

**DARPA Tech, DARPA's 25th Systems and Technology Symposium
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Anaheim, California
Teleprompter Script for Dr. Brett Giroir, Director, Defense Sciences
Office**

IDEAS Begin Here

» **BRETT GIROIR:**

Thank you Amy.

Tell us that something is just too difficult.

That gets our attention.

Or tell us that the scientists and engineers do not exist, and there are no guiding principles to govern advancement;

That is exactly the space we occupy.

And please, please tell us that something **simply cannot be done — it's science fiction**

That is the challenge
we cannot resist.

**Good morning and welcome to the far side of the far side, to the keepers of the dream,
to DARPA's DARPA – welcome to DSO –
the Defense Sciences Office**

In 1960, who could have imagined the need for an entirely new scientific

discipline, and then did nothing less than create the modern field of materials science?

In the 1980's,
who developed the processing technologies for ceramic composite armor that now protects our warfighters?

In the mid-1990s,
who ushered in an entirely new paradigm of electronics based on the spin of electrons?

Or in the year 2000,
who discovered that chlorine dioxide gas killed spores, just in time to restore American infrastructure after the anthrax attacks of 2001?

And in this decade,
who **BUT** DSO could have initiated research to literally decode the language of the brain?

I think you are getting the point...

**When your only mission is to “mine the far side” to radically change defense paradigms,
it is not surprising that at DARPA ideas begin here.**

But before I tell you more about WHAT we do,
I first want to introduce you to WHO we are.

Because clearly,
it is our incredibly creative program managers
who fuel innovation
in our office.

It may *even* appear that our program managers predict the future -- both future military needs and the technical pathways to address them.

How **do they do this?**

Well on this,
the beginning of the
50th Anniversary of DARPA,
I will reveal a few of the secrets of our success: how DSO program managers live in the present yet anticipate the future.

So join me for a moment as we take a trip
to the far side.

Now that you understand what makes DSO different, let me tell you how we exploit these differences for the Department of Defense.

DSO continues to build on our 50 year legacy in Materials Science.

Two years ago,
we announced a radically new process designed to dramatically reduce the cost of aerospace-grade titanium.

We have now scaled up this process with a major industrial partner, and the price, not the cost, is promised at \$3.50 per pound – a 10-fold reduction.

DSO's price even beats the T2 mart!

At \$3.50 per pound, titanium will be used ubiquitously, for applications as diverse as piping on ships and tactical vehicle armor.

Most importantly, our process guarantees a domestic source of high grade titanium and eliminates our current foreign dependence.

DSO has also developed *entirely new classes* of materials.

In fact, we have pioneered the first new class of metals in over 4000 years – so called, amorphous metals.

Compared to normal crystalline metals, amorphous metals have no grain boundaries or higher order structure, so they manifest toughness and corrosion resistance far superior to our best stainless steel and nickel superalloys – and at a fraction of the cost.

Amorphous metal coatings are now being transitioned to the Navy to reduce corrosion and wear on surfaces such as carrier decks.

Now here is a materials idea that originated from a small business.

Hardwire is an armor system that uses common, inexpensive ceramics confined by high strength twisted steel wires, similar to the steel belts in your automobile tires.

Hardwire provides high level, multi-hit protection against fragmentation and armor piercing threats, and at markedly reduced weight.

As demonstrated in the following video...

As I speak, Hardwire panels are being transitioned to our Service partners for use on a wide range of military vehicles.

From idea, to deployed life saving force protection in a very short time – THAT is the power of DARPA.

When DSO takes on an area, we engage it at all scales.

I have already spoken about bulk metals and armor systems, so what about the nano-scale?

Imagine cooling a cloud of atoms to a temperature of one nanokelvin (that is one billionth of a degree).

At this temperature, the atom cloud collapses into its lowest quantum state, and quantum mechanical effects become macroscopic.

Dr Jay Lowell, a DSO Program Manager and Air Force LtCol, has used these ultra-cold atoms to develop an atom based inertial navigation system with unprecedented accuracy.

What this will mean is highly precise, GPS-independent navigation for all kinds of operations –on foot, in a fighter aircraft, or onboard a submarine.

But “Ideas Begin Here” for many other areas of science and technology far beyond physical science.

One of DARPA’s strategic thrusts is Bio-Revolution, which we broadly interpret as *harnessing breakthroughs in Biology – at all scales – for the benefit of the warfighter.*

The Bio-Revolution is an incredibly rich and diverse thrust, but at its core is our passionate belief that the primary weapons system of the U.S. military is, ***and will remain, the highly trained, cognitive, peak-performing human warfighter.***

In the mid 90’s, DSO challenged the nascent BioDefense community to abandon its conventional dogma, best described as “one bug, one

drug.”

Instead, we aggressively pursued single therapies that could be used against broad classes of pathogens – including bioengineered and newly emergent threats.

As a result, the DSO developed many “first in class” therapeutics, including a new vaccine adjuvant called CpG.

This vaccine adjuvant enhances the human immune response **to any** specific vaccine.

As an example, we demonstrated a 10-fold enhancement in anthrax protection for subjects receiving the current AVA anthrax vaccine plus CpG, compared to those receiving the AVA vaccine alone.

This adjuvant is now in clinical trials for vaccines as diverse as anthrax and avian influenza, and may even be the key to new vaccines for cancer.

Next, let’s turn our attention to Combat Medicine.

We are revolutionizing it. Period!

DSO’s Trauma Pod Program is developing a portable, self contained robotic trauma unit that will bring specialized diagnostics and surgical interventions directly to the battlefield.

Certainly, there will be a tele-present combat surgeon controlling the surgical robot.

But all other operating room functions, including anesthesia, airway management, fluid administration, and surgical assist, will be performed

robotically and autonomously.

Just a fantasy? Not at all!

Only 4 months ago, a laboratory-scale Trauma Pod, controlled by a tele-present surgeon, performed the first operative procedure on a surgical mannequin **WITHOUT ANY HUMANS IN THE OPERATING ROOM.**

Within the next 2 years, DSO will deliver to the Army a prototype Trauma Pod capable of performing the most critical battlefield diagnostics, imaging, and life saving procedures – anywhere, and anytime.

As incredible as Trauma Pod may seem, it is overshadowed by another initiative whose vision was presented so powerfully to you at DARPATech 2005 by another DSO program manager.

Dr. Geoff Ling, an Army colonel, medical doctor, neuroscientist, and veteran of two combat tours, outlined a bold vision to give back full and normal lives to upper limb combat amputees.

DSO's vision is to develop a fully functional, brain-controlled upper limb prosthesis - with full motor and sensory function.

We stated that if warfighters could play the piano before their amputation, they would again play the piano with their new prostheses.

This was more than a prediction from DSO.

This was a PROMISE – a COVENANT – with all our injured troops.

Now in only the second year of the four-year program, DSO's Revolutionizing Prosthetics program has already produced two radically

improved prototype prosthetic arms, with highly functional hands.

And, while these prosthetics do not yet enable performance of Mozart piano concerto, they do provide markedly improved function and degrees of freedom.

They are lightweight, already include basic sensory feedback, and can be controlled by nerves remaining in the amputee's shoulder.

If you see nothing else here at DARPA Tech, go see the first truly bionic arms being demonstrated at the DSO booth, and imagine with me the improvements in quality of life that these limbs will bring to our wounded heroes.

Now before I turn the podium over to my DSO colleagues, let me introduce a few new ideas: ideas that truly span the disciplines of modern science, and even a few disciplines that have yet to be created.

So what is the next radical advancement for materials and structures?

At DSO, we envision materials that can be programmed to self organize from a set of simple instructions.

And then, we will program these materials to adapt their physical properties to environment conditions.

We put no limits on the range of material applications.

You probably have heard the word "TRANSFORMATION."

At DSO, we envision more than "Force Structure Transformation" – we strive for "Warfighter Transformation."

What does *that* mean??

We want to define,
and then create the techniques to transform every 18-year-old recruit into a highly cognitive, adaptable, and culturally attuned military professional, including being conversant in the indigenous language of deployment.

We must also impart to every new recruit the experience and savvy of a seasoned veteran – that soldier “sixth sense,” and to do it prospectively – before the first shot is fired.

To accomplish these goals, we must lead a revolution in training and learning based on the rapidly advancing field of neuroscience.

Indeed, DSO is already catalyzing collaborations and neuroscience discoveries previously unimagined.

We have begun to understand the fundamental molecular and biochemical bases of learning and memory, and to develop techniques and training to optimize them.

We are learning how and when to cue perception, so that critical information is perceived at the right time.

Finally, we have much farther to go in the area of tactical biomedical technologies.

We want no wounded soldier to die, and ALL those who are wounded to return home with normal physical and mental function.

What if we *could* induce a state of suspended animation to allow survival even after otherwise fatal hemorrhage so that there would be

time for evacuation to a combat support hospital, or even back to the United States?

This is no longer science fiction.

Dr. Mark Roth of the Fred Hutchinson Cancer Institute has demonstrated that hydrogen sulfide gas, in the right dose, can shut off an organism's need for oxygen and induce a state of controlled hibernation.

He first demonstrated this in zebrafish, and then, with DARPA support, he induced a similar hibernation state in mammals and proved they could survive an otherwise fatal hemorrhage for many hours.

The visions I described today are not meant to predict the future, they are really meant to define it.

But this future can only be realized with your creativity and hard work.

We want to hear from you.

Here at DARPA Tech, please talk to us and visit our booth.

And perhaps YOU have a vision that someone else says is just too hard, or for which there is no community and there are no scientific principles.

Or maybe they have told you that your vision is impossible.

We have a place for you along with us at DARPA's DARPA, where IDEAS begin.

DSO.

It is my great pleasure to introduce you to my colleague, Mitch Zakin.