

FORWARD ENGAGEMENT

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Final Report

Preface

In keeping with the regular course of the history of this century the world has changed drastically in the last fifty years; the next 25 years offer us considerably more diversity and instability to profit from.

The challenge lies in preparing government for the long-term problems that will require the attention of more than one administration. Institutions we now possess may no longer deal effectively with the problems that they were designed for, much less future challenges. It is our hope that this report will give this administration direction in mapping the complexities of the future, and encourage an energetic response that will be relevant in 25 years.

Introduction

Each new administration has a duty to contend with current problems and an opportunity to devise solutions for the future. The aim of this report is to present the administration with a succinct overview of the major problems that will challenge U.S. National security interests in the long-term, and posit our suggestions for short and long-term that will ensure security and prosperity for the generation of 2025.

The working group focused on four global trends that it determined will grow in magnitude, deeply affecting both worldwide stability and U.S. national security. While examining these trends we searched for certain events, or choke points, that enable the advances in these trends to develop in new directions that would not have otherwise been possible.

- Technology: Nano-technology, genetics and biotechnology, space
- Economics and Development: North-South disparities, demographic shift, financial markets
- Military: RMA
- Environment: environmental degradation, global water shortage, energy issues

With the goal of participating in the crafting a national security policy for the year 2025 we commend the following report to the administration's attention.

The Future of Technology

As the momentum of the technological boom accelerates in the future, the time will soon come when science fiction becomes reality. From information technology to genetics, robotics, and the use of space, scientific principles coupled with engineering innovations will open the way for development of a growing number of products with real-world applications. Robots will perform human functions. Virtual reality (VR) will allow for more people to work out of their homes. Better understanding of the human genome will help doctors more quickly detect the genetic predisposition of a disease. The great simultaneous benefits and dangers that will come with these technologies will be among the primary policy challenges facing the United States.

In the industrial era, science and technology (S&T) was approached from the top-down approach, as large-scale factories and manufacturing were the centerpiece of the economy. In the decades to come, the opposite will occur. Technology will be fueled from the bottom-up, with greater research and understanding of the molecular level of our physical and natural universe.

Nanotechnology: the Reality in 2025

Nanotechnology, the science of molecular-manufacturing, will combine with new innovations in robotics, to manipulate matter at the atomic level. This trend will mirror the way scientists currently manipulate biology, and become a common bond among a number of technologies that will emerge in their own directions. The scientific community is confident nanotechnology will emerge because the laws that govern molecular systems are reasonably well-understood.

Nanotechnology will enable computer bandwidth to increase, thus continuing the acceleration of computer processing. The speed of computer bandwidth is dependent on the amount of transistors that can fit on a silicon chip. In accordance with Moore's Law (a prediction made in 1968 by Intel co-founder Gordon Moore which has proven to be true), the number of transistors on a sliver of silicon has doubled approximately every 18 months, every year, since the 1970s.

The choke point, however, is related to size. Eventually, transistors will become so small that electrons will converge, generating tremendous heat that will short-circuit or melt the silicon chip foundation. The use of nanotubes offers the opportunity to work through this choke point and enable Moore's Law to continue. Nanotubes are made of carbon molecules that are much more solid than steel (at the molecular level) and more resistant to heat. In the future, as scientists develop the means to affordably mass-produce them, nanotubes can then be used on silicon chips to absorb heat and allow for the bunching of microscopic transistors without electron convergence melting the chip away. What does this mean for the future of computers and information technology?

Consequences

The ability to continue the acceleration of bandwidth speed will allow for a computer-driven VR experience that will eventually change the way humans live and work. People will be able to have any type of experience with anyone – business, social, romantic, sexual – without having to be in the same place.¹ The most profound influence of VR will be in the workplace, as workers with the required knowledge and expertise increasingly will be able to perform their job from anywhere, even from their own homes.

The lowering of society's need to commute to work will be one of the most dramatic positive trends stemming from VR. The toll on our local infrastructures will be reduced as fewer roads and bridges will be needed. Fossil fuel emissions and greenhouse gases will be dramatically decreased. Businesses can reduce their overhead aimed at accommodating workers because the need for parking lots, as well as the lighting and heating of buildings will be reduced.² This will not only lower costs but also alter the geopolitical equation by reducing our dependence on oil from overseas.

But like any technology, nanotechnology has the potential to be used for both peaceful and aggressive ends. What is most worrisome is the fact that, unlike technologies of the past and present which eventually settle into society's needs and move at society's pace, nanotechnology is self-accelerating.

¹ Ray Kurzweil, "Will My PC Be Smarter Than I Am?" Time Magazine. 19 June 2000.

² James Richardson, "The Coming of Virtual Labor – Waldoes," Georgia Department of Natural Resources. The article appeared on website, *The GWU Forecast of Emerging Technologies: A Continuous Assessment of the Technology Revolution*.

The products of their own processes enable them to develop ever more rapidly. New computer chips are immediately put to use developing the next generation of more powerful ones. . . . When nanobots are finally perfected, you can be sure that one of the first things they will do is make new and better nanobots.³

Replication is a distinct possibility, especially if those with hostile intentions engineer nanobots. Thus, our policies need to be crafted in a manner that will pave the way for productive uses while stifling aggressive use.

Policy Recommendations

Nanotechnology will be driven by engineering innovations without much need for government assistance. As policymakers, our role will be to regulate and harness rather than stimulate. Our approach is to divide nanoresearch into two classes: consumer and experimental. In the consumer class, we should adopt a policy which allows U.S. companies to conduct nanoresearch and molecularly manufacture products while restricting self-replication research. A new Office of Nano-Affairs should be established under the Department of Commerce which will be tasked with licensing these companies and imposing export controls ensuring that U.S. companies do not provide overseas nanoproducts the necessary technology to perfect replication.

Unfortunately, it would be naïve to believe that the technology needed for replication will not eventually fall into the hands of a U.S. competitor. Thus, in our experimental class, the Department of Defense (DOD) will be responsible for maintaining a classified environment in which replication can be researched and developed. It must be emphasized, however, that all military research and testing be done in a way that avoids proliferation of nanoweaponry among nation states.

In a hostile public atmosphere, research would be pushed into secret programs, and in secrecy the prospects for broad international cooperation would disappear. Attempts to stop nanotechnology for fear of a new, unstable arms race become self-fulfilling prophecies.⁴

The Department of State will be responsible for working with international organizations to craft international norms and rules framing the appropriate uses of

³ Stewart Brand, "Is Technology Moving Too Fast?" Time Magazine. 19 June 2000.

⁴ "Unbounding the Future: The Nanotechnology Revolution," a paper by The Foresight Institute. 29 July 1997.

nanotechnology. A regime will need to be created whereby those states that break rules, or harbor terrorists who do, will receive international condemnation and punitive economic sanctions. Nanotechnology has enormous potential for good, but the United States will need to work with the rest of the world to ensure this technology is steered in productive directions.

Genetics and Biotechnology: the Reality in 2025

Manipulating nature's physical surroundings is one thing, but manipulating nature itself carries a number of potentially positive breakthroughs and ethical dilemmas. The mapping of the human genome is already completed and more sophisticated ways of genetically modifying (GM) crops to increase overall yields will be discovered. Genetic manipulation and developments in nanotechnology will complement each other, both in innovation and use. Scientific progress will clash with religion in debates that will be more contentious than the Evolution-Creationism debates of the 20th Century.

Consequences

Full understanding of the human genome will allow scientists to discover the genetic trigger for hundreds of diseases. It will help pharmaceutical companies develop drugs specifically tailored to a person's genetic profile – treatment will go directly to the source of a virus without flooding into other parts of the body and causing side effects. Biomedical engineering will exploit advances in biotechnology by producing new surgical procedures and systems, including better organic and artificial replacement parts for human beings.⁵ As life-span increases, formulating policies to adjust Social Security to the demographics of the future will be a challenge.

And then there is the issue of human cloning. Debating the ethics would extend beyond the scope of this paper. One fact we know for certain, however, is that people will try. Because of the public's warranted fear of human cloning, the government and scientific community must hold such research in check and the influence of human cloning by 2025 will still be negligible.

⁵ "Global Trends 2015: A Dialogue About the Future With Nongovernment Experts," prepared under the direction of the U.S. National Intelligence Council.

The future for GM crops appears to be heading in a different direction. A growing movement of scientists believes that GM food may hold the key to feeding the exponentially growing population of the developing world. By cross-breeding the genes of bacteria with different foods, new kinds of rice, for example, could be created containing beta-carotene, the nutrient that serves as a building block for Vitamin A. Bananas would not rot on the way to market; corn could supply its own fertilizer; wheat could thrive in drought-ridden soil.⁶ In a world where demand for grain will rise while the amount of arable land will fall, GM food may be the solution to a catastrophe that is already underway in parts of Africa.

Policy Recommendations

Breakthroughs in the life sciences continue to invoke public support, evidenced by the National Institutes of Health (NIH) which has received substantially more federal funding for research and development (R&D) than any other federal agency. From 1998-2003, NIH R&D funding is on pace to double from approximately \$12.5 billion to \$25 billion, with a large portion of that funding allocated to basic research.⁷ NIH innovations will be critical in supplying private industry with the knowledge to embark on their own applied research initiatives.

Thus, while government's role in steering nanotechnology is uncertain, its role in biotechnology is imperative. By controlling the purse strings of basic research, government will have the necessary leverage to stimulate research in those areas it deems worthy and stifle research in others. For those wanting to apply the basic research, the NIH will be given the power to license scientists and firms wanting to embark on cutting-edge cloning research. Research into human cloning should be restricted to a classified level. Meanwhile, the Department of State should also work to build international consensus on lawful ways in which cloning research can progress.

As for GM foods, despite European ambivalence, the United States should continue on its course to fund and utilize genetic engineering to increase crop yields and make them more pest resistant. Environmentalists are correct in their charges that

⁶ Time Magazine, July 31, 2000.

⁷ The President's Fiscal Year 2002 R&D Budget, April 9, 2001.

splicing different species alters the food cycle and may cause harm to those who are allergic to certain foods, yet consume them without knowing of the GM by-products. These are dilemmas that can be easily remedied with tighter restrictions on packaging and labeling from the Food and Drug Administration. As for selling and growing GM foods in the developing world, some will say that it is treating the needy like guinea pigs by exposing them to experimental “Frankenfoods.” But the alternatives need to be considered. As former President Jimmy Carter put it, “Responsible biotechnology is not the enemy; starvation is.”⁸ Nourishing the developing world will be an important first step in controlling the outbreak of diseases.

Finally, any discussion involving manipulating the building blocks of life, should at least include the religious sector in a roundtable capacity before important policy choices are made.

Space: the Reality in 2025

Whereas funding for the life sciences has increased in recent years, R&D funding in the physical sciences, especially for the National Aeronautics and Space Agency (NASA), have decreased. In a post Cold War setting where spin off from defense application has subsided, innovations in rocket sciences have not progressed at a quick rate, leading some technology forecasters to call space the “lagging field.”

Some relatively simple space technologies are likely to arrive fairly soon, particularly the privatization of space efforts, but almost all serious technologies seem destined to wait about 30-60 years for their development and implementation. Space programs can be most readily postponed because the payoffs are uncertain and distant; furthermore, serious space exploration beyond the solar system will require technological breakthroughs that transcend our present knowledge of physics.⁹

Consequences

Unwillingness by the government to fund expansive projects will delay plans of manned-flight to Mars or exploration of the outer reaches of our solar system until after 2025. However, the growing trend of private satellite launches will bring many societal benefits in the near term. As low-orbiting telecommunications satellites become more cost-effective, more of the developing world will get tele-connected and go “on-line,”

⁸ Time Magazine, July 31, 2000.

⁹ “Emerging Technologies,” The Futurist. November-December 1997.

dramatically reducing current communication barriers. In the developed world, Global Position Systems (GPS) will make for intelligent transportation systems that commuters can use to reduce traffic congestion and, in turn, reduce fossil fuel emissions. The onset of commercial satellite imagery will dramatically affect what has always been a domain dominated by the military. States and firms will be able to purchase photographs taken from private satellites with resolutions that will likely be compatible to military satellites by 2025.

We are moving from an era in which only a handful of governments had access to high-resolution imagery to one in which every government – and businesses, nongovernmental organizations, and terrorist and criminal groups – will have such access. Nonstate actors will be able to peer behind the walls of national sovereignty, accelerating a shift in power that is already under way.¹⁰

Policy Recommendations

In order for developing countries to get connected to the digital world, the U.S. government will need to play its part by continuing to deregulate the telecommunications industry and offering tax incentives to those firms willing to invest in developing countries most in need. Inside the United States, the Department of Transportation should offer matching grants to cities wanting to invest in GPS technology to create their own intelligent transportation systems. As for satellite imagery, the United States should give tax incentives to commercial imagery providers that want to film the atmosphere for environmental research purposes.

Defense planners in this working party have expressed the need to maintain United States “control” of space. In order to accomplish this DOD must be more willing to supplement its own capabilities with that of the private sector. This will ensure a rapid and sufficient response to crises. Other countries will be embarking on similar goals, some with possible hostile intentions against the United States or our allies. While DOD will need to develop anti-satellite weaponry to support U.S. satellites, it must do so in a way that prevents the “militarization” of space.

¹⁰ Jessica T. Matthews, foreword to “Secrets for Sale: How Commercial Satellite Imagery Will Change the World,” Carnegie Endowment for International Peace.

Final Thoughts

A lot will change between now and 2025 – most notably, the demographics of our work force. Our children are the future and, thus, any science and technology is remiss without addressing the importance of education. More funding needs to be poured into science and technology in our schools, both for our youth and for the growing amounts of adult workers whose present trades will be left out of the new economy.

Economics and Development

Focusing on the continued development and growth of the poorer countries of the world is in the best interest of the United States, in social, economic, and security policy. As the gap between rich and poor countries becomes increasingly pronounced, the system as it is currently configured will be unable to satisfy the needs of the international community. Discontented countries pose threat to U.S. national security. The financial instability that has traditionally characterized developing countries will become a threat to the U.S. economy as linkages between markets grow in complexity. Further, as countries develop and move into the sphere of wealthier countries, the global middle class will swell dramatically, providing vast new markets and possibly straining energy resources. As globalization advances, economics becomes ever more an integral part of relations between states, and thus should be looked at together with more traditional security and diplomatic issues. It is the opinion of this working party that globalization will remain the dominant trend of international economics in 2025: the question then is not *whether* globalization will change the world, but *how*.

North-South Disparities: the Reality in 2025

The gap between the global North and South has become more pronounced due to greater availability of information and technology. The global spread of democracy has led to greater prosperity, but economic instability is also rapidly increasing. According to recent statistics, the gap between rich and poor has *doubled* in the past 30 years.¹¹ This disparity has grown to such a degree that 20 percent of the world's population now

¹¹ www.parl.gc.ca/information/library/PRBpubs/bp347-e.htm

possesses over 80 percent of its wealth. Beginning in the 1980s, incomes have steadily increased in developed countries while in sub-Saharan Africa, they have fallen 25 percent. If nothing is done to counteract these trends, the percentage of the world's population who live in poverty will grow exponentially. By 2005, there will be 75 million children in the world who are not in school. By 2015, that number will grow to over 96 million, most of which will be female. Of these children, over three-quarters will live on the African continent and the remainder in Southeast Asia.¹²

Consequences

Poverty-stricken countries are a more likely source for asymmetrical threats and the greater availability of cheap weapons could allow these countries to become significant security concerns. In 25 years, education will be the hallmark of success, both within individual countries and in the global system.¹³ In the majority of developing countries, agriculture remains the largest industry, in both GDP and employment. Unless incomes and technologies in developing countries are enhanced, parents will be unable or unwilling to commit their children to prolonged education, and developing countries will stagnate. The current market instability that characterizes poor countries will become even more severe if left unattended.

Policy Recommendations

To deal with the future consequences of unequal development among countries, the United States will need to significantly alter its development aid strategy. If this is not done, the situation will only intensify, becoming more complex and difficult to manage. The first component of this new strategy is to dramatically increase funding to international development, in the form of development banks and the U.S. Agency for International Development (USAID) structure. The Dag Hammarskjold Foundation has released a report that development must be considered as a whole, not just in terms of humanitarian relief or economic recovery.¹⁴ The United Nations Development Programme (UNDP) has stated that development must include two components: first, a

¹² www.caa.org.au

¹³ <http://www.cia.gov/cia/publications/globaltrends2015>

stable economic pattern must be encouraged, and second, development strategies must contain a provision for basic social services.¹⁵ Fully funding aid organizations is an important first step in ameliorating the problems caused by the North-South gap. By supporting development banks (for example the Inter-American Development Bank, the Asian Development Bank, and the World Bank), the United States can provide money for projects and ultimately influence the strategic development of global aid policy.

Once the United States increases funding to the development banks and to USAID, the second component can be implemented. Currently, the United States allocates large amounts of the aid budget for relief work, democracy aid, and economic development. The U.S. development strategy should be designed so that it encompasses two distinct approaches. First, there is the traditional assistance, consisting of relief, democracy aid, and economic structures. This relief is very valuable, but needs to be augmented with greater focus in micro-enterprise, education, and women. While there is already movement toward these issues, the United States must immediately devote time and resources to long-term projects that highlight these issues. Micro-enterprise support allows development funds to go directly to those in need and teaches those disenfranchised groups the skills to increase their capacities and incomes.

A second assistance component would stress helping countries that have reached a certain level of development, but are still not yet fully participating in the global economy. Latin America provides the best examples of these nations. Brazil is a generally wealthy country, but a large portion of their population lives in poverty. In these situations, the United States should continue with micro-enterprise support in the rural areas and complement this effort with agricultural technology-lending/sharing. Building the agricultural sector in developing countries strengthens the overall economy and boosts incomes of poorer people. The key factor in this second level of assistance is remaining engaged long enough to make certain the investment of time and money is paying off in higher incomes and standards of living. By increasing development funding and implementing this two-prong strategy, the United States can rectify many of the problems caused by the income disparity between wealthy and poor nations.

¹⁴ www.parl.gc.ca/information/library/PRBpubs/bp347-e.htm

¹⁵ www.undp.org

Demographic Shift and the Growing Global Middle Class: the Reality in 2025

Although there are many countries left behind by globalization, there are still significant numbers that will be lifted into the global economy. This group will form a new global middle class. They are primarily centered in China and India and will be an essential market for U.S. goods. They will also be competitors for crucial scarce resources, like energy and food. This group already constitutes 2 billion people worldwide, and this number will explode as Indian and Chinese economies grow to include more of their populations. UNDP indicates that in 20 years, the global middle class will have at least 3 billion members.

Consequences

Currently the wealthy western countries consume most of the world's energy. However, Asia is closing the gap, and within a few years will consume more energy overall. In 20 to 25 years, Asia will consume *75 percent* of the oil coming from the Middle East.¹⁶ Food could also easily become a scarce resource. On a positive note, these new demographic groups will provide a new and robust market for American industrial goods and services.

Policy Recommendations

The United States must be prepared to make the most of the opportunities this demographic shift presents. First, U.S. policy must focus on energy, market contacts, and technology transfers. Energy consumption is rapidly growing in developing countries. The United States must immediately alter its traditional dependence on oil as a primary source of energy, as oil reserves will be significantly depleted in the next decades. Following the above development strategy should provide for a better and more sustainable agricultural system. The United States must more actively export its tremendous abilities in efficient and high-quality agricultural production implemented

¹⁶ <http://www.cia.gov/cia/publications/globaltrends2015>

through USDA and USAID programs. The current Farmer-to-Farmer Program is an excellent means to achieve this technology dissemination. By encouraging technology transfers to developing countries, the United States ensures that there will be a sustainable food source as the global middle class expands while simultaneously improving the lives of farmers worldwide. In order to facilitate market contacts between the United States and India and China, the United States needs to expand its export promotion program. Doing this now ensures a steady export market for US goods and services in the next 20 years. The United States needs to provide greater funding for organizations that promote trade linkages. The U.S. Commercial Service, The Export-Import Bank, and a variety of federal, state, and local agencies already work to this end, but the current trend has been to decrease their funding. This policy must be reversed to ensure that when the global middle class in India and China begins to consume at western levels, the United States stands to benefit.

Financial Markets: the Reality in 2025

Financial markets, including currency markets, must be considered as a key aspect of the international political and economic environment of 2025. One major consequence of globalization has been the increased international movement of not only goods and services, but also capital. The volume of flow will only increase in the next 20 years. Another major trend of globalization has been the increase of linkages between national financial markets; technological advances have played a significant enabling role. Many smaller national markets may disappear, becoming absorbed in larger supranational markets like the European Union. Not only financial markets, but currency markets will become more integrated. Ricardo Hausmann, a former chief economist at the Inter-American Development Bank suggests, “The idea that each country should have its own currency is very much an idea of the twentieth century. It wasn’t so in the nineteenth century, and it probably won’t be in the twenty-first.”¹⁷ Large national markets like the United States and Japan will be increasingly linked to each other, to major supranational markets, and even to smaller national markets as free-trade areas

¹⁷ *Atlantic Monthly*, “Getting Used to the Greenback,” v. 287 no. 5

expand in scope and scale. There are a number of dangers implicit in this situation, and policies should be crafted now to address these dangers.

Consequences

With close ties between markets and increasing economic integration, a crash in one market will precipitate collapses in other markets. If multiple major markets experience turbulence, bailout schemes would be compromised. Another danger is the possible rise of what could be called “financial terrorism.” Currency speculation could be used to perpetrate an act of aggression against countries. The ultimate danger would be the financial equivalent of the “Perfect Storm”—a convergence of factors which would bring about total global financial market collapse on a scale never before seen. George Soros has likened the global financial system to a “giant circulatory system” pumping capital to markets around the world. A large-scale collapse would entail the freezing up and wholesale failure of the global financial system, precipitating a debilitating international depression. Even a major crash of the U.S. market, resulting in widespread contagion would have severe repercussions on the global financial system. The security implications of international depressions or major market crashes are significant.

Policy Recommendations

The goal of U.S. policy regarding international financial markets should be to promote stability in the global financial system. Some analysts promote national regulation on the grounds that “competing” regulatory regimes have a greater incentive toward efficiency. However, others argue that the interconnected nature of financial markets, which have intricate cross-border links, makes an international system of regulation and oversight preferable to many national systems. The best solution, which acknowledges the supranational realities of the global financial system without compromising sovereignty, would be a combination of healthy, harmonized national regulatory systems and well-governed international organizations with limited enforcement power. This paper focuses on policy action the U.S. can take unilaterally while recognizing that the U.S. has the ability to direct and shape international policy

through building organizations and regimes. To that end, multilateral recommendations are offered as well.

In terms of national legislation, there are a number of actions the United States can take. The United States should establish policies to encourage greater transparency in its financial institutions, such as requiring greater financial statement disclosure, especially regarding derivatives and off-balance sheet instruments. The United States should require financial institutions to hold greater capital reserves to back off-balance-sheet leverage tools. The United States should more closely regulate hedge funds. The United States should push the IMF to hold greater capital reserves in case of crisis. The United States should spearhead the creation of a new international fund (not a bailout agency) to allow developing markets greater access to credit. George Soros describes this as an International Credit Insurance Corporation.

In addition, the United States can lead in the creation of international policies. The United States should encourage the IMF and World Bank, as well as other development entities, to institute policies encouraging, or even requiring, developing countries to institute strong conflict of interest laws. The United States should encourage the international to give the Bank for International Settlements (BIS) more authority, jurisdiction, and ‘teeth’ to enforce international banking regulations. The United States should lead an international drive to create policies and institutions to better regulate international currency market manipulation, using our domestic securities market regulation as a model.

Direct Threats to National Security

The Revolution in Military Affairs (RMA) currently underway will dramatically change the nature of warfare in 2025. RMA is at a nebulous stage and its consequences cannot be absolutely predetermined or predicted. There is, however, no doubt that warfare as we know it will change dramatically. The current RMA, like past revolutions, is made possible by rapid technological innovations. The Internet, robotics, nanotechnology, and new satellite and space technologies will not only alter weapons systems, but will also affect military doctrine and geopolitics. American power after the Cold War is supreme, yet will be challenged by growing powers such as China and India,

a resurgent Russia, and secondary and tertiary powers coalescing to reduce American power or disrupt the current international system. Furthermore, non-state actors will take advantage of these potentially destructive technologies in order to exploit U.S. vulnerabilities.

The United States has a comparative advantage in the technologies that create this revolution. Because of this advantage, the United States is able to mold and direct the future of warfare. It must do more than "stay ahead" of competitors. This approach of looking over ones shoulder is not the offensive approach needed. The military must make a strategic effort to direct the methods of future warfare toward its comparative advantage. The United States must do more than wholeheartedly pursue technologies. It must pursue technologies that will continue to reinforce its dominance in the ability wage warfare in every environment.

Technological Innovations and the Military: the Reality in 2025

The Internet has made the obtainment, management, and dissemination of information the key to successfully wielding military power. The side that possesses strategic information will have a greater chance of winning any given conflict. Traditionally, militaries from the time of Julius Caesar to Dwight Eisenhower have been constrained by the lack of information and the inability to maintain full communication with force components.¹⁸ For example, Operation Overlord by allied forces in the Second World War was hampered by the inability to predict weather conditions, the lack of knowledge on enemy forces including size and location, and difficulties in communicating with allied forces that had landed on the beaches of Normandy.¹⁹ Even Operation Desert Storm, although a spectacular success, was plagued by misinformation and miscommunication. However, new technologies will enable U.S. forces to gather a vast amount of data and propel the U.S. military toward its goal of lifting the fog of war.

The information revolution will allow United States to collect, analyze, and utilize information more efficiently. In addition, the information revolution will allow for the

¹⁸ Bill Owens, Offley, Ed., *Lifting the Fog of War* (New York,: Farra, Straus and Giroux, 2000), 104.

¹⁹ Ibid

creation of an information grid accessible to the U.S. military. The grid will contain information gathered from a multitude of worldwide sensors including satellites, and manned and un-manned terrestrial platforms. These sensors will provide Intelligence, Surveillance, and Reconnaissance (ISR) allowing a field commander to collect information real-time about the enemy. New technology will also dramatically improve Command, Control, Communications, Computers, and Intelligence (C4I). This exponential improvement in the availability of information to all participants will allow them to coordinate forces and more efficiently wage warfare.²⁰ A field commander will then be able to use precision force to insure maximum accuracy and battlefield success.

Technological innovations involving robotics, nano-technology, and biological engineering will also be crucial to the RMA. Robotic technology and artificial intelligence will allow for Unmanned Aerial Vehicles (UAVs) to conduct reconnaissance, air-to-ground strikes, replenishment, and air refueling. Due to the advancement of missile technology and potential political complications, UAVs will play a large role in ISR and combat missions. Robotics will enable the U.S. military to take full advantage of its information gathering/analysis capabilities, allowing soldiers (preferably guiding combat units from remote locations) to make efficient use of information to direct operations. Furthermore, nano-technology allows for the miniaturization of weaponry. For example, tiny UAVs and sensors will allow individual combatants a wider field of vision in future battles. The revolution in genetics and biological engineering will permit the genetic modification of human combat guides to better filter, format, and access vast amounts of data. The above technological innovations are complimentary, meaning that the military possesses the opportunity to utilize these technologies together in order to be in sync with the RMA.

Consequences

The paradox of embracing this revolution is that the United States will accelerate the demise of many central weapons systems and military doctrines. Traditionally, military revolutions have allowed winning states to supersede the weapons and doctrines of their opponents. For example, gunpowder and firearms made armor and the heavily

²⁰ Martic Libicki, *Illuminating the Battlefield* (Washington D.C., : National Defense University, 1999).

armored knight obsolete. In the near future, the U.S. aircraft carrier stands to become extremely vulnerable to PGMs and other technological advances in stealthy aircraft and submarines. Sea power, essentially the battle carrier group, is paramount to maintaining a forward deployed presence and guaranteeing U.S. national security. The notion that the carrier could be rendered useless by enemy advances in RMA is a real possibility.²¹ A competing nation may take advantage of RMA to hide information from U.S. forces through information warfare, or by destroying U.S. sensors such as satellites. Stealthy UAV and PGM, among other “smart” weapons will also enable enemy forces to target stationary command centers, airfields, ports, depots, and even field armies.

The European Union, Russia, China, Japan, and most likely India will maximize the advantages in the new technologies of warfare. In particular, the United States should focus its attention on China and Russia. China’s rising economy will lead to increased military and political clout. China will undoubtedly examine U.S. force structure in order to determine its vulnerabilities brought about by the RMA. Chinese precision guided missiles and airborne, surface and sub-surface UAVs, as well as information denial and disruption may be used to deny access to the West pacific. Given its history as a traditional Asian power, China must be considered as a potential strategic competitor. U.S. military strategy and doctrine must be reconfigured to reflect that fact. A resurgent Russia must also be considered as a potential military rival. India’s strategic interests may very well conflict with U.S. interests in the future. Smaller powers such as North Korea or Iraq may develop niche capabilities such as disrupting U.S. civilian and military communications or damaging critical infrastructures. Non-state groups may resort to biological or chemical attacks on U.S. bases or cities.

Policy Recommendations

In order to ensure U.S. national security and take advantage of the RMA, the United States should substantially increase investment in technology research and new weapons procurement. New satellite systems capable of monitoring greater portions of the earth’s surface at longer hours must be created, along with stealthy UAVs capable of penetrating deep into enemy territory without negative consequences. Since warfare in

²¹ George and Meredith Friedman, *The Future of Warfare* (New York: Crown Publishers, 1996).

the future will be characterized by access to information, stealth, and long range strike capabilities, the United States must increase procurement of missiles, UAVs, and stealthy craft. In addition, the United States will need to maintain its influence in space by protecting government and commercial U.S. satellites in the future.

More importantly, information and communication systems between the military and civilian sectors and between military branches must be integrated in order to create a vast and accessible information grid. The United States must integrate its military and civilian information systems in order to deal with a myriad of threats. Furthermore, the United States should set up a uniform system and doctrine for weapon procurement and use among the military services. The key to future warfare, including asymmetric warfare, will lie in the collection and access to intelligence and information as well as the denial and control of information to the adversary.

It is also essential that the United States has access to and shares intelligence with allied nations. The nations of NATO in addition to Japan, Taiwan, Australia, New Zealand, Singapore, and South Korea are key to future U.S. geo-strategy. Ad hoc alliances and intelligence sharing operations with nations on the periphery of rising powers should also be considered. Cooperation with allies and the integration of civilian and military systems, in addition strengthened homeland defense will help in containing and preventing future threats. A inter governmental agency must be created to coordinate action with the military in the event of a biological or chemical attack on American cities.

The increasing impact of the media on military operations must be addressed. Information coordination and media relations must be better integrated. Media relations personnel are often perceived as unimportant or a nuisance. Operational leadership must be more accountable for media performances at every level. Media relations should be incorporated into every major decision.

Technological innovation is well under way. So much so, that the real emphasis for national security improvement must be organizational. The military and national security community, including intelligence, must emphasize a change that will encourage the best use of new and emerging technologies. First and foremost, operational leadership must realize the potential effects and consequences of the information

revolution. Information Technology has to be elevated in the civilian department of defense with appropriate nominations for key positions. In the uniformed service, the Vice-Chairman of the Joint Chiefs of Staff must be given the primary responsibility for the incorporation of Information Technology. He should be held accountable for this and his power as the second ranking military person must be re-emphasized. Information Technology must not be separated from the "operator" but should be incorporated, not as ancillary, but as another means of warfare. Additional improvements in the advancement of information technology include extending benefits to those that demonstrate proficiency.

This emerging complex network of information assurance has the potential to encourage centralized control of operations. This centralization and the rapid flow of information creates an environment which is more susceptible to exploitation and compromise by the enemy. Doctrine and policy makers should realize this danger and work to decentralize control.

One of the tremendous advantages of the U.S. military is its superiority in training and ability to exercise realistically. Information assurance and the control of information should be exercised with equal importance of conventional attacks and defenses. This training should be as realistic and coordinated as possible.

GLOBAL ENVIRONMENT

The condition of the global environment will be a primary focus for U.S. policymakers as well as the international community in 2025. The United States needs to design long-term environment strategies now in order to implement effective short-term policy changes. Based on scientific evidence it is not possible to state definitively the future path of the global environment. However, there are a few issues that are certain to be a major concern by 2025. The international community is struggling with the needs of a growing population, a plethora of developing nations, and the demand for international equality of living standards. International and domestic strife over resources will indeed occur and environmental refugees will ensue. There will be disagreements over energy creation and use, and trans-boundary pollution. The United States must adopt a forward

and innovative policy concerning the global environment in order to ensure our position as a leader in the international community on environmental issues.

Environmental Degradation: the Reality in 2025

Intensive land use will reduce the amount of land available for cultivation. Nutrients and chemicals employed as fertilizers will seep into the watershed affecting local and regional water quality. Although technological developments in the developed world will increase telecommuting opportunities thus reducing western emissions of greenhouse gases, the developed world will increase emissions as the westernize. It is speculated that 50% of global CO² emissions will originate in less-developed countries by 2020.²² Global climactic change will move at glacial pace, but it will eventually result in increased land and ocean temperatures and the melting of polar permafrost. This will have a destabilizing effect on the world. The ozone hole over Antarctica will continue to expand while many countries will face water and air quality problems due to the environmental effects of rapid industrialization and neglect of environmental issues.²³

Consequences

A change in atmospheric and marine temperatures has caused a change in known ocean currents and weather patterns, thus affecting the viability and location of food sources. A rise in sea levels could flood coastal areas and islands, demanding more money to be allocated for emergency management, and affecting growth along coastlines. Island and coastal nations face environmental emigration problems, and entire nations could disappear from the map. Shifts in world-wide weather patterns will greatly affect the growing seasons of crops, and their ability to survive in a potentially new climate. This would have a dramatic affect on a nation's ability to independently sustain its population and/or export food products or renewable resources.

²² Christopher Green, "The Greenhouse Effect and Environmentally Induced Technological Change," *Innovation in Technology* (University of Michigan Press, 1994), 98.

²³ Global Trends 2015, 31.

Policy Recommendations

The key to addressing environment issues is to meet them head on with aggressive policy measures, before they become a threat to U.S. national security. To this aim the President should organize a feasible international environmental treaty, in lieu of the Kyoto Protocol, as no one country will have incentive to unilaterally reduce emissions.²⁴ This treaty and ensuing conferences would address the issues of water shortages, climactic change, and environmental degradation.

The United States should push forward with efforts to reduce consumer emissions of greenhouse gasses through legislation and economic incentives including: tax cuts for automobiles that use clean-burning fuels or electricity, financial incentives for recycling, such as battery exchanges, and tax incentives for businesses that promote telecommuting. The legislation should be designed under the guise of a flexible framework so that it can adapt quickly to technologic development.

Pursue biotechnology to ameliorate irrigable land quality and quantity. As opposed to climate change and air and water quality deterioration, developed countries currently have this problem under control, but a growth in global population will put a greater strain on the world's farmlands. Bioengineering of more resilient strains of food crops will offer agricultural stability domestically. The passing of this technology to unstable countries, and/or ones with poor land quality will offer regional stability as it will lessen the need to fight over resources.

Water Shortages: the Reality in 2025

A majority of the world's population will be living in "water-stressed" countries, with a third of the world's population (2.7 billion people) experiencing severe water scarcity by 2025.²⁵ Exorbitant population growth will exacerbate the water shortages as countries fight to produce food for their growing populations. The United Nations estimates there are already 25 million "water refugees", a figure sure to increase dramatically in the next 25 years.²⁶ Armed conflict over water-related issues is an

²⁴ Green, 98.

imminent threat. One water hot spot of particular concern to the United States, in its economic and strategic planning, is the Middle East/North Africa region.

Consequences

Regional war could erupt in the Middle East, as water has been a contentious issue between Israel and Jordan. The continued political instability in the region makes the water issue of immediate concern.²⁷ Egypt, Sudan, and Ethiopia also threaten stability in the region over the Nile River. The conflict over the Tigris and Euphrates Rivers has the potential of causing a third Middle Eastern conflict. Besides regional conflicts, social unrest could erupt over water shortages, potentially threatening the stability in the region and demanding U.S. involvement.²⁸

Policy Recommendations

Pursuing diplomatic ends to help reduce water-related conflicts that threaten world stability and U.S. national security. We propose the United States lead the charge toward establishing an international, multilateral Water Accord to lay the ground rules for the management of lakes and rivers. This partnership would not only preserve the regional stability, protecting U.S. national security, it would provide a model for future environmental accords throughout the world, establishing the United States as a leader in this arena.

The United States should pursue research of innovative water-related programs. Some promising options include USAID research regarding a possible canal to direct water from the Gulf of Aqaba on the Red Sea in Jordan overland to the Dead Sea, using the difference in elevation to drive a hydro-electric plant to desalinate sea water, using reverse osmosis to provide 533 million square meters of fresh water to the region per annum.

²⁵ 1999 study by International Water Management Institute and Future Harvest.

²⁶ <http://www.defencejournal.com>

²⁷ Sandra Postel, *Last Oasis* (Norton: New York, 1997).

²⁸ www.gsreport.com.

Energy: the Reality in 2025

Industrialization and continued increases in world population will have increased the demand for energy by more than 60 percent. The demand for oil will reach unprecedented levels and the consumption of natural gas (largely due to the rapid industrialization of Asia) will also reach epic proportions.²⁹ Fossil fuels seem endless, and relatively inexpensive to extract. The United States alone has over a 300 years supply of known coal reserves, and has not gone exploring for more in 100 years.³⁰ China has enormous coal reserves, and has no incentive to explore options for cleaner energy, when pure energy is all they desire.

Consequences

Pressure by oil-producing countries will push up the price of oil. A regional Middle East war has the potential for disrupting the flow of oil from the region or at least causing a frightening increase in price. A disruption or even shortage of energy supplies is a very plausible reality and would threaten US national security. Countries with no incentives to clean their energy-producing technologies, including the United States and China, will pose domestic and international health and security threats, as air quality becomes worse, and the highly detrimental effects of trans-boundary pollution, related mostly to health standards, will threaten alliances, as the polluter will be charged with the ending of the pollution, and its ensuing cleanup.³¹

Policy Recommendations

The United States should pursue research and development of nuclear fusion technology. This advancement could provide electricity for commercial purposes and can help reduce domestic dependence on foreign oil. In addition, funding research for national solar energy program that would have the capability of meeting domestic energy

²⁹ Global Trends 2015, 28.

³⁰ Robert Rycroft, lecture at Elliott School of International Affairs, Washington, D.C., April, 2001.

³¹ Trail Smelter Arbitration, 1941

needs, creating environmentally friendly energy while saving money and limiting dependence on foreign oil.

The United States should offer technological assistance to friendly nations to develop clean or renewable energy sources, in order to lessen the problems and probability of international mitigation of trans-boundary resource pollution. Offer non-technical information to potential or known threat-nations to demonstrate the efficiency and advantages of clean or renewable energy sources. This may be done at summits, structured to bring us to more familiar ground regarding other threats to our national security.

The United States can encourage the development of environment friendly energy sources by scrapping subsidies to all current energy producers. This will be politically difficult, but it will stimulate innovation in all areas of energy.

Conclusion

The future of U.S. national security resides with this administration for the next few years. Although most of U.S. policy fluctuates on a relatively short-term basis it is important to remember that we develop policy not only for the present, but also for the future.

Our goal in presenting this report has been to ensure that a long-term vision of U.S. national security concerns be incorporated in the short-term policy initiatives of this administration. Taken as a whole the challenges and developments that the United States will face in the future require an absolute subscription to the notion that preventative measures taken now will ensure survival and prosperity in the years ahead.

2025 waits to greet us with fascinating developments that we can use to our advantage; our only task is to prepare for them now.

