as silver and chitosan, offer enhanced healing capabilities and lower the risk of infection during long-term wound treatment. The use of artificial platelets and red blood cells could prove effective in minimizing blood loss in traumatic hemorrhage.

Nanotechnology also offers the promise of creating more efficacious vaccines and anti-infectives, which could be deployed easier to combat areas and remote locations. Although nanotechnology is still very much an emerging technology, it is important to not discount its ability to revolutionize military medical care, especially now as the nanotechnology enterprise focuses more on the use of engineered nanomaterials in systems. However, it is still advised that specific applications of nanotechnology be evaluated for patient and healthcare worker safety, cost effectiveness, and technological improvement over current practices. The important take away is that even though nanotechnology has been actively researched for its potential use in military medicine, there are still many more opportunities to improve warfighter health that can and should be investigated.

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**Greg Nichols is the program manager for the Nanotechnology Studies Program at ORAU in Oak Ridge, Tenn., where he provides expertise on nanotechnology-related topics. Previously, he supported a variety of occupational and environmental health projects for corporate and government clients. Nichols spent 10 years in various healthcare roles. He has published on a variety of topics in peer-reviewed journals and co-authored a book chapter on the use of epidemiology in risk assessment. He has a bachelor's degree in philosophy and a Master of Public Health degree, both from the University of Tennessee and holds the Certified in Public Health credential.**

# RAPID RESPONSE

## QUICK, ACCURATE IDENTIFICATION OF BIOLOGICAL PATHOGENS

**By: Kimothy Smith, Ph.D., DVM**

The Department of Defense operates worldwide, including in remote and austere environments without access to modern medical facilities. The task of diagnosing and caring for sick and injured soldiers on the battlefield, especially in isolated regions, remains a challenge. The austere environment, coupled with the potential to contract local diseases, creates a need for rapid diagnostics and treatment. Developing in-field detection of pathogens, disease and biological warfare agents allows warfighters to request necessary medical evacuation or quarantine for sick or contagious troops; thus mitigating the risk of exposure to other personnel.

Soon, taking clinical and environmental samples to a laboratory for high quality, highly reliable molecular diagnostics tests will be outdated. The era of point of care and point of need diagnostics tests is here and the applications for these diagnostic tests are broad, diverse and limited only by the imagination. But, ensuring the sensitivity, specificity, robustness and reliability of performance of point of care and point of need molecular diagnostics is essential.

This means the platform or device running the test, as well as the assays, or the test itself, must be thoughtfully and rigorously designed, and have proven performance. Investment in this type of product represents a significant opportunity for DoD to improve the survivability rate for its soldiers and maximize the potential of field medics to treat as many ill and wounded as possible.

Researchers with the PositiveID Corporation designed Firefly Dx, a hand-held, battery powered, cartridge-based, rapid, multiplex, real-time polymerase chain reaction diagnostic device for point of care and point of need, lab-quality detection of pathogenic organisms, biomarkers and single nucleotide polymorphism identity assays.

The device will allow detection and identification of Influenza at the point of need with lab-grade results in 15 to 30 minutes. This is simply not possible with existing systems, which require lab-based equipment, technical personnel, and can take hours or even days to provide results. The ability to rapidly test and diagnose a contagious or deadly illness will allow medics to administer appropriate treatment for the correct illness instead of providing general care while they wait for lab results. In remote locations, the option to send for a laboratory test is not feasible. The use of the Firefly Dx would allow for testing and identification of an infectious disease when previously there was no option.

The Firefly Dx is a two-part device consisting of a portable hand-held instrument and disposable single-use cartridges. The cartridges will contain all of the reagents necessary for sample lysis, purification and PCR analysis of the extracted DNA or RNA. Firefly Dx will be able to process a variety of sample types, including whole blood, buccal and nasopharyngeal swabs, urine and environmental field samples. PositiveID Corporation is teaming up with GenArraytion, Inc., to provide high quality, rapidly developed, proven assays.

**Key attributes of the Firefly Dx system design include:**

- Portable and battery powered
- Low cost and fully automated
- Single-use disposable cartridges
- Ease of use (one-button operation)
- Sample-to-results in 30 minutes
- RFID tracking of cartridges
- Public Health trusted real-time PCR chemistry and interpretable results

GenArraytion brings its highly successful approach to assay development to bear on development of Influenza assays. GenArraytion's MultiFLEX™ Bioassays for infectious disease agents provide a significant advance in multiplexing flexibility, with more than 20 DNA and/or RNA targets in a single assay panel that can be mixed and matched to suit various platforms and operational scenarios.

The multiplex PCR assays are readily configurable, highly specific and ready for use in real-time and bead-based, end-point platforms. The assays are available for clinical pathogens and veterinary disease agents as well as food or waterborne pathogens and biological threats. Recently the company developed panels for both tick and mosquito-borne pathogens including Aedes aegypti (yellow fever mosquito) associated viruses.

GenArraytion's approach to molecular infectious disease diagnostic assay devel-

## Broad Range of Applications

### First Responders

- Biothreat agent detection and confirmation (such as Anthrax) from environmental samples and powders
- Rad/Nuc incident true exposure determination of casualties
- Agricultural
- True "Pen-side" diagnostic ability for high-priority and routine animal diseases (such as Porcine Reproductive and Respiratory Syndrome) for veterinarians and animal health technicians
- Rapid and accurate diagnostics on-site for Foreign Animal Disease outbreaks (such as Foot and Mouth Disease Virus)
- Field diagnostic capability for high-consequence invasive crop diseases

### Human Infectious Diseases

- Biothreat agent detection and diagnosis in multiplex test
- True "Bed-side" diagnostic capability for example, respiratory differential diagnostic panels
- Diarrheal differential diagnostic panels
- Antibiotic resistance detection panels (such as MRSA)
- Seasonal and Pandemic Influenza panels
- Other emerging and re-emerging concerns such as Dengue Fever Virus, Chikungunya, Nipah, Zika, etc. in resource constrained environments
- Human Clinical (non-infectious disease)
- Radiation exposure biodosimetry panel post-Rad/Nuc incident and for manned space missions (such as the International Space Station)
- Cancer detection and diagnostics panels

opment leverages available genetic sequence information by mining the data for highly informative genetic targets that are optimized and validated using a robust iterative laboratory assay development process. The company demonstrated the ability to rapidly develop high fidelity molecular infectious disease tests and various real-time PCR platforms, as well as more highly multiplexed assays, including planar microarrays and bead-based assays.

Figure 1 shows a graph of real-time PCR raw data generated in the Firefly Flu Dx integrated breadboard following RNA extraction and sequence specific reverse transcription, using GenArraytion Influenza assays. GenArraytion has performed a bioinformatics analysis of flu strains published in GenBank and we have designed a screening array containing over 15,000 sequences representing unique regions of various Influenza isolates. Assay targets were selected based on the specificity of more than 20 Influenza isolates.

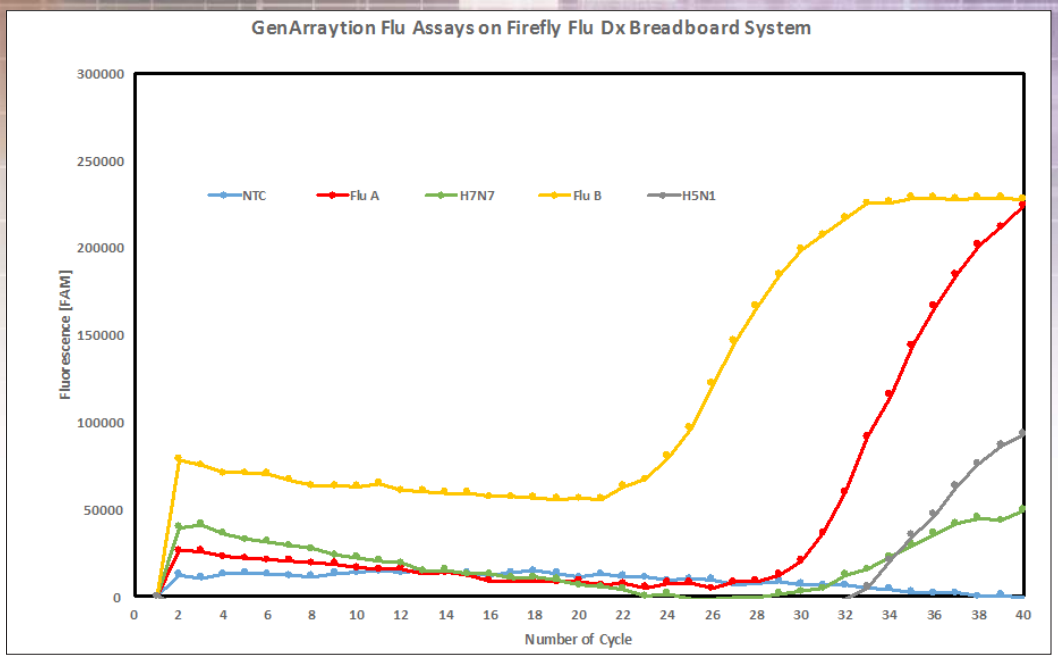


**Figure 1. Real-time PCR raw data generated by the Firefly Flu Dx breadboard system following RNA extraction and sequence specific reverse transcription using GenArraytion Influenza assays. Target amounts were all 500 pg. (Released)**

**Dr. Kimothy Smith is the chief technology advisor on the Board of Advisors for PositiveID Corporation. Dr. Smith has served as a professor of advanced analytics and most recently the senior director for the Applied Innovation Center for Advanced Analytics at the Desert Research Institute. Dr. Smith is a co-founder of McCarthy & Smith Consulting, LLC, where he provides professional consulting services in the areas of biosurveillance, bioforensics, biodefense, biosecurity, molecular genetics and diagnostics, and food safety, defense and security. Dr. Smith was named the first Chief Veterinarian for the Department of Homeland Security in 2005. PositiveID Corporation™ (OTCQB: PSID) is a life sciences tools and diagnostics company specializing in biological detection and molecular diagnostic systems for America's homeland defense and the global healthcare market. PositiveID specializes in the development of microfluidic systems in order to detect biological threats and outbreaks, whether airborne, in a healthcare setting, or at the point of need. PositiveID is also a leader in the mobile technology vehicle market.**

# The Role of Medical Mannequins in Battlefield Death Prevention

**By: HDIAC Scientific and Technical Analysis Team**

The Homeland Defense and Security Information Analysis Center received a request for technical information and analysis on emerging technologies, challenges and solutions in simulation and medical mannequin training to reduce preventable battlefield deaths due to hemorrhaging, airway obstruction and pneumothorax. This inquiry fell into HDIAC's medical focus area, one of the eight core areas for HDIAC. The medical focus area encompasses any facet of medical research relating to security or military operations, including training and combat life support equipment. HDIAC provided research and a comparative analysis on new human-like medical mannequin technologies for medical training and simulation.

Treating injured soldiers on the battlefield presents a major challenge for the military due to limited access to medical units. HDIAC identified recent technological advances in compressible bandages [1] and prosthetics increase survivability, but providing more resources and materials can better equip and train military personnel in the field. The Department of Defense needs to prepare and train military personnel to assess and treat traumas in dynamic combat zones.

According to the Wound Data and Munitions Effectiveness Team, [2] the leading causes of preventable death in Operation Enduring Freedom and Operation Iraqi Freedom were compressible hemorrhage and airway compromises. [2, 3, 4]

The autopsy records from the study showed that 33 percent of deaths caused by hemorrhage could have been prevented with proper tourniquet application, [2, 4] and a majority of fatalities occurred before transportation to a treatment facility. [5] This emphasizes the need for increased training and readily available supplies for medical and nonmedical personnel in the field.

Airway obstruction is the third leading cause of preventable deaths in combat. [6] A multitude of external factors can complicate injuries—including food, debris, and in extreme cases, tissue and flesh from explosions, burns and damage to the face—cause airway obstructions. If the muscles at the base of the tongue lose their support, airway obstruction can also occur when the tongue rolls back, blocking the airway. [7, 8] A few basic and advanced airway support techniques exist that can be employed by DoD personnel, however, many require prior training and those techniques without a training requirement are not suitable long term solutions.

Medical mannequins can provide a wide range of simulations from traumatic wounds to airway obstructions. Different simulation trainings require varying types of mannequins. Numerous companies provide trauma mannequins to aid in simulating combat zone injuries. The DoD currently employs many of these options, but it is looking for mannequins with realistic features, such as tissue structure and blood flow simulation. Some mannequins available employ realistic anatomy and ruggedized materials to create life-like and challenging training scenarios, helping prepare medical providers to save lives on the battlefield. [9]

HDIAC's analysis included DoD applications that will benefit service members as well as civilians. Other companies design, manufacture and market simulators for health care education. Some feature wireless communication to program the mannequin as a trauma simulator that allows for realistic simulation of combat wounds similar to what a soldier might experience in the field. [10] A few companies provide a customizable trauma mannequin as a military training solution. The mannequins allow for training in rapid assessment of trauma emergencies, hemorrhage control and airway management. Currently, special effects companies are assisting surgeons by developing a lifelike model that look and feel human. [11]

Surgeons work collaboratively with special effects artists to capture the tensile properties of human tissue. These lifelike materials allow for surgical simulation, giving surgeons the ability to prepare for procedures with precision and accuracy. A special gel mimics real brain tissue and allows surgeons to practice hand-eye coordination. [11] The realistic-feeling tissue including the membrane between the muscle and veins [12] can help military personnel to hone their skills by practicing specialized techniques, such as those used to determine the pressure required to treat trauma wounds. HDIAC highlighted additional areas of research showing that the rigid plastic of traditional mannequins often makes it difficult to judge the appropriate pressure needed for treatment in the field, but the mannequins made from specialized tissue could mitigate this issue.

Accompanying software provide a wide range of training simulations and enhances different scenarios to complete unique learning objectives. [13] The Portsmouth Naval Medical Center's Healthcare Simulation Unit utilizes mannequins to create a

customized experience. [14]

Medical mannequins offer a unique solution to trauma training because they can simulate real injuries in a controlled environment. Studies show simulation-training results in quicker and more accurate situational interpretation for medical professionals. Skills acquired while practicing on medical mannequins transfer to human patients, improving the accuracy and speed of potentially lifesaving treatment methods. [15, 16] Due to the increased use of improvised explosive devices and the complexity of blast injuries, hemorrhage control is a priority in military medical training. [17] Medical personnel who complete a simulation and are debriefed and taught correct techniques are better able to retain knowledge and make use of it in the field. [18] The use of mannequins will allow military personnel to hone their skills and gain confidence to perform lifesaving procedures on their fellow mates in times of need. The information provided by HDIAC allows the customer to compare current and emerging technologies to best provide training for military medics.

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# Decontaminants

## Protecting the Warfighter Against Chemical and Biological Warfare Agents

**By: Brian France, Ph.D.**

Effective decontamination technology is an ongoing need for the Department of Defense as crude weapons utilizing biological and chemical payloads are readily fashioned from non-military technology. Despite global restrictions on the production and stockpiling of chemical and biological warfare agents, [1] many precursors required to fashion a crude chemical weapon remain widely available as industrial chemicals, [2] while widespread research of common virus strains creates opportunity for purchase or theft to facilitate the creation of a biological weapon. [3]

Some of these agents, particularly chemical agents, linger or leave residue behind, which requires decontamination prior to human re-occupancy of the area. Thus, the DoD supports new and innovative research that will protect the warfighter against chemical and biological warfare agents.

Scientists have developed a new water-based decontaminant solution effective against both classical chemical and biological warfare agents. Registered with the Environmental Protection Agency under the Federal Insecticide Fungicide and Rodenticide Act, the technology claims efficacy against bacterial spores, including anthrax and overcomes long-standing challenges in storage and transport of decontamination solutions.

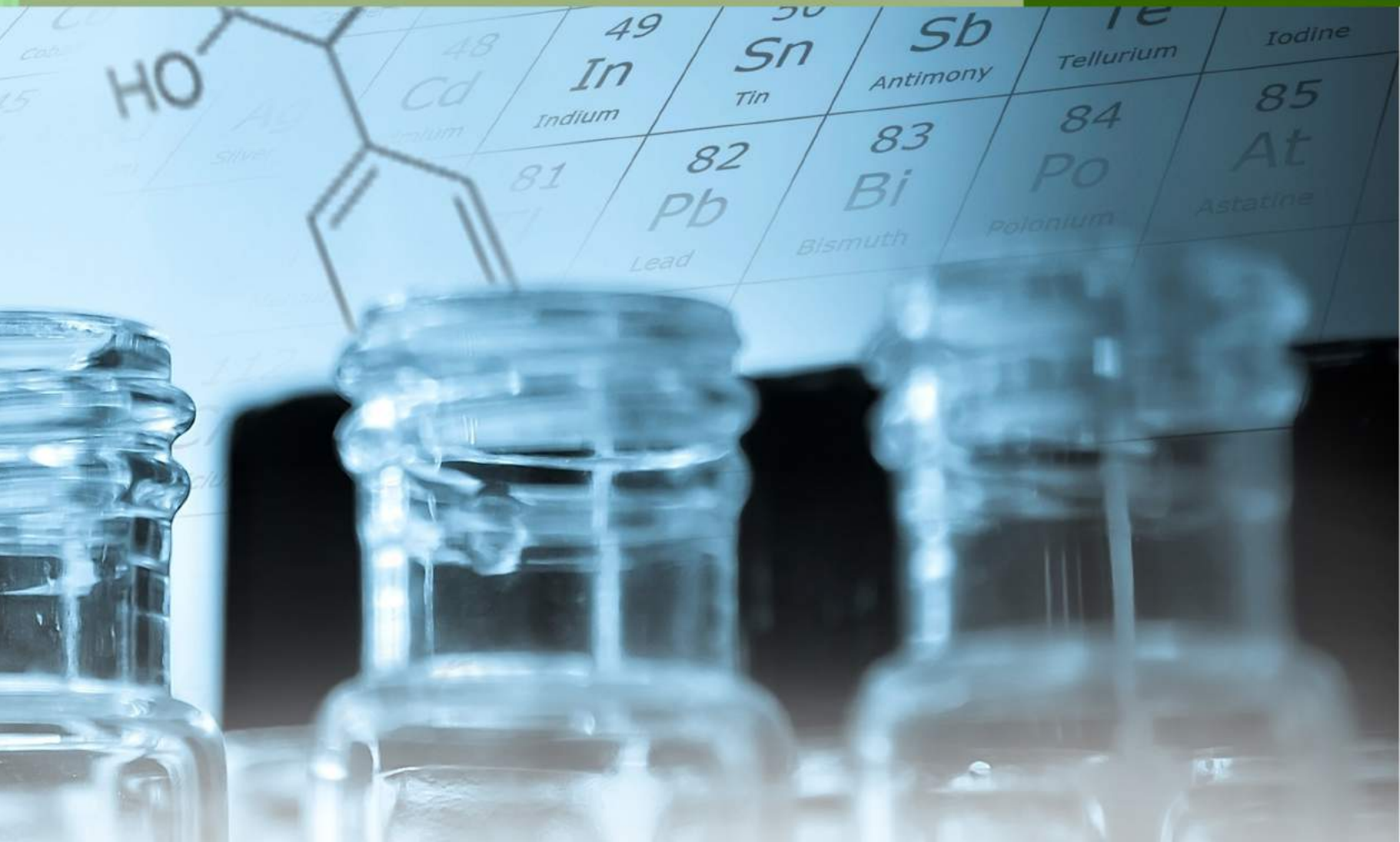
Decontaminants used to treat surfaces contaminated with chemical and biological warfare agents must be stable so they can be stored for long periods and stockpiled for times of need. They must also be non-reactive so that they are environmentally benign and can be safely handled by personnel and rapidly transported. At the same time, the decontaminant must be very reactive upon use so that it can quickly detoxify chemical warfare agents and sterilize bacterial spores.

These conflicting requirements for stability and reactivity are addressed by a new technology that stores and transports a solid salt, which when needed is dissolved in water and activated just as it is applied to produce a reactive, fast acting, decontaminant solution.

The solution is applied directly onto a contaminated surface through a miniaturized electrochemical cell, producing reactants that act quickly and then decompose. One of the primary reactants is chlorine dioxide, a highly effective antimicrobial. The electrochemically generated chlorine dioxide, eClO2, effectively detoxifies chemical agents HD (mustard agent) and VX (nerve agent) as well as biological agents such as anthrax.

Other reactive components are simultaneously produced to provide reactive efficacy against G-class nerve agents. This solution provides the DoD an effective means to decontaminate chemical and biological warfare agents and keep the warfighter safe.

The decontaminant is stored in its most concentrated form, as a powder solid and maximum concentration liquid surfactant. This approach minimizes the size of the storage facility and the effort required to transport the material to locations of need. These starting materials are non-hazardous (salt and soap), and can be shipped in large quantities using military or civilian air transport. Water does not need to be shipped in to dissolve the solid materials. It can be acquired locally, and can include




water taken directly from lakes or rivers or even seawater.

The decontaminant materials are inexpensive, commonly used industrial materials that are available in bulk. The fact that salts are used as the starting materials ensures a long shelf life. The applicators are operated with complete portability using lithium primary batteries (with a 10-year shelf life) or rechargeable batteries. The units can also be plugged into a 12 volt generator, vehicle or powered from the electrical grid.

This eClO2 technology has demonstrated efficacy against chemical warfare agents in tests at the Edgewood Chemical and Biological Center, and was recently registered with the EPA under the Federal Insecticide, Fungicide and Rodenticide Act as effective against bacterial spores, including anthrax (EPA Reg. No. 85797-1). Scientists at the Naval Surface Warfare Center Dahlgren Division completed efficacy testing against a 1x107 colony-forming unit Bacillus anthracis Ames (anthrax) challenge. The virulent anthrax was eliminated within one-minute contact time. [4]

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**Brian France holds a Ph.D. in Analytical Chemistry and works to bridge fundamental science and customer needs to develop new commercial products. Dr. France is a Senior Scientist at TDA Research and a Principal Investigator currently leading several R&D efforts. Dr. France has been involved in chemical defense and decontamination R&D for the past decade and is an honorably discharged veteran of the U.S. Army. TDA Research, Inc. is a privately owned small business with significant research and development capabilities. TDA develops technology and manufactures advanced materials, chemical processes, and aerospace and military hardware. TDA has a history of maturing technologies from concept to ton size production.**

Homeland Defense & Security
Information Analysis Center

# HDIAC SERVICES

## Core Analysis Task (CAT)

PRE-AWARDED PRE-COMPETED CONTRACT VEHICLE

### RAPID START TIME
Work can begin in as little as six weeks, once the statement of work is approved.

### EXPANSIVE TECHNICAL FOCUS AREAS
HDIAC's broad scope is especially valuable for the efforts that cross multiple focus areas.

### EXTENSIVE SME NETWORK
HDIAC is able to leverage support from its expansive SME network.

### ACCESS TO THE LATEST SCIENTIFIC & TECHNICAL DOD FINDINGS
HDIAC draws from the most recent studies performed across the DoD, and the results from all of HDIAC's CATs are collected, stored and used to support HDIAC's future efforts.

## Technical Inquiry Services

HDIAC provides four free hours of analytical, scientific and professional research within our eight focus areas. These services are available to academia, industry and other government agencies. To utilize HDIAC's free technical inquiry service, log in and submit a technical inquiry form at **hdiac.org** or contact **inquiries@hdiac.org**.

# HDIAC Basic Center of Operations & Mission

**The Homeland Defense & Security Information Analysis Center (HDIAC)** is one of three Department of Defense Information Analysis Centers. HDIAC is responsible for acquiring, analyzing and disseminating relevant scientific and technical information, in each of its eight focus areas, in support of the DoD and U.S. government R&D activities.

**HDIAC's mission** is to provide authoritative, responsive solutions by generating, acquiring, processing, analyzing and disseminating relevant information and analysis to our customers.

Through our Basic Center of Operations, subject matter expert network and extensive database collection, HDIAC is positioned to help support the nation's toughest scientific and technical challenges. HDIAC provides a wide range of additional services, including:

- Access to the HDIAC Journal, a quarterly publication featuring scientific and technical innovations within our focus areas.
- A network of subject matter experts in each of the focus areas.
- Participation in key technical conferences and forums to engage and network with the science and technology (S&T) community.

Homeland Defense & Security
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# HDIAC FOCUS AREAS

Alternative Energy | Biometrics | CBRN Defense | Critical Infrastructure Protection | Cultural Studies | Homeland Defense & Security | Medical | WMD

# Calendar of Events

## July 2016

**7/02/16 - 7/23/16 • Sydney, Australia**
**HD** Symposium on Innovations in Traffic Flow Theory and Characteristics in the Era of Autonomous Vehicles

**7/08/16 • Brussels, Belgium**
**M** Horizon 2020 - Health, Demographic Change and Wellbeing Info Day

**7/11/16 • Colorado Springs, CO**
Geological Modeling: Methods and Methodologies Session

**7/17/16 - 7/22/16 • Durban, South Africa**
**M** International AIDS Conference 2016

**7/19/16 - 7/21/16 • San Francisco, CA**
**AE, HD** Automated Vehicles Symposium 2016

**7/22/16 - 7/24/16 • Pittsburgh, PA**
**HD** Community College Cyber Summit

**7/24/16 - 7/26/16 • Evanston, IL**
**CIP** 22nd International Symposium on Transportation and Traffic Theory

**7/24/16 - 7/27/16 • Missoula, MO**
**AE, HD** Transportation-Related Noise and Vibration Committee Summer Conference

**7/25/16 - 7/27/16 • Salt Lake City, UT**
**AE, HD** Propulsion and Energy Forum and Exposition

**7/27/16 - 7/30/16 • Aspen, CO**
**HD** 2016 Aspen Security Forum

## August 2016

**8/2/16 - 8/4/16 • Washington, DC**
**B** Biometric ID for Government

**8/8/16 - 8/10/16 • Istanbul, Turkey**
**CIP** Istanbul Bridge Conference

**8/09/16 - 8/11/16 • OMAHA, NE**
**CIP** 2016 Summerail Conference

**8/21/16 - 8/23/16 • San Diego, CA**
**HD, CIP** Cyber Security for Critical Infrastructure Exchange

# HDIAC Call for Papers

The HDIAC Journal is a quarterly publication, focusing on novel developments and technology in the alternative energy, biometrics, CBRN, critical infrastructure protection, cultural studies, homeland defense and security, medical and weapons of mass destruction fields.

- Articles must be relevant to one of the eight focus areas and relate to Department of Defense applications.
- Articles should be submitted electronically as a Microsoft Word document.
- We require a maximum of 3,000 words.
- All submissions must include graphics or images (300 DPI or higher in JPG or PNG format) to accompany the article. Photo or image credit should be included in the caption.

**HDIAC is now accepting abstracts and articles for consideration for the 2016-2017 publications. For more information, contact the Managing Editor at publications@hdiac.org**

## Publication Schedule

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**Volume 3; Issue 4**
**(Publish Dec. 2016)**
**Abstract deadline:**
**7/15/16**
**Article deadline:**
**8/15/16**

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**Volume 4; Issue 1**
**(Publish March 2017)**
**Abstract deadline:**
**10/16/16**
**Article deadline:**
**11/16/16**

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**Volume 4; Issue 2**
**(Publish June 2017)**
**Abstract deadline:**
**01/16/17**
**Article deadline:**
**02/15/17**

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