

Funding of the Bio-Computational Program in Regard to the Biological Defense Budget
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I pledge on my honor as a student that I have neither given nor received any unauthorized aid on this assignment.

Introduction

Debates over the proliferation of biological weapons of mass destruction currently dominate the defense agenda as well as the political scene. After the events of September 11, 2001, the number of terrorist incidents involving biological agents jumped in number throughout the world. Incidents such as anthrax being sent through the mail to various government offices in the United States to Sarin gas in the Japanese subways has raised a great deal of concern throughout the world.

Currently, biodefense consultants to the Pentagon estimate that worldwide there are about 1,000 to 10,000 “weaponers” working on various types of biological weapons while there are about 1 million other qualified scientists that could construct bioweapons if tasked to do so (Mintz, 2004). Thus, due to the number of incidents and experts increasing within recent years, many fear that biological agents will pose a serious threat to national security as well as human health in the future. The combination of these threats and other national security issues provides the foundation for the immense increase in the federal research and development (R&D) budget funding. According to the Wall Street Journal, the defense programs are receiving the bulk of the R&D funding increases and have been for the past few years. These defense appropriations are encompassing a wide range of projects spanning a myriad of companies and clientele (Regalado, 2004).

One initiative, which stands on the forefront of technology and biological defense research is a Defense Advanced Research Projects Agency’s (DARPA) project called BioCOMP. The inception of the BioCOMP program occurred in 2001 through DARPA project managers. Hence, it is a relatively young program and has great potential for

growth if funding continues to allow researchers to work. Currently, there are eleven academic institutions involved in its development along with key integrator, SRI International. This program focuses on identifying and simulating both biological functions of a human cell and virulent organisms like biological agents (Walker, 2002).

The implications of such a program has the capability to not only allow immediate response to a biological attack, but also to allow for great medical advances in the future. Thus, when examining the budget appropriations for the biological defense programs through the federal government, Congress must look to safeguard this program's funding and the funding of other biological initiatives through DARPA in order to ensure public health in the future.

The Threat of Biological Weapons

In 1925, the Geneva Protocol banned the use of "Asphyxiating, Poisonous or Other Gases, and of Bacteriological [biological] Methods of Warfare." However, it wasn't until March 26, 1975 at the Biological and Toxin Weapons Convention (BTWC) that the United States and other nations around the world fully agreed to the conditions it set forth. Before this time a great deal of research and money went into the study and development of biological agents specifically for the purposes of weaponry. However, after the leading nations in the world agreed to the Geneva Protocol in 1976, many of them continued to reserve the right to use their discretion in the research they were conducting. These nations wanted to ensure that their nation's development of countermeasures in the area of biological agents was current in case a terrorist or rogue nation developed a biological weapon and used it. Thus, although the use of these agents

in war was prohibited, labs were still fully stocked with these virulent living organisms for research purposes (Bureau of Arms Control, 2004).

Still to this day, many factions of the population both domestically and internationally continue to investigate the potential capabilities of biological organisms in labs around the world. In these labs biological agents present a difficulty in security measures. Unlike nuclear components such as plutonium, living organisms reproduce and if a small amount of cells are stolen it is difficult to detect it because they will be replaced naturally within the vial. Additionally, the cells are so small that it would not be obvious that they were missing in the first place. Therefore, there is great concern in the defense community in regard to the use of biological weapons in war and terrorist activities due to the availability of these pathogens, such as anthrax, Ebola and plague, at multiple lab locations around the world (Loranger, 2004).

At the Stony Brook Forum on Global Security on November 7, 2003, experts from various government agencies, universities and industries discussed and formed recommendations on the best ways to prepare experts to combat bioterrorism. The major recommendations were to provide an early detection and analysis system to identify, contain and eliminate the threat with the minimal amount of casualties. Additionally, biosecurity experts emphasized the importance of understanding the cellular mechanisms and being knowledgeable about how these biological agents spread, infect and kill their hosts (Stony Brook Forum, 2003).

BioCOMP

One way in which research scientists are trying to meet these goals is through DARPA's programs. The DARPA Bio-Computational Program (BioCOMP) focuses on the defense aspect of computational biology to generate computer simulations of a cell through a variety of mathematical models. The major application of the computational techniques being developed in this project is the Biological Simulation Program for Intra-Cellular Evaluation (BioSPICE) platform. Through this development of the software program BioSPICE, scientists will be able to analyze and predict biological functions by using genomic information to model the molecular networks and pathways of the human body. Functions created in the open source framework of the program will allow the computers to mimic such cellular capabilities as cell division, circadian rhythms, bacterial sporulation, and gene transcription. Using this computer modeling to understand the intricacies of biological complexities such as cellular functioning and mechanisms, will allow us to improve the quality of life for many people in a variety of ways (Walker, 2002).

Within the past three years, developers have used the BioSPICE platform and have integrated it into a myriad of different computer applications in order to enhance many different aspects of the program. One example of this is the Systems Biology Workbench, which allows both frameworks to share tools and incorporate various functionalities of each system together. An initiative such as this is the future direction researchers would like to take on this project (Sauro, 2003).

Consequently, the impacts of such a predictive biological system are great and far reaching. Having the capability to simulate models based on established knowledge and

relevant experimental data will allow for the rapid evaluation and response of potentially dangerous situations. Each biological agent's behavioral functions and characteristics will be accessible in a matter of seconds due to the storage capabilities developed in the BioCOMP mathematical models. Thus, each model will possess an algorithm that would allow it to be matched to the scenario at hand, which in turn would to identify the pathogen (DARPA, 2004). These capabilities will not only improve the response time of health officials, but also aid in reducing the amount of biological samples of virulent agents used in laboratory research.

Furthermore, researchers are looking to this system to aid in the development of treatment methods for potential terrorist attacks by pinpointing the genetic and molecular targets of the agent used and develop drugs or techniques that will disrupt their virulence through the human body. These techniques could prove to be critical in matters of national security and the health for our armed forces (DARPA, 2004).

Additionally, techniques such as this possess broad implications for the world of computing. In order to model such complex systems, the further development of faster computational processes and mathematical tools will advance computers and generate new and more innovative algorithms. Moreover, the design is conducive to the creation of ultra-high density information processing and storage capabilities. All of these advances have the potential to greatly improve many types of computing hardware (Feidler and Kumar, 2003).

2005 Budget Appropriations

In order to implement these R&D initiatives, the federal government must approve a budget that reflects its priorities. The challenge then comes in deciding who is responsible for what task and what programs will be the most beneficial in the long run. For instance, the funds for national security in terms of biological defense encompass many different government agencies and programs, which causes a great deal of overlap and calls for collaboration among parties. While looking at President Bush's budget for the upcoming 2005 fiscal year it is evident that one of his goals is to improve the nation's defenses against bioterrorism and meet the concern of the public ("Presidential Budget 2005," 2004).

The Department of Health and Human Services, which is responsible for running the Center for Disease Control and Prevention (CDC) and National Institutes of Health (NIH), is teaming together with other governmental organizations to implement the President's programs on the "War Against Terror." In order to do so, the 2005 budget for bioterrorism defense through HHS will increase the program by .161 billion dollars from last year. Its focus, to continue the health preparedness initiatives and further research the best preventive measures in regard to attacks or outbreaks ("Presidential Budget 2005 (WWT)," 2004).

The plan has four major components that are supported by R&D funding in the areas. They include upgrading federal capacity of surveillance, extending the strategic national stockpiles, improving food defense methods, and increasing preparedness programs throughout state and local governments. The distribution of monetary resources

across these programs is visible in the graph below (“Presidential Budget 2005 (HHS),” 2004).

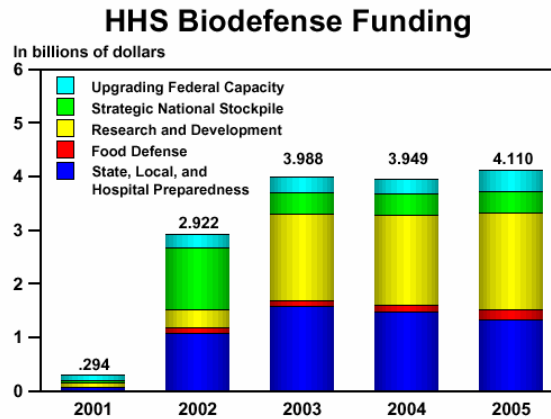


Figure 1. Department of Health and Human Services Biodefense Funding Breakdown (“Presidential Budget 2005 (HHS),” 2004, p. 11)

It is evident through the graphical trends that over the years the federal government drastically increased the initiatives in the biodefense field through HHS. Furthermore, the research and development allotments within this graph indicate the amount of resources used solely to support and advance the knowledge and techniques of each program. Consequently a great deal of money flows into basic and applied research programs at HHS in the area of biological terrorism and civilian health (“Presidential Budget 2005 (HHS),” 2004).

In addition, over the past three years alone, President Bush’s economic initiatives increased the Department of Defense’s (DOD) budget by thirty-five percent, overall spending an annual increase of seven percent since 2001. As a result the research and development funding increased by fifty-six percent across the agency and continues to grow in the 2005 Presidential Budget recommendations. As evidenced in the graph in figure two, a large influx of funding streamed into the Defense Department’s R&D

budget allowance. This in turn created funding for many new projects especially in the area of biodefense (Presidential Budget 2005 (DOD), 2004).

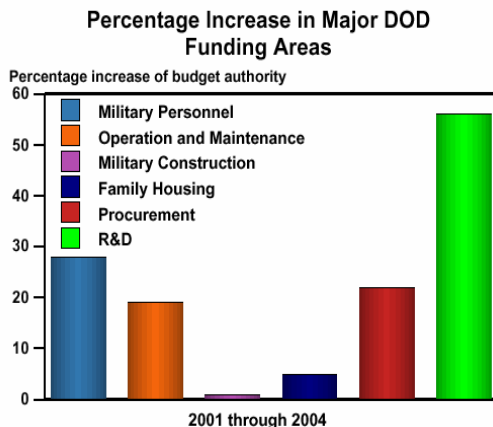


Figure 2. Department of Defense Budget Increases (“Presidential Budget 2005 (DOD),” 2004, p. 88)

The research, development, test and evaluation line item accounts for 17.2% of the Defense Budget for the 2005 fiscal year (“Presidential Budget 2005 (DOD),” 2004). With this new funding however, DOD chose to use the funding toward applications of their research instead of more basic scientific endeavors. When distributing research grants within the DOD there is a six-step pipeline program that corresponds to the progression of the technology. The first step in the pipeline is basic research, which accounts for technology that is at least ten to fifteen years away from use in field operations. Progressively the pipeline increments through six steps to the highest levels in which the fifth and sixth steps, consist of the implementation of applied technology and testing of defense applications respectively. However, with the new provision of funds, defense program directors are placing more money into the applied technologies in steps four, five and six in the pipeline in order to accelerate the development of field devices for soldiers (Howell, 2004).

DARPA's Role

One branch within the Department of Defense, which receives a high portion of defense research funding for the higher stepped pipeline programs is DARPA. The purpose of this sector of DOD is to produce "DARPA hard" products, which are defined as high-risk/high-yield programs. Some examples of the resulting products from these programs are the stealth fighter plane and the Internet ("In Defence of DARPA," 2003). Unlike other agencies within the government such as the National Science Foundation (NSF), DARPA is not peer reviewed. Any program undertaken is up to the discretion of the project manager, even if the probability of the project success is very low. (Brumfiel, 2003) Due to past controversies over non-traditional programs, some Congressional members feel that DARPA has too much freedom and should account for its spending to them since they have no rigorous check and balance system. Consequently, when deciding on appropriations the BioCOMP program is overly scrutinized due to this fact.

In the past, DARPA enjoyed a great deal of freedom when setting appropriations. However, DARPA recently encountered a great deal of scrutiny due to one of its projects. Under the former head of DARPA's Information Awareness Office, John Poindexter, a project to combat terrorism went too far and crossed the line into infringement of citizen's privacy. Once the public found out and Congress was made aware of it, all of DARPA's projects were questioned ("In Defence of DARPA," 2003). Thus, last fiscal year during appropriations, Senators attempted to reduce the amount of freedom DARPA had in spending its budget because of the negative controversy, which was reflected in the BioCOMP funding as well. While interviewing congressional staff on the hill about

the debate, this fact was cited as a possible reason as to why the BioCOMP program was initially cut from the budget in 2003 (S. Loranger, e-mail communication, 2003).

Furthermore, these programs encompass many different areas of research dealing with national defense, thus when specifically appropriating funds to a distinct project, there is potential for great controversy since the need for biodefense in many areas is seen as an essential investment. A pertinent example here is the association of defense funding with biological research. On Capital Hill many Congressmen have questioned the involvement of DARPA in programs dealing with biology since both HHS and NSF spend a high percentage of their budget on research and development in the biotechnology field. Also, initially, the goals of the project were not fully understood and some claimed that it “does not directly meet the needs of the armed services” (S. Loranger, e-mail communication, 2003).

However, the American Association for the Advancement of Science (AAAS) estimates that about one-third of the DOD’s basic science research, through agencies like DARPA and ARO, is bio-oriented (Hanley et al., 2002, p. 5). Thus, after considering budgetary increases across the board in the areas of biodefense and defense research and development, it is evident that DARPA is the agency that should fund BioCOMP due to its direct application to military preparedness against biological weapons and the high-risk nature of this program.

The Overlap in Funding BioDefense Projects

The BioCOMP program through DARPA illustrates one avenue that scientists are working on to combat the problem of terrorism. However, there are a myriad of different

government agencies, organizations and industries that are vying for funding to implement different solutions and technologies for these same biodefense issues. In particular, the federal government has allotted new budget appropriations to a wide range of biodefense issues and programs. For example, National Institute for Allergies and Infectious Disease (NIAID) are in the process of proposing the construction of \$125 million worth of safe space Biocontainment Laboratories to study dangerous bacteria and viruses (Jonietz, 2004). These labs contain the most state of the art security facilities for these pathogens and require security clearances for all of its employees. Continuing this trend on a larger scale, the upcoming presidential budget for the new fiscal year has set forth a comprehensive plan to increase defense funding by developing applied technology to protect Americans from terrorism and noncompliant countries. One of the key areas concentrated on in this comprehensive proposal focuses on the prevention and rapid response to bioterrorism and infectious agents across multiple government agencies (“Presidential Budget 2005,” 2004).

The allocation of research and development (R&D) funding for technological innovation in the area of biodefense lies at the forefront of the United States’ budget debate. Every agency within the federal government allocates a certain percentage of the department’s budget toward research and development in an area specific to their concerns. However, there is some overlap between agencies especially with convergent technologies such as biotechnology and biodefense. Thus, when appropriating various amounts of money to specific programs Congress may encounter controversy over what programs to cut. Due to the dual nature of biological weapons as a threat to human health and national security, the funding of R&D programs for biodefense span multiple

agencies and often encounter conflicts relating to whose should be responsible for specific projects.

The BioCOMP program funded by DARPA encountered this exact problem when going through the appropriations process in 2004. Initially the House of Representatives approved the program's budget, but the Senate cut the \$33 million budget to zero in the second round of cuts. After much debate the funding for the program was reinstated once the goals and purpose of the program were better clarified to legislators (Department of Defense, 2004).

Currently, in order to achieve the future goal of BioSPICE, to further simulate the bio-molecular systems of the human body in order to analyze, predict and simulate biological functions, researchers must work with a variety of different organizations to accomplish this goal. Agencies including the DOE, NIH and NSF are beginning to collaborate with DARPA in the further development of BioSPICE for other various applications in a myriad of disciplines. Each organization and project consists of varying timelines for the final stages of the product. Yet, the majority requests an extended funding period for at least another year or two. For instance, one collaborator, Walter Reed Army Medical Research Institute, leads the way in biological defense applications of the entire BioCOMP program. It projects to optimally enhance the program for specified pathogens in the next two to three years. As a result, the continued funding of the BioCOMP program is critical in order to fully utilize the potential benefits of the partially developed system (Kumar, information packet, 2004).

Recommendations

Advances in biodefense and health technology center on the scientific community's knowledge of the most basic structure of life, the human cell. The Human Genome Project decoded the basic components of this structure, but the real benefit of the project's information lies in its application. Scientists must look to establish how these genes interact with and affect their cellular environment. This will allow for the development of remarkable new tools that could save lives and increase the economic productivity of defense research, medicine and the environment. Programs that integrate high-performance computing techniques and biological knowledge possess the potential to be highly advantageous in the years to come.

In this post-September 11th world in which the United States focuses a great deal of time and funding on "The War on Terror," the government must allocate its increasing financial resources on defense wisely. As with the development of nuclear technology, the biological research community and society as a whole has to reassess the policy, programs and attitudes of the country in order to generate an effective defense strategy while further assessing the long-term implications of their actions. Scientists and lawmakers must strive to evaluate the technical and ethical implications of research in the field by using the research and development funding budget to advance the most promising of these programs.

With these considerations in mind, the importance of the BioCOMP/BioSPICE program is evident. The program illustrates the quintessential convergent technology that combines high-level computational models and biological systems to generate accurate and useful simulations. Moreover, the application of the basic methodology possesses

direct relevance to the defense of soldiers in combat as well as national security issues regarding rapid response and research. Thus, DARPA funding for this technology should continue into the next few years facing reassessment as necessary.

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