STEPS

SCIENCE, TECHNOLOGY, ENGINEERING, AND POLICY STUDIES

ISSUE 4, 2016

Robert Hummel, PhD
Editor-in-Chief

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About *STEPS*

STEPS stands for Science, Technology and Engineering Policy Studies. *STEPS* is the technical publication of the Potomac Institute for Policy Studies, where scholarly articles of broad interest are published for the policy studies communities. We welcome original article submissions including, but not limited to: discussions of policies that either promote or impede S&T research; articles that address implications and/or consequences of S&T advances on national or international policies and governance; articles that introduce or review topics in science, technology, or engineering, including considerations of potential societal impacts and influences; and non-partisan opinion pieces concerning policies relevant to S&T, to include S&T research trends; S&T policy event highlights; editorials; letters to the editor; book reviews; and similar contributions.

The Potomac Institute for Policy Studies defines policy and policy studies as a two-way street with respect to science, technology, and engineering. Policy is necessary to advance scientific research toward achieving common good, appropriate use of human and material resources, and significant and favorable impacts on societal needs. At the same time, the creation of effective policy depends on decision makers being well-informed by science.

Societal changes arising from technological advances have often been surprises to mainstream thinking – both within technical communities and the general public. *STEPS* encourages articles that introduce a bold and innovative idea in technology development, or that discuss policy implications in response to technology developments. These articles can include more controversial "outside-the-box," thought provoking contributions intended to 1) encourage discussions concerning science, technology, and engineering developments and related policies, 2) stimulate new research and development or policy actions, and/or 3) stimulate scientist, engineers, and policymakers to support relevant activities. Articles published in *STEPS* will include contributions that consider potential advances that might otherwise be suppressed by reviewers as being too unlikely or "too far out there."

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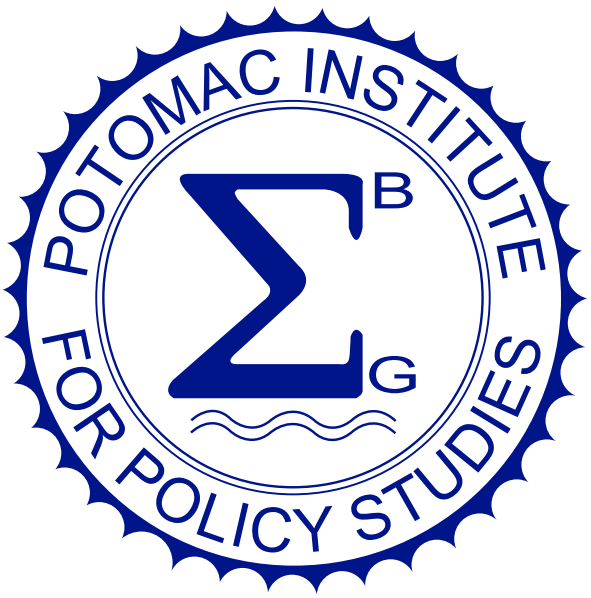
About the Potomac Institute for Policy Studies

The Potomac Institute for Policy Studies is an independent, 501(c)(3), not-for-profit public policy research institute. The Institute identifies and aggressively shepherds discussion on key science, technology, and national security issues facing our society. The Institute remains fiercely objective, owning no special allegiance to any single political party or private concern. With over nearly two decades of work on science and technology policy issues, the Potomac Institute has remained a leader in providing meaningful policy options for science and technology, national security, defense initiatives, and S&T forecasting. The Institute hosts centers to study related policy issues through research, discussions, and forums. From these discussions and forums, we develop meaningful policy options and ensure their implementation at the intersection of business and government.

These Centers include:

- Center for Revolutionary Scientific Thought, focusing on S&T futures forecasting;
- Center for Adaptation and Innovation, chaired by General Al Gray, focusing on military strategy and concept development;
- Center for Neurotechnology Studies, focusing on S&T policy related to emerging neurotechnologies;
- Center for Regulatory Science and Engineering, a resource center for regulatory policy; and
- International Center for Terrorism Studies, an internationally recognized center of expertise in the study of terrorism led by Professor Yonah Alexander.

The Potomac Institute's mission as a not-for-profit is to serve the public interest by addressing new areas in science and technology and national security policy. These centers lead discussions and develop new thinking in these areas. From this work the Potomac Institute develops policy and strategy for their government customers in national security. A core principle of the Institute is to be a "Think and Do Tank." Rather than just conduct studies that will sit on the shelf, the Institute is committed to implementing solutions.



From the CEO

Michael S. Swetnam

Innovation has become a buzzword around Washington DC that everyone uses, but what does it really mean? The Department of Defense (DoD) has begun several initiatives to bring in more innovation via avenues like Defense Innovation Unit Experimental (DIUx), Rapid Reaction Technology Office (RRTO), and innovation groups in nearly every service. These efforts, predictably, have been met with skepticism by those who consider themselves "real innovators" in places like Silicon Valley.

But the DoD, despite its slow and plodding bureaucracy, is actually quite innovative. The history of research and development (R&D) efforts in DoD shows they have resulted in incredible technologies, ranging from planes that go faster than the speed of sound, to the internet, to advanced prosthetics. But the key to these government R&D efforts is not to generate commercial products. The key is to give the United States a military advantage over our adversaries and to keep us in the position of being a global leader.

Industry and government have different strengths, different drivers for their R&D investments, and different strategies. There are 1) some things that industry does best and should pay for; 2) some things that only government can do and must pay for; and in the middle are 3) the areas where we can develop public-private partnerships, use government investment to kick-start an industry, or adapt a commercial product for military use.

This distinction between industry and government investment priorities should form the basis for the government's strategy on making investment decisions. DIUx and other innovation efforts are an essential component of this strategy and apply to the third area, where government adapts commercial technologies. Their job is not so much to innovate on their own – we have Defense Advanced Research Projects Agency (DARPA) and other R&D efforts that do that. They are an effort to tap into rapidly emerging technologies and leverage them for US technological superiority. Their job is to find incredible new technologies that we need to maintain our edge, and their success is essential to our future.

Editor's Notes

Robert Hummel, PhD

While this issue of *STEPS* was not designed to be a special issue on a single theme, the articles this month nonetheless revolve around the idea of taking science and technology from the academic and commercial environments, and applying them to government needs.

The Secretary of Defense (SecDef) has emphasized this theme through the Defense Innovation Initiative, and the opening of a Department of Defense (DoD) office in Silicon Valley, and soon another one in Boston. I had been talking to the team at the Defense Innovation Unit Experimental (DIUx) in Silicon Valley, prior to the leadership change instituted by the Secretary of Defense in May, and so have authored an article with Kathryn Schiller Wurster about strategies that DIUx might take to foster innovation in DoD.

Brian Barnett and Jennifer Buss of the Potomac Institute present findings and recommendations concerning the DoD commercial technology acquisition. They have spent much time and energy working in the "Innovation Outreach" program of DoD, which uses venture capitalists and technology experts to provide advice to government organizations as to how they can leverage cutting-edge technology and best practices in commercial technology developments. Based on lessons learned, they outline some of the roadblocks and potential solutions.

James Giordano and Rachel Wurzman discuss the concept of NEURINT, which they suggest as a way to leverage advances in neural and cognitive sciences, and neurotechnology to better understand motivations and behaviors of individuals and groups, to gain greater intelligence and to provide policy-makers with better options as to how to deal with conflicts. They view NEURINT as supplementary to legacy approaches in the intelligence community involving HUMINT, SIGINT, and COMINT, which then require subjective human analysis in order to understand the threats and potential responses. Based on data that can be collected from social media and other means, together with experience, and combined with neuroscientific tools and techniques, they propose that we can develop concepts and approaches to optimize our use of intelligence.

This issue again includes several "Viewpoints," wherein authors express opinions on timely topics of science and technology policy.

As the political season heats up, transition teams will be considering possible agendas for the next administration. While we are strongly nonpartisan; our hope is that issues discussed in *STEPS* will help steer the thinking of all parties and all relevant policy people in the next Congress and next administration. In that regard, we welcome submissions for the next issues to appear in 2016, before the transition in January 2017. I would be glad to discuss proposals for articles with prospective authors. You can find more information at: www.potomacinstitute.org/steps.

We hope you find utility in this current issue of *STEPS*.

Robert Hummel, PhD
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From the CReST Blog

The Center for Revolutionary Scientific Thought (CReST) blog features timely discussions addressing key societal, national, and international science and technology issues. CReST addresses Bold Ideas, current events, and policy recommendations. The CReST Blog is one of CReST's forums for discussion of science and technology futures from both an academic and policy perspective. These blog entries are available online at: *www.potomacinstituteceo.wordpress.com*.

REBECCA MCCAULEY RENCH, PHD

Data to a New Democracy

We can embrace data sharing to streamline democracy.

REBECCA MCCAULEY RENCH, PHD

Would you Like a Job? Check Back in 6 Months

Why aren't we rapidly hiring the best and the brightest?

CHARLES MUELLER, PHD

Future By Design

The time for designing our destinies is already here.

PAUL SYERS, PHD

A Phone Conversation

The possibilities that come with new technologies are limitless.

CREST
CENTER FOR REVOLUTIONARY SCIENTIFIC THOUGHT

STEPS Policy News

Attempt to Repeal Cyber Bill

Representative Justin Amash (R-MI) along with a bipartisan group of cosponsors introduced legislation H.R.4350 to repeal the Cybersecurity Act of 2015. The Cybersecurity Act expanded the power of network operators by granting companies immunity if they conduct internet surveillance of their users and employees for the goal of cybersecurity. Rep. Amash called the Act an "anti-privacy law." According to Rep. Amash, the Cybersecurity Act should also be repealed because it was written by "just a few members of Congress," and was hidden inside the Consolidated Appropriations Act of 2016 (which prevented many from realizing the bill had passed). H.R.4350 was introduced in the House on January 8, 2016, but is still in committee. See: *https://amash.house.gov/press-release/amash-introduces-measure-repeal-anti-privacy-cyber-bill*.

Chemical Regulation Bill in Amendment Exchange

On May 24, 2015, the House of Representatives introduced the Frank R. Lautenberg Chemical Safety for the 21st Century Act, modernizing the Toxic Substances Control Act (TSCA). The bill, H.R.2576, passed the House in June 2015, and passed the Senate in December 2015. As of May 24, 2016, two chambers were resolving differences between their respective versions of the bill. The updates to the TSCA would allow the EPA greater authority to request safety data from companies and would set a higher standard for human exposure to unsafe chemicals. The bill has widespread bipartisan support in Congress and is expected to pass. See: *https://www.congress.gov/bill/114th-congress/senate-bill/697*.

Fed Abandons Demand for iPhone Hack

On March 28, 2016, the federal government withdrew its demand that Apple unlock the iPhone used by one of the shooters in the San Bernadino shooting. Apple had refused to unlock the phone, however, the FBI claims to have accessed the information without the company's assistance. While this ends the current debate over companies installing a universal backdoor into personal electronics, this conversation creates a precedent for future law enforcement operations. See: *http://www.politico.com/story/2016/03/feds-drop-fight-with-apple-over-terrorists-iphone-221310*.

Department of Energy Recommends Continuation of ITER

In a report to congressional budgetmakers, the Department of Energy recommended that the US should continue its participation in ITER through 2018. ITER is an international program to build and operate a magnetic fusion device to test the viability of nuclear fusion as an energy source. ITER began in 2005, and is based in the south of France. Along with the US, the other members of the ITER program are the European Union, China, Japan, India, South Korea, and Russia. All members contribute to funding the construction and operation of the ITER facility. The cost of this program has been higher than predicted. In FY 2017, the Department of Energy requested $125 million for the ITER effort. In FY 2018, they requested $230 million. The House of Representatives has agreed to continue funding ITER by cutting Department of Energy research for biology and the environment. The Senate wants to eliminate all funding for ITER and increase funding for other Department of Energy programs. See: *http://www.sciencemag.org/news/2016/05/us-should-stick-troubled-iter-fusion-project-secretary-energy-recommends.*

White House Launches Microbiome Study

The White House recently announced the new National Microbiome Initiative, and multiple federal agencies will contribute a total of $121 million to support this new program. Microbiome refers to the communities of microorganisms that influence almost every process and environment on Earth. For example, the microbiome in the human gut digests food, and research has found that it is influenced by diet and antibiotics. For years, scientists have asked for a widespread, coordinated effort to study microbiomes. Scientists aim to identify healthy microbiomes, and learn how to alter unhealthy ones. See: *http://cen.acs.org/articles/94/i21/White-House-announces-microbiome-initiative.html*.

New Limits on Methane Emissions by Oil and Natural Gas

The EPA issued new regulations on May 12, 2016, to reduce methane released by the oil and natural gas industries. The EPA will require these operations to phase in technologies that capture methane. These regulations only apply to newly constructed or modified oil and gas facilities, but new regulations for existing operations are in development. These regulations are the first that seek to limit methane released by the oil and gas industry. These regulations follow an EPA report in 2014 that revealed that oil and natural gas operations are the greatest emitters of methane gas. See: *http://cen.acs.org/articles/94/web/2016/05/EPA-moves-cut-methane-emissions.html*.

FDA Approves First Commercial Zika Test

The FDA has granted emergency authorization to Quest Diagnostics to sell a Zika virus test. This is the first commercially developed test that diagnoses the Zika virus. Quest Diagnostics planned to make the tests available to doctors, which expands their availability from the Center of Disease Control and Prevention laboratories. Infection with the Zika virus can present no symptoms, so the test will allow people who live in or have traveled to an area with Zika virus transmission to know if they are infected. The Emergency Use Authorization (EUA) allows the use of certain medical products after an emergency has been declared by the Secretary of Health and Human Services (HHS). Due to Zika's significant potential for a public health emergency, the Secretary of HHS declared that the emergency use of in-vitro diagnostic tests for Zika is justified. See: *http://www.fda.gov/EmergencyPreparedness/Counterterrorism/MedicalCountermeasures/MCMIssues/ucm485199.htm#eua.*

Pentagon Contracts Eight Companies for Microelectronics Program

The Pentagon has issued contracts worth $7.2 billion USD over the next twelve years to upgrade legacy and/or unreliable electronics in DoD systems. To support this effort, the Defense Microelectronics Activity (DMEA) awarded contracts through its Advanced Technology Support Program IV (ATSP4) to companies that can give the DoD access to expertise on microelectronic engineering. The companies that were awarded contracts are Northrop Grumman Systems, Lockheed Martin, BAE Systems Information & Electronic Systems Integration, General Dynamics Advanced Information Systems, Aeroflex Colorado Springs, Raytheon, Boeing, and Honeywell International. See: *https://defensesystems.com/articles/2016/04/01/dod-atsp4-electronics-support-contract.aspx*.

Department of Defense Discusses Cyber Strategy

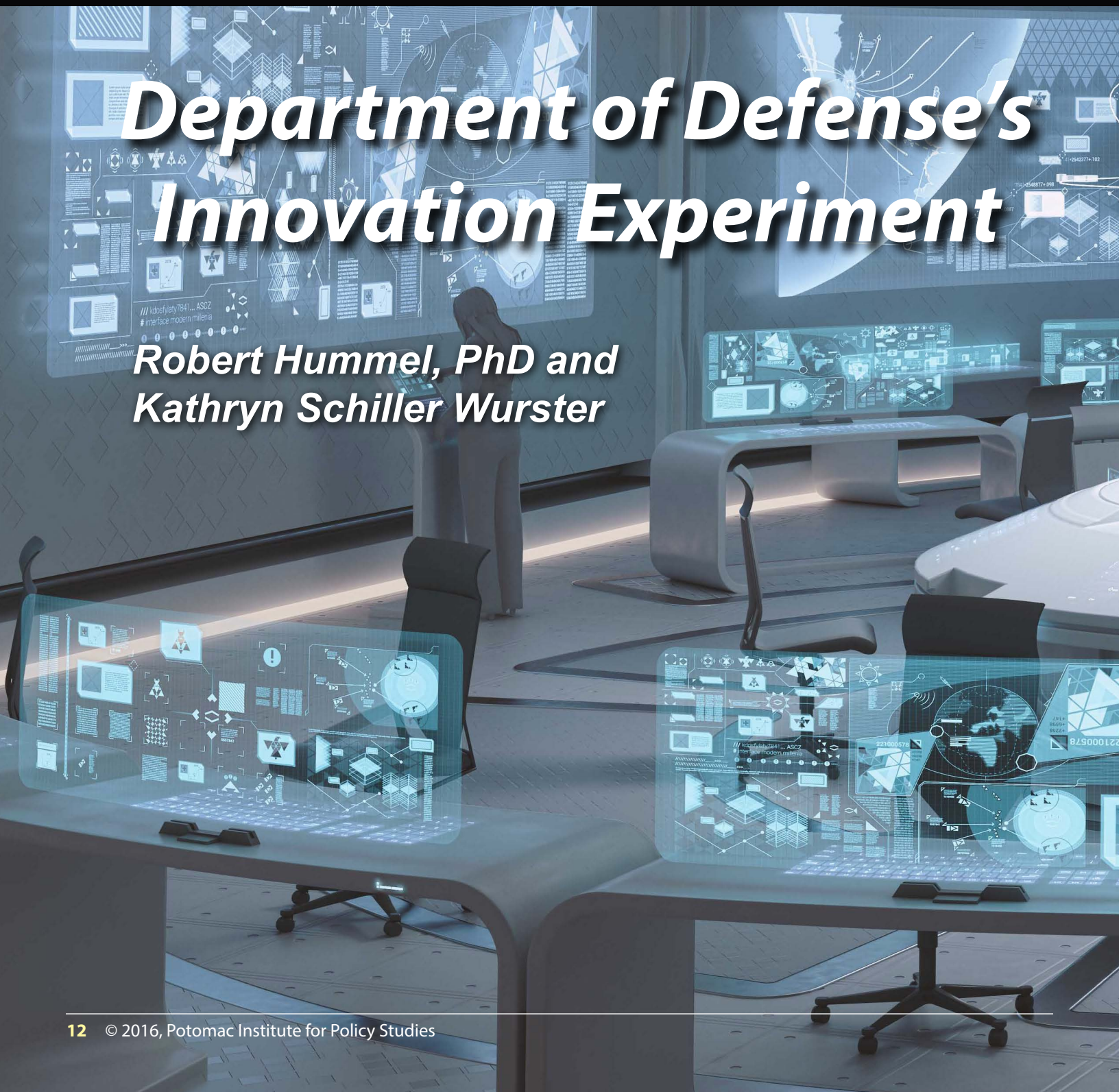
On April 18, 2016, DoD Chief Information Officer, Terry Halvorsen discussed the need to modernize DoD networks as part of the Department's cybersecurity strategy. The DoD also aims to consolidate data centers, empowering mobile data access, and facilitating cooperation and short-term personnel trades between government and industry cybersecurity workers. The DoD is focused on their shift to the Joint Regional Security Stacks, a centrally managed, regionally based suite of security appliances, to secure networks and reduce the number of access points that can be attacked. See: *http://www.defense.gov/News-Article-View/Article/723174/dod-cio-discusses-modernizing-networks-consolidating-data-centers*.

Industrial Control Systems Make Industry Vulnerable

The Deputy Director of the NSA, Richard H. Ledgett Jr., warned of industry's reliance on industrial control systems (ICS) in his keynote address for the Joint Service Academy Cyber Security Summit at the US Military Academy. In recent years, ICS has become less obscure, but providers have not adequately addressed threats to their security. Cyber attacks can cause significant damage to infrastructure, such as the four-month blackout of the Ukrainian power grid. Ledgett warned, "Any system is only as strong as its weakest link." See: *http://www.defense.gov/News-Article-View/Article/740177/critical-infrastructure-vulnerable-to-attack-nsa-leader-says.*

ARTICLES

FEATURE ARTICLE



Department of Defense's Innovation Experiment

Robert Hummel, PhD and
Kathryn Schiller Wurster

"I don't care to belong to any club that will have me as a member."

Groucho Marx

The US Department of Defense (DoD) is in the midst of an experiment to inject "innovation" into its procurements and processes. The Defense Innovation Initiative is now in its second year, and has multiple components, but one of its high profile efforts is the Defense Innovation Unit-Experimental (DIUx), which has opened an office in Silicon Valley. The authors contend that the purpose of DIUx is not just to locate and fund interesting companies, but also to educate organizations within the DoD as to the changed culture and funding model that drives innovation in the commercial marketplace. They offer some suggestions for ways that DIUx might operate in the future.

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The US DoD believes that the best way to retain, or restore, American technological superiority is through the use of innovation, and they have recently turned to Silicon Valley for help. But when it comes to selecting sources that can help bring innovative technologies and innovative processes into the DoD, it is perhaps best that they select companies that would not want DoD as a client.

In November of 2014, Secretary Chuck Hagel announced a DoD-wide initiative to pursue innovative ways to advance US military superiority, the "Defense Innovation Initiative" (DII). In January of 2015, the Deputy Secretary of Defense Bob Work gave a talk titled "The Third U.S. Offset Strategy and its Implications for Partners and Allies," and spoke of the need to maintain a technological edge though innovation. Then in April 2015, the new secretary Ash Carter visited Silicon Valley, and in a speech at Stanford University, announced the creation of the DIUx, with an initial office to be stood up in the Silicon Valley area. He stated that the office would "strengthen existing relationships and build new ones, help scout for new technologies, and help function as a local interface for the Department. Down the road, they could help startups find new work to do with DoD." This is a great concept, but DIUx will need to find and convince companies to accept DoD as a client.

Behind the Defense Innovation Initiative is a worry that the US technological edge is eroding. Bob Work stated that this is "one of the greatest strategic challenges facing the department…that impacts America's leadership around the globe." Thus the Third Offset strategy, and the creation of a Defense Innovation Unit, is intended to "sustain and advance America's military dominance" not only through technology, but also through innovative processes and strategies.

The key is this magic buzzword, "innovation." It means doing things differently, and not just incrementally improving upon current systems, technologies, and strategies. It implies agility: fast adoption of ideas, and fast transition from the start-up and lab to operational use. And it means taking advantage of ideas generated for the commercial marketplace, to rapidly integrate those capabilities into defense needs. None of these come easy to the DoD.

But what does "innovation" really mean? And how do you create innovation? This is the dilemma that confronts the DoD as they attempt to harness the power of innovation. The Services, such as the Army, have been conducting "innovation summits,"[1] and have laboratories and directorates intended to find innovative ways to fight and accomplish missions. The Navy has launched the "Navy Innovation Cell" to speed up acquisition of information technology.[2] The Air Force has opened up its own Silicon Valley office,[3] and has an "Airmen powered by innovation" initiative.[4] Even the White House has "Presidential Innovation Fellows" and a "Strategy for American Innovation." Clearly, in this new period after the drawdown of major operations in Iraq and Afghanistan, DoD has turned to the notion of "innovation" as a solution, but it is not yet clear how this will be achieved.

For DoD, the challenge is daunting: To use innovation to turn around the erosion in our technological edge and to thereby create military dominance, when adversaries are going to school on developing new and disruptive military capabilities based on observing decades of American operations. The technical areas where the United States is challenged range from ship defense, to air defense, to hypersonics, to electronic warfare, to materials science, to space assets. Analyses of the third offset strategy and the costs of military innovation warn of many challenges, from the vulnerabilities of our potential developments, to financial costs.[5] How can the DoD create and sustain innovation, when most of its sources in the defense industrial base are those whose business model is to maintain the status quo through updates and refinements?

Ultimately, to innovate, you have to rapidly ingest and accept innovative ideas, and in the case of the DoD, from companies that might not want you as a client. The challenging job of the small and nascent Defense Innovation Unit is to address this dilemma for the DoD.

DIUx CHALLENGES

One aspect of the DII is the creation of the Defense Innovation Unit (experimental), called DIUx. The office was stood up in August, 2015, in Mountain View, California. Since then, the Department has announced an intention to start another DIUx office in the Boston area, and it is expected that another office will open in Austin, Texas sometime later in 2016. Other offices are expected in future years. The combined set of offices will form DIUx, and they can be expected to change course and reboot multiple times as they conduct a large portion of the DoD innovation experiment.

"There are plenty of other mechanisms to learn about technologies – it is the DoD's acceptance of those innovative technologies and processes that needs to change."

Each office is intended to be a small point of presence in the respective locale, with a few staff from the Office of the Secretary of Defense (OSD), and a few military or reservists from the Services. Initially, DIUx was structured administratively under the Assistant Secretary of Defense for Research and Engineering, and effectively the Under Secretary for Acquisition, Technology, and Logistics. However, both the Secretary of Defense (SecDef) and the Deputy Secretary have taken an active interest in DIUx-West, and recently restructured DIUx to report directly to a board within the SecDef's office with a new partnership-style leadership.[6]

The real intention is that the collection of DIUx offices should help give DoD access to innovative technologies and processes. The thinking is there are likely ideas and technologies that are being pursued in small business, or start-ups, or in laboratories in commercial companies, that could have a game-changing impact on national security. In this way, new processes and new systems, both offensive and defensive, might leapfrog capabilities that are being continually incrementally improved. In this sense, the DIUx offices are a means to help find such technology gems.

But in another sense, DIUx is located in innovation hubs in order to give DoD the opportunity to interact with and learn from those companies, entrepreneurs, and investors. The DIUx points of presence are there to influence and change DoD, and not just to provide DoD another way to find potential sources. **There are plenty of other mechanisms to learn about technologies – it is the DoD's acceptance of those innovative technologies and processes that needs to change.**

DIUx needs to both convince innovative companies to accept DoD as a worthwhile client, and to convince DoD to embrace innovative companies as viable suppliers. DIUx will need to develop relationships between the companies and DoD, by building or restoring existing relationships, and creating opportunities for new relationships. Relationships will go beyond funding and statements of work. They involve face-to-face interactions, and mutual trust.

THE R&D AND IP MISMATCH

In order to build those relationships, DoD and the representatives from the commercial company's ecosystem will need to understand one another's operating models for research and development (R&D) and product development. A major challenge to DoD's efforts to court commercial companies to increase innovation is that DoD's R&D funding model does not comport with the culture and valuation of intellectual property (IP) in the commercial marketplace. Whereas DoD pays a company to conduct R&D on their behalf, and expects to own the IP at the end, companies invest in their own R&D using venture capital and expect a big payback from the IP when a company succeeds.

The Ecosystem Model of Innovation Development

It used to be that companies invested in research and development in order to form an internal pipeline that helped reinvigorate the company as time progressed. The pipeline was fed by corporate basic research, which often fed a parent corporation. We can think, for example, of the marvelous inventions of Bell Labs, or the Xerox Palo Alto Research Center, or General Electric Global Research, to name but a few. Historically, these laboratories fed the innovations that the corresponding company used to improve and refresh their product lines.

Today, the way that companies in the commercial sector pursue innovation has completely changed. A large portion of the research and development conducted by companies in recent years works in a much different way than the pipeline approach depicted by a monolithic company investing in research by means of its own corporate research lab. One of the main ways that companies acquire technology innovation is through acquisition of small businesses and other companies whose sole business is to innovate. As a result,

the entire commercial R&D ecosystem has evolved to a much different model of operation.

Basic research into fundamental science remains largely the purview of universities. That has not changed recently, although regulated monopolies such as Bell Labs, many decades ago, enjoyed the luxury of being able to invest in basic research. That has largely gone away. There are some large legacy corporations that still perform basic research, such as IBM, Microsoft, and United Technologies, but their basic research is increasingly on a short leash to development. Newer corporations, such as Google, Amazon, and Facebook have begun to embrace exploratory science, which may represent a new model of basic research.[7]

But on the development side of research, there is now an ecosystem of companies whose aim is to develop innovative products and innovative processes, through experimentation and demonstrations, with the goal of selling or licensing the IP that is acquired. While this ecosystem is not exclusively resident in Silicon Valley, many of the companies in that environs exemplify this type of operation. Often a single entrepreneur with an idea musters a small team of programmers and engineers, and using some funding from an investor, rapidly attempts to build a demonstration of the idea, in order to justify greater investment in subsequent rounds of funding. Then the "start-up" begins to mature into a larger operation, with a more mature cache of IP. The investors, ranging from independent wealthy persons to venture capital firms to established big firms investing for strategic purposes, provide support for the start-up in exchange for a percentage of the IP. Accelerators and incubators also help start-ups, via mentoring and provision of space and facilities, again for a percentage of the eventual sale.

This ecosystem of start-ups and innovators thrives on taking risk. Many of these start-ups fail. The workers then move to some other start-up. The young programmers and engineers quickly find work elsewhere. For the entrepreneur, a failure or two can be a badge of honor. They have presumably learned from their mistakes.

Over a diversified portfolio, however, the investors are looking for a good return (better than the stock market), fueled by occasional big wins. A win occurs when a larger company buys a start-up, to acquire the IP, to incorporate into its products or business line. They will often stipulate that the people should remain with the company for some period of time, but it is more usual that they are interested in the IP as opposed to the people, since the people (including the entrepreneur) are mobile. A really big win occurs when the purchasing company is one that has a lot of cash and is able to value the IP at a large premium. Google (Alphabet), or Apple, for example, can generate big wins. The larger companies have big piles of cash available to acquire IP that will lead to quantum leap improvements in their product lines, or new leading-edge products, and thus new revenue streams.

> ***"… the commercial marketplace buys stock in intellectual property, the government purchases the process of R&D."***

We call this the ecosystem model of innovation development. In the "big wins," the large corporation is buying the IP; they are not buying R&D, but rather the fruits of R&D. The previous investors were only indirectly supporting the R&D; in reality, they were purchasing shares in the anticipated future IP. They were literally buying stock in the company's IP. It was the company itself that was "buying" the process of the R&D.

The DoD Model of Innovation Development

In comparison, the DoD invests in companies in a pipeline that migrates from basic research to advanced development and fielding of products. They outsource much of the R&D and eventual production to companies, but they maintain control of the entire pipeline

of processes. In many cases, government laboratories mediate the pipeline. Through this process, the government creates, demonstrates, and owns rights to IP. Over the years, the pipeline became differentiated from commercial companies, as the "Defense Industrial Base" expanded with companies that increasingly serviced the Department exclusively. DoD solicits companies to perform R&D within this pipeline through the well-known process of publishing "Requests for Proposals" or "Broad Agency Announcements." This process assumes innovative companies will come to DoD and are incentivized by the possibility of a contract for performance of R&D. For example, DARPA looks for advanced research from innovative sources, through its projects and solicitations, and thereby funds many small companies throughout the nation, including in Silicon Valley.

This method of procurement, however, assumes the best available sources will be lured to offer their services by the prospect of 6-10% profit on the revenue stream. Many do apply for funding, but it remains difficult for DoD to entice "nontraditional sources" to even consider working on DoD problems. Further, the government typically assumes that all funded work gives the government the rights to use the results for their broad purposes, thus capturing a large portion of the IP, which is a great disincentive for these nontraditional sources.

The result is that even when soliciting innovative solutions, the government receives offers from companies that are in the business of doing work for the government. This greatly limits innovation, because every good proposal writer knows that one should only propose to do precisely what the government reviewer wants and expects. When performing R&D, there are even stronger impediments to taking risks.

Thus, whereas the commercial marketplace buys stock in intellectual property, the government purchases the process of R&D. The government has to perform a lot of due diligence and oversight to ensure that they receive useful results from the bulk of R&D that they purchase, and so they are highly risk-averse. The industry model is to pay for risk upfront by using venture capital, hedging bets by investing widely, and then making money off the IP when they get a big win.

Piles of Cash

Venture capital and large commercial companies have far more cash available, and can spend it far more easily, than DoD. Innovative companies are therefore much more likely to turn to them than to DoD.

The numbers are murky because much of the cash is overseas, and because corporate investments can include treasuries, bonds, or investments related to the corporate business. But one report has Apple as having $193 billion in cash and liquid investments, Microsoft with more than $100 billion, Google with $67 billion, Pfizer with $54 billion, and Cisco with $52 billion.[8,9] Including energy companies, another estimate has corporate cash holdings at $1.4 trillion.[10] These holdings generate interest and dividends, and are actually a burden to companies, because the return is unattractive to shareholders, who could get equivalent returns with their own cash. The companies are motivated to spend this money by buying companies that then improve their valuation through their IP. Thus higher valuations are given to companies with innovative IP.

Some companies choose to disburse cash through dividends to shareholders or stock buy-backs. Such tactics are hallmarks of companies that have lost an ability to absorb innovation. The fact that piles of cash have accumulated would suggest that there is a high demand and dearth of supply for innovation, at least in the areas where the existing large commercial corporations operate.

Compare this situation to the DoD. The government does not have piles of cash, although they do have a revenue stream. Agencies such as DARPA, ONR, AFOSR, etc., are able to invest in companies to perform R&D to help the Department innovate. DoD is purchasing the process of R&D. All total, DoD invests around $13 billion per year in S&T, and around $70 billion in all R&D.[11] DARPA, DoD's innovation generator, spends around $3 billion per year. However, these numbers include a great deal of spending on management control, oversight, proposal preparation, etc. While companies performing R&D have many of these same expenses, government acquisition of R&D is undoubtedly less efficient.[12]

In any case, the amount of money available for investment by commercial companies vastly exceeds the amounts spent by the government. That does not mean, however, that commercial expenditures on R&D are actually more than DoD's expenditures. The investment models are different. It is the potential for investment by the commercial firms that is interesting, together with the way in which their model permits, and even encourages, risk, in distinction to DoD purchases.

RELUCTANT CONTRACTORS

As a result of the ecosystem model of innovation development, truly innovative companies don't need to turn to the government to support their R&D. Indeed, they often would prefer not, so as to maintain as much of their IP themselves. They have plenty of opportunities for support from investors who seek the big wins. Furthermore, the best innovative companies, and especially the small businesses, are highly motivated to not share their ideas and thinking in public forums, again, so that the IP is not diluted.

Moreover, it is well known that the government is a bad customer. There are regulations, encumbrances, audits, and penalties that can be incurred. Profit levels are limited and meager, compared to the prospects for the "big win." The International Traffic in Arms Regulations (ITAR), which control export of ideas even to foreign persons in the United States, is particularly onerous.[13] But the greatest impediment is the length of time it typically takes to "get on contract." From the concept phase, presented to a government agency, to the time a project is created and awards are made, several years can pass.[14] For example, the process of conceiving of a new project at DARPA, getting it approved and funded, writing and then issuing a BAA, and then selecting and awarding contracts, will typically take two years. This does not include the time it took for a prospective program manager, who had the idea in the first place, to be hired and come to DARPA. DARPA is considered fast and nimble by DoD standards. But Silicon Valley companies, and small companies in the innovation ecosystem, can come and go in six months. From their standpoint, a delay of two weeks from concept pitch to obligation of funds would be reasonable, but is far, far from possible with current government contracting authorities.

So why should an innovative company bother with the US government? The government, after all, is only one of multiple suitors.

Nonetheless, based on empirical evidence, companies in the ecosystem of innovation development are glad to talk to the US DoD. In talking, they can explore ideas and potential future markets. The interest expressed by DoD can further bolster investment from the private sector. Department of Defense problems tend to be stressing and interesting, and can lead to greater innovation when examining solutions. Companies are generally supportive of working in the national interest, and are often happy to talk.

Further, companies and investors are happy to receive federal funds, as long as the restrictions that come with those funds are not too onerous. Companies will (usually) gladly accept money to demonstrate their technology, work with other companies in integrating different technologies, and participate in experiments, providing their IP is protected. What they can't endure is the kind of delay that is typical in government contracting. However, "seedlings" such as those used at DARPA based on "Open BAAs" and Small Business Innovation Research (SBIR) projects can sometimes happen in a few months, and these vehicles start to be more viable for small businesses.

Thus it is a myth that the ecosystem companies don't want to work with DoD. They will work with DoD, but they might not want a traditional contract with the usual restrictions. It is more a matter that DoD makes it too difficult, often to the point of being impossible.

WHO'S IN COMPETITION?

The DoD operates on a monopsony model of market dynamics, believing that they, as the buyer, are in the driver's seat, and that the sellers are the supplicants applying for funding. (A monopsony occurs when there is a single principal buyer who can control the market, and thus beat down prices.) DoD is used to dealing with the defense industrial base, a largely captive set of large companies who are accustomed to dealing with DoD's bureaucracy, acquisition rules and culture, and whose primary business is the government.

However, in Silicon Valley, and elsewhere, many of the potential suppliers have other options, as we have

"But the greatest impediment is the length of time it typically takes to 'get on contract.'"

noted. In this sense, it is the sellers that are in the driver's seat, and the DoD is the supplicant asking for help in achieving innovative solutions.

Of course, both viewpoints are true in certain situations. However, many of the sellers are interested in working with DoD, but are less motivated by funding, and more interested in the problems, interactions, and vetting that DoD provides through their interest in the technology. DIUx will need to educate both the buyers and the sellers. This will be a significant cultural adjustment for DoD, which is used to operating as the buyer with the ability to dictate terms and conditions to a degree that most industries will not tolerate. But these companies – the club that doesn't want DoD as a member – are exactly the ones that DoD needs to learn how to leverage.

DIUx'S REAL MISSION: TEACH DoD HOW TO INNOVATE

The reason the first DIUx office has been opened in Silicon Valley is not to change the ecosystem of the Valley, but rather to give DoD the opportunity to be educated by participants in the Valley about the realities of the marketplace. In many cases, this means informing DoD that they are in competition for the attention of the small businesses and the innovative ideas that are being generated. And that DoD needs to operate on much tighter timelines than their usual acquisition processes afford.

Thus, as DIUx mediates the conversation and interactions between Silicon Valley ecosystem companies and DoD, they will need to make sure that the representatives from DoD understand that they are supplicants for innovative technology. Among other issues, they will need to establish a level of trust that the IP of the companies will not be unduly diluted or shared, even if contracting should occur.

Moreover, DoD believes that they know what is innovative, and the technology trends. It is likely true, because there are many scientists and engineers within DoD who have followed technology trends for many years. But with the pace of change, and the forefront of advanced development in companies, it is also possible that there are hidden gems. You don't know what you don't know: the "unknown unknowns." It will also fall to DIUx to ferret out those, again in an environment of trust with the companies, so that DoD can be assured that they are on top of technology breakthroughs and innovative developments, as they occur.

"The reason the first DIUx office has been opened in Silicon Valley is not to change the ecosystem of the Valley, but rather to give DoD the opportunity to be educated by participants in the Valley about the realities of the marketplace. In many cases, this mean informing DoD that they are in competition for the attention of the small businesses and the innovative ideas that are being generated. And that DoD needs to operate on much tighter timelines than their usual acquisition processes afford."

Thus DIUx, wherever it is located, is primarily facing the rest of DoD.[15] Its mission is to help DoD understand the marketplace and the competition in which they, DoD, is a participant. DIUx is located in innovation hubs in order to facilitate the gathering of experts who can help explain to DoD these realities, and so that a level of trust can be developed between the companies and DoD. This is not about DoD telling the companies how they can improve their chances of receiving funding from traditional DoD acquisition processes. Instead, it is about letting DoD understand the opportunities that innovation affords them, and exploring ways in which that innovation can be incorporated into DoD systems without disrupting the IP and commercial prospects of these companies. DoD's role is about imagining the use cases of the technology that they discover, and finding ways to enable the integration of that technology without hurting the commercial opportunities or the IP that might apply to non-defense applications.

SO WHAT SHOULD DIUx DO?

The 'x' in DIUx means that it is still an experiment, and DIUx will be experimenting with different kinds of activities in order to fulfill its mission in support

of DoD. As of this writing, DoD has been recalcitrant in receiving the DIUx message, with resulting growing pains and clashes, even among other DoD groups charged with improving innovation.[16] It is the authors' opinion that DIUx is among the Department's most exciting initiatives, with the possibility of making game-changing advancements in our ability to support national security, but that the rest of DoD has not yet accepted the message. We recommend here several possible activities that should take place at the existing DIUx office, and at the offices yet to be opened. In actuality, DIUx has already undertaken examples of each of the activities that we recommend below. Our purpose here is to emphasize some ways in which the challenges that we have outlined above can be addressed by specific actions.

- DIUx should maintain its own database of companies, people, venture capitalists, and experts who participate in the ecosystem model of innovation development. This database will supplement existing compendiums, such as TechCrunch, but will incorporate thoughts by DoD personnel as to possible utility of the resources to national security, such as use cases for developing technology. Some of the use cases might be classified. The database will help DoD to know who is appropriate to invite to forums and exchanges, as described below.

- DIUx should hold forums and technical exchanges on theme topics, inviting government laboratory scientists and representatives from the DoD "Communities of Interest" to meet with relevant technical experts, venture capitalists, CEOs, and corporate developers to explore DoD needs and possible solution spaces. The information flow needs to be two-way, but it is especially incumbent on the DoD participants to not preach, but rather to listen and learn about potential new technologies, and especially about the challenges in leveraging those technologies for DoD purposes. The DoD personnel need to be "prepped" to make sure that the interactions are mutually beneficial.

- DIUx should create spaces where innovators can demonstrate their ideas, and have DoD personnel attend these demonstrations to exchange ideas and come up with potential use cases. In some cases, DIUx might fund companies to execute a demonstration, or to participate in an integration exercise. In other cases, DIUx might offer a prize for the most relevant or most innovative demonstration.

- DIUx could host symposia, where government personnel can spend informal time with companies and entrepreneurs, to build closer personal relationships and better understanding of the challenges and the opportunities. After certain excesses by some government agencies in holding off-site conferences, the notion of conventions and conferences became problematic in DoD and the rest of government, much to the detriment of government. DIUx offers ideal venues to restart the flow of ideas through symposia-type interactions.

- DIUx should have the contracting authority and funds to make good on the promises of the Secretary and others who have placed such high hopes in DIUx's ability to change the way DoD does business. With such high level backing, DIUx should be able to set an example for how to do contracting quickly and efficiently. Authority to waive provisions of the Federal Acquisition Rules and use of Other Transactions is a start, but probably not enough. All the promises of innovation will be fruitless if DoD is not able to move at the pace that the innovators expect. New tailored contracting authorities and new contracting vehicles will be needed. DIUx should be able to operate and spend funds as quickly as the counterparts at a venture capital firm or large company.

These are among the ideas that might enable DIUx (and other government organizations) to effect change in DoD. Other aspects of the Defense Innovation Initiative might also contribute to this cultural change, and might interoperate with DIUx, such as the DoD's Rapid Reaction Technology Office. The experiment is an important one, and fraught with challenges. However, through greater understanding by both government and business, perhaps we can convert reluctant suitors to become enthusiastic partners in re-establishing our technological edge.

Image credit: USNavy.com

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Department of Defense Commercial Technology Acquisition: A Survey

Brian Barnett and Jennifer Buss, PhD

The United States' national security and military capabilities are dependent on the development, acquisition, and utilization of innovative technologies. The Department of Defense (DoD) has robust processes for developing its own high-tech solutions and it has developed strong partnerships with major suppliers of military technologies. However, the commercial technology arena, which is full of start-up companies and small businesses, generates a gigantic market for science and technology research and development that cannot be ignored. Centers of innovation like Silicon Valley develop technologies across a wide swath of categories, from advanced materials, displays, cybersecurity software, and wearable electronics to neurotechnology, communications devices, and artificial intelligence. The current DoD and federal government acquisition process cannot keep pace with the commercial market, and as a result, many opportunities for integration of innovative technologies are lost.

Images/ composition: Alex Taliesen.

Government initiatives like Better Buying Power 3.0 are developing new efforts within the defense acquisition system to utilize technology innovation from the commercial sector. New initiatives from the Defense Innovation Unit experimental (DIUx) to the Air Force's Office of Transformational Innovation (OTI) are tasked with improving acquisition processes and improving interactions with commercial industry. These efforts aim to maintain technological superiority through effective science and technology programs, spanning development, prototyping, and technology insertion. This article seeks to outline some of the roadblocks to the successful acquisition of commercial technologies and to provide recommendations on how to address them.

A growing number of Commercial Technology Experts (CTEs) are interacting with the government to provide insights to the commercial marketplace. These experts span a variety of commercial technology areas that are of interest to government technology needs, including alternative energies, communications, data analytics, imagery, sensors, biometrics, and social networking. The Potomac Institute for Policy Studies has established relationships with CTEs to be called upon for in-person meetings, conference calls, and introductions. Each person we've consulted identifies similar struggles in working with the government. Through interviews with government officials, CTEs, and many of these subject matter experts, several recommendations recurred for changes that the federal government and the DoD can make to successfully partner with leaders and developers of commercial technology and innovation. Based on advice from senior advisors and senior subject matter experts who have deep background in innovative approaches, acquisition insights, and direct experience in the exploitation and leveraging of commercial and dual-use technologies, we have assembled specific common findings and recommendations. These are presented below.

IMPROVE THE CONTRACTING PROCESS

From top to bottom, government contracts diametrically oppose the kinds of business opportunities that are sought by startup companies, technology innovators, and commercial solution developers of all business sizes. These contracts do not just deter startup companies, but also provide difficult hurdles for larger, more established companies. Prior year requirements, long lead times for funding, and other regulatory factors discourage companies from working with the government. The government market is not lucrative for startups that need to be agile to survive. In addition, there are cases and business areas where prime contractors have the unintended ability to monopolize the marketplace.

The government needs to create and improve upon credit and incentive programs that will encourage companies to want to operate in the government market. Also, the government needs to engage in more risk and attract companies with contracting options that fit their business plans. Lastly, there is a need to create opportunities for diverse company types to enter contracting spaces that are typically monopolized by large defense contractors and companies. The rules that require businesses to have a five-year track record need to be reduced to a maximum of one year.

Theme I: Understanding the Commercial Technology Market to Make the Department of Defense More Successful

The DoD's efforts in acquiring innovative technologies can be more successful by drawing from what works for commercial industries. There is a mismatch between the federal government's perception of Silicon Valley and the trends that are driving commercial technology. The federal government needs more integration of commercial technology experts' insights into acquisition processes. The federal government should interact with company founders, venture capitalists, and commercial technology experts to better understand the experiences in the commercial marketplace, what trends they are tracking and how to best target opportunities for partnership. They should develop opportunities for engagement with the commercial technology experts that can guide federal government organizations through all phases of commercial innovative technology investment.

Theme II: Encouraging Public-Private Partnership Through Legislative and Regulatory Reform

Many federal government regulations dissuade small businesses, start-up companies, and even established corporations from partnering with the federal government. There is a definite need for legislative reform that can address these federal regulatory issues in ways that remove costly burdens while retaining the intended business benefits and protections. The federal government needs to make changes and improvements to the laws that impact all phases of technology investment, from the regulatory issues that place undue burden on small businesses to the abilities of government programs and organizations to rapidly fund, prototype, and test new capabilities.

Methodology

The information contained within this article was derived through a variety of means. Many interviews were conducted with government officials, technology investors, lawyers, commercial integrators, and other relevant subject matter experts (SMEs). During these informal engagements with SMEs, various questions were asked in order to gain more specific insight into ways the federal government and DoD could successfully sustain acquisition and usage of commercial technologies. Examples of the types of questions asked are below:

- *Do you (or your portfolio companies) collaborate or conduct business with the federal government? If so, what do you like most about this partnership and what are some of the challenges that you face? If you are not conducting business with the federal government, are there any specific reasons why?*
- *If you are involved with or are interested in government collaboration, how do you find out about government contracting opportunities? What do you think about the communication process for these opportunities?*
- *What are the technology trends that you pay attention to?*
- *What are your company's priorities for cybersecurity and intellectual property?*
- *What are the metrics of success that you apply to your company?*

Through these discussions, many of the problems identified in this article were discovered. These problems were further researched to substantiate their existence through examination of relevant industry, academic and government reports. Additionally, the Potomac Institute for Policy Studies reviewed previous study efforts carried out through their academic centers that focused on issues relevant to both defense acquisition reform and the International Traffic in Arms Regulations. The culmination of this thorough research effort led to the recommendations presented in this article, which are supported by the SMEs interviewed and literature analyzed. Lastly, the findings in this article are not unique and many of them have been identified elsewhere, as our research revealed. Instead of presenting new problems, this article aims to reexamine these old issues and offer up fresh solutions in hopes of creating a new dialogue focused how best to move forward.*

* See: http://potomacinstitute.org/featured-news/1816-the-decline-and-fall-of-the-itar-empire-written-by-robert-hummel-phd-richard-pera-charles-mueller-phd.

SET EFFECTIVE METRICS OF SUCCESS FOR GOVERNMENT ACQUISITION PROGRAMS

The current metrics of non-traditional technology insertion are poorly matched to actual acquisition situations and outcomes. There are several factors that play into this disparity, which include a lack of acquisition authority for these acquisition programs and a gap between DoD project timescales and the timeframes of commercial industry.

The government should modify and improve the metrics that are employed to evaluate commercial technology insertion and fielding, increase the pathways by which government acquisition programs can develop contracts, and prepare more on-the-shelf capabilities. The metrics that are used to evaluate government acquisition programs must effectively describe the utility of these programs. Program evaluation should include measuring the rate of technology insertion and fielding, keeping track of readily available, on-the-shelf, prototyped technologies, and maintaining a significant level of situation awareness for both internal and external technology capability opportunities. Using prototypes of weapons and conducting more experimentation is key to acquisition reform. Conducting prototyping and experimentation allows the government to speed up the development process and inform critical decisions on operational utility, technical feasibility, producibility, cost and risk.[1] There are key elements that make rapid prototyping and experimentation successful. These include a skilled acquisition workforce

and the insertion of technology through open systems and standards. There is a definite need to improve the budget process timeframe. It is imperative to reduce the time required to move from the initial identification of a threat or a crucial technology need to the actual process for acquiring the needed technology solution. Prototyping and experimentation will help to inform and better define requirements. We want the ability to take the risk in that phase before we have invested large dollars and committed ourselves to a particular system solution.[2] There should be room for risk-taking that allows for expedited experimentation of current commercial and military technology solutions, definition of requirements, and cost evaluations before the final commitment of large resources.

ADDRESS OVERBEARING AUDIT REQUIREMENTS FOR SMALL BUSINESSES AND STARTUPS

Audit requirements and their associated costs are a huge burden to startups and small businesses. These audit requirements represent a major difficulty in coordinating business between companies and the federal government, as it takes significant time and financial resources to complete these audits. Many businesses cannot afford to spend $500,000, allocate the resources to sit with a DCAA auditor for three months while they review costs from a three-year-old contract, and place their day-to-day activities on hold to complete these kinds of audits. Systematic and independent examination of a company's accounts is a very important task, but when companies are already required to perform audits in the private sector, the addition of further government auditing processes is a large burden.

There are opportunities to mitigate the burden of these audits, one of which is to focus on risk. The federal government needs to think about how much fraud risk that it is willing to take on. If there can be identifiable metrics for risk, then the system for auditing could center around businesses and technology areas where the risk is elevated, rather than a blanket policy that forces all companies to be audited to the fullest extent. Opportunities exist through interactions and policy development with entities like the Auditing Standards Board, which works to provide clarified statements on auditing standards, making them easier to read, understand, and apply.[3] The Public Company Accounting Oversight Board, which oversees the audits of public companies, can assist in developing accurate and independent audit reports. The federal government should end the blanket audit requirements, at least for these small companies. Because these companies already pay for commercial audits for their own records, there should be a process established to avoid the need for duplication of effort and to more closely follow the industry's auditing standards. The federal government should accept commercial industry audits in place of separate government requirements.

CLEARLY DELINEATE WHEN TO ACQUIRE COMMERCIAL TECHNOLOGY SOLUTIONS AND WHEN TO DEVELOP THEM INTERNALLY

The commercial sector develops technology solutions that are profitable for them and shareholders, but these will not always be perfect matches for government needs. The federal government, especially the DoD, has established processes for developing "in-house" technology solutions, but it cannot solve all of its technology needs areas alone. There is a need to categorically identify needs areas for which government research and development is sufficient, areas for which commercial solutions are the most cost-effective option, and areas for which overlap and collaboration between the two is a good idea.

The federal government needs to clearly define decision points on when to use commercial parts and when to develop technology through internal mechanisms. The concept ought to be that the government should buy what it can from commercial options (commercial off the shelf, or COTS) and then only develop internally what it absolutely must. This technology landscape is constantly changing, so it is essential to stay updated on when a technology needs area is sufficiently covered by commercial options so that resources are not spent developing a solution that already exists. This goes back to the requirements problem, as many requirements are made without a full understanding of what is technically feasible, up to date, or, even worse, necessary to complete the mission. To address this issue, requirements should be reduced as much as possible and the program manager should be responsible for the technical capabilities delivered in the system. The investment strategy should focus on acquiring commercial solutions to save on government R&D investment, utilizing internal R&D investment in situations where there are no commercial options, and engaging in public/private partnerships in cases where overlap occurs. A historical example is the US government's investments in aerospace technologies. For a long time, NASA was the predominant leader of spaceflight R&D. Today, commercial entities like SpaceX and Blue Origin are taking on the brunt of the development and manufacturing, and NASA is engaging in new partnerships with these commercial options.

INCREASE THE PACE OF FUNDING AND ACQUISITION OF NEW TECHNOLOGY

Slow-moving procurement and acquisitions policies for the government cannot keep pace with new technology, and startups. In particular, cybersecurity is an area that the government has not yet leveraged innovation in the private sector. The Navy is using operating systems from four generations ago in part because of outdated GSA procurement rules. The GSA acquisition process and other government regulations mean that it takes months to years before funding for new technologies, software, and solutions can be approved. Small companies and startups cannot afford to take on the current business model used by the federal government. Meanwhile, large, established companies do not want to take on the risk of overhauling their business processes to match the government's model.

The government must implement major acquisition reform provisions and better procurement rules to allow for faster acquisition of new technology. Project managers need the capability to make time sensitive project decisions as soon as possible, thus shortening the time required to go through the acquisition pipeline. In addition, the government procurement process must utilize analytics to increase efficiency and field the best technologies.

MITIGATE THE "VALLEY OF DEATH"

Currently, there is a gap in middle stage funding, investment, and support in manufacturing innovation. These gaps are commonly referred to as the "Valley of Death", and describe the difficulty of covering negative cash flow. The Valley of Death is characterized as the middle stage in development and is common when doing research and development on new technologies. These gaps are commonly seen in technologies awaiting different stages of development and production. Energy technology development is a prime example of a technology area that is hampered by the Valley of Death: Energy technologies are slow to move because of various difficulties in obtaining capital, managing risks efficiently, complying with existing energy infrastructure requirements (let alone create entirely new energy infrastructure systems), and developing systems that can integrate hardware, software, and services cohesively.

The government needs to commit to becoming a major lead customer and develop procurement and contracting strategies to push real orders that will result in real cash flow into startups for specific and essential technologies. This will increase their valuation, and will help persuade investors to buy their shares and back the startups. As a result, startups can accumulate more resources to overcome the Valley of Death.

REDUCE THE RESTRICTIONS THAT ITAR PLACE ONTO THE COMPETITIVENESS OF STARTUP COMPANIES AND SMALL BUSINESSES

International Traffic in Arms Regulations, or ITAR, hamper all companies and small businesses in today's globalized economic and technology environment. ITAR was originally designed to secure vitally important science and technology to help the US to sustain its dominance as an economic power and to improve national security by ensuring that defense articles did not show up in the hands of the US' adversaries.[4] Today, the restrictions that ITAR puts in place have a negative economic impact on business, especially small business.

ITAR should be rescinded and the security of US science and technology should be ensured through updates to the security classification system. The ITAR restrictions have made it difficult for startup companies and businesses that focus on technologies that are key to the DoD's technological success to stay competitive. These companies have to dedicate resources to meeting requirements and performing due diligence, and they have to worry about strict liability standards and possible violations.

PROMOTE A STRONGER MESSAGE REGARDING FEDERAL GOVERNMENT HANDLING OF COMPANIES' INTELLECTUAL PROPERTY

There is a perception among small business owners and startup founders that the federal government and DoD are not properly managing the intellectual property of companies and small businesses with which they initiate contracts. There have been cases of complaints that proprietary technical data is mishandled, that patented technology has been used on government programs without compensating the patent holder, and that SBIR programs have not been enforcing protection policies that should have been afforded to small businesses. The point is not to place blame or dispute these claims, as the federal government has policies in place that do provide contracting businesses with intellectual property protections.

There is an opportunity to address some aspects of the intellectual property rights issue. In order to better engage with small businesses, the federal government should initiate dialogue with companies to identify their concerns with these intellectual property claims.

CTEs provide insight into the mindset that startups in innovative places like Silicon Valley have in regards to intellectual property. A large motivator for many of these companies is to be acquired, and thus eventually transfer their IP to a large company. It would certainly serve to placate these companies if they knew that they would not jeopardize their chances of meeting their development and growth goals with their IP intact, by working with the federal government.

The federal government should negotiate intellectual property protection, and it should structure Federal Acquisition Regulations (FAR) and Defense Federal Acquisition Regulations (DFARS) clauses to protect startups and their intellectual property. The government needs to have consistent openness and transparency about its intent to use intellectual property and small businesses need to respect the deliverables and rights that are absolutely necessary for the government to accomplish the acquisition strategy.

LEARN MORE ABOUT WHAT MAKES SILICON VALLEY SO SUCCESSFUL AND TRANSLATE THIS INTO SUCCESSFUL DEPARTMENT OF DEFENSE ACQUISITION

The federal government wants to leverage the successes of commercial technology companies from centers of innovation like Silicon Valley, but this goal cannot be achieved without an understanding of the drivers and factors involved in this success. Silicon Valley is still leading the country in big technology winners. There are other cities like Boston and San Diego that are well known for specific technologies, but many of the companies and talent are fused together in the Bay Area. Part of the reason for their success is the ability of companies to get the right people working in cohesive teams. Information about new product ideas and startups also flows very rapidly in these communities. The commercial world sticks out from the government in the way they balance their strategy and

Images/ composition: Alex Taliesen.

resources for risk mitigation. Specifically, they manage risk instead of avoiding it in a common sense way that spends the right amount on detection versus response. Small startups are fantastic at solving small problems or projects in innovative ways (e.g. how do I make this sensor cheaper?) whereas large companies are better at solving whole system problems (e.g. the F-35 JSF). The right size company has to fit the correct size of the problem space.

GAIN INSIGHT INTO THE ECONOMIC AND TECHNOLOGY TRENDS IN THE STARTUP COMMUNITY

The federal government is not deeply ingrained in the business realities of the commercial technology ecosystem. There are many pressures on the ecosystem that the government is not tracking. A majority of startup company founders are seeing that it is becoming more difficult to raise capital. Reaching an initial public offering is an overarching goal for many startups, but the longer that a company is in existence, the perception of being able to achieve this goal diminishes. Company founders are seeing the power shifting from entrepreneurs to investors. Founders fear long-term failure but are not worried about short-term mistakes.

In emerging technologies, the biggest trends and disruptive new ideas have been in the fields of data, sensors, and artificial intelligence. These include: wearable health monitoring, digital health, ubiquitous sensors, new unique apps, big data analytics, predictive algorithms, cyber security, and the Internet of Things. In the health and biology fields, there are some cutting edge products coming out in wearable, health monitoring and overall digital health. Sensors that can be plugged into your phone are becoming more popular and can collect vast amounts of data for low cost (e.g. barometers). Apps and other software programs can be quickly developed in the commercial space. Big data

analytics and predictive algorithms used for commercial purposes (including real time in-store monitoring) were pointed out as readily available. Lastly, cyber security and the Internet of Things continue to be important topic areas for investors.

The federal government should engage with CTEs, company founders, and venture capitalists to improve its understanding of the ongoing trends in the commercial technology sector. Of course, the Defense Innovation Unit is a small step in the right direction. All of these trends highlight the opportunity for the federal government to develop and provide attractive options for these companies to contribute to national security.

TAKE ADVANTAGE OF BUSINESS TRENDS TO ENSURE GOVERNMENT TECHNOLOGY SUCCESS

Government contracting opportunities are incompatible with the current commercial technology sector business trends. The government acquisition process reduces the fluidity and ease of procurement. PMs and PEOs are notoriously risk-averse in contracting. Rapid innovation and fielding on the other hand requires more flexibility and empowerment of government managers. The length of time and hurdles in dealing with government (e.g. Fedbizopps.gov) is not tolerable by most innovative companies. Lastly, taking time to implement the correct and most useful acquisition strategy for a particular good or service is critical to procurement.

The government must leverage the commercial market by recognizing market incentives. By acknowledging the market incentives, the government can benefit from cheaper products. Developers, inspired by market incentives, and provided with flexibility, will better serve government needs. Interaction and collaboration with startup companies is a way to access the top-tier talent that might typically be drawn away from public service and federal government jobs. Instead of a zero-sum competition where talented scientists, engineers, administrators, and executives are either going to the private or public sector, a strong collaborative environment can ensure that top talent is always being utilized for government needs areas.

Because of the perceived shift in power from entrepreneurs to investors who back their companies, the federal government needs to engage with the venture capitalists and CTEs just as much as it does with small company founders and entrepreneurs.

Going forward, it may be useful to develop resources that effectively prepare, equip, and convey acquisition tools as necessary to assist the government. It should be possible for government entities with urgent needs to purchase and field a solution immediately. Government customers should be provided with actionable advice from resources that leverage knowledge of all available acquisition methods and authorities. By understanding the different acquisition tools available for rapid procurement (e.g., Other Transaction Authorities), program managers can more successfully follow through on purchases. Government customers will often delay or hold off on opportunities to evaluate commercial technology solutions because they are unsure of their ability to follow through on acquisitions. This could be mediated in the future through coordination of acquisition practices and authorities available to them. When executed in a respectful manner (taking care to avoid any kind of forced commitments), this added capability could produce more acquisitions and successfully fielded technologies.

GO TO CTEs TO UNDERSTAND HOW THEY IDENTIFY AND FUND SUCCESSFUL TECHNOLOGIES

Venture capitalists are examining what is going to be commercially available within the year, rather than what technologies will be available five or ten years down the road. The technology pipeline of the commercial and entrepreneur investment community is vastly different from the government needs, so the process by which they review technology is dramatically different. Identifying successful technologies is a very dynamic process that involves tracking new technologies and talking to industry and academic experts who are on the cutting edge of technical innovation. Technology can be developed through investment as a four step process: 1) invest in the science, 2) invest to conceptualize a product, 3) invest in development to realize the product, 4) invest to generalize the product to a technology. These steps do not predict how successful a technology will become or how a technology will be used in society, but as the chances of great profitability increases as one progresses through the steps.

Some experts explain that their experience with product development is not well represented when the government sponsors discuss their challenges. The experts' knowledge of cutting-edge product development is largely disconnected from the government's focus on research and laboratory work. Commercial technology experts have a wide range of experiences in both research-oriented science and technology areas

"A significant effort to improve how the federal government and DoD acquire innovative technologies will be crucial for the maintenance of US defense leadership across the globe and the development of new capabilities that will benefit all of society..."

as well as in helping startups create finished products and solutions.

The federal government needs to engage in this process in order to successfully encounter innovative technologies and operationalize their capabilities. The federal government should reach out to organizations that are funding technology growth in the developing world, since transition is so important in these domains.. They should determine methods to present their technological and classified needs to CTEs, and maintain an information flow free of excessive jargon and bureaucratese.

"Redteaming" could be implemented to federal government-commercial technology workshops to discuss how technology can both be implemented unconventionally for improved government capabilities and be used outside of its intended purpose for the development of offensive capabilities, or to understand threats when the technology proliferates.

INCREASE COMMUNICATION OF CONTRACTING OPPORTUNITIES

Currently, the government marketplace is unfavorable for startups, but recent policy changes such as Better Buying Power 3.0 and the 2016 National Defense Authorization Act (NDAA) have explored new ways for acquiring innovative technologies. These changes have not been met with a concurrent push to reach out to the commercial sector to demonstrate this sea change in acquisition and contracting policy.

There needs to be more communication of improvements to the acquisition and contracting process. In addition, the government needs to increase their marketing strategies to provide information on contracting opportunities for startups, and restructure SAM.gov to attract startups, and not turn them away.

CONCLUSIONS

The problems and recommendations described above only begin to address the numerous challenges facing the federal government in its mission to develop, acquire, and utilize innovative technologies for our national security and military capabilities. While each topic area faces its own unique set of challenges, each of which requires intelligently applied and nuanced solutions, there are certainly overarching themes. These themes constitute a pathway for approaching the policy and legislative solutions. Before confronting substantive policy changes, the DoD should engage in extensive data gathering through partnerships and dialogues with CTEs and representatives from the innovative technology sector. This engagement process will, above all else, help the federal government to better understand the realities of the commercial technology economy and provide key insights into commercial stakeholder concerns, market trends, and opportunities for partnership.

Enacting changes that make federal technology acquisition work more like the private sector will be a boon to the pace of acquisition and the ability to utilize truly innovative solutions for the DoD. Seeking to improve upon and maintain a robust technology acquisition process is a monumental task, but this is a goal that should be met head-on with confidence. A significant effort to improve how the federal government and DoD acquire innovative technologies will be crucial for the maintenance of US defense leadership across the globe and the development of new capabilities that will benefit all of society.

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Integrative Computational and Neurocognitive Science and Technology for Intelligence Operations

Horizons of Potential Viability, Value and Opportunity

James Giordano, PhD and Rachel Wurzman, PhD

The authors present a case for a NEURINT (neurocognitive intelligence) approach to intelligence operations. This newly developing technology integrates tools from computational and neuro-cognitive sciences to enable automated access, acquisition and analysis of multiple sources of information to model and predict targets' intentions and actions. The approach would utilize information from the brain sciences, together with human cognitive and machine-based processing, and cyber technologies and methods to synergize HUMINT, SIGINT and COMMINT in assessing and influencing target individuals and groups. Citing recent research in the field, the authors maintain that these techniques and technologies are ready to be further developed and engaged to optimize intelligence operations.

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"Past thinking and methods did not prevent world wars; future thinking must."

Albert Einstein

CONFLICT, THE HUMAN DOMAIN, AND THE IMPORTANCE OF INTELLIGENCE

As international conflict dynamics shift ever more toward effecting power in the information space, outcomes are often decided not by military capabilities on land, sea or air, but rather by the influence of ideas and emotions that motivate behaviors of state and non-state actors alike.[1] Ideas about needs, values, and the nature and intentions of other groups, and resulting feelings of trust, mistrust, dread, and threat determine priorities and influence attitudes and actions. In light of this, it is becoming increasingly important for intelligence operations to understand the ways that individuals perceive and respond to various types of information. In turn, this requires knowledge about how humans communicate with one another in groups, and orient and respond to economic, social and political environments. Human perceptions and behaviors involve interacting biological, psychological and social factors. To date, detecting these interacting variables with scientific rigor has been difficult, due in part to limitations of extant technologies and techniques available for intelligence acquisition, assimilation, analysis and use. However, we believe that newly developing technology systems can be employed in and for intelligence operations, and that the use of these approaches may greatly supplement current intelligence capabilities, and in this way, afford important and perhaps necessary additions to the intelligence community (IC) toolkit.

TOWARD A TECHNOLOGY SUITE FOR INTELLIGENCE AND INFLUENCE OPERATIONS

To succeed in a global environment of increasingly complex and diversified information, the IC requires methods and instruments that can detect, assess, and respond to the evolving capabilities, actions – and intent(s) – of targets and adversaries. These dynamics require intelligence systems to be more agile and precise than those of potential targets. On a practical level, this mandates an ability to acquire and integrate massive sets of data that are highly diverse and cross domains of signal, communications, and human intelligence data. Moreover, there is a need to process these data to provide information that can yield understanding and predictions of the cognitive and behavioral conditions that define key targets' current and future behaviors. Such information must be correctly interpreted for use in information, influence, as well as kinetic (e.g., "boots on the ground") operations.

New techniques and technologies may enable the development of an integrated system for intelligence acquisition, assessment, and influence.[2] What components might form such a system? Figure 1 represents a conception of an integrated system consisting of three overarching modules that can be conjoined in a flexible technology suite. First (on the left of the figure) is a module for the automated analysis of information content in the IC environment. This information feeds into behavior – and sentiment-predictive forecasting

models that drive campaign planning tools (in the middle of the figure). These models, in turn, drive an "IO cognitive test bed" utilizing human-in-the-loop neurocognitive signal feedback to finesse the products of the campaign-planning tools, for maximal effectiveness in the human domain.[3]

The construction of influence operations (IO) cognitive test beds that connect planning tools to concept of operations development would employ neuro-cognitive technologies and techniques to assess the reactions of a representative target. These predict and evaluate the physiological and psychological responses that can

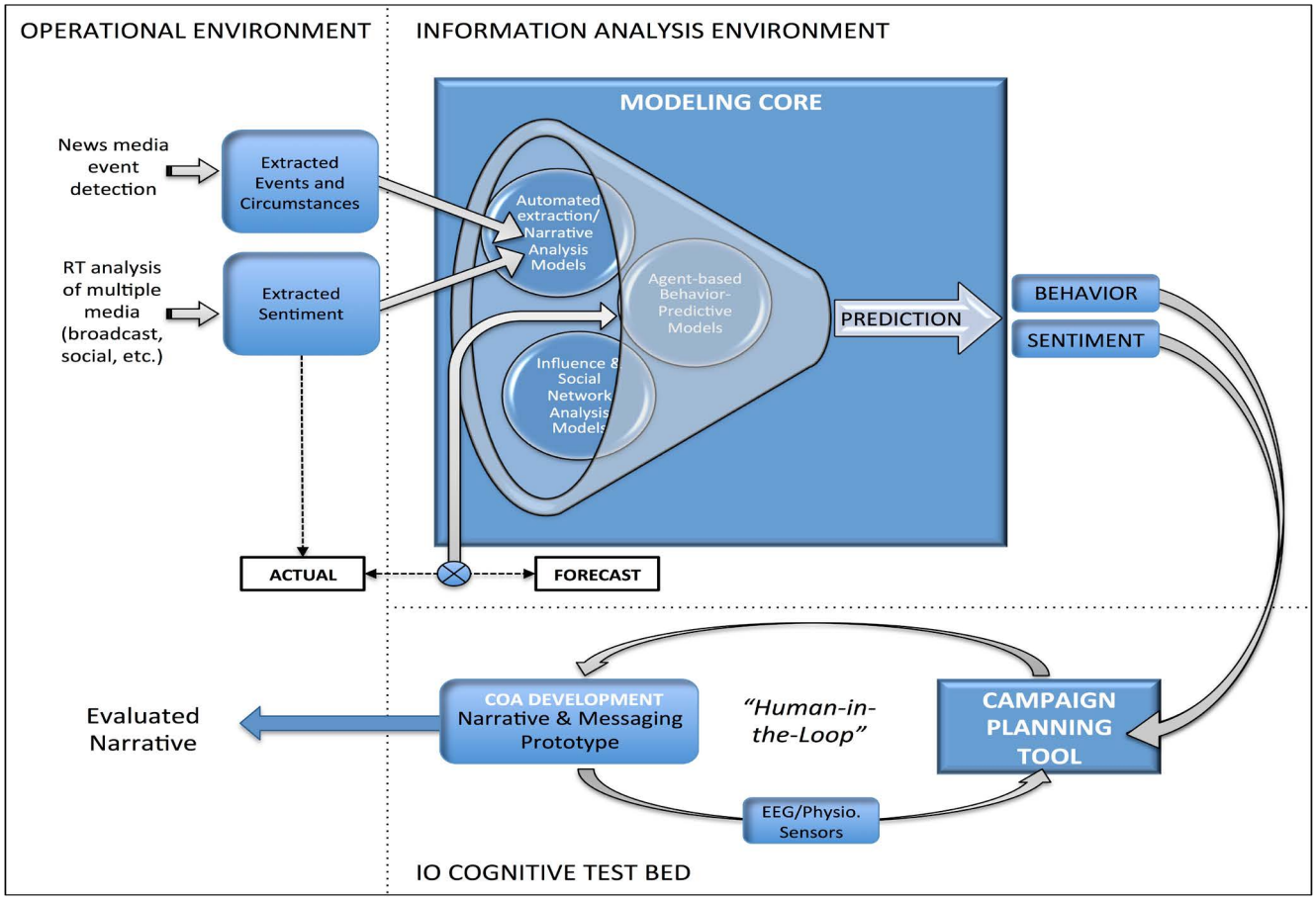

Figure 1

Such a system could incorporate technologies to automate access, acquisition and analysis of multiple sources of information. For example, the system might combine broadcast and social media, communications, inter-individual interaction patterns, etc., summarize, and provide the information directly to analysts, and also feed data into computational agent-based modeling programs. These modeling programs would then forecast future sentiments and behaviors of individuals and groups. Outcomes of both analyst analyses and computational models can be used to drive campaign planning tools, which can be developed and implemented to optimally influence key targets' behavior in particular operational environments.[4]

be expected for a given operational plan.[5] The results gained from IO cognitive test beds can increase the likelihood of optimizing assessment and influence tactics and strategies by: 1) fortifying identification and analysis of target-specific variables; 2) providing information upon which to develop successful narratives and other psychological tactics, and 3) utilizing "human-in-the-loop"-based results to generate approaches that more precisely assess and affect specified target(s) in desired ways.

Many technologies essential to this system already exist, and reportedly those that are currently in "the pipeline" that require further development would not take long to mature.[6] For example, mature, validated,

and operationalizable systems for automated, real-time monitoring of massive international news-media, such as the *Expandable Open Source – EOS –* system (see: http://osvpr.georgetown.edu), and Lockheed-Martin's *Integrated Crisis Early Warning System* (ICEWS), use extracted event-traces from news media to drive event-depiction and forecasting models. As well, "Big Data" tools, such as the *AvesTerra* system can acquire and extract information from multiple functional domains, such as biological, behavioral, economic, environmental/ecologic reports, from myriad resources to enable real-time identification and tracking. These can generate profile and output patterns for near- and intermediate-term event predictions (see: http://osvpr.georgetown.edu). Such data could be used in tandem with decision technologies to establish a modeling core to generate predictive algorithms to plot potential trajectories of targets' behaviors, and evaluate how such trajectories and outcomes may be affected by implementing various interventions to alter variables that influence environments, resources, individual and group interactions, narratives, etc.[7,8]

NEURO-COGNITIVE SCIENCE AND TECHNOLOGY: VIABILITY – AND POTENTIAL VALUE – FOR INTELLIGENCE OPERATIONS

Strategic intelligence at the individual and group levels relies critically on the roles that biological factors, social identities, cultural norms, and narratives play in the context of events.[9] Furthermore, there is a neural basis for such effects, operating both upon the subject/target, and the analyst or decision-maker. This has fostered increased interest in the possible utility of systematically incorporating neuroscientific and neurocognitive techniques and technologies (neurocogS/T) to detect, analyze, and understand target information, and to provide operational planning tools to influence target behaviors in ways that are of use and value to the IC.[10]

There is much ongoing academic work that establishes a relationship between environmental effects with narratives and detectable neural signals that can be correlated to behavior change.[11–15] Findings from recent studies support that individual and group neurophysiological data can be useful for describing and predicting the relative likelihood of targets' cognitive and emotional state, and resulting behaviors in defined environments under particular circumstances. From this, it might be possible to identify – and implement – operational actions and messages that exert influence in ways that are specifically reflective of a particular target and/or target group. Such information provides an additional layer of context to HUMINT, SIGINT, and COMINT collection by depicting how neuro-cognitive systems and processes operate under various environmental conditions, interpersonal communications and interactions, and how neural processes contribute to certain behaviors.

Neurocognitive science may also be utilized to optimize the performance of an intelligence analyst. Information about an analyst's neurocognitive state and processing can be fed into intelligence acquisition schemes and predictive models about their targets, so as to "fine tune" information assessment and predictions to account for the analyst's cognitive filters and activity patterns. For example, a suitably equipped workstation would take electroencephalographic (EEG) measurements of brain-wave activity collected from the analyst (while reviewing the raw information and generating analytic products) that could be integrated with state-of-the-art computational systems to assess patterns of neuro-cognitive engagement in various information processing regimes. This could be coupled to neuro-feedback systems to fortify neuro-cognitive mechanisms and optimize analyst performance. Laboratory experiments of this sort have been conducted have been conducted in the past.[16, 17]

Thus we define a new kind of intelligence collection modality based on this assimilated approach, which we call "NEURINT" (i.e., neuro-cognitive or neural intelligence).[18] NEURINT could enhance intelligence analysis in several ways. First, it employs information from the brain sciences (in tandem with other forms of human terrain information) to establish patterns of human neuro-cognitive and behavioral processes. Second, it enables pairing of human cognitive and machine-based computational processing to increase analyst capabilities in information detection, discrimination and assessment. Third, it could be linked to cyber-based approaches to assess and influence effects of various forms of messaging used by target individuals and groups (e.g., social media).[19] The resulting analysis could optimize tactical and/or strategic engagement of target individuals' or groups' psychological states to achieve best advantage in effecting changes in their cognitions, emotions and behaviors.[20]

UNIQUE CONTRIBUTIONS OF NEURINT FOR STRATEGIC INTELLIGENCE

Human beings are often portrayed as "rational actors" and indeed, rational actor models can be useful for predicting the behavior of individuals or groups.[21] However, findings from neuroscientific studies increasingly reveal human behavior, cognition, and decision-making as a combination of both rational and irrational, more emotively driven processes, driven by social cognition and social dynamics.[22,23] Given that neuro-cognitive sciences have only recently advanced these insights, the neuro-cognitive bases and effects of social identities, cultural norms, and narratives have heretofore been somewhat under-valued,[24] and under-employed when considering contexts for strategic intelligence.

The commander of US Central Command (CENTCOM) has said that success in an age in which the human domain trumps the land, sea, air, and space domains requires that strategic intelligence incorporate a neuro-cognitive understanding of the dynamics that mark this seemingly-perpetual conflict.[25] The outcomes of intelligence and influence operations are dynamic, and can be expected to change as a consequence of biological, psychological and social factors. NEURINT approaches can synergize HUMINT, SIGINT and COMMINT, and, we posit, in this way, make neuro-cognitive advances especially valuable for strategic intelligence in the human domain.

RESEARCH, DEVELOPMENT AND USE

While NEURINT can, and arguably should be employed to enhance certain IC operations, it is important not to misinterpret and/or misuse these techniques.[26,27] Indeed, human thought and activity involves biological, and social factors and effects, and all must be taken into account when gathering and interpreting intelligence. As stated in a recent Joint Staff Strategic Multilayer Assessment (SMA) group report:

> *Neuro-cognitive technology can reduce the volume and complexity of information…by sorting complicated information in order to augment human analysts' formulating a cohesive picture from which to draw necessary inferences about the capabilities and intentions of (friendly, neutral or hostile) intelligence targets. Neurotechnologies can facilitate and enhance collection and interpretation capabilities and… might decrease the fallibility of "human weak links" in the intelligence chain.*[28]

In sum, there is great potential and opportunity to utilize currently available neurocognitive science and technology in IC operations. In light of growing threats to national security, and the rapidly shifting international capabilities in science, technology and intelligence,[29-31] we believe that investment in neuro-cognitive technologies could produce particularly high returns. These approaches are ready to move from the laboratory to be evaluated for viability and value in practical applications and for use in real-world intelligence operations. By so doing, they can be further developed and articulated so as to keep pace with the tasks and challenges of the future IC mission to mitigate or prevent the escalation of international conflict and threats to national security.

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DISCLAIMER

The perspectives and opinions presented in this essay are the authors' and do not necessarily reflect those of the Department of Defense, Joint Staff of the Pentagon, or the Defense Advanced Research Projects Agency (DARPA).

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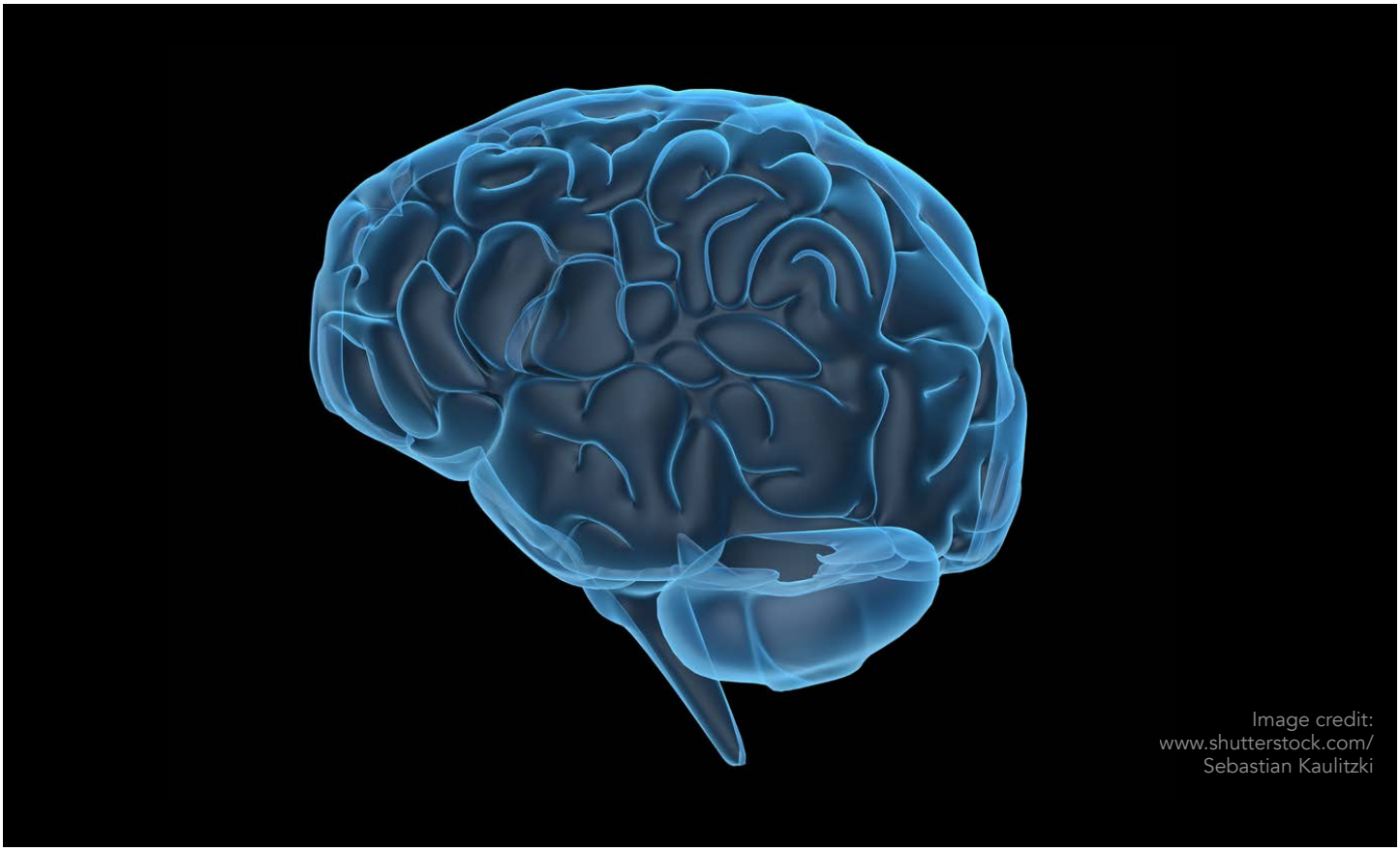

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VIEWS IN BRIEF

REIMAGINING THE AMERICAN DREAM

Charles Mueller, PhD

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By U.S. Navy photo by Photographer's Mate 2nd Class Dennis Cantrell [PD].

The American Dream is an idea – an idea that has driven this country and inspired the world for almost 300 years. This dream is rooted in our Declaration of Independence with the words:

We hold these truths to be self-evident, that all men are created equal, that they are endowed by their creator with certain unalienable rights, that among these are life, liberty and the pursuit of happiness.

As this country has evolved, so too this dream. This dream is about finding comfort in the idea that we live in a country where there is opportunity for all and regardless of your race, creed, sex, class or the family you were born into, through hard work and determination you can create the life you want. However, for many, the American Dream is beginning to feel like the American Nightmare, a sick illusion of hope in a world full of fear, hostility and inequality relative to times past. Just as James Truslow Adams inspired a nation coming out of the Great Depression in his book *Epic of America* by first coining and describing the American Dream, our nation today, one coming out of its own era of financial despair, needs a reimagining of the American Dream.

The generation that emerged following the first references to the American Dream was the generation that helped save the world from the evil that prompted WWII. This generation's ethos was all about hard work, survival, and creating a better future for their children. Their attitudes are what came to define the American Dream. Over time, this generation's children evolved the dream to include a greater emphasis on the pursuit of happiness. Happiness was not necessarily hard work, it was also about working the jobs you wanted and having time to enjoy the efforts of your labor with the ones you loved most. As the country continued to mature, the third generation of the post-Great Depression American Dream became the first to truly reap the rewards of the sacrifices of the first generation; the world they lived in was evidence of the success of their grandparents. This generation of people was promised the American Dream, which was now, at last, the American Reality.

Unfortunately, the combination of the devastating effects of 9/11 on the American psyche and the Financial Crisis of 2008 on the American wallet has challenged the ethos of our time and exposed parts of the American Dream, which have turned out to be false. The wealth gap in this country continues to grow, hateful speech is becoming more of the norm, and graduated students are entering the job market with university degrees only to find a genuine lack of opportunity compounded with a mountain of student debt. Hard work no longer seems to be paying off. While this reality is still greater than many other parts of the world, it represents at a minimum the flattening of the trend President Franklin Roosevelt always said should be upwards in his last Inaugural Addresses in 1945:

> *"Things in life will not always run smoothly. Sometimes we will be rising toward the heights – then all will seem to reverse itself and start downward. The great fact to remember is that the trend of civilization itself is forever upward, that a line drawn through the middle of the peaks and the valleys of the centuries always has an upward trend."*

It is time we reimagine the American Dream. It is time we generate a new idea, a new hope, a new vision for the future that will inspire this nation once again and give new meaning to our purpose. In a world dominated by the advancements of science and technology, the definition of hard work looks much different from the days when it was synonymous with long hours on the farm or at the factory. This new American Dream should anticipate the future that will be arriving, one where we can communicate with our thoughts, have robots do our chores, and free ourselves from the limits of our genes.

This new American Dream should be about making the pursuit of happiness easier. This is a dream where people don't have to work harder to move up, they have to work smarter, they have to work more creatively; they have to take advantage of the world that has been gifted to them and imagine it to the future. This American Dream should be about providing everyone with the ability to do this, giving everyone access to things like the Internet and creating new jobs that seek out the human imagination. It should be about developing a society where we reward our creativity and an ability to dream up the futures no one else can envision.

The future of the American Dream should be that no matter who you are, you live in a place where your imagination can come true, where opportunity exists to let your bold ideas grow into things that will change the world. This is a world where opportunity still knocks even if you fail. It is a world about the future and it will take all of us to make sure this new American Dream becomes reality.

This article also appears as a blog post on the Potomac Institute for Policy Studies' CReST Blog. Available at: https://potomacinstituteceo.wordpress.com/2016/04/15/reimagining-the-american-dream/.

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Alex Taliesen.

ORGANIZING CHAOS:

A UNIFIED VISION FOR S&T

Charles Mueller, PhD
Rebecca McCauley Rench, PhD
and Paul Syers, PhD

Until recently, the United States relied on our vast expenditures and resources to remain at the forefront of the technological revolution. Given the increasing speed of global advancement, this is no longer an effective strategy. We cannot rely on investments that only support government agencies seeking incremental advancements in science and technology (S&T), serving the issues of today rather than enabling the world of tomorrow.

Our investment into S&T and research and development (R&D) needs to be an end unto itself. In a world dominated by advancements in S&T, the US must lead. In order to lead the world, we must be the prominent player in the most important areas of S&T – the areas that promise to revolutionize our future. Leading the charge on sequencing the human genome and dedicating the resources needed to get us to the moon were riddled with challenges. A government-focused effort can overcome these types of difficulties and get us where we want to be. Working towards a vision of the future is not a task for one company or industry.

The United States government should establish a cabinet-level Department of Science (DoSc) to unify our vision and manage and coordinate the $153B spent each year by the government on S&T and R&D.[1] A DoSc could ensure that priority efforts receive sufficient attention and sufficient resources, and that issues are resolved with appropriate knowledge and understanding of the requisite science.

We are on the precipice of extending human existence both in time and breadth of capability. We are creating new consciousness and rediscovering that other beings are capable of more thought than our old worldview allowed. We are at the beginning of an age where we will explore and understand not only neighboring planets, but also our solar system and beyond. The future is enticing and it is inevitable that some country will do what it takes to lead the world forward. Many of the most exciting potential advances are simply too risky and require too many resources to fully implement without some sort of government-led effort. A DoSc can create a unified vision of S&T that will help ensure the US remains true to its roots and continues to lead the world into the 21st century – the century of S&T. What are we doing to create the world of tomorrow and who is currently positioned to lead the charge?

THE CASE FOR A DEPARTMENT OF SCIENCE

Executive departments are justified in the Constitution in Article 2 Section 2, where it states "(the President) may require the opinion in writing of the principal officer in each of the executive departments upon any subject relating to the duties of their respective offices." The executive departments act as the tool by which the President is able to carry out his or her duties to the American people and Congress. The President uses the executive departments to provide services that benefit all of society, and cannot be relied upon to be provided by the private sector. These departments provide for a common societal need, as the table below illustrates.

Over the last half-century, S&T has become the primary change agent for how our society and economy function and evolve. S&T has become critical to who we are as a people. However, our process for managing and investing in S&T remains ad hoc, with different agencies each investing into areas of S&T that align with their mission and current needs without consideration for the overall advancement of S&T in our society. More can be accomplished with greater effectiveness and efficiency if S&T is viewed as an end goal, rather than merely a support function for agency agendas.

SOCIAL NEED	EXECUTIVE DEPARTMENT
Defense	Department of Defense, Department of Veterans Affairs, and the Department of Homeland Security
Diplomacy	Department of State
Education	Department of Education
Health	Department of Health and Human Services
Infrastructure	Department of Transportation and the Department of Housing and Urban Development
Natural Resource Management	Department of the Interior
Economy	Department of Commerce, Department of Labor, and the Department of the Treasury
Food	Department of Agriculture
Energy	Department of Energy
Justice	Department of Justice

Currently, initiatives address specific problems one at a time. For example, the BRAIN Initiative and the Precision Medicine Initiative co-exist with little coordination. One is focused on the brain and the other on genomics of the body. Both initiatives are focused on creating a better understanding of human health writ large. However, if our goal is to bridge our understanding of the mind and body, the lack of coordination in these initiatives will ensure there are gaps to be filled down the road. In addition to the choice of research organization, funding and implementation of these initiatives could also use an overhaul. The BRAIN Initiative is approximately 90% sponsored by NIH,[2] yet agencies like the DoE could help make the initiative more successful. Each participating organization intends to use the research it funds toward a specific mission. This lack of synergies highlights the need for a unified vision in managing and investing in S&T because without one, the end result is what we currently have – a chaotic system under which it is virtually impossible to describe the vision or direction of our national investment into S&T.

Similar to our need for a DoE and DoD to manage our energy and defense needs, a DoSc would manage our S&T and R&D needs independent of whether the application is to energy, defense, or both. On the near horizon are multiple areas of S&T that promise to forever change the world. Without a coordinated, focused government investment, the United States will struggle to remain a relevant leader going forward.

In the following, we look at three of these opportunities on the horizon, and discuss how a DoSc would change our prospects.

CONTROLLING OUR GENOME

Biotechnologies have evolved to the point where we can precisely manipulate the genome in remarkably predictable ways. Sequencing technology has advanced since the 1970s such that we can decode the human genome in a matter of hours.

The enzyme system CRISPR-Cas9 is giving us extraordinary control over how the body operates. We can use technologies like these to construct entire genomes from scratch,[3] or to edit existing genomes, including those of embryos. These technologies have led to the development of things like gene drives, which can pass a particular gene on to progeny, leading to potentially unique solutions to eradicate pathogenic diseases like the Zika virus.[4] Furthermore, technologies that allow us to make chemical modifications to the genome or alter the RNA and protein inside cells is making it so we can change the phenotype (i.e. behavior) in living cells and in mammals like primates.[5] Researchers are beginning to experiment with these capabilities to modify human embryos in efforts to ensure that children are born without mitochondrial diseases.[6]

These capabilities are enabled by advancements in genetic sequencing, proteomics and transcriptomics. They are driven by a desire to develop effective cures to genetic diseases like cancer Alzheimer's, and even blindness.[7] However, these biotechnologies also promise a future where people will be able to make non-medical changes to themselves and their offspring, ushering in a future of genetic enhancement. These technologies can alter the direction of evolution imposing a large impact on our society and species. This all leads us into a future where those with the will to push moral and ethical boundaries can alter the direction of humanity.

CONTROLLING OUR BRAINS

Neuroscience provides an unprecedented understanding of the mind. Decades of research in manipulating individual neurons and recording whole brain function have advanced our understanding to the point where we can now interpret memories, transmit thoughts, play games and control prosthetics directly with our minds.[8] Concepts that have been pure science fiction, like direct thought communication, downloading knowledge and memories, or even mind control, are beginning to seem realistically achievable. Improved precision, better materials, and lower costs of some neurotechnologies enable increased incorporation of these technologies into everyday products.

While these areas have direct implications for human health and disease prevention, the implications and applications are far broader. The technologies carry issues of ethics, access, future management, and unintended consequences. In order to be a leader in controlling our genome and brains, we must take control of our S&T vision through a DoSc.

CONTROLLING OUR ENVIRONMENT

Technologies are being developed not just for manipulating local, man-made environments, (such as the temperature in our homes and businesses) but also for changing the ecosystem on a global scale. We are beginning to understand how to take control and mold our global environment through geo-engineering techniques dictated by elaborate computer models. Concepts have been proposed to confront the growing carbon dioxide in our atmosphere by filtering it out at a pace unmatched by typical plant life.[9] According to some, widespread use of carbon capture and sustainable energy technologies could change global levels of

carbon dioxide in a matter of years, not centuries.[10] Resource excavation industries have given our species the tools to tear down mountains, create or destroy massive forests, and even create new islands on similarly short timescales.

We are discovering materials and building techniques that allow us to expand into ever-harsher environments. Nanotechnologies allow us to control materials on a near atomic scale, by harnessing a deep understanding of chemistry. Bio-nanotechnologies use microbes to perform an astounding number of chemical and structural processes. Used in concert, we can use that control to recapture waste, and eliminate the discarding of resources.

This vision is at great variance with common wisdom, which is based on an industrial society that predates this level of material control. While the technologies are still mostly in basic research phases, and thus the purview of agencies such as the National Science Foundation, the applications, many of which are near-term, cut across a myriad of missions throughout government and business. By embracing these technologies and furthering their development through a unified S&T vision, the US can lead in bringing the beneficial aspects of the environment and materials to rapid fruition. A DoSc could carry this vision forward.

INTERNATIONAL CONSIDERATIONS

Many of the crosscutting S&T research domains raise issues of ethics, safety, health, contamination, validation, and other procedural concerns in how the research is conducted, or whether it is conducted at all. In order to avoid a race to the bottom, or unilaterally abdicating US leadership in certain research areas through the self-imposition of restrictions, international agreements and standards are often required. A DoSc could much more powerfully represent US interests in international discussions, compared to individual agencies and representatives. There are multiple examples of serious issues that need resolution; we consider a few examples in the following.

The US government has a strong history of opposing the application of technologies to controversial areas of research, as was the case with stem cell research. This made it hard for the US biotech industry to compete with the rest of the world in exploiting these new technologies, even though the science was first developed in the US. This trend is continuing as Congress and agencies like the FDA and NIH, have restricted human genetic modification research.[11] Just as with stem cell research, this strategy, as currently constituted, will lead to cures and treatments being developed abroad instead of here in US facilities and hospitals.[12]

The international community varies in its openness to this new era of medical research – with some countries strongly opposing it and others deciding to set up virtually no barriers.[13] There is an effort underway to create a set of international standards and guidelines for genetic research, but in the meantime, China ignores pressure to exercise caution with this kind of research.[14] In fact, China has the world's largest primate research capability, and shows little to no moral/ethical obstacles toward clinical experimentation,[15] potentially leading to faster applications. For example, the Chinese company BGI currently dominates the genetic sequencing industry,[16] with the result that China has become the owner of more genetic data than any other country. Researchers are lining up and likely will continue to use their genetic engineering infrastructure to discover the secrets of the genome.

In a similar vein, Chinese research in neuroscience is based on a national strategy, but seems less likely to conform to the strictures of US neuroscience research. As a result, the continued US leadership in neuroscience research is not guaranteed, given the comfort levels of US research in experimentation. The concern is that asymmetric restrictions might limit US leadership of the most important neuroscientific breakthroughs that will revolutionize the way people learn, communicate, and experience their lives.

In addition to fighting for a level playing field in the area of ethics and procedural restrictions on research, a DoSc might be far better at understanding the international competitive research environment, and thereby emphasize or prioritize US research efforts. At issue is whether a particular area has a sufficient critical mass of resources, as opposed to being spread out among multiple agencies with varying agendas.

Once again, we look to the example of China, which has developed an investment plan to bolster their science and technology capabilities over a period of years, to become competitive with the US. Many other countries have substantial technology catch-up plans (or leap-ahead plans), but China is a favorite example.

For example, to become a leader in microelectronics technology, the Chinese government plans on investing more than $100 billion between 2015 and 2025 into increasing manufacturing and innovation within the country[17] with a goal of cornering the market irrespective of economic viability. China is also poised to lead

the world in materials recycling and renewal processes, including developing alternative energy and carbon capture technologies. Already, China dominates the solar panel industry.[18] To the extent that these industries of the future are founded on today's scientific developments, the lack of focused US investments or strategies in these areas is reason for concern.

We do have federal dollars supporting university laboratories and agencies interested in specific applications, such as creating recycling systems for water and air reclamation aboard the international space station, yet we do not have a focused long-term federal policy on creating sustainable material reclamation. If we are interested in creating a future where we can adopt a circular economy whereby trash is fed into reverse 3-D printers, we are lacking the vision, resources, and coordination to get there.

CREATING A UNIFIED VISION FOR S&T

The government supports a large number of offices, agencies, and initiatives funding S&T, but in a chaotic and often haphazard way. The White House boasts having launched over 20 S&T initiatives during the Obama Administration. While portfolio diversity is useful in research endeavors, the separate agendas of each agency and the relative lack of visibility across agencies is not helpful to the efficient development of technology. The cacophonic nature of so many agencies and initiatives working independently means that few agencies are aware of which research efforts other agencies are funding. When multiple government agencies fund research in one lab, the lab must serve multiple masters and multiple missions. For example, the National Center for Atmospheric Research received $173.9M in FY2013 with 67% from NSF, 6% from NASA, 5% from DOE, 4% from DoD, 4% from the FAA, and 3% from NOAA.[19] The incentives foster low-risk efforts that result in incremental increases to our knowledge base. The fundamental issue is that science and technology is always viewed, and funded, in the context of a restricted mission, and judged in terms of progress toward application to that mission.

A DoSc would be able to guide the various science agencies of the federal government in support of a unified vision for improving the S&T and R&D for our country. Rather than the current Office of Science and Technology (OSTP) or the Congressional Research Service (CRS), which serve only in an advisory capacity to the Administration and Congress, respectively, a DoSc would need the budgetary control to solve the larger issue of focused science missions that look forward to our future. We don't specify the mechanics of how such a department would be formed and operate, but they might assign executive agents in specific departments to specific initiatives. The goal would be to maintain and strengthen our technology lead for the national security applications and economic benefits that accrue from driving the innovations.

A DoSc could identify and focus on major areas of S&T that will truly revolutionize the future. The DoSc would promote a national strategy for the most important areas of S&T, the ones anticipated to impact not just the US, but the world in ways that will forever change humanity's story. Without something like the DoSc, we are forced to rely on our ad hoc approach to investing and managing our S&T/R&D portfolio. Our current strategy is based on a hope that progress will work out because no one else can match us in resources nor ingenuity. With a DoSc, we wouldn't have to hope because we would have a plan for the future and an organization dedicated to making it happen.

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Dr. Rebecca McCauley Rench successfully defended her PhD in Geosciences and Astrobiology at the Pennsylvania State University in 2015. Her graduate work focused on the diversity and metabolic potential of cave microbial communities as they relate to early Earth analog environments and the search for life. A West Virginia native, she completed her undergraduate schooling at West Virginia University and holds a BA in Biology and a BA in Chemistry. Before starting her graduate education and after obtaining her bachelors degrees, Dr. McCauley Rench participated in disaster preparedness response as an AmeriCorps member in San Francisco. Dr. McCauley Rench is a Truman Scholar and NSF Graduate Research Fellow, as well as a Research Associate at the Potomac Institute for Policy Studies. Dr. McCauley Rench can be reached at: rmccauleyrench@ potomacinstitute.org.

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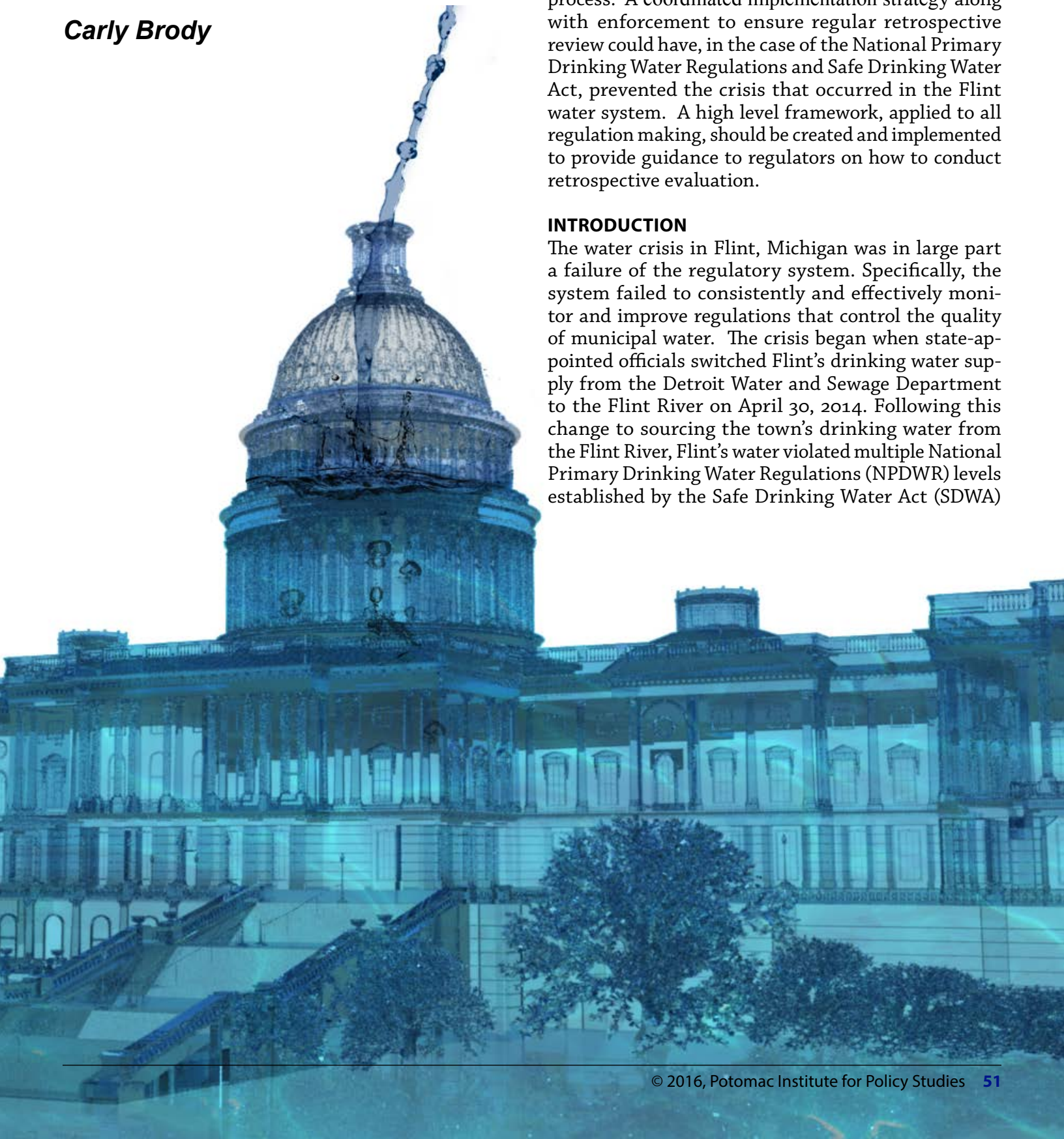
Image credit: Alex Taliesen.

Regulatory Failure in Flint, Michigan

Carly Brody



The Flint, Michigan water crisis represented a failure of government at multiple levels. However, the damage could have been prevented if key components of a regulation evaluation process had been required at the inception of the rule making process. A coordinated implementation strategy along with enforcement to ensure regular retrospective review could have, in the case of the National Primary Drinking Water Regulations and Safe Drinking Water Act, prevented the crisis that occurred in the Flint water system. A high level framework, applied to all regulation making, should be created and implemented to provide guidance to regulators on how to conduct retrospective evaluation.

INTRODUCTION

The water crisis in Flint, Michigan was in large part a failure of the regulatory system. Specifically, the system failed to consistently and effectively monitor and improve regulations that control the quality of municipal water. The crisis began when state-appointed officials switched Flint's drinking water supply from the Detroit Water and Sewage Department to the Flint River on April 30, 2014. Following this change to sourcing the town's drinking water from the Flint River, Flint's water violated multiple National Primary Drinking Water Regulations (NPDWR) levels established by the Safe Drinking Water Act (SDWA)

throughout 2014 and 2015.[1] Flint resident Lee-Anne Walters first notified EPA Region V of high lead levels in drinking water in February 2015, when Flint utility administrator, Mike Glasgow, measured lead at 104 ppb in her home. In response, the City of Flint tested the drinking water for iron and lead multiple times, and even after pre-flushing, found excessively high lead and iron levels. The EPA Region V made numerous inquiries about whether the required optimized corrosion control treatment (OCCT) program was being implemented. After first stating that they were implementing OCCT in Flint, Michigan Department of Environmental Quality (MDEQ) admitted in April 2015 that they had not been doing so.[2] The MDEQ decision to not immediately implement OCCT led to the corrosion that resulted in drinking water contamination.

The water crisis in Flint, Michigan was a result of "government failure, intransigence, unpreparedness, delay, inaction, and environmental injustice"[3] at the local, state, and federal levels. This should come as no surprise as the US regulatory management system has changed little since it was first overhauled in 1981, and as a result, the US is falling behind other developed countries, which have been updating their regulatory management systems and regulations in recent years.[4] Our outdated regulatory system is still unable to protect its citizens despite three executive orders (EO 13563, EO 13579, and EO 13610) calling for regulatory review to improve regulations' efficiency and efficacy. Systematic review of the SDWA and its implementation would have prevented the Flint crisis by exposing the failures of oversight at the local, state, and federal levels. By implementing a framework for retrospective evaluation, which assesses a regulation's effectiveness in meeting its objectives after implementation, the Flint water crisis could have been prevented. The US lacks coordinated implementation and enforcement to ensure that agencies are completing effective retrospective review, making the process ad hoc and creating an environment where its citizens are placed in harm's way by situations such as that in Flint, Michigan. Our regulatory system consists of a culture where efficacy is determined by regulators simply checking boxes rather than ensuring protection. This article explores the Flint water crisis and how it could have been prevented if key components of retrospective evaluation were required to facilitate the regulatory process and protect Americans as regulations were intended.

A FRAMEWORK FOR RETROSPECTIVE REVIEW

Regulatory Principle #1: Regulatory agencies should use measures to evaluate the changed circumstances for a regulation and consistently review the method and tools that are used to evaluate the impact of a regulation.

Cary Coglianese, professor of law and political science at the University of Pennsylvania, is director of the Penn Program on Regulation. According to Coglianese, "Rather than relying on impressions, the federal government needs careful, systematic research that addresses the question of causation: What benefits and costs can actually be attributed to a regulation after it has been implemented?"[5] A framework for guiding regulators in ex post evaluation requires "*indicators* to measure relevant outcomes of concern" and "*research designs* to support credible inferences about the extent to which a regulation has actually caused a change in the measured outcomes."[6] Assigned responsibility for measurement would allow regulators to determine whether a regulation is operating to an appropriate level of efficiency and if it is meeting its intended outcome. This would require that the regulation itself specify how scientific measurements and a systematic process of unbiased evaluation would improve transparency and accountability, and would prevent crises that result from ineffective or insufficient regulation.

PRINCIPLES OF GUIDANCE

Through our research, we identified three principles to guide regulation evaluation:

1. Evaluations should be based on measurements of either indicators and/or attribution.[7]
2. Regulators should create and rely on a method to review the tools used for evaluating regulation to ensure that they are efficient, effective, and replaced if better alternatives exist.
3. Regulators should establish periodic review of the regulation's effects and compare the outcomes to its intended purpose. Periodic review must account for technological changes and innovations in order for the regulation to stay current.

These principles would have helped prevent the crisis by requiring monitoring of the SDWA to ensure that the outcomes were meeting its intended purpose, especially if the change in water supply would have triggered a periodic review. Prior to MDEQ's decision to

switch the source of drinking water to the Flint River in 2014, the Office of Drinking Water and Municipal Assistance (ODWMA), which is responsible for SDWA enforcement and lending assistance to public water suppliers, anticipated this would create problems, "but deferred to state emergency manager decisions to proceed."[8] If the framework suggested here had been in place prior to the crisis, requiring the EPA to monitor how the SDWA was performing, there would have been tracking of the MDEQ's adherence to the goals of the SDWA. As a result, MDEQ's actions would have been more transparent, and the EPA may have actually held the MDEQ accountable for their decision to change the source without triggering a comprehensive monitoring or ensuring that appropriate OCCT measures were being implemented.

Another factor leading to the crisis was the "inadequate and improper sampling of distribution system water quality, potentially in violation of the Safe Drinking Water Act."[9] MDEQ instructed Flint Utilities Department to implement techniques such as sampling water that was pre-flushed and failing to test homes considered high-risk for lead.[10] Pre-flushing, which involves letting the water run prior to taking lead samples, is discouraged by the EPA, but is not illegal. Evaluation of the measurement approach would have facilitated the discovery of Flint's fundamentally flawed water quality sampling method,[11] and would have shown that pre-flushing was distorting Flint's data. Additionally, the EPA considers a system in compliance with the lead and copper rule (LCR) if at least 90 percent of the homes tested for lead contain 15ppb or less, known as the "90th percentile level." Review of this tool would have revealed that officials nationally manipulate test results by conducting more tests to lower the average, so as to discount the highest samples that may exceed 15 ppb.[12] Accordingly, the existence of such manipulation suggests a second regulatory principle needs to be enforced.

Regulatory Principle #2: Regulatory agencies should be held accountable for their retrospective review processes and evaluations.

To improve regulatory transparency and accountability, agencies should involve the public in the regulatory process to check and provide feedback on the purpose, efficiency, and need for a regulation, both before and after a regulation is put into place.[13] We compile principles that could guide implementation:

Principles of Guidance

1. Regulators should conduct regular assessments of how a regulation is changing and whether it is meeting its goals by designating an independent review team with people who are not responsible for producing or enforcing the regulation.[14]
2. Regulators should have their agency findings validated by an outside group, to serve as a quality check by using agency data to replicate and validate its review.[15]
3. Regulators should engage the public to both determine which regulations need review and validate their retrospective analyses through independent replication.[16]

Periodic review of the SDWA's LCR would have revealed that the regulation was not achieving maximum efficiency or efficacy. MDEQ misinterpreted the SDWA's LCR, which "requires public water systems to minimize lead and copper levels in drinking water by controlling corrosion in the distribution system…by implementing corrosion control treatment."[17] MDEQ chose not to require Flint to implement OCCT immediately, deferring the decision until after the second six-month monitoring period, although the EPA had "advised MDEQ that the LCR unambiguously requires OCCT."[18] Although the EPA is now reviewing and revising the rule, had such measures been in place beforehand, requiring periodic review of the LCR's effects and comparing them to its intended purpose, the EPA would have recognized the LCR's inconsistent implementation earlier. Furthermore, periodic review likely would have revealed that the minimalist culture of the ODWMA at the MDEQ, which considered "technical compliance" sufficient, and was failing to ensure the safety of human health and the environment which was the intended goal of the SDWA.[19]

Finally, the "disregard of compelling evidence of water quality problems and associated health effects" and "callous and dismissive responses to citizens' expressed concerns" contributed to the problem.[20] The Flint Water Advisory Task Force determined that communication regarding the Flint water situation and its impacts to health has at times been inappropriate and unacceptable.[21] Had the principles stated above been in place, requiring reliance on indicators and/or attribution, MDEQ would have been held accountable for intentionally disregarding the evidence. By engaging the public, regulators would have required public

involvement and communication of data to the public. Moreover, the public might have been able to publish data collected in their homes, and thereby act as a check on MDEQ's actions and procedures, ensuring that the impacts and goals of the SDWA were being assessed.

SUMMARY

The US regulatory system produces thousands of regulations every year, yet a coordinated implementation strategy for making effective regulations does not yet exist. Regulatory agencies implement the laws Congress creates to keep the United States safe, prosperous and fair. Without a regulatory system that can effectively and efficiently enforce the laws, the entire regulatory system undermines our Constitution and does little to protect the citizens of the United States. In order to effectively implement retrospective evaluation, policy must be created to implement a framework, such as the one described here, at a national level. The framework should enforce periodic re-evaluation of regulations, and revisions to stay current and achieve maximum effectiveness. Finally, in order to increase transparency and accountability through public involvement, all agency data, documentation, and communication should be published on the Internet for the public to view. This provides the public the opportunity to validate reviews and ensure that the government is conducting retrospective reviews appropriately and as needed. Congress should enact legislation that ensures a framework is put in place that allows for the determination of regulatory efficiency and efficacy. Otherwise, the crisis in Flint, Michigan will continue to be a symptom of a broken system rather than the spark that forced us to improve our regulatory process.

NOTES

1. Miguel Del Toral to Thomas Poy, June 24, 2015, EPA Region 5, Memorandum, WG-15J.
2. Matthew M. Davis et al., "Flint Water Advisory Task Force Final Report." *Flint Water Study,* March 21, 2016, http://flintwaterstudy.org/wp-content/uploads/2016/03/Flint-task-force-report_2438442_ver1.0.pdf.
3. *Ibid*.
4. "Quality Control: Federal Regulation Policy," *Council on Foreign Relations* (2016).
5. Cary Coglianese, "Moving Forward with Regulatory Lookback," *Faculty Scholarship* Paper 1190 (2013): 61.
6. Cary Coglianese, "Improving Regulatory Performance through Ex Post Evaluation," *RegBlog, Penn Program on Regulation, University of Pennsylvania* (2012).
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8. *Ibid*, ref 2.
9. *Ibid*.
10. *Ibid*.
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13. Based on discussion with Hon. Tevi Troy (former Deputy Secretary of Health and Human Services and the author of *Shall We Wake the President? Two Centuries of Disaster Management from the Oval Office*), March, 2016.
14. Joseph E. Aldy, "Learning from Experience: An Assessment of the Retrospective Reviews of Agency Rules and the Evidence for Improving the Design and Implementation of Regulatory Policy," *Administrative Conference of the United States,* (2014): 67.
15. Based on discussion with Sofie Miller, (Senior Policy Analyst at the George Washington Regulatory Studies Center), April 2016.
16. Joseph E. Aldy, "Learning from Experience: An Assessment of the Retrospective Reviews of Agency Rules and the Evidence for Improving the Design and Implementation of Regulatory Policy," *Administrative Conference of the United States,* (2014): 7.
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18. *Ibid*, ref 2.
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