UNMANNED AND ROBOTIC WARFARE:
Issues, Options, And Futures

A Summary from the Harvard Executive Session of June 2008

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INTRODUCTION

What does the future hold? Are we ready for it? What can we do to prepare?

We stand today on the cusp of a revolution in warfare. Unmanned and robotic warfare has taken its first steps and will soon assume a prominent, if not dominant, position in the doctrine, strategy and tactics of the United States military.

We are not alone. As the United States has gained extraordinary insight to these systems over the past ten years, other nations are now ably replicating the American experience. Where today we enjoy uncontested airspace, and unbridled conventional force advantage on the ground, in air and at sea, those situations are rapidly changing.

What does the future hold? Are we ready for it? What can we do to prepare? What are the imperatives for leadership today to assure that the technical and operating gains Coalition forces have achieved in the cauldrons of Iraq and Afghanistan are harvested as insights, and translated into strategic and tactical advantage for years to come?

In June, 2008, Harvard University's John F. Kennedy School of Government, together with Booz Allen Hamilton, convened a group of senior American military leaders, retired and active duty, together with senior civilian researchers to explore the extraordinary developments in unmanned and robotic warfare of recent years. We took pains to assess our current situation, the road we are on, and the challenges ahead. We asked, "Is that the right course? Will we meet our national security goals? If not, what must we do today to assure that we do?"

This is a report of that session – *"Unmanned and Robotic Warfare: Issues, Options, and Futures"*. It offers the considered views, often in remarkable consensus, of some of our nation's most experienced military and civilian leaders.

We write to share their views and perspectives, in the hope of holding a mirror to our current position and likely futures, seeing in its reflection the nation's critical choices at this juncture. From our current position, how do we convert our lessons and deal with the issues ahead to leverage continued strategic and tactical advantage?

We do not pause to explicate many terms or concepts, or to document with footnote. We assume of readers, rather, a level of experience, knowledge and awareness not unlike that of the participants. It is in some respects their statement.

[1] The authors wish to acknowledge the special contribution of Mark Herman to this report.

OVERVIEW: TEN YEARS OF PROGRESS

Invention. *"Predator* is the equivalent of a Wright *Flyer."* That statement sums both the position and the potential of unmanned warfare today.

Ten years ago, the United States possessed one unmanned aerial vehicle (UAV), purchased from the Israelis. There was no domestic United States production.

Today the United States possesses 5,000 such devices, deploying 3,500 "in theater". The various systems have advanced from pure reconnaissance, to precision weapons, to land-based support for "dirty, dull and dangerous" missions. They have diversified in type and mission for air, sea and land operations.

The wars in Afghanistan and Iraq have provided laboratories of extraordinary development. American industry responded with unparalleled inventiveness. The United States, in consequence, gained a rapid technical and operating advantage, stimulating a profusion of new technologies. "We have," one participant said, "the biggest laboratory in the world going on every day."

"Predator is the equivalent of a Wright Flyer." That statement sums both the position and the potential of unmanned warfare today.

Funding. The urgency of the war brought forward funding that has in some cases doubled Service budgets. The United States Army, for example, now has a base budget of $137 billion, and a supplemental budget of $118 billion – or a total of $255 billion.

Fueled by the "supplementals", the acquisition system responded. "It saw the problem, fell on top of the problem, thought of the solution, and quickly delivered capabilities," one participant said. New firms entered the market, and new systems proliferated. Unfamiliar with and unconstrained by the formal acquisition processes and restrictions of "programs of record" in the defense or intelligence market space, they cobbled together off-the-shelf capabilities in newly valuable ways, moving innovative systems to the warfighter with astonishing speed.

Adaptation. The United States Air Force, for example, weaponized surveillance-only *Predator* drones with *Hellfire* missiles in under 90 days, converting *Predator* from a passive, persistent-monitor air vehicle to one that could also attack the targets it was watching.

Separately and essentially "on the fly", the Air Force mounted GPS guidance systems onto World War II bombs, loaded them onto a B-52, and used laser designators from an airman on a horse to target Afghani insurgents deep in a remote valley.

"Here is the B-52 that we developed to fly to the Soviet Union to drop nuclear weapons, refitted with a World War II bomb, a GPS guidance kit, and a horse with a wooden saddle, talking by dish to the B-52, all put together in completely different ways, invented by our kids," said one participant. "If Curtis E. LeMay thought his planes were doing close air support, he'd roll over in his grave. But that's what we were doing."

Risks: Reliability, Scale, Interoperability. The gains have not come without consequence. Few systems in the field have been subjected to rigorous or standardized testing or experimentation, for example. "DoD today has virtually no investment in R&D in systems up to the tactical level," one participant observed. Rather, "industry is bringing us entire systems" without any central OSD or Service investment or vetting.

In the conditions of warfare, the reliability of these systems – many of which are teleoperated – is in hours, not days. "These are not necessarily the kinds of figures you want to see in future systems."

Logistics capabilities have not kept up. "We have non-traditional companies who really don't know the government business," one observer said, "who have helped us proliferate and push these systems out; these are the same companies that are trying to catch up in understanding how we do logistics and support."

In Iraq and Afghanistan "we have had the biggest laboratory in the world going on every day."

As systems and firms have proliferated, so too has an astonishing lack of interoperability among them. "Every OEM will tell you they come with a solution – their solution set is cheaper because, while they bring us what we want, they own the rights," said a participant. "We have not wanted to share the expense to buy the IP rights up front."

ASSESSMENT: WHERE ARE WE TODAY?

Chaos.

It is a simple but powerful descriptor. In its most positive and negative senses, America's keenest observers describe our situation with respect to unmanned warfare as exactly that: "chaos".

To some, it is the natural result of wartime development, and to be carefully exploited.

"War tends to do this," one observer noted. "Throughout history," he said, "officers have had to wrestle with not only a total inversion of what they thought the war-fighting mission was, but a whole explosion of new technologies."

"When you're in Iraq, there is a common saying," he said. "'Let's embrace the suck.' The corollary for us might be, 'Let's embrace the chaos'."

Others are less sanguine. Where's the plan, what's the vision?

"Technology is pushing our doctrine," one participant observed. "We've found products that meet our requirements in war, bought them, and thrown more of those into theater, thinking that layering a steady stream of these new systems solves the problem."

"In reality," he said, "we're almost going out of bounds right now because we've stressed other systems – including an airspace control system that was just not ready to have 5,000 new vehicles put into it. Overly stressed a command and control system that now has more systems to control. Stressed an intelligence system that now has more information than it can handle."

To others, today's confusion is the natural wellspring of promise, and opportunity. "We need not necessarily despair that we've got this huge kluge of new technologies that are overwhelming us and our systems," observed a participant. "Maybe something good comes out of the back of it even if it doesn't feel like it while we're in the middle of it."

"We are really at the beginning of this," a participant observed. "It's that 'fun time' in a new technology and a new capability where we don't know any better, so we actually do good stuff. We haven't jumped in and over-specified everything, or overcomplicated it. We're just trying to solve problems with it."

In the conditions of warfare, the reliability of unmanned systems – many of which are teleoperated – is in hours, not days. "These are not necessarily the kinds of figures you want to see in future systems."

What is the content of this chaos?

Systems are not doing all they can do. From a design perspective, systems have far more potential than we have been able to exploit. We have proliferation without interoperability or plug-and-play. Some systems have aged prematurely – become dinosaurs before their time – as they do not easily upgrade or fit into current operational needs.

Situational awareness is still impaired. Information sharing in contested space remains a challenge. There is still much information around the battlefield that is not connected. The platforms do not easily "speak" with each other, even with billions of dollars of software patches. Operationally, command echelons "turn off the informational switch" at high levels with the consequence that information cannot reach decision makers on the ground.

"It was shocking to discover the limited SA on the Pakistan-Afghanistan border," a participant observed. "Even if we had 10,000 *Predators*, the linkages of HUMINT, SIGINT and imagery intelligence just don't come together there."

Manning and training is not keeping pace. We are struggling to staff and train commands to accommodate the influx of devices in the battle space. No one yet understands how to incorporate the UAV career path into traditional Service paths. That will be essential if we are to attract, develop and retain talented young men and women.

The acquisition mindset has not really adapted. There is frustration that program of record acquisition cannot keep up with the fast-changing pace of adaptation – ours and our adversaries' – and the timetable to get new capability quickly into the hands of warfighters.

"We still have a 30-year mindset on having to do full engineering and testing before I give it to someone," one participant observed. As government acquisition has become extremely complex, protests have increased. It is both low risk and low cost to protest should a firm lose a competition. "That sets us back years."

The requirements process is flawed in important respects. With procurements taking upwards of a decade, Services over-specify requirements as insurance against exigencies which may develop down the road. "If 90% of targets are soft, why does a platform need a deep-penetrating weapon?" one participant asked. "Those are the kinds of technologies that get poured on because this could be their only chance for another ten years."

There is no process driving towards interoperability. Rather, Services continue to pursue their options and their benefits. Without a "forcing function", for example, there is risk that we will continue to build UAVs that cannot land on ships. "That's wrong," one participant observed. "There must be someone saying, 'UAVs are the wave of the future, embrace it, and force the Services into doing it."

"Jointness" continues to fall short. While Joint action has occurred in the field, and architectures have been revolutionized, the same transformation has not occurred in the "Joint establishment". There remains contention over who should "drive the car" — who has operational control over airspace and seaspace, for example, to manage and deconflict.

"What UMS functions are properly Joint? We don't have an answer for this yet, and we need one," the Session was told.

There is no unifying vision. There is concern that all these issues – from requirements and acquisition, to logistics and command and control – suffer from a still fractured, stovepiped approach. There is an overarching concern with platforms rather than effects, for example, with technologies and systems rather than with capabilities, data and results.

Our approach has failed, yet, to capture the true bounty of our investment.

"The very thing that would have enabled the sort of transformation we need to do is the thing that didn't get transformed," said a participant. "We ended up confusing novelty with transformation. We tried to fund novel things that were never going to get funded, and never worked in the first place."

"We seem," one participant said, "to be using an evolutionary model for a revolutionary capability."

Post-war retrenchment risks future development. Unmanned systems strike all as, in fact, potentially disruptive technologies, truly transformative of warfare. As has happened before, there will be a post-war pull-back to older technologies and missions. Without a common and compelling vision, we risk missing the moment.

In history, America has dealt variably well nurturing its war-time technology advances as it entered post-war periods. The profusion of new war-time technologies immediately after the American Civil War, for example, highlighted the need for and allowed the development of the Naval War College. Yet the Spencer repeating rifle was abandoned in development after the Civil War. Tank development faltered between the two World Wars.

"We're almost going out of bounds right now because we've stressed other systems - including an airspace control system that was just not ready to have 5000 new vehicles put into it."

We will, certainly, continue acquisition and procurement of unmanned systems in the aftermath of Afghanistan and Iraq. Yet without a robust and far-reaching vision, we risk not only "buying things to fight with long before we've decided how we're going to fight," as one participant put it, but the potential to transform warfare to our strategic and asymmetric advantage for many years to come.

ISSUES ON THE HORIZON, HEADING TO TOMORROW

If that, then, is an assessment of our current situation, what are the issues on the horizon with which we must soon contend – issues which will have great consequences for the future of unmanned and robotic warfare?

Dealing with Supplementals. First, and of greatest concern, are the issues of supplementals. Supplemental appropriations are now decreasing, and are expected to completely disappear. *We require a bridging strategy that takes us from the supplemental process to accelerate proven systems into programs of record.*

All other UMW matters need to be seen through this lens. Today, no unmanned system is a formal program of record. If supplementals decline and vanish, as they surely will, it is likely *Predator* or *Reaper*, for example – unless adopted by Services as programs of record — will come to a standstill.

"Five years from now," one participant observed, "we may have less than we have now. If we are not careful, we won't get to where we're now headed."

Even if adopted as programs of record, however, UMW systems futures are not assured. They will compete for funds against other significant Service requirements. Health care and fuel cost increases are expected to be substantial. Even today Services are struggling to balance those demands against command growth increases – all in a "zero cost environment" where the Joint programming guidance is, "base plus inflation".

"I am concerned," said one participant, "that the revolutionary advances that we have made in integrating unmanned platforms in the field will die in a defense budget that is more constrained, in a period where commanders are more concerned about individual Service activities than about Joint war fighting."

How then do we migrate from a relatively flush era of supplementals forward to a post-war era of "base plus inflation" – making room for UMS as new programs of record along the way? We require a bridging strategy – which we do not now have – that takes us from the supplemental process to accelerate proven systems into programs of record, and to fund and sustain them there.

Maintaining Our Asymmetric Advantage. It is not simply a matter of maintaining current capabilities. It is, rather, taking steps to assure that as the United States moves to a post-war footing, American military and industrial collaboration continue to innovate in ways that will secure our continued asymmetric advantage. *We require an innovation strategy that brings forward technologies and systems which will confer asymmetric advantage for the foreseeable future to the warfighter and the nation.*

Surely if tomorrow we stand still, other nations will close today's asymmetric gap. The constituent elements of autonomous weapons system are being developed and are widely available in the commercial environment. Energy efficiency and closing the wage gap in manufacturing, for example, are driving robotics worldwide.

We require a bridging strategy that takes us from the supplemental process to accelerate proven systems into programs of record.

We are, in fact, seeing less and less *militarily-unique* research and development. That suggests that in the future R&D will principally focus on "fusing what's out there into military systems," as one participant observed. Many nations can do that, and are indeed already making advances. They have been energized by our success. Some potential adversaries confide in American general officers that they seek to be "just like us".

Where today we operate in a relatively benign battle space, we cannot be assured that that will continue, or know for how long.

We must ask then, *What is it that is unique and distinguishing about our development, our armed forces, indeed our culture that is our core competency as a polity and society, and which can be a competitive and strategic differentiator? How can we translate that into a strategy for innovation to assure asymmetric advantage for the future?*

An innovation strategy cannot rely solely on expediting existing processes. Much of it may come from a new approach – a *wisdom of crowds* approach – that recognizes the "wisdom of the war fighter", and that accelerates the "translational research" process from laboratory bench to war fighter in the field.

The Session was told that in history authoritarian regimes are classically at a disadvantage. "Historically," the Session heard, "totalitarian regimes are not successful war fighters. In suppressing freedom they suppress the entrepreneurial spirit, the innovation that makes someone a successful war fighter."

The United States faces many such regimes today – adversaries who seek parity by mirroring our own capabilities. Yet *if our openness as a society is a strategic differentiator,* how can we capture that systematically, and harvest it to augment our tactical and strategic advantage?

We require an innovation strategy that brings forward technologies and systems which will confer asymmetric advantage for the foreseeable future to the warfighter and the nation.

In some respects, the seeds of that shift are now planted. They are visible today, for example, in the shift to integrated information systems which place the war fighter at the center, *empowering* the war fighter to *pull* information as required, rather than remaining on the periphery, only receiving information *pushed* from higher echelons.

Can we translate that first pass at *personal empowerment* into *organization strategy* that incentivizes innovation, speeds adaptation, and accelerates dissemination? That capability will be a foundation of any future sustained asymmetric advantage.

The millennial generation is ready for it. Whether we prevail will depend on whether and how we stimulate the steady flow of ideas from research, practitioners and war fighters, and translate those ideas into action.

Adaptive Automation. In spite of America's dramatic investment in defense budgets, there is a belief that there has been, in fact, little new capital acquisition.

"Even after record defense budgets, we are still under-capitalized," said one participant. "We're going to be fighting for the next 15 years on what we bought in the Reagan administration." Another participant observed, "80% of what is afloat, in the air, and on the ground today, will be there 15 years from now."

As supplementals wind down, we must do more with the same or less. An adaptive automation strategy is essential – one that creates the effects we seek from retrofitting the existing capital plant to unmanned capabilities.

Over the past 10 years we may have paid too much attention to "the cool new stuff" – or at least not enough to our legacy platforms. Yet those legacy platforms will be with us for the next two decades.

"We are not," one observer said, "spending enough energy automating stuff that we already have with small changes. If we are going to innovate, we'd better spend as much attention migrating what we already own. No one should believe that we are going to have a blank piece of paper to start with some new force."

There is an "installed base" of about 200,000 Humvees, for example. The future of convoys is soon to be some hybrid of manned and unmanned vehicles. How can we best retrofit the Humvee fleet to confer that capability on commanders as needed – to enable unmanned convoys, for example, with platform-independent and autonomous following kits, robust vehicle-to-vehicle communications, and redundant platform location sensors?

DARPA's grand challenge demonstrates that we *can* retrofit traditional unmanned systems and increase their capabilities. Our challenge is to bring that low-cost capability into existing platforms such as the Humvee fleet. We need an adaptation strategy to guide us down this path.

Future design should incorporate accountability and allocation of decision rights and authorities from the beginning.

Global Acceptance. Our future investments will be limited by our own and global "appetite" or acceptance of unmanned capabilities.

Today, for example, there is no technological bar to completing unmanned airlift and tanker for missions. However, few nations, including our own, will accept the notion of an unmanned plane taking off or landing on military or civilian installations. Investing in such capabilities could therefore be unwise at this time.

Ethics and Accountability. Accountability is a desired future capability of unmanned systems. The human in that system will continue to be the key factor, especially in weaponized systems with the capacity to kill. We will be unable to detach ourselves from that decision-making, and very likely would not want to.

Our current allocation schemes of responsibility seem likely to work with unmanned systems. However, unmanned systems add complexity. With proper design and development they can also resolve it.

Currently, for example, unmanned systems are not designed to support investigation. They do not archive information. All of that can be addressed in future design which incorporates accountability and allocation of decision rights and authorities from the beginning. With this clarity we can reduce after-the-fact conflict and confusion, soldiers pointing to the machine, declaring, "I'm not responsible – the machine is."

THE FUTURE CAPABILITIES WE REQUIRE

From our current position, facing the opportunities and obstacles that we do, how do we convert the lessons learned from the past ten years to leverage continued strategic and tactical advantage for the future? As we look to the future, the Session identified three *must haves* — essential capabilities if the nation is to harvest its investment and assure its continued strategic advantage:

- A coherent vision of what is possible that animates all future design, development, acquisition and procurement, and deployment. We describe this as an *effects-oriented vision*.
- An architecture reflective of this vision that is minimally specified at the level of interface and effects, yet entirely appropriate to achieve it. We describe this as an *effects-oriented architecture.*
- Leadership qualities and imperatives which are unique to the transformational challenge ahead, and which can help confer continued strategic advantage from the nation's investments in unmanned and robotic systems.

From our current position, facing the opportunities and obstacles that we do, how do we convert the lessons learned from the past ten years to leverage continued strategic and tactical advantage for the future?

An Effects-Oriented Vision (the Un-Concept of Operations for Unmanned Warfare)

A formal *concept of operations,* or CONOPS, typically embodies a vision of what is possible, together with what is required, and a series of specifications regarding how we will achieve it. A CONOPS, well-rendered, is the score against which the orchestra plays its symphony – whether in procurement and acquisition, deployment and operations, or staffing, recruiting and training, for example.

A formal CONOPS may of its very nature, and in some important respects, not fully address the requirements of agility, adaptability and innovation required for the future of unmanned warfare. In some respects, UMW may require its own *Un-CONOPS:* a vision that is "holistic without being overly prescriptive," as one member observed.

To be successful, a holistic vision of UMW would need to guide future design and development, as well as acquisitions and procurement, and deployment and operations. However, as the specific capabilities involved *may not be known today,* or even if known today *rapidly change tomorrow,* the vision could specify few of these in advance.

What *can* be known, today, are the *effects* we want to achieve. It is suggested then, that as we develop a vision for unmanned warfare that we speak "about the *effects* that we must create in order to be successful."

If rendered well, the *effects-oriented vision* — the *Un-CONOPS* for UMW — would guide any future design, development and organization structure. While the vision would suggest if not enumerate some *capabilities* that we required – it would do so only pointing to the *effects* to be achieved.

An *effects-oriented* vision for unmanned warfare would, therefore, be relatively brief – a matter of some few pages, perhaps, not hundreds or thousands. Of its nature, it would be quite "updateable" – easily modified to reflect changes in desired effects, as might be required.

What is such a vision for future development of unmanned warfare today? "In its simplest terms," it was suggested, "it is the next-generation mission planning system tied to the autopilot."

Such a vision, if specified correctly, can help leverage industry collaboration. An effects-oriented vision, embodied in a statement, can help tell industry "where we are going", as industry requires. The effect we want to achieve may be *integration*, for example; we need not tell industry how to achieve it. Industry can figure that out.

As we seek agility, the capability to innovate, to fully tap the potential of unmanned systems, and to maintain our asymmetric advantage, an *effects-oriented vision for unmanned warfare* can best express those requirements. In keeping with the very capabilities we require, the vision is brief and light, permitting constant adaption to a core set of desired effects.

From the foot soldier to the UAV, unmanned warfare is now, and has always been, in fact a hybrid system comprising many individual actors and platforms.

An Architecture of Effects

We are, some say, "enamored of the platform."

"*Predator* has become to the UAS world what Kleenex has to tissue – a generic term for a long dwell-time aircraft that has a heck of a lot of different capabilities," one participant observed. "When soldiers ask for *Predator*, what they're really asking for is a vertical perspective that they don't normally enjoy from their position."

From the foot soldier to the UAV, unmanned warfare is now, and has always been, in fact a *hybrid system* comprising many individual actors and platforms. While we have tended to treat unmanned warfare as *platform-based* and a *feature of individual Services*, the reality of its success – the effects it achieves – derives from this hybrid array of systems, platforms and services.

When the nation's military planners first approached the problem of IEDs, they searched for a single breakthrough technology – a platform or system that would be decisive. That proved unavailing. What has succeeded, instead, is an *architecture of systems and activities* reflecting a panoply of assets, arrayed to achieve certain effects.

As we speak of an architecture for unmanned systems then, we should speak not of specific platforms, but rather of *effects* to be achieved, and look to an architecture of these systems, arrayed to create those effects.

We might therefore use the term *effects-oriented architecture* to establish our goals for these collaborations[2]. Any solution we consider would operate on the principles of that hybrid operation, rather than on platform-specific, independent action.

While we might be tempted to specify closely such an architecture of effects, that approach in fact permits us to let much specification pass *unspecified*. We might specify only the effects, and the interfaces, for example, to the level required for all systems to interoperate so as to achieve the intended effects.

[2] This expression was introduced to the session by Dr. Benn Konzynski.

An Analogy: The Color-Coded Plugs in Our Home Theater Systems. A useful analogy is to the common home theater system. After years of industry battles, there is basic agreement about *effects* relative to the user experience. There is basic agreement as to how various devices will work together to *achieve* those effects, in particular, for example, what the red, white, and yellow plugs mean.

Underneath it, nothing further is specified. The marketplace rules: there continues to be massive innovation and enormous complexity within the various individual components. All are focused on effects, all are interoperable at the device level, and all end up in a red, white, or yellow plug.

For unmanned warfare, expanding the use of service oriented architectures (SOA) can enable this same capability, providing a focus on interface and interoperability among platforms, aimed at achieving battlefield effects, while innovation flourishes behind it, often with huge complexity in individual systems.

A formal CONOPS may of its very nature, and in some important respects, not fully address the requirements of agility, adaptability and innovation required for the future of unmanned warfare.

It must reflect the fact that in the battle space, clearly there is a need for interoperability that will permit all to have access to the information products and war fighting capabilities they require regardless of platforms.

At the same time, the asymmetric wars we are fighting today and likely tomorrow bring forward adversaries who make incremental improvements every day. An architecture correctly defined at the level of interface, linked to capabilities or effects, can address the anticipated need for growth and changing requirements, while conferring the benefits of flexibility with currently fielded capability.

For unmanned warfare, then, organizationally there is a benefit in having the Joint Staff concentrate more on assuring these effects, focusing on gaining agreements to effects-oriented enterprise architectures, and less on particular platforms. Assuming an architecture focus would lead the Joint Staff to embrace a greater emphasis on interoperability, horizontal accountability, and a more holistic approach to mission accomplishment.

"Good architecture," it is said, "is essential. Great architecture is invisible." Only industry can today create an invisible architecture. The burden falls to government to articulate *what are the bare minimum simplest sets of interfaces that will allow the effects to be achieved, and for ideas to flow and innovation to flourish underneath all.*

The Requirements of Leadership

"We have ways to take things that we are doing and put them in a new context without a whole lot of shuffle to the institution," one participant observed. "Most of what we require and are talking about can be achieved by getting the right kind of leadership to lead us to the place that we have to go."

As we speak of visions, architectures and effects – of sustaining strategic advantage by stimulating adaptation, innovation and dissemination – what are the imperatives for leadership? What are the observed traits of leaders who have been successful in moving unmanned systems to their current position of global primacy and strategic advantage for the nation?

"Most of what we require and are talking about can be achieved by getting the right kind of leadership to lead us to the place that we have to go."

They love the idea of change. Success in asymmetric war – "out-asymmetric-ing our adversaries" – requires adaptation, innovation and change.

They understand the requirements of change. Successful leaders have sought out the "calculus-changer", the "game-changer" — the individuals and groups who have been willing to take on the doctrinal issues.

They love to compete new ideas. Leaders who foster a process that lets the best ideas compete and surface see innovations arise faster, and disseminate broadly.

They take technology and use it to make a difference from the outset. Not everything must be battle-hardened or proven beyond a shadow of a doubt. Leaders who spot promising innovation and know how to manage its risks are fast at achieving rapid, continuous asymmetric advantage.

They have the heart for the long war. Persistence is the key to success; accepting failure within the context of a learning organization and a goal of success over the long haul is essential to the challenge.

They reward the innovator. Leaders who value accountability for success and failure have found ways to incentivize risk-taking necessary for success in the emerging battle spaces.

They find their natural allies. The political management of innovation and adaptation is a key requirement and talent of those who have been successful.

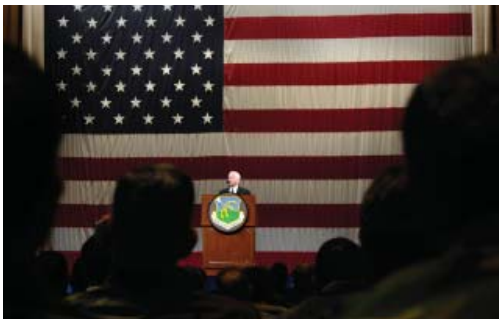
They help industry understand what is required of it. Industry is essential to solving the riddles or asymmetric primacy in the battle space quickly.

CONCLUSION

As the United States looks to its recent experiences in unmanned warfare, it can see extraordinary and rapid advances in science, operations, acquisition and procurement, and deployment of unmanned systems. These systems have truly transformed the battle space in their respective theaters.

For the future, the challenge of maintaining this advantage turns on continued funding, but also on maintaining those special qualities of adaptation, innovation and rapid dissemination that have proven so critical to our success.

No system can exist for long, or in an era of fading supplemental appropriations, outside of traditional support structures afforded programs of record.



Leadership which understands this vision, the requirements of people, systems and platforms comprising the architecture, and how best to move innovation rapidly from the field to the bench and back to war fighter, will leverage our current success and help the nation prevail.

However, no traditional approach can yet capture the requirements of unmanned systems for speed and agility in the asymmetric battlespaces of the future.

America's strategic advantage is its open society and the flow of ideas, translating rapidly into action. Giving structure to that through an effects-oriented vision for unmanned warfare, and an effects-oriented *architecture* reflective of that vision specifying standard interfaces and effects and not much else, is essential. Leadership which understands this vision, the requirements of people, systems and platforms comprising the architecture, and how best to move innovation rapidly from the field to the bench and back to war fighter, will leverage our current success and help the nation prevail.

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Issues, Options, And Futures

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