Beyond 'Fortress America': National Security Controls on Science and Technology in a Globalized World

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BEYOND "FORTRESS AMERICA"

National Security Controls on Science and Technology in a Globalized World

Committee on Science, Security, and Prosperity
Committee on Scientific Communication and National Security
Development, Security, and Cooperation
Policy and Global Affairs

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Preface

The national security controls that regulate access to and export of science and technology are broken. As currently structured, many of these controls undermine our national and homeland security and stifle American engagement in the global economy, and in science and technology. Fixing these controls does not mean putting an end to them, but implementing reforms based on the realities of the risks and opportunities of today's threats to the nation.

A growing number of leaders in academia, industry, and government now concur that the system of national security controls needs fundamental change. The National Research Council of the National Academies convened the Committee on Scientific Communication and National Security, a select group of national security officials and leaders from the sciences, the defense industry, the information technology sector, academia, and the legal community (listed in Appendix A), to assess the impact of these controls. Being in agreement on the pervasiveness of the difficulties, they concluded that attempts to modify the existing regulations or to give guidance to the enforcing federal agencies would be insufficient, because the problems were both large and system wide. They recommended that the National Research Council assemble a committee to conduct a systemic review of the national security controls that oversee scientific and technological research and development.

Subsequently, the National Research Council established the ad hoc Committee on Science, Security and Prosperity to propose policy solutions. Members were selected on the basis of their participation in the creation and implementation of the current system of national security controls, or their expertise in various fields of science, industry, or university administration. Their biographies are listed in Appendix B.

The committee's charge was to produce a report on the relationship between scientific and technological advances and national security threats, and the global context within which they interact. Specifically, the report addresses (1) the changes in scientific and technological advances, interlocking global economies, and current geopolitical factors since this regulatory system was established; (2) the problems with the current federal regulatory system related to national security that oversees the conduct of science and technology; and (3) recommendations for making fundamental changes to the system of export and visa controls.

The committee reviewed reports and recommendations from the organizations listed in Appendix D. They also heard from government and private sector experts, and tested proposed policy changes through debate and discussion. The committee also reviewed the extensive collection of the Academies' reports, listed in Appendix E, that have addressed science and security concerns for more than 25 years, beginning with the 1982 report, *Scientific Communication and National Security*, through to the 2007 release of *Science and Security in a Post 9/11 World*.

The committee's findings confirm the urgent need for fundamental policy change to counteract the harm that is being done to national security and economic prosperity by national security controls adopted in the 1960s and 1970s that reflect Cold War-era policies.

The committee recommends specific provisions for an Executive Order, issued by the President, to govern a revamped set of controls that will promote the United States' scientific and technological competitiveness, while more effectively protecting national and homeland security. The committee recommends decisions at the presidential level, as this will be required to bring bureaucratic coherence to the network of national security rules and regulations that now spans eight agencies of the federal government.

In conclusion, we would like to add a personal note of deep appreciation to the committee members and staff who helped us to come up to speed on the committee's deliberations. Their wide-ranging expertise and commitment to the project made our participation very rewarding.

Brent Scowcroft
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Acknowledgments

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report: Norman Augustine, Lockheed Martin (Retired); Lewis Branscomb, Harvard University; William Burns, United States Army (Retired); Barry Carter, Georgetown University; David Goldston, Princeton University; Seymour Goodman, Georgia Institute of Technology; John Gordon, United States Air Force (Retired); Maura Harty, International Center for Missing and Exploited Children; J. Christian Kessler, U.S. State Department (Retired); Ellen Laipson, Henry L. Stimson Center on Global Security; James McGroddy, IBM (Retired); Michael Moodie, Chemical and Biological Arms Control Institute; Randall Murch, Virginia Polytechnic Institute and State University; Eva Pell, Pennsylvania State University; William Reinsch, National Foreign Trade Council; Scott Silverston, United States Military Academy; John Steinbruner, University of Maryland; and William Webster, Milbank, Tweed, Hadley & McCloy.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of

the report before its release. The review of this report was overseen by Robert Frosch, Harvard University, and Granger Morgan, Carnegie Mellon University. Appointed by the National Academies, they were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Contents

Summary

The export controls and visa regulations that were crafted to meet conditions the United States faced over five decades ago now quietly undermine our national security and our national economic well-being. The entire system of export controls needs to be restructured and the visa controls on credentialed foreign scientists and engineers should be further streamlined to serve the nation's current economic and security challenges.

During the Cold War, the United States was the international center of scientific knowledge and technology. U.S. national security depended on maintaining the technological superiority of our military forces against the quantitatively superior military forces of the Soviet bloc. To help ensure its superiority, the United States established a system of national security controls to prevent the leakage of military-related goods and technologies, including so-called dual-use goods and technologies that could give military advantages to our adversaries. This system was codified in export, visa, and classification laws and regulations. In addition, the United States and our allies forged multilateral controls on the international transfer of militarily sensitive goods and technologies. While far from perfect, this system met the needs of the Cold War reality of a bipolar power struggle with a known and well-characterized enemy.

Today, world conditions are very different. Our adversaries are diffuse; they range from sovereign states to small terrorist cells without state affiliation. There is no longer a consensus in the Western alliance about who its adversaries are or how they should be contained. Many of the most important technologies for continued military superiority originate in the commercial sector rather than in the military sector. Furthermore, such technological capabilities increasingly arise from

scientific and engineering research taking place around the world, not just in the United States. Today, for example, the United States has lost its dominance in fields such as semi-conductor manufacturing. Several countries now rival the United States in creating a climate that encourages and rewards business and scientific innovation. As economic conditions have improved in China, India, and other countries, many young people who would have come to the United States to study or work in science and technology now opt to stay home for their education or to return to their home country after graduate school in the United States. All these changes mean that American security and prosperity now depend on maintaining active engagement with worldwide developments in science and technology, and with the global economy.

While the United States remains a world leader in advanced science and technology, it no longer dominates; it is now *among* the leaders. We are increasingly interdependent with the rest of the world. What is the United States doing to reap benefits from its increased interdependence? Instead of promoting engagement, the United States is required by our current system of controls to turn inward. Our visa controls have made it more difficult or less attractive for talented foreign professionals to come and learn what is great about this country, or to stay and help grow the American economy. Our export controls retard both the United States and its allies from sharing access to military technology, and handicap American business from competing globally.

In the post-9/11 world, even if we could accept the costs associated with mistakenly turning away some of the brightest international students or accept the forfeit of some business growth opportunities in the interest of national and homeland security, these are not the only outcomes of current policies. Such policies also weaken relations with allies, reduce the capability and strength of America's defense industrial base, and help to create foreign competitors that diminish U.S. market share in critical technologies.

These unintended consequences arise from policies that were crafted for an earlier era. In the name of maintaining superiority, the United States now runs the risk of becoming less competitive and less prosperous; we run the risk of actually weakening our national security. The Cold War mentality of "Fortress America" cripples our ability to confront the very real dangers of altered world conditions.

This conclusion is not unique to this report. Several of these ideas have appeared in reports by the National Academies and by others in the wider policy community over the last 25 years. Two of the most

recent are last year's Academies' report, *Science and Security in a Post 9/11 World,* and *The Deemed Export Rule in the Era of Globalization*, a report to the Secretary of Commerce by the members of the Deemed Export Advisory Committee (see Appendixes D and E for titles of additional reports and studies). Rather, the uniqueness of this report lies in two areas:

1. Tying together the multiple strands of the problem—the changing requirements of national security from the Cold War era, the impact of economic globalization on the U.S. economy, the impact of the globalization of science and technology on the U.S. economy and on its science and technology leadership—into a single narrative that shows the need for new policy.
2. Proposing policy innovation that can be enacted quickly by the new President that will provide needed fixes to U.S. export control policy, even if Congress continues to prove unwilling or unable to deal with this issue; as well as needed improvements to visa policy.

This report provides an account of the costs associated with building walls that hamper our access to global science and technology and that dampen our economic potential. It also makes recommendations for changes to address the task set forth in the committee's charge:

> The ad hoc Committee on Science, Security and Prosperity will produce a consensus report on the relationship between scientific and technological advances and national security threats and the global context within which they interact. The report will succinctly survey (1) the changes in scientific and technological advances, interlocking global economies and current geo-political factors since this regulatory system was established; and (2) the problems with the current federal regulatory system related to national security that oversees the conduct of science and technology. The report will review the national security policies and regulations that have an impact on the conduct of science and technology, and make recommendations for fundamental changes. The recommendations may include those pertaining to the reorganization of an agency or the creation of a new institutional entity. The target audience of this report will be the presidential candidates and the Departments of Commerce, Defense and State, as well as the White House.

In carrying out its charge, the committee developed a brief set of findings and recommendations that are listed below and are discussed in detail in the accompanying text.

FINDINGS

Finding 1. Designed for the Cold War when the United States had global dominance in most areas of science and technology,[1] the current system of export controls now harms our national and homeland security, as well as our ability to compete economically.

A. In almost all cases, the technology base that supports our national security also supports the high-technology sector of the civilian economy.

B. Many controls imposed in the name of national and homeland security do not, in fact, improve national and homeland security.

C. Many current controls (outside of narrow military niches) aimed at protecting national security, in fact weaken U.S. innovation and competitiveness in global markets, thereby reducing economic prosperity, which is an essential element of U.S. national security.

Finding 2. The system of export controls on the international flow of science, technology, and commerce is fundamentally broken and cannot be fixed by incremental changes below the presidential level.

A. For most of the last 20 years, the executive and legislative branches of the federal government have failed to come to agreement—either internally or with each other—on dual-use export control policy. This failure has led to unnecessary vulnerabilities in our national security and in our economic competitiveness.

B. The current list-based systems are unwieldy, slow, difficult to administer rationally, and are overly proscriptive given global developments in science and technology.

C. The lack of multinational consensus among our allies about export controls further reduces the effectiveness of unilateral U.S. actions.

Finding 3. U.S. national security and economic prosperity depend on full global engagement in science, technology, and commerce.

A. Highly capable centers of scientific research excellence and industrial innovation have been developed in many foreign countries

[1]Throughout this report, the term "science" is used to mean the natural sciences, social sciences, and mathematics. The term "technology" refers to the products of engineering, or to the application of scientific knowledge.

over the past 20 years; the United States maintains scientific leadership in some areas, and it is hotly contested or has been lost in others.

B. Global information exchange via the Internet, the increased speed of science and technology advancement, and the strategy of "run faster" are all incompatible with our existing systems of regulating the movement of people, ideas, components, and products.

C. The best practices that underpin successful competition in research and technology advancement are undermined by government regulation that restricts the flow of information and people participating in fundamental research. These best practices include:

- Freedom of inquiry
- Freedom to pursue knowledge for its own sake
- Freedom to collaborate without limitation
- Pluralistic and meritocratic support of science
- Freedom to publish

D. The best scientific talent from outside the United States has been and remains critical to the U.S. research and development enterprise. Maintaining access to this talent depends on visa policies that are welcoming to legitimate and qualified students and researchers.

Finding 4. A new system of export controls can be more agile and effective, recognizing that, under current global conditions, risks to national security can be mitigated but not eliminated.

An important caveat attaches to any discussion of changes in the current system of export controls: there is no "risk-free" solution. Today's system is not risk-free either; in fact, it is arguably becoming more and more dangerous because the inclination to equate control with safety gives a false sense of security.

RECOMMENDATIONS

The committee structured its recommendations into three areas: reforming the export control process, ensuring scientific and technological competitiveness, and improving the non-immigrant visa system that regulates the entry into the United States of foreign science and engineering students, scholars, and professionals.

In the committee's view, it is important to act immediately, within the boundaries of the President's authority to ameliorate the policy

logjam that is the unintended consequence of Congress's inaction over dual-use export controls. The new President needs to make the changes that will stem a serious decline affecting broad areas of the nation's security and economy.

Recommendation 1. The President should restructure the export control process within the federal government so that the balancing of interests can be achieved more efficiently and harm can be prevented to the nation's security and technology base, in addition to promoting U.S. economic competitiveness.

Restructuring the export control process does not involve abandoning all export controls. Rather, the committee recommends that two policy changes and two structural changes be made to retain needed export controls while shedding the largest obstacles to an efficient system. With these changes implemented in an expedient manner, the United States will stem the loss of technological and economic competitiveness and begin to benefit from carefully targeted and calibrated controls that reflect and meet current challenges that the country faces in protecting both our national security and our economic well-being.

Action Items

A. Recognize the interdependence of national security and economic competitiveness factors in making export control decisions with respect to individual requests for licenses through a principle-based system.

When the licensing agency applies principles to decisions about export controls, the focus will stay on *why* items should or should not continue to be controlled, rather than on adding to otherwise static lists of controlled items. This kind of governance system can assess each decision in terms of whether an item should be controlled against the governing principles that have been established within the system. Doing so can ensure that the remaining controlled items are relevant to rapidly changing global conditions. It can also help ensure that decisions are made in a timely manner. The following are the principles that the committee recommends:

1. Maintain the value of protecting traditional U.S. national security in export control policy.

2. Recognize that today this value must be balanced against the equally important value of maintaining and enhancing the scientific and technological competitiveness of the United States.

3. Allow openness and engagement to prevail unless a compelling case can be made for restrictions.

4. Articulate a rational basis for each restriction. Restrictions on unclassified technology should be implemented only when**:**

a. The United States alone, or the United States and cooperating allies, possesses technology that leads not only to identifiable military advantage, but to an advantage that is likely to persist for a significant period of time (i.e., the time needed to field a system based on that technology);

b. The United States, or the United States acting together with allies, controls the technology such that they can prevent it from moving into the hands of possible adversaries;

c. The restrictions do not impose costs and inefficiencies that are disproportionate to the restrictions' security benefits; and

d. Restrictions are re-examined and re-adjusted periodically to ensure they remain appropriate.

5. Protect the capability to "run faster."

6. Treat weapons separately—but define them narrowly and precisely.

7. Recognize the "global public good" nature of health-related technologies.

B. Apply "sunset" requirements to all items on export control lists that are controlled unilaterally by the United States, and require findings to be made every 12 months that removing controls on an item would present a substantial risk to national security. No version of the current control system should survive without an effective method for pruning items from the control lists when they no longer serve a significant definable national security interest.

C. Establish as a new administrative entity a coordinating center for export controls, with responsibilities for coordinating all interfaces with persons or entities seeking export licenses and expediting agency processes with respect to the granting or denial of export licenses.

This small coordinating entity would be responsible for:

- Receiving all applications for export licenses;
- Determining whether the Department of Commerce or the Department of State should handle the license application and dispatch the application to the appropriate agency for a decision;
- Maintaining timetables for decision making on license applications so that applications do not languish;
- Receiving decisions on applications from the designated agencies and distributing these decisions to applicants;
- Receiving appeals of licensing decisions and petitions for review of sunset decisions, and delivering these to the appellate panel (see description below);
- Maintaining timetables for decisions on appeal;
- Receiving decisions on appeals and distributing these decisions to applicants;
- Providing administrative support to the appellate panel (see description below); and
- Monitoring and oversight of the sunset process.

D. Establish an independent export license appeals panel to hear and decide disputes about whether export licenses are required, whether particular decisions to grant or deny licenses were made properly, and whether sunset requirements have been carried out properly.

An independent, neutral decision-making authority is required to break the logjams in the system caused by philosophical differences and varying interpretations of statutory, regulatory, and executive order language. Two kinds of issues can be resolved quickly and effectively using an appellate decision-making panel:

- First, if the agency makes a decision (either requiring or not requiring a license), and a party or a government agency believes the matter was wrongly decided, there is an avenue to resolve these differences.
- Second, if the agency fails to remove an item or category of items from the control list under the sunset requirement, or does not act at all within the one-year time period for review of each item on the list, an affected party could appeal either to reverse the agency's determination, or to require the agency to act in a timely way to make the necessary determination.

The committee recommends that an independent export license appeals panel be constituted, appointed by the President or the National Security Advisor.[2] Panel members would serve a five-year term. The panel would be co-located with the coordinating center and would be housed, for administrative purposes, under the same organizational umbrella. Appeals panels such as this one are not "directed" by an administrative authority. This kind of panel acts independently and neutrally to resolve disputes. It has no operational responsibility other than to hear disputes and issue opinions.

The best organizational home for the proposed coordinating center and the export license appeals panel would be within the National Security Council (NSC) structure, with the coordinating center's director reporting directly to the National Security Adviser. This placement in the White House structure will ensure the coordinating center's independence and will establish its relationship to the President. The coordinating center and the export license appeals panel would not necessarily be co-located with the NSC. This would not be required for an effective exercise of its powers under the Executive Order.

The committee weighed several options before making the recommendation for a new coordinating center and an export license appeals panel and locating them within the NSC. The option to create an interagency group was rejected because experience supports the conclusion that this would devolve into just another debating society and would not constitute a practical means to improve the present export control system. The option to use a group made up of private sector members was rejected because that alternative would not be acceptable to the government agencies involved. The option to place this responsibility with the Department of Defense was rejected, because the department, through its management of the Militarily Critical Technologies List, is an important player in the export control regime. Similarly, any placement within any other cabinet-level department involved in licensing would

[2]It is at times difficult to get presidential action on appointments in a timely way, particularly at the beginning of an administration when there are many competing concerns. For that reason, the President's Executive Order would allow 90 days from the date of issuance of the Order for the appointments to be made through the presidential processes, and after that, the appointments would be made by the Chief Judge of the Federal Court of Appeals for the District of Columbia Circuit within 30 days. Replacement judges would be selected in the same way. No Senate confirmation would be required because this is not a "court"; it is an administrative panel assembled by the President to assist agencies in carrying out their responsibilities. This panel makes decisions among competing interests of agencies the same way the National Security Council's staff makes decisions about the competing interests of the Departments of State and Defense.

also compromise the independence of the proposed center. The option to place these administrative functions in the Office of Management and Budget was also considered. Although neither the NSC nor the Office of Management and Budget is an operational agency, the committee thinks that the NSC provides the better fit, because of its focus on national security and economic policy. In addition, the chain of command would have the coordinating center's director reporting directly to the National Security Advisor. This would not only signify the importance of these issues, in terms of both national security and economic policy, it would also serve as a brake on the director in terms of choosing his or her battles carefully.

Recommendation 2. The President should direct that executive authorities under the Arms Export Control Act and the Export Administration Act be administered to assure the scientific and technological competitiveness of the United States, which is a prerequisite for both national security and economic prosperity.

Action Items

A. Maintain the Fundamental Research Exemption that protects unclassified research, as provided by National Security Decision Directive 189, and ensure that it is properly implemented.

B. Create an economic competitiveness exemption that eliminates export controls on dual-use technologies where they, or their functional equivalents, are available without restriction in open markets outside the United States.

Recommendation 3. The President should maintain and enhance access to the reservoir of human talent from foreign sources to strengthen the U.S. science and technology base.

Traditionally, the United States had to worry about science and technology flowing out of the country. In today's conditions, the United States must make sure that advanced science and technology will continue to *flow into* the country. For this reason, the U.S. visa regulations as applied to credentialed foreign scientists should ensure that the United States has access to the best talent. Science and engineering degree-holders who prefer, after graduation, to work in the United States should have ready access to permission for long-term stays. Granting this access for

highly trained technical and scientific personnel is an important way of augmenting a critical segment of the workforce. The United States cannot protect U.S. jobs by denying entry to foreign professionals; jobs will simply go abroad. It is important for both the national security and economic prosperity to maintain the flow of human talent into the United States.

Action Items

A. Streamline the visa process for credentialed short-term visitors in science and technology fields.

The committee recommends the President's Executive Order require that a non-immigrant visa applicant who is a graduate student, researcher, or professional in any field of science or technology and whose application is supported by a qualified university, scientific body, or corporation should receive a determination on his or her visa application within 30 days. This will allow access for credentialed academic researchers to work with U.S.-based colleagues and in U.S.-based programs, and will facilitate work done in U.S. science laboratories.

B. Extend the duration of stay for science and engineering graduates with advanced degrees.

The committee recommends the President's Executive Order provide a one-year automatic visa extension to international students to remain in the United States to seek employment or acceptance into further advanced study on receipt of advanced degrees in science, technology, engineering, mathematics, or other fields of national need at qualified U.S. institutions. If these students are offered jobs by U.S.-based employers and pass security screening measures, they should be provided automatic work permits and expedited residence status. If students are unable to obtain employment within one year, their visas would expire.

C. Include expert vouching by qualified U.S. scientists in the non-immigrant visa process for well-known scholars and researchers.

The committee recommends that the President's Executive Order allow qualified U.S. scientists, as part of the visa application process, to vouch for the technical credibility and legitimacy of visa applicants who are in the same or in a similar field. A more interactive application review procedure would permit those with expertise in relevant scien-

tific and technology fields (and personal knowledge of the expertise of the individual whose application is being reviewed) to aid consular officials in accurately and efficiently determining the existence of a real security threat.

D. Institute skills-based preferential processing with respect to visa applications.

The committee recommends that the President's Executive Order institute a new skills-based, preferential processing with respect to visa applications. The visa applications of scientists and engineers should be given priority. Graduate-level education and science and engineering skills should substantially raise an applicant's chances and confer priority in obtaining residence permits and U.S. citizenship.

IN CONCLUSION

As a nation, we cannot, and should not abandon well-conceived efforts to keep dangerous technology and scientific know-how out of the hands of those who would use this knowledge to create weapons of mass destruction and other, equally dangerous military systems. However, these represent a very narrow and limited set of goods, technology, and knowledge. Our former unilateral strategy of containment and isolation of our adversaries is, under current conditions, a self-destructive strategy for obsolescence and declining economic competitiveness. A strategy of international engagement is a path to prosperity that can be coupled with a smarter approach to security using an adaptive system of government regulation and incentives. The committee recommends the issuance of an Executive Order that implements the recommendations it has outlined as one of the first orders of business in 2009.

I.

Introduction

Many of the federal government's regulations governing what information, components, and products can be delivered to or shared with citizens of other countries are harming the nation's security and its economic prosperity. This system was designed for a world that no longer exists, and it needs to be replaced.

- U.S. national security, including the protection of the homeland, is not well served by the current controls.
- The single technology base that today supports both U.S. commercial and military capabilities is constrained from expanding into new fields and from applying new scientific developments.
- Entire international markets are denied to U.S. companies because they are forbidden to ship their technologically sophisticated products to foreign countries.
- Obsolete lists of controlled components prevent U.S. companies from exporting products built from prior generation technologies not likely to harm national security.
- U.S. scientists are hobbled by rules that prevent them from working with world-class foreign scientists and with advanced laboratories located overseas, making it less likely that valuable discoveries and inventions will occur in the United States.
- The government's rules are driving jobs abroad—knowledge-intensive jobs critical to the future of the U.S. economy.
- The government's rules are accelerating the development of technologies in capable research centers outside the United States.

To deal with this alarming situation, in 2007, the National Research Council appointed this committee of scientists, technologists, and defense experts, with deep experience in both national security and the nexus of scientific and technology research and economics to propose policy solutions.

The committee recognizes that concerns exist about the potential for China to present a significant military and economic challenge in the coming years, assuming that its economy is able to maintain robust rates of growth and that its indigenous science and technology capabilities continue to develop. There are also concerns about the potential military threat posed by a resurgent Russia, fueled largely by oil and gas revenues, and these concerns have only been heightened by recent events in Georgia.[1] Yet even if these projected scenarios are realized, the committee's findings and recommendations would be the same, because the realities of today's economic environment will not bring about a return to the economic and technological hegemony the United States enjoyed during the Cold War. The committee also acknowledges the problems presented by the accumulation of enormous amounts of dollar-denominated assets by overseas governments; the issues related to the ownership of U.S. high-technology corporations; the difficulties and protections afforded by the classification system; and ever-present trade policy issues. These important challenges are beyond the scope of this report except in this way: without a successful resolution of national security control issues as they affect scientific and technological development in the United States, each of these problems becomes harder to solve.

The findings and recommendations set out below go beyond Cold War conceptualizations to examine the protection of national security and promotion of economic prosperity through more effective global engagement policies. The committee's findings summarize the gradual, but cumulatively dramatic changes that have occurred over the past

[1]While the 2008 Russian military incursion into Georgia is serious and worrisome, it does not necessarily suggest that the United States and its Western allies are likely to return to an overtly adversarial relationship with the Russian Federation. Should Russia seek to impose its will militarily on other states in the "Near Abroad," such as Ukraine or the Baltic countries, this would necessarily require a fundamental reassessment of all aspects of U.S. and NATO policy—but it would still not justify the imposition of export controls unsuited to the current state of scientific and technological globalization.

50-plus years, and that have been documented in numerous, extensively researched prior reports and studies (listed in Appendixes D and E). The committee's recommendations include basic changes in policy, which should be implemented by the new President, to quickly reverse the damage that is accumulating.

II.

Findings

Each of the committee's findings is summarized and then discussed in detail in the text that follows.

FINDING 1

Designed for the Cold War when the United States had global dominance in most areas of science and technology, the current system of export controls now harms our national and homeland security, as well as our ability to compete economically.

A. In almost all cases, the technology base that supports our national security also supports the high-technology sector of the civilian economy.

B. Many controls imposed in the name of national and homeland security do not, in fact, improve national and homeland security.

C. Many current controls (outside of narrowly defined military niches) aimed at protecting national security, in fact weaken U.S. innovation and competitiveness in global markets, thereby reducing economic prosperity, which is an essential element of U.S. national security.

The current system of federal controls on the flow of scientific information developed, by accretion, over almost six decades. It is based largely on the experience of the Cold War years when the United States was confronting a unitary threat from the Soviet Union, and on the conditions of economic and technological competitiveness that existed in the 1950s, 1960s, and 1970s. Although economic and security conditions have changed dramatically, our approach to export controls has

persisted, both in substance and in the administrative structures within which the controls are carried out.

How Did We Get Where We Are?

In response to the numerically superior military forces of the Soviet Union and its Warsaw Pact allies, the United States committed to building a military establishment that fielded qualitatively superior forces. To sustain this "run faster" strategy, the United States invested significantly in advanced research and development in university, industry, and national laboratories to produce superior technology in fielded military systems. As a result, the United States achieved the leadership position in many areas of science and technology.

There followed well-documented efforts by the former Soviet Union to systematically collect and exploit for military purposes scientific and technical information produced in the West.[1] These efforts were unprecedented in scope and in the resources (both human and financial) dedicated to their implementation. To counter this threat, the United States crafted a system of policies and regulations designed to limit the flow of technology to the Soviet Union and its allies. This system included classification, export controls, deemed export controls,[2] restrictions on the dissemination of government-funded research, and limitations on visa and visitation privileges by those who could collect advanced scientific and technological knowledge within the United States. Each of these regulatory requirements was premised on the direct application of particular elements of technology to specific military uses. Moreover, all of these military uses were envisioned, in the U.S. regulatory design, as being wielded by an identified state power—most specifically, the former Soviet Union and its allies. With a common understanding of the security threat they faced, the United States and its allies acted to deny crucial technology to the Soviet Union and the other states of the Warsaw Pact.

[1]See, for example, National Academy of Sciences, National Academy of Engineering, Institute of Medicine. 1982. *Scientific Communication and National Security* (hereafter known as the Corson Report after the panel's chair, Dale Corson). Washington, DC: National Academy Press, pp. 17-18.

[2]Deemed export controls refer to controlling the transfer of technical information to foreign nationals who are studying or working in the United States.

How Have Global Conditions Changed?

The fall of the Soviet Union was a triumph for the West, eliminating the single largest threat to the security of the United States and its allies. However, the demise of the former Soviet Union let loose regional animosities that in some cases had lain dormant under Soviet control, and in others, had been obscured by Cold War geopolitics. At the same time, this dissolution loosened the ties among the countries of the anti-Soviet West that had cooperated with one another out of a common fear of the Soviet Union. This has made it difficult for the United States and its allies to deal consistently with the rise of smaller politically motivated enemies, who in many cases are non-state actors—even mere groups of individuals—and whose size is disproportionate to the nature of the threat they pose.

The post-Cold War period is also marked by major changes in world economics that have transformed the international economic landscape. The opening of trade among nations of East and West, combined with advances in information technologies, have made it possible for people, goods, and technology to move freely across formerly closed borders. Well-financed centers of scientific excellence with long-term goals sprang up in South Korea, Singapore, China, and India. The scientific establishments in Europe, Israel, Japan, and more recently, Russia, have realized a new vigor in the post-Cold War global economy. Several countries in the Middle East are now investing to advance their own scientific research capabilities. Many countries—and especially China—are learning to exploit their new scientific strengths by means of globalized business models that take advantage of peer-to-peer initiative structures.[3]

For many countries, trade policies that fostered economic development became a high priority. The need to control exports for mutually agreed national security objectives no longer dominated the policy agenda of U.S. allies. Meanwhile, multinational corporations based in the United States shifted research and development efforts offshore to accompany the opening of markets, as in China; or to take advantage of lower costs and well-educated English-speaking technical elites, as in India and Ireland. Moreover, innovation itself is becoming increas-

[3]See, for example, Lewis M. Branscomb's article, "Research Alone is Not Enough," in *Science*, 321: (1589) (August 15 2008), pp. 915-916 that calls for American policy makers to encourage the development of relational business models.

ingly international.[4] Finally, advances in information, communication, and transportation technologies and a switch to "just-in-time" inventory management have made U.S. industries increasingly reliant on global supply chains whose disruptions, when they occur, hurt the U.S. economy.[5]

Increasingly, American science and technology lost the dominance that had characterized earlier decades as scientific and technological capacity increased dramatically in other nations.[6] The reflexive tightening of security after the September 11, 2001, attacks blunted recognition in U.S. policy of the breadth and depth of the rising competition to American science and technology.

The Single Technology Base

The technology base of a nation consists of all the elements that contribute to the ability of the nation to develop technology, to field advanced systems, and to compete in technology-based markets; it encompasses people, infrastructure, research laboratories, and manufacturing capacity, as well as science and engineering education capacity. As conditions in the marketplace changed, the separate, and often secret, military technology base that in the 1970s supported the military market gradually merged with the much larger technology base that supported the commercial market. This global commercial market provided enormous incentives for the rapid development of sophisti-

[4]Sociologists and economists are uniformly pointing to an increasing interdependence of innovation systems in various countries. This interdependence consists of increasingly complex collaborations across national borders and among researchers and users of research from various institutions. These collaborations allow firms to take advantage of foreign innovation systems for a variety of solutions to technological problems. For an overview of innovation system literature, see Carlsson B. 2006. Internationalization of innovation systems: A survey of the literature, *Research Policy*, 35: (1), pp. 56-67. Also see Etzkowitz, H., and Leydesdorff, L., 2000. The dynamics of innovation: from national systems and "Mode 2" to a triple helix of university–industry–government relations. *Research Policy* 29: (2), pp. 109-123.

[5]The West Coast dock strike in 2002 that lasted for 10 days had an estimated cost of $15 billion to the U.S. economy. See The Reform Institute's 2008 report, *Global Supply Chain Presents Opportunities and Perils*, released March 6, 2008.

[6]The 2007 report to Department of Commerce Secretary Carlos Gutierrez from the independent Deemed Export Advisory Committee (hereafter referred to as the DEAC Report), has listed the following areas in which the United States has lost its scientific and engineering leadership: "polymer composites (Germany), 3D optical memories (Japan), bulk metallic glass (Japan), biostatistics/multivariate statistics (France), population biology (UK), adaptive dynamics (Germany/Switzerland), theoretical biology (Netherlands), and solar energy (Japan/Germany)." The DEAC Report, p. 11.

cated technologies, while the market for specific military applications became relatively smaller.[7] As the military market shrank, investments flowed naturally, by market-driven forces, to the civilian sector. More and more of the technologies and components used for war-fighting and intelligence collection came to be based on the same technology that supported the development and production of civilian goods and services.[8]

The communications that support military situation awareness today are predominantly civilian technology. During Operation Iraqi Freedom (2003), 80% of all satellite communications used commercial satellite services.

SOURCE: Cavossa, David, "State of the Satellite Industry", presentation for the FAA's Commercial Space Transportation Advisory Committee (COMSTAC), October 25, 2006. Available at *http://www.faa.gov/about/office_org/headquarters_offices/ast/industry/advisory_committee/meeting_news/media/COMSTAC_Presentation-SIA_Cavossa.ppt*.

Innovations came quickly in the 1980s and 1990s—especially in electronics and information technology—and the U.S. military was able to incorporate civilian components, or variants of them, to add functional capability to military systems. By 2000, except for small but important niches in the military sector, components for both military applications and the commercial market were drawn from the same technology base. A key differentiating characteristic in the military market now was not the underlying scientific or technological information, components, or products, but the methods by which these were applied to specific military uses.

With the evolution to a single technology base supporting both military and commercial demand came the opening of global markets through political means, such as the loosening of Russia's grip on its satellite states, the rise of state-controlled capitalism in China, and various world trade agreements. These global markets, although they often

[7]The consolidation of the defense industry is in part emblematic of the establishment of a single technology base. In 1993, there were 36 major prime contractors. By 1999, these contractors had consolidated to just 8 prime contractors. A similar consolidation has happened among second- and third-tier contractors with their numbers falling from 85 to 44 in a similar time period. See Bear Stearns, *The Consolidation of the Defense Industry: Winners and Losers*, February 7, 2000; and Bear Stearns, *The Consolidation of the Aerospace Industry/Defense Merchant Supplier Base*, April 17, 2000.

[8]Defense Science Board, 2006 Summer Study: 21st Century Strategic Technology Vectors, available at *http://www.acq.osd.mil/dsb/reports.html*.

started at considerably lower levels, grew at much higher rates than the more mature domestic U.S. markets. These global markets became as important as—and increasingly more important in some areas for U.S. companies—than the market within U.S. borders.[9]

Despite, or perhaps because of, the merger of the military and commercial technology bases, the U.S. federal bureaucracy redoubled its efforts to prevent the transfer of information, components, and products to potential U.S. adversaries by adding new items to the control lists that could not be exported from the United States without an export license.[10] With the tensions that developed after the September 11, 2001, attacks, the licensing process slowed even further. Items rarely came off the lists, even if newer, more advanced developments completely bypassed the technologies on which they were based. In addition, the bureaucracy's attention to "deemed exports" became more focused.[11] Foreign scientists and students in the United States were barred from exposure to export-controlled items unless their host institutions obtained an export license.

The Harms Caused by the Current Export Control System

If appropriately construed and implemented, export controls (and the derivative "deemed export" controls) constitute a legitimate constraint on commercial activity for the purpose of protecting national

[9]*Ibid*.

[10]The one exception is in 1995-1996 when the multilateral forum, the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies (hereafter referred to as the Wassenaar Arrangement), was established. The categories of items that were either decontrolled or controlled at more advanced levels included computers, beta-test software, precursor chemicals, and integrated circuits. See the *Export Administration Annual Report 1994 and 1995 Report on Foreign Policy Export Controls*, U.S. Department of Commerce, Bureau of Export Administration.

[11]The National Defense Authorization Act for Fiscal Year 2000 authorized the Inspectors General of the Departments of Commerce, Defense, Energy, and State, in consultation with the Directors of the CIA and FBI, to conduct a multiyear assessment of the adequacy of current export controls and counterintelligence measures to prevent the acquisition of sensitive U.S. technology and technical information by countries and entities. The 2004 reports focused on regulations regarding deemed exports. A total of seven reports were issued in April 2004, including a report from the Department of Homeland Security (established in 2003), and an interagency review summarizing the findings and recommendations of the six individual agency IG reports. Three of the reports—State, DHS, CIA—remain either classified or are publicly unavailable. See in particular *Deemed Export Controls May Not Stop the Transfer of Sensitive Technology to Foreign Nationals in the U.S.*, Final Inspection Report No. IPE-16176, March 2004. Available at *http://www.oig.doc.gov/oig/reports/2004/BIS-IPE-16176-03-2004.pdf*.

security. However, the export control system enforced in the United States today has failed to evolve with changing global conditions, and now produces significant harm to U.S. military capability, to homeland security, and to the nation's economic competitiveness.

Harm to U.S. military capability. Over time, the harm to the U.S. military capability caused by export controls has expanded and has now reached substantial proportions. In response to export controls, decisions of U.S. corporations actually prevent full utilization of American technology for defense purposes. Some U.S.-based companies that have developed valuable new technology choose to stay out of military markets because they believe (often erroneously) that if they do not sell to the military, then export controls would not apply to them. Other companies opt not to enter fields in which controls may apply and direct their investment capital elsewhere.[12] Such decisions deprive the military of the benefits of new scientific and technological developments that otherwise might be available for incorporation into new military systems. Companies with significant commercial markets that continue to sell to the military may suboptimize military systems to minimize the impact of the export controls. As foreign companies and governments fill the competitive gaps left by U.S.-based companies that are not permitted—or choose not—to export, valuable technical developments occur outside the United States to which the U.S. military and intelligence agencies then have no access. The additional financial costs to companies for compliance with export licensing are particularly difficult for smaller, innovative suppliers to absorb, and

Even more than 25 years after the international sales of the F-16 jet fighter aircraft, only non-major F-16 spare parts can be transferred between countries that purchased this fighter. An official third-party transfer license is needed—even in-theater—when one country provides emergency repairs for another. As a result, force readiness may be compromised.

SOURCE: Defense MOU Attachés Group (Defense Cooperation Attachés of 21 member nations).

[12]In a 2002 unpublished report by the Office of the Deputy Under Secretary of Defense (Industrial Policy), titled "Less Traditional Suppliers for transformational warfare" (summarized in the 2003 report, *Transforming the Defense Industrial Base: A Roadmap*), it was found that export control restrictions are a major impediment to participation of less traditional suppliers.

they are thus deterred from working with the military to solve critical defense problems.[13]

Export controls also constrain the contribution that allied military forces can make to U.S. military operations. For example, in an overseas military operation, some allies may be cleared to repair U.S. equipment and others may not; this can prevent repair at facilities closest to the theater of operation. Allied military equipment returned to the United States for repair may need to be cleared for "export" (before shipment back) by determining that nothing has changed to affect the equipment's compliance with U.S. export law. The military thus faces difficulties in outsourcing maintenance and other services to take advantage of lower-cost foreign commercial sources for functions traditionally performed by military personnel.

Foreign manufacturers increasingly refuse to install U.S. equipment in systems they produce. If non-U.S. equipment is used, U.S. export controls do not apply. If U.S. equipment is used, then export controls do apply, and the systems may not be shipped or re-exported without approvals that involve a lengthy bureaucratic process. Foreign defense contractors also avoid using U.S. subsystems to avoid U.S. controls that would restrict third-country transfer and other commercial uses.[14]

Finally, these controls may actually hamper the U.S. government's own understanding of foreign military capabilities and foreign scientific developments. When components or products are available from many sources around the world, U.S. export controls cannot prevent foreign militaries from acquiring them. Allowing foreign military services to buy such components from U.S. sources can improve U.S. awareness of the characteristics of their systems, which might otherwise be just as capable but less well understood.

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[13]It is the view of small entrepreneurial companies, such as the Insitu Group which helped to pioneer the unmanned aerial vehicle (UAV), that classification of their technology as dual-use can "significantly impede small company growth." This example and others are described in *Transforming the Defense Industrial Base* (see footnote 16) available at *http://www.acq.osd.mil/ip/*.

[14]In 1999, commercial satellites were reclassified by Congress from being controlled by the Commerce Department as a dual-use item to being controlled by the State Department as munitions under the International Traffic in Arms Regulations. Alcatel Space (now Thales) then announced in 2002 its company policy to build ITAR-free satellites, launching its first ITAR-free satellite successfully in 2005. Since then, other European aerospace companies such as EADS, Morotta, and Surrey Satellite Company have all followed suit and advertise their products as being "ITAR-free." The European Space Agency has recently implemented a policy of "nondependence" on U.S. spacecraft parts as a "key performance indicator" in purchasing decisions. Sources: William Mathews, U.S. Holds Up Sale of C-295s to Venezuela, *Defense News*, October 24, 2005, and Peter B. de Selding, Europe to Reduce Need for Foreign Spacecraft Parts, *Defense News*, October 6, 2008.

Given the globalization of science and technology, it is particularly important to monitor technological developments overseas, not only to ensure that U.S. military systems use the world's best technologies, but also to understand what capabilities might become available to U.S. adversaries. Constraints on interactions between U.S. and foreign researchers will handicap this country's ability to track global technical developments that might have relevance to national security. As the CSIS Commission on Scientific Communication and National Security put it, "In a world of globalized science and technology, security comes from windows, not walls."[15]

The Russian RD-180 engine powers all Atlas V vehicles for critical U.S. national security and civil space launch missions. Export controls inhibit U.S. engineers from collaborating in troubleshooting or improving the engine in any way. An RD-180 engine (or derivative engine, such as the RD-171M) failure or serious anomaly on a U.S. or foreign launch could ground the Atlas V fleet. Resolution of the root cause and corrective action needed to return the Atlas V fleet to flight status is severely impeded by the export control regime that highly constrains U.S. interactions with the Russian designers and producers of the engine.

SOURCE: Greg Pech, Director, Atlas Propulsion Systems, United Launch Alliance LLC.

Harm to homeland security. Many export controls have the potential to damage homeland security because they are based on the premise that selected technology should be limited to use inside the United States and by American citizens—in other words, an extension of the "Fortress America" mindset. Yet U.S. homeland security may be well served by the use of sophisticated military-like systems in international locations such as airports and seaports. The movement between U.S. and international commercial locations—and movements between one international location and another—required for aircraft that might be equipped with anti-terrorist devices is also not addressed in the current export control regime. As a result, some anti-terrorist systems may be most essential in precisely the countries where the risk of diversion brings export controls into play and encumbers their use.

[15]CSIS Commission on Scientific Communication and National Security, *Security Controls on the Access of Foreign Scientists and Engineers to the United States*, October 2005, p. 15. Available at *http://www.csis.org/media/csis/pubs/051005_whitepaper.pdf*.

Export controls may also act to make U.S. advanced technology companies less able to compete for global business, particularly homeland security business, and therefore less able to sustain their technological preeminence that produces the technology needed to protect the United States and its citizens.

Counter-MANPADS systems (Man Portable Air Defense System) are designed to protect aircraft from a shoulder-launched missile. They are categorized as munitions by the International Traffic in Arms Regulations (ITAR). Installing Counter-MANPADS systems on commercial aircraft would require an ITAR license for each travel leg outside the United States. Inherently unpredictable airline schedules make it impractical for airlines to provide such protection.

SOURCE: Richard Barth, De-conflicting Counter-proliferation and Counterterrorism Policy, presented at COSSP Meeting, Irvine CA, December 13, 2007.

In addition, some important new areas critical to homeland security cannot be made to fit into the current regulatory framework, such as the free exchange of civilian information on the Internet, or the rapid advances in the biological sciences. The implications of these two domains for greater homeland or global security are not yet fully understood. They have largely been the province of the commercial world, academia, and the non-security sectors of the U.S. government. Advances in these fields rely for their creative success on broadly distributed, informal networks of individuals committed to an unprecedented level of openness well beyond the control or economic leverage of the homeland security community. Both are examples of newly important areas in which current export controls may not work well.

Harm to U.S. economic competitiveness. The artificial limitations on trade imposed by lists of controlled technologies have had predictable results with respect to the U.S. position in global markets. With U.S. companies prevented by export controls from competing in certain markets, foreign competitors, often sponsored by their governments, spring to fill these competitive gaps. As these competitors have proliferated, U.S. companies have suffered challenges in the marketplace that would not have been present but for export controls. The biggest risk to U.S. jobs is a lack of economic competitiveness, and U.S. export control policy directly undermines

that competitiveness.[16] Even if a U.S. company is licensed to export a controlled product, a foreign buyer may be reluctant to use it because of the fear that a separate export license will be required to make repairs, or even to honor a request for additional information about the product.

As U.S. companies have evolved to compete in global markets and have become multinational corporations with a substantial presence in numerous countries, the cost of complying with U.S. list-based export controls has risen dramatically. This additional burden on U.S.-based companies makes them less competitive.

A 2007 survey of 202 aerospace companies indicates that compliance costs associated with export controls average $50 million annually and have increased 23% since 2003.

SOURCE: Air Force Research Laboratory analysis of survey of 202 space companies/ business units, 2007. Reported in the CSIS report, *Health of the U.S. Space Industrial Base and the Impact of Export Controls* by Pierre Chao, February 19, 2008. Available at *http://www.csis.org/media/csis/pubs/021908_csis_spaceindustryitar_final.pdf.*

The regulatory limits on providing controlled information to foreign scientists and students now affect the research and development capacity of U.S. corporate laboratories. This is especially true as U.S.-based firms establish laboratories overseas, and even as they staff their U.S. laboratories with graduates of U.S. science and engineering programs, an ever-increasing share of whom are foreign nationals. Failure to "run faster" by developing qualitatively better products and services with the best talent available is a serious threat to U.S. economic competitiveness.

Similarly, export controls and "deemed export" rules make U.S. universities less able to attract the most capable foreign researchers or to retain some of the most creative faculty members.[17] Important discov-

[16]A key to designing the Boeing 787 aircraft is the ability of engineers at Boeing to work closely with foreign suppliers. Yet many of Boeing's engineers are veterans of the B-2 stealth bomber program of two decades ago, who refused to guarantee that their know-how in designing aircrafts did not come from their participation in that program. This caused delays in the 787 program, as lawyers had to pour through documents from the 1970s to determine if key technologies for the 787 came from the commercial sector and were thus free of ITAR controls. In some cases, engineers had to develop new tests to prove well-known facts in technologies like composites to ensure that this knowledge did not come from the B-2. Dominic Gates, Separation anxiety: The wall between military and commercial technology, *Seattle Times*, January 22, 2006.

[17]See, for example, *Science and Security in a Post 9/11 World*, pp. 40-48 (National Academies Press), and The DEAC Report, pp. 35-46 (Deemed Export Advisory Committee, Department of Commerce).

eries may be hindered, or may simply occur elsewhere. The rapid and dynamic nature of leading-edge fundamental research makes it almost impossible to predict with any precision the disciplines in which a researcher will work, the colleagues or laboratories with whom he or she will collaborate, the equipment needed, and the possible modifications that may have to be made to that equipment. All of these factors would need to be tracked so that a research institution could, with assurance, know when to apply for an export license for its foreign scientists and students.

Licensing requirements inevitably lead to delays, and they may deter or even eliminate the spontaneous discoveries that arise from serendipitous interactions and spur-of-the-moment collaborations, most of which are impossible under "deemed export" rules. For example, during a conversation at a conference or research seminar, a researcher may realize that his or her laboratory apparatus is well configured to help solve a colleague's problem. If export licenses are required to use that apparatus, or even to share technical data about the possible application, the opportunity to help will be delayed by a month or more, and will therefore likely be lost.[18]

FINDING 2

The system of export controls on the international flow of science, technology, and commerce is fundamentally broken and cannot be fixed by incremental changes below the Presidential level.

A. For most of the last 20 years, the executive and legislative branches of the federal government have failed to come to agreement—either internally or with each other—on dual-use export control policy. This failure has led to unnecessary vulnerabilities in our national security and in our economic competitiveness.

B. The current list-based systems are unwieldy, slow, difficult to administer rationally, and are overly proscriptive given global developments in science and technology.

C. The lack of multinational consensus among our allies about export controls further reduces the effectiveness of unilateral U.S. actions.

[18]These two paragraphs draw heavily from *Security Controls on the Access of Foreign Scientists and Engineers to the United States*, CSIS, October 2005, p. 15.

Policy Making in the Absence of Law

The current system of federal controls on exports is based on three statutes enacted in 1968, 1978, and 1979. The Arms Export Control Act of 1968[19] governs the export of weapons systems and information associated with weapons systems. It is administered by the Department of State through the International Traffic in Arms Regulations (ITAR). The Atomic Energy Act of 1954, as modified by the Energy Reorganization Act of 1974 and the Nuclear Non-Proliferation Act of 1978, governs the export of nuclear materials and technology. It is administered principally by the Nuclear Regulatory Commission, with inputs from the Departments of Commerce, Energy, and State. The Export Administration Act of 1979[20] addresses the export of dual-use[21] technologies and information. It is administered by the Department of Commerce through the Export Administration Regulations (EAR). However, this act has lapsed several times, most recently in 2001. During each hiatus and since 2001, the EAR has been continued by invocation of presidential emergency powers under the International Economic Emergency Powers Act of 1977[22] on the grounds that the expiration of the act poses an "unusual and extraordinary threat to the national security, foreign policy and economy of the United States."[23]

[19]"The International Security Assistance and Arms Export Control Act of 1976 (P.L. 94-329), enacted on June 30, 1976, changed the title of the Foreign Military Sales Act (FMSA) of 1968 (P.L. 90-629), as amended, to its present one—the Arms Export Control Act. (22 U.S.C. 2751 et. seq.) All references to the predecessor statute, the FMSA, are legally deemed to be references to the AECA." *U.S. Defense Articles and Services Supplied to Foreign Recipients: Restrictions on Their Use*. Updated March 14, 2005, Richard F. Grimmett, Specialist in National Defense Foreign Affairs, Defense, and Trade Division, RL30982, p. CRS-1. Available at *http://www.fas.org/sgp/crs/natsec/RL30982.pdf*.

[20]The Export Administration Act (EAA) was enacted in 1969 to replace the Export Control Act (enacted in 1949 and renewed, largely without amendment, seven times). The EAA was amended in 1974, 1977, and 1979. The 1979 Act constitutes the basis of the current export control system. *The Export Administration Act: Evolution, Provisions, and Debate*, Updated January 9, 2008, Ian F. Fergusson, Specialist in International Trade and Finance, Foreign Affairs, Defense, and Trade Division, RL31832, pp. CRS-2-3. Available at *www.fas.org/sgp/crs/secrecy/RL31832.pdf*.

[21]The committee uses the term "dual-use" to refer to technologies that have legitimate commercial use but could also be used in military systems.

[22]For a history of these efforts, see *The Export Administration Act: Evolution, Provisions, and Debate*, Updated January 9, 2008, pp. CRS-2-6.

[23]Despite twelve attempts to reauthorize the Act in the 1990s and regular attempts since then, Congress has been unable to update the Export Administration Act. In seven legislative efforts since 1996, four did not get beyond committee, one was approved by committee but did not reach the floor, and two failed to pass when sent to the other house of Congress. *The Export Administration Act*, Updated January 9, 2008, p. CRS-12.

The lack of existing legislation on dual-use export controls means that economic globalization, the 2001 terror attacks on the United States, the wars in Iraq and Afghanistan, the impact of globalized communications, the role of China in the American economy, and the rise of Europe as an economic competitor, are all not reflected in current export control legislation. The absence of dual-use export control legislation undermines the implementation of policy in the executive branch because there is no current statute to provide the legal framework within which the Departments of State, Commerce, and Defense can reconcile their differences.[24] Thus, there is no core agreement within the executive branch or between the White House and Congress about what export controls on dual-use items and technologies are supposed to achieve.

In the breach, the competing bureaucracies in the Departments of State, Defense, and Commerce become a principal source of stagnation and inertia.[25] The constituencies within each of these agencies are disconnected and sometimes work at cross-purposes, resulting in extended inaction on particular problems as the departments struggle for policy primacy in the interagency process.[26]

One set of conflicts results from ambiguity about which agency an exporter must apply to for an export license. Under the current system, the Directorate of Defense Trade Controls within the Department of State issues licenses for defense items and services, and the Bureau of Industry and Security, within the Department of Commerce, issues licenses for dual-use items and technologies. Yet these categories leave

[24]See, for example, the April 2008 GAO Report, *Export Controls: State and Commerce Have Not Taken Basic Steps to Better Ensure U.S. Interests Are Protected*.

[25]The Departments of Homeland Security and Treasury, and the Federal Bureau of Investigation play lesser roles in this bureaucratic infighting.

[26]While not a licensing agency, the Department of Defense also plays a central role in export control policy decisions and in the determination of individual licensing cases, both munitions and dual use. First, Defense is responsible for providing the technical expertise that guides the formation of the U.S. Munitions List, and it is responsible for compiling the Militarily Critical Technologies List. Second, both the Office of the Secretary of Defense (OSD) and the Joint Staff have a "seat at the table" on all interagency export control policy reviews and issue discussions, and their views are generally influential. Third, the Defense Technology Security Administration (DTSA), which is part of OSD, routinely reviews each license application—for both munitions and dual-use items—that is not subject to automatic approval. In some cases, DTSA may raise concerns about the technical parameters of the proposed export, finding that a particular configuration may be too close to the version used in U.S. military systems. In other cases, it (or the military Services) may raise operational concerns about the enhanced military capability that a particular export might give to a potential adversary. It is an extremely rare event that the Departments of State or Commerce (and especially the latter) can or will move ahead to approve a proposed export without the explicit, or at least the tacit, approval of the Department of Defense.

ample room for overlap and varying interpretations. These interagency conflicts adversely affect the public—researchers and exporters—and may hamper enforcement when controls are actually needed. The United States today is the only country in the world that has more than one agency designated as the licensing authority for both munitions and dual-use items for export (see Appendix F for a list of the U.S. government agencies involved in export controls).

Another set of conflicts occurs with respect to the substance of individual determinations as to the approval or denial of particular licenses. The question of whether a particular export should be allowed often turns on the proper categorization of the item; namely, whether it falls within or outside of a controlled category of items. Another factor is the destination of the item when exported; i.e., whether it is going to a commercial or military buyer, and in which country. For example, a commercial manufacturer of communications devices may argue that a particular component is available on the open market in Europe and therefore the manufacturer should be allowed to export. The government agencies charged with guarding national security may argue that this component is used in specific military guidance systems and therefore the manufacturer should not be allowed to export.

A third set of conflicts arises when agencies, corporations, and universities disagree about the categories of items, or particular items, which should or should not appear on the control lists. A system that removes items from the control lists in a diligent way and on a periodic basis will generate disputes that need to be resolved. For example, if a component part of a weapons system is removed from the control list because components of that type have a civilian application and are sold commercially elsewhere in the world, an agency with national security responsibilities may still argue that the category or listed item, including the component part, has special capabilities applicable only to weapons systems, and therefore only a less capable component should be allowed to be exported.

This logjam is not hopeless. One solution is for Congress to reform export control laws. Given the lack of decisive action for the last two decades, this may happen, but not without a significant push from the White House. Thus, the second and most viable short-term solution is for the President to become personally involved. In fact, President George W. Bush did so in January 2008 with the release of NSPD 56 on Defense Trade Reform. While five bills were under consideration in the 110th Congress, nothing came of these efforts (see Appendix J for a list of these

bills). This effort will have to be revived with the next administration. Specific recommendations to this effect are discussed in Chapter 2.

Lists Are Necessary, but Not Sufficient

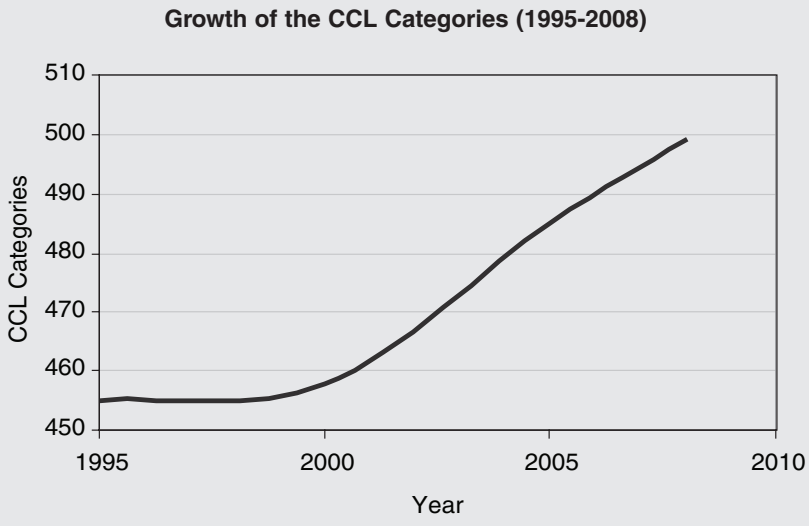
The acts described above gave rise to an interlocking set of lists that informs the current system. These include:

- The *United States Munitions List,* compiled by the Department of State, specifies the defense goods and services that require a license in order to be exported and implements the Arms Export Control Act. This list sets out 18 categories such as toxicological agents and equipment and radiological equipment (Category XIV) and spacecraft systems and associated equipment (Category XV).
- The *Commerce Control List,* compiled by the Department of Commerce with interagency input, specifies which dual-use items require licenses for export. It includes almost 3,000 separate items in ten categories, including materials processing (Category 2), electronics (Category 3), and sensors and lasers (Category 6).
- The *Technology Alert List,* compiled by the Department of State, implements the Immigration and Nationality Act. It acts as a guide to consular officials reviewing visa requests from students and researchers seeking to enter the country. It identifies "sensitive" areas of science and technology in which exports of technology or information might be controlled.
- The *Militarily Critical Technologies List,* compiled by the Department of Defense, advises the administering authorities in the Departments of State and Commerce as to technologies that could permit significant advances in the development, production, and use of military capabilities of potential adversaries.

An item on the Commerce Control List or the U.S. Munitions List is either prohibited from export or requires a license to export. The inclination of bureaucracy is generally to play it safe; items are added to the lists as science and technology developments occur in fields in which military uses could be envisioned.[27]

In 1994, the controls on exports—sending information, components, and products out of the United States—were supplemented by

[27]See Appendix H for the technology categories of the Commerce Control List and the U.S. Munitions List.



SOURCE: The Export Control Classification Numbers (ECCNs) counts for 1985-2008 are taken from annual editions of the Code of Federal Regulations: 1985 (CFR 399.1), 1990 (15 CFR 799.1), 1995 (15 CFR 799.1), 200 (15 CFR 774 Supplement No. 1), 2005 (15 CFR 774 Supplement No. 1), and 2008 (15 CFR 774 Supplement No. 1). The relationship between the number of ECCNs and the number of controlled goods is neither direct nor proportional and is influenced by several variables, including the breadth of products and goods controlled and the list of destination countries defined for each ECCN. The Commerce Control List (CCL) is not in fact an explicit list of commercial items to be controlled and is instead a list of technology descriptions that may qualify a product for export. A cross-reference between an ECCN and common product types is included within the current CCL, but it clearly states that it is not an exhaustive list. Furthermore, the index cannot be independently derived from the CCL itself, and different derivations based on different interpretations will lead to different lengths. Comparing the ECCN totals over time introduces additional variables and ambiguity; in some cases, the decontrol of a specific item can lead to splitting an ECCN in two; on other occasions ECCNs covering the same items are grouped or divided; and in yet other cases, technologies covered by an ECCN may stay the same while the list of controlled destinations changes. Changes in size therefore are not always proportional to changes in the scope of control, and while the number of ECCNs is a reasonably reliable indicator of the extent of control, the numerous specifics involved in interpreting each ECCN, and each ECCN change, prevent broad and definitive conclusions from being made.

a related system of controls on "deemed exports," which were defined as delivering information or allowing exposure to export-controlled components and products within the United States to non-U.S. persons. Because these individuals might be expected to take this information with them in their heads or in personal notes when they leave the United

States at some future time, providing the information or access to them was "deemed" to be an export for regulatory purposes. In this way, the reach of the lists was extended to many activities conducted entirely within the United States, and not just to the activities of exporting goods and services.

Making lists is a natural and logical response to the perceived need to prevent information, components, and products from leaving the United States if those items might be used militarily by hostile foreign powers or terrorists to harm the United States, and if equivalent goods or services are not otherwise legally available overseas. List-making produces a stable platform from which the government bureaucracy can operate within a vigorous competitive environment on the part of export-minded U.S. companies. During the Cold War, list-based controls largely succeeded in preventing the export of illicit items and technology because the lists were shorter, and the criteria for export decisions could be tied directly to Soviet military needs and capabilities.

However, the list-making regime became static very early in its life. Only infrequently would items be removed from the lists, regardless of competitive developments that made the technology available in open international markets. Examples of the outmoded nature of these lists have been identified in numerous previous studies and reports and stand un-rebutted.[28]

This list-based system of controls constitutes a technological Maginot Line. It has seven major problems.

First, the lists are always out of date. They do not, and cannot, reflect what is available in real time on the open market or in open published sources in the global marketplace of scientific ideas. For that reason, in some cases, the United States is controlling information that is readily available elsewhere. In addition, emerging research in very new fields will typically not appear on any government-generated list until considerable time has passed, by which point the technology is no longer new or emerging and may be well known in commercial markets or in the international research environment. This is not to suggest that only new, emerging technologies should be subject to controls. Some technologies that have been in existence for a long time still need to be controlled, such as technologies related to nuclear, chemical, and biological weapons. The relevance to security is a function of what a technology can do and where

[28]See Appendixes D and E for related recent and ongoing studies in this area.

else it might be available, not just whether it is new. Moreover, the current lists are governed by broad categorical definitions of sensitive technologies that lead to an inevitable lack of specificity. This, in turn, leads to a system in which little bureaucratic effort is required to apply controls to new technologies, whereas significant bureaucratic effort is required to address an out-of-date control. The fundamental structure of today's lists produces export controls that are not only out of date, but also expand without restraint or careful consideration.

Items on the Commerce Control List that are Widely Available

1. Computers with an adjusted peak performance above 0.75 weighted TeraFlops (speed rating) in aggregation are controlled. Yet, using information easily obtained on the Internet, linking together 8 Cell processors (jointly developed by IBM, Sony, and Toshiba, and commonly found in the Sony Playstation 3), can produce 1 TeraFlop.
2. Symmetric key encryption using greater than 64 bits key is controlled. However, software algorithms with capability greater than 64 bits, such as Twofish and Serpent, are already widely available via the Web.

Second, the government's list-keepers are not—and cannot be—the cutting-edge researchers who know the current state of research work in every relevant field, or the extent and nature of work in foreign countries that would render the listed items out of date and beyond effective control. The lists are now so detailed that it would be impractical for the government to employ recognized experts in every field. Even if it could, their governmental responsibilities would preclude these experts from keeping up with their research—a prerequisite for maintaining specialized expertise. For that reason, it is virtually impossible for the government to maintain lists that actually reflect current conditions.

Third, the lists contain overlaps that the list-keepers themselves do not agree on how to manage. The embargo controls at the Office of Foreign Assets Control at the Treasury Department include items controlled by the Department of State munitions list, and overlap occurs in the munitions exports to Cuba, Iran, and Sudan, and also in the case of re-exports. There is no official deferral procedure and it is generally assumed that approval must be sought from both parties. Generally, items controlled by State are not controlled by Commerce, although not always. Usually, when

State removes an item, it becomes controlled by Commerce, although sometimes it becomes decontrolled entirely. Items are also occasionally transferred back and forth. Adding even more to the confusion, some items are explicitly included in both lists. In some cases, this is because the Commerce Control List is written to conform to the European Union control list and includes many items that are actually under State jurisdiction. Reliance on lists further complicates this issue twofold. First, State does not allow detailed descriptions of its controls on the Commerce Control List, and second, while these entries are denoted on the Commerce list, if industry notices that an item is removed from Commerce's list, this is entirely misleading, as the item may actually have been, and will continue to be, controlled by State. Confusion has not only led to inconclusive congressional efforts to clarify jurisdictions, but also creates a disincentive for industry, as the onus lies on exporters to navigate the system and determine which agency has jurisdiction.[29] (See Appendix F for the agency decision-making tree.)

Fourth, when the United States lists exports that it intends to restrict as defense goods or services, and other countries list those exports as dual-use items, where there is a significant commercial market, other countries have both a priority list for and a strong incentive to fund research and development in precisely those areas. For that reason, we are, in effect, actively nurturing foreign competitors for our own goods and services. Indeed, our lists provide foreign competitors with a "road-map" regarding the specific technologies and end products in which they should invest.[30] In addition, the lists—especially those developed under international agreements—can be used defensively by countries that are developing their own commercial capabilities and wish to protect themselves from U.S. exports. Once an item goes onto a list under one of the international agreements and is then automatically incorporated into the U.S. lists, the U.S. authorities will prevent U.S. companies from exporting the item into the foreign market—precisely the effect desired by the foreign competitor.

[29]See *United States Export Controls* by William A. Root, John R. Liebman, and Roszel C. Thomsen II, 5th edition. Aspen Publishers, 2007, Chapter 1, pp. 9, 11-12.

[30]In 2004, for example, the European Components Initiative was formed to identify technologies to be developed within the European community to lessen dependence on components for space that are under U.S. export restrictions. Phase 1 was the development of 18 key components and is to be completed by 2009. Phase 2, started in 2006, is targeting 54 additional components. Source: *https://spacecomponents.org/public/eci/* (accessed October 15, 2008).

Fifth, lists are reasonably well adapted to controlling exports of readily identified materials or systems (stealth and nuclear weapons, for example) that are concrete and tangible, but they are poorly suited to controlling exports of knowledge or complex systems of vastly different levels of sophistication.

Sixth, the listed areas affect the research choices of the best scientists and engineers within the United States. Some avoid involvement in research areas that are affected by federal controls out of an apprehension that significant work may not be published or that students and researchers needed for first-rate laboratories will not be available.[31] Breakthroughs will thereby be thwarted. For items that must be controlled—weapons-grade materials and systems—such opportunities may be a necessary cost, but to the extent that the lists are out of date or include overly broad definitions, important research opportunities remain unexploited.

Seventh, some technologies, such as computer processors, encryption chips, and the high-temperature components of gas turbine engines, are produced at various levels of capability. Low-capability products for the commercial market are readily available worldwide and are inappropriate for export control, whereas very high-technology applications may warrant restrictions until they are overtaken by new developments. However, the boundary between low and high capability moves rapidly, and the lists cannot keep up.

As significant as these problems are, however, lists are also an efficient way—indeed the only way—to keep track of items. In Recommendation 1, the committee proposes a strategy for making lists more relevant and manageable.

Lack of International Agreement over "Dual-Use" Export Controls

During the Cold War, the NATO allies and Japan shared a multilateral consensus on the need for effective and relatively uniform con-

[31]Examples of how federal controls affect research choices can be found in the 2007 NRC Report, *Science and Security in a Post 9/11 World*. See Box 2-B on the effects of classification on research into wireless sensor networks on p.33 and the testimony of Rachel Claus and Michael Nacht on p.36.

trols on a range of munitions and dual-use goods and technologies to the (former) Soviet Union, the other Warsaw Treaty member states, and to a lesser extent, the Peoples' Republic of China. In 1949, the allies established the Coordinating Committee on Multilateral Export Controls, known as "CoCom," as a mechanism to give each participating state the opportunity—and the right—to review the exports of each of the other member states *prior* to shipment. Under the informal terms of CoCom, each state had the right to exercise a veto over another state's proposed export to any of the proscribed countries. After the dissolution of the Soviet Union and the termination of the Warsaw Treaty, CoCom was disbanded, reflecting the loss of a basic sense of common purpose and consensus among the advanced industrialized countries on the need for controls, as well as on the countries or non-state entities to be targeted.

Today there are five informal multilateral regimes that address the harmonization of national export control policies.[32] As discussed above, the Departments of State and Commerce, respectively, rely on the U.S. Munitions List and the Commerce Control List to determine which items, services, or technologies require a license for export. These lists, in turn, inform and are informed by the lists that support the multilateral export control regimes in which the United States participates.

Like the old CoCom, none of the five international arrangements are treaty-based, and therefore have no legal standing under U.S. law or under the laws of any other participating state. Moreover, none of them include a veto right by member states, nor do they require unanimity for an export to go forward. The member states of all of these informal organizations are responsible for implementing the guidelines on the basis of their own national discretion and in accordance with their own national legislation and practice.

- The Nuclear Suppliers' Group (1974) is an informal group of 45 countries that seeks to ensure that nuclear transfers for peaceful pur-

[32]The passage of United Nations Security Council Resolution 1540 in 2004 marks a potentially significant addition to the function and scope of multilateral regimes that deserves further scrutiny. This resolution affirms official support for the existing multilateral treaties aimed at limiting the proliferation of weapons of mass destruction to states. United Nations Security Council Resolution 1540 constitutes a binding obligation to the states parties to prevent non-state actors from acquiring WMD technologies. While they are intrinsically tied, it remains to be seen how the relationship between this resolution and the existing multilateral agreements that it supplements will evolve in the coming years.

poses are not diverted to unsafeguarded nuclear fuel cycle or nuclear explosive activities. In 1992, the Nuclear Suppliers' Group included guidelines on transfers of nuclear-related dual-use equipment, material, and technology that could make a significant contribution to an unsafeguarded nuclear fuel cycle or nuclear explosive activity.

- The Zangger Committee (1974) is an informal forum of 36 members. Its purpose is to harmonize the interpretation of nuclear export control policies for States Parties to the Nuclear Non-Proliferation Treaty. The Zangger Committee maintains a Trigger List (triggering safeguards as a condition of supply) of nuclear-related strategic goods to assist countries that are party to this treaty in identifying equipment and materials subject to export controls.
- The Australia Group (1985) is an informal forum of 41 countries that seeks to ensure that exports do not contribute to the development of chemical or biological weapons. The Australia Group Common Control Lists cover chemical weapons precursors, dual-use chemical manufacturing facilities, dual-use biological equipment and related technologies, biological agents, and animal and plant pathogens.
- The Missile Technology Control Regime (1987) is an informal group of 34 countries that seeks to limit proliferation of unmanned delivery systems exceeding a certain payload weight and range. The MTCR Equipment, Software, and Technology Annex is the common list of controlled items agreed on by the countries participating in the Missile Technology Control Regime.
- The Wassenaar Arrangement (1995) has 40 member countries and is focused on transfers of conventional arms and dual-use goods and technologies. The Wassenaar Dual-Use Goods and Technologies and Munitions List contains nine categories of items to be controlled, each consisting of many subcategories and individual items.

The informal nature of these organizations does not create a major impediment to the effectiveness of the four multilateral regimes that are specifically concerned with weapons or technologies of mass destruction, because of the general agreement regarding the need for their control.[33] The same cannot be said of the Wassenaar Arrangement, however. Its members disagree about which countries are states of

[33]See, for example, James A. Lewis' 2005 article, Looking Back: Multilateral Arms Transfer Restraint: The Limits of Cooperation, *Arms Control Today*, Volume 35. Available at: *http://www.armscontrol.org/act/2005_11/NOV-LOOKINGBACK*.

concern—particularly with regard to China—and what constitutes a destabilizing dual-use transfer.[34] For example, despite U.S. protests on the transfer of dual-use technology, the European Union signed an agreement with China in 2003 that allowed China to invest 230 million Euros in the European Union's satellite navigation system.[35] The members of the Wassenaar Arrangement also foster suspicion toward one another. The United States, for example, is concerned that other members do not take national security threats—and hence, export controls—seriously enough, while several of the other members think that the United States is seeking to use export controls to maintain a competitive advantage in high-technology goods. The net result is that the export control systems of the member states have grown increasingly heterogeneous and asymmetrical, with a growing gap between what is controlled by the United States and what is controlled by everyone else, which has in turn put U.S. exporters at an increasing competitive disadvantage. (See Appendix K for a comparison of multilateral dual-use control lists.)

The problems discussed here regarding informal multilateral control regimes—and the Wassenaar Arrangement in particular—do not suggest that they should be abandoned, but point to their inevitable weakness when their members no longer share a strong consensus on the nature or goals of the enemy. In truth, no security-focused multilateral organizations have ever thrived, except at times of strongly shared perceptions of threat, such as during the Cold War. Given that all of these regimes are products of the Cold War, they ought to be redesigned for this globalized world.[36] However, the details of such a redesign are beyond the purview of this report.

The multilateral regimes are not the only venue in which the United States and its allies diverge over controls. For example, U.S. allies continue to press for liberalization of U.S. export defense rules, particularly as these rules adversely affect proposed joint production and procurement activities. The U.S.-U.K. and U.S.-Australia Treaties on Defense Trade Cooperation, if ratified by the Senate, would free up numerous

[34] "The Wassenaar Arrangement at a Glance." Arms Control Association Factsheet, 2007. Available at *http://www.armscontrol.org/factsheets/wassenaar*.

[35] José Carlos Matias, E.U.-China Partnership on the Galileo Satellite System, *Power and Interest News Report*, July 17, 2007. Available at *http://www.pinr.com/report.php?ac=view_report&report_id=665&language_id=1*.

[36] The committee decided not to propose a corresponding recommendation, however, because the report's recommendations are intended to be acted on in the short term.

ITAR goods (articles, services, and related technical data) for export to those two countries. One key objective of these treaties is to enhance foreign participation in the production of the Joint Strike Fighter, a project with close and traditional allies of the United States that was threatened by U.S. export controls.[37]

Because the majority of militarily sensitive technologies and products today are *dual-use* in nature, and many of those that are not multilaterally controlled are available in global commerce from multiple sources, unilateral restrictions can be effective only for the limited number of items for which the United States is the sole supplier, or where it has overwhelming market dominance. A similar logic applies to the exchange of science and engineering information, where today there are only a limited number of fields in which the United States holds a commanding lead such that the bulk of new discoveries or technological advances are coming from U.S. laboratories. In instances in which that might be the case, the relevant laboratories would rarely be staffed exclusively with U.S. citizens, unless they are doing classified work.

The Royal United Services Institute asserts that "the International Traffic in Arms Regulations is the biggest obstacle to trans-Atlantic R&D collaboration in the defence field, and possibly in other fields as well" in its 2007 study, Defence Research and Development in the Atlantic Nations. They cited the F-35 as showing "the weakness of present arrangements. The UK, the leading collaborator with the US, has had increasing and increasingly public difficulties in collaboration with the US, because of the restrictions placed on all US technology transfers to other countries (even of unclassified technology) by ITAR."

SOURCE: Defence Research and Development in the Atlantic Nations. A RUSI European Security Programme Study. Contributions by Graham Jordan CB and Tim Williams. Edited by Alastair Cameron.

Under these circumstances, it no longer makes sense for the United States to attempt to impose unilateral controls across a wide range of dual-use technologies and scientific information. Such policies do not help to advance either U.S. or international security. Instead, they reduce the global competitiveness of U.S. companies and the ability

[37]Note, however, that the Joint Strike Fighter project includes six other partners: Canada, Denmark, Italy, Netherlands, Norway, and Turkey. They will be excluded from the benefits derived from these treaties if ratified.

of U.S. researchers to stay at or near the leading edge of science and technology.

It may be possible for the United States to continue to control, for some limited period, those few fields of science and technology where our companies and research establishments still hold a commanding lead relative to the global competition. There is also a case to be made for maintaining unilateral controls pertinent to a very small number of sensitive research areas that pose a genuine risk of catastrophic terrorism.[38] However, for most areas of science and technology, there are persuasive and urgent reasons to eliminate unilateral controls on dual-use goods and technologies.

FINDING 3

U.S. national security and economic prosperity depend on full global engagement in science, technology, and commerce.

A. Highly capable centers of scientific research excellence and industrial innovation have been developed in many foreign countries over the past 20 years; the United States maintains scientific leadership in some areas, and it is hotly contested or has been lost in others.

B. Global information exchange via the Internet, the increased speed of scientific and technology advancement, and the strategy of "run faster" are all incompatible with our existing systems of regulating the movement of people, ideas, components, and products.

C. The best practices that underpin successful competition in research and technology advancement are undermined by government regulation that restricts the flow of information and people participating in fundamental research.

[38]Some contend that research on pathogenic organisms warrants unilateral controls. However, studies of the dual-use implications of biological research—including the landmark National Research Council's 2004 study, *Biotechnology Research in an Age of Terrorism*—point out that although there are concerns that the scientific community has to take seriously, the government is not and cannot be the appropriate control mechanism. Various self-governance approaches would be more appropriate. Although transfers of pathogenic agents themselves are now subject to strict control in the United States and other countries, controlling the dissemination of research involving these agents is much more problematic for reasons that go beyond the disincentives to control fundamental research in other areas. Building on the recognition that public health is an international responsibility, research on pathogens has long been internationalized. The "bugs," equipment, and expertise are widely available, and the existence of disease as an ongoing human calamity means that constraints on research could mean that people who might otherwise be saved will die.

D. The best scientific talent from outside the United States has been and remains critical to the U.S. research and development enterprise. Maintaining access to this talent depends on visa policies that are welcoming to legitimate and qualified students and researchers.

Breakthrough discoveries in science often come when supporting advancements in related fields have occurred in sufficient numbers or new types of instrumentation have become available. If one researcher or laboratory "misses" a new advance, it is likely that a competitive researcher elsewhere will make the discovery soon thereafter. Also, important discoveries can still be made by an individual scientist working with a small team in a single laboratory, but with increasing frequency, important discoveries are made by scientists who work in teams and who have access to the best work going on in scientific centers around the world and access to state-of-the art instrumentation. Collaboration among individual scientists and laboratory teams is vital.

Maintaining Leadership in Science and Technology

Science has always thrived on open communication and open participation, and it advances most rapidly wherever the environment is most supportive. The frontiers of science have moved from continent to continent throughout history. Only in recent decades has science and technology leadership been centered in the United States. During the period immediately following World War II, the United States became a champion in supporting and funding research as the nation responded to the national imperatives generated by the Cold War and the launch of Sputnik. The National Science Foundation was started, scholarships were created to attract young people to science and engineering programs, the national laboratories were created, and scientific think tanks were developed. Through the remainder of the twentieth century, American scientists and engineers—many of them naturalized citizens—published the most significant papers, won the majority of Nobel and other prestigious science-related prizes, founded the famous technology companies, and filed the most patents.

During the past two decades, virtually all of these conditions have changed. Other nations invested heavily in science and technology, both in industry and in academia, and developed programs to attract young people to these disciplines. Globalization came to science and technology in the same way that it came to manufacturing, although with

somewhat more stealth. In the field of physics, for example, during the ten years from 1997 to 2006, American production of scientific articles published in the American Physical Society's journals declined from 50 percent to 30 percent, with foreign scientists now accounting for the remaining 70 percent.[39] Similarly, in 2006, Americans originated only 50 percent of the total patents filed in the United States, with foreigners originating the remainder.[40] At the present time, the reality of "American science" at its highest levels, under the influences of globalization, is far different from what it was 20 or even 10 years ago.

Multinational Foreign Laboratories and Fabrication Plants

GE: China, Germany, India

IBM: China, India, Israel, Japan, and Switzerland

Intel: China, Germany, Mexico, India, Russia, and Spain

Sun Microsystems: China, Czech Republic, France, Germany, India, Ireland, Israel, Japan, Norway, and Russia

SOURCE: Derived from the following corporate webpages: *http://www.ge.com/research/grc_3.html*, *http://www.research.ibm.com/worldwide/*, *http://techresearch.intel.com/articles/None/1475.htm*, *http://www.oecd.org/dataoecd/32/9/37846828.pdf*. Last accessed July 25, 2008.

Similarly, advanced technology leadership has become global. Japan leads in a number of key technologies such as flat screens, Korea has become a world leader in semiconductor memory, Europe leads in some aspects of telecommunications and embedded systems, and China is increasingly a center for high-technology manufacturing. In addition, U.S.-based multinational companies have developed research and development facilities around the globe, including in China, India, Israel, Eastern Europe, Russia, and South America. Much of this globalization of scientific research and development has been driven by the search for talent, lower staff costs, and market share.

Today, the interaction of U.S. and foreign scientists has global reach and occurs on several levels. Directors of academic departments and research laboratories seek to attract the very best talent from the avail-

[39]American Physical Society, "Physical Review, Physical Review Letters, and ST-AB Published Articles; Geographic Distribution of Corresponding Authors," available from the American Physical Society.

[40]U.S. Patent and Trademark Office, *Patents By Country, State, and Year - Utility Patents: December 2006*, available at *http://www.uspto.gov/go/taf/cst_utl.htm*.

able pool of graduate students, post-doctoral fellows, and more junior researchers, wherever they can be found.[41] The most talented students and researchers push the frontiers of science further and faster. Brainpower is paramount; nationality is irrelevant. A leading American scientist in a cutting-edge field wants the very best scientific colleagues working with him or her regardless of nationality. An outstanding pool of talent working on a problem is the most likely path to significant scientific advancement.

Similarly, in a world in which breakthroughs can happen anywhere, being competitive requires being aware of—and capitalizing on—developments in other places. American scientists benefit from exchanges with their intellectual peers, no matter where those peers are working. Developments in one laboratory may lead to insights that stimulate breakthrough discoveries in other laboratories, and the professional ties that grow through international conferences, exchanges, visits, e-mail communication, and technical interaction with colleagues all over the world maximize the chances of staying abreast of—and advancing—the state of the art. Ease of communication and transportation of people, ideas, material, and equipment are essential for making progress anywhere, and barriers to that movement will impede national technical capability.

In a parallel development, the boundaries separating research, development, and production have been blurring. Science and technology have never quite fit the "linear model" in which research leads to development that leads to production and then to sales and marketing. The innovation process has always been an iterative one with knowledge and incentives flowing in both directions. Science is used to solve problems on the factory floor, and market demand can stimulate initiation of the research needed to develop next-generation products. The acceleration and globalization of science and technology, along with the progressive

[41]Although some contend that the large number of foreign nationals in U.S. science and engineering graduate programs inhibits Americans from enrolling, evidence suggests that low student interest is the stronger explanation. The number of U.S. citizens and permanent residents entering and completing undergraduate degrees in STEM fields has remained stable over the past 20 years (*Rising Above the Gathering Storm*, National Academies Press, 2007, p. 98). Meanwhile, STEM graduate programs have grown from 212 universities producing 18,052 PhDs in 1970 to 339 universities producing 29,951 PhDs in 2000 ("Changing Demographics of U.S. Science-Engineering PhDs," NBER Working Paper No. 10554). Thus, the number of Americans earning college science degrees has remained constant while the size of graduate programs has increased. Furthermore, subsequent studies show that graduate education is far less attractive to Americans than to foreign students ("Changing Demographics of U.S. Science-Engineering PhDs," NBER Working Paper No. 10554).

abandonment of central corporate research laboratories, makes the distinctions among "research," "development," and "production" even less appropriate now than in the previous era.

Speed Is a Critical Factor

As the global scientific community grows larger and more connected, it grows more competitive and dynamic. Introducing unilateral delays into the progress of the U.S. scientific enterprise can be damaging in a globally competitive environment. A new scientific breakthrough, or a newly developed technological capability, can stimulate additional research in laboratories around the world. Although science does depend on the ability of researchers to validate previously published results, the scientific reward system–and the allocation of competitively awarded resources–strongly favors the first to publish. Speed is equally critical in bringing high-technology products to market. In some markets, a considerable percentage of product revenues at a given point in time comes from products that did not exist one year earlier.[42]

The Internet has transformed the conduct of research. In digital form, huge amounts of information can be stored and transferred around the globe at lightning speed. Knowledge can be transferred, overtly or covertly, much more efficiently than was formerly possible. But the Internet continues to transform the conduct of research in ways that transcend its role in the dissemination of information. It has become an essential infrastructure for the conduct of collaborative interchange because it allows researchers in dispersed locations to plan future activities and researchers worldwide to collect, analyze, and forward data taken at remote locations. It greatly facilitates the collaborative interpretation of data and enables the rapid and global dissemination of research results. Instantaneous Web-based communication, in which authors post papers for distributed and ongoing post-publication review and comment, is in many instances replacing the traditional publication model, in which draft papers have to run through such traditional gatekeepers as peer reviewers and journal editors prior to publication in regularly scheduled journals. Some laboratories have gone so far as to maintain their research notebooks in an online *wiki* format, with each day's raw

[42]The DEAC Report, p. 12, citing an example from a corporation in the microprocessor manufacturing business.

data posted to the Web in a form that is accessible to all.[43] Web-enabled research and publication is particularly incompatible with a security review process that depends on time-demarcated milestones such as pre-publication review and formal publication.

The "run faster" strategy served the United States extremely well in winning the Cold War. There is really no alternative strategy in the current competition for knowledge, technology advancement, and economic competitive advantage except to engage on a global level, and to "run faster."

Best Practices that Enable Success in Fundamental Research

Science in the United States has been effective because, for the most part, the following practices governing the conduct of scientific research have been recognized and honored. Maintaining these practices would naturally allow us to become more aware of advancements in science and technology and how they relate to our national security, including how our advancements could be countered by others.

Freedom of inquiry. Subject to limitations in support, scientists are generally free to pursue any question that is of interest. It is often visionary scientific teams that discover paradigm-shifting advances leading to whole new fields of inquiry.

Freedom to pursue knowledge at the scientist's own discretion. Many scientists are interested in unraveling the mysteries of the natural and physical worlds without regard to practical applications. Others pursue opportunities driven by technology shifts, but without a defined end goal. Yet others choose to tackle and solve problems that confront mankind. Experience has shown that expansions of knowledge, as well as opportunity-driven research, often eventually lead to products and processes of great significance to national security or the economy in ways that were never anticipated by those conducting the initial research. For example, those working on the quantum theory of matter in the early twentieth century did not know that their work would lead to the computing and communication capabilities that have transformed the world.

[43]The synthetic biology community is increasingly operating in this mode through use of *Open Wetware,* an open source collaborative online research environment. See Mitchell Waldrop, Science 2.0: Great New Tool, or Great Risk?, *Scientific American online, http://www.sciam.com/article.cfm?id=science-2-point-0-great-new-tool-or-great-risk*. Last accessed January 14, 2008.

Freedom to collaborate without limitation. Open communication among scientists can provide insights into problems and their solutions that otherwise might escape notice. Rapid advances often occur at the interfaces between fields or from the application of advances in one field to a related field. Free and open interaction among scientists serves to open windows of intellectual inquiry that otherwise might remain closed.

Pluralistic and meritocratic support of science. Science in the United States is not guided by a master plan that constrains scientific activity to defined avenues. A variety of federal agencies and philanthropies provide support for research, thus providing some assurance that important areas of work will be funded, even if they depart from the mainstream view. Multiple funding sources and decisions also help ensure that research with implications for a particular organization's mission will be conducted. Similarly, most scientific research funding is administered under a meritocratic review system designed to support the best researchers who propose the best ideas.

Freedom to publish. Science is a cumulative subject in which each scientist builds on the work of others. The fundamental error-correction mechanism of science arises from the replication of work that has been conducted by others, thus enabling mistakes to be exposed. This approach depends on the wide dissemination and open communication of scientific results and methods.

These practices are threatened by government regulation that restricts the flow of information about scientific and technological endeavors and the flow of people participating in research. Indeed, the need to prevent government restrictions from damaging the fundamental research enterprise was recognized as far back as the Truman Administration, and it was codified by President Reagan in 1985 in National Security Decision Directive 189 (NSDD-189). This Directive states that the United States' "leadership position in science and technology is an essential element in our economic and physical security," and that "the strength of American science requires a research environment . . . in which the free exchange of ideas is a vital component."[44] It then goes

[44]CSIS Commission on Scientific Communication and National Security, "Security Controls on Scientific Information and the Conduct of Scientific Research," June 2005, p. 1; available at *http://www.csis.org/media/csis/pubs/0506_cscans.pdf*. Quotations are from National Security Decision

on to direct that "where the national security requires control, the mechanism . . . is classification," and that to the extent consistent with law, "no restrictions may be placed upon the conduct or reporting of [unclassified] federally-funded fundamental research."

Presidential Directives remain in force until supplanted or rescinded, and for this one, neither has happened. In fact, it was explicitly reaffirmed by then-National Security Advisor Condoleezza Rice in 2001. According to the CSIS Commission on Scientific Communication and National Security,

> This Directive does not assert that the open dissemination of unclassified research is without risk. Rather, it says that openness in research is so important to our own security–and to other key national objectives–that it warrants the risk that our adversaries may benefit from scientific openness as well. And even though today's adversaries differ from the ones we faced during the Cold War, the world's scientific and technological landscape has also evolved. Science and technology are global enterprises, and our ability to constrain their adverse application by unilaterally restricting their dissemination is if anything even poorer today than it was when NSDD-189 was issued.[45]

Despite this directive's language barring restrictions on either the *conduct* or the *reporting* of fundamental research, it has not had the effect of precluding all such restrictions. A number of recent reports have addressed the effect that "sensitive but unclassified" information controls, contractual clauses, and "deemed export" controls have had on fundamental university research in the United States, particularly that involving foreign nationals.[46]

The Need for Scientific Talent from Outside the United States

Three parallel developments have increased U.S. dependence on foreign scientific talent. U.S. corporations are shrinking their U.S.-based laboratory infrastructure and are expanding their overseas research capabilities. At the same time, U.S. university-based science

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Directive 189, "National Policy on the Transfer of Scientific, Technical, and Engineering Information," September 21, 1985, a directive that applies to "federally-funded fundamental research in science, technology and engineering at colleges, universities and laboratories."

[45] *Ibid.,* p. 2.

[46] *Ibid.,* as above. Also, see *Restrictions on Research Awards: Troublesome Clauses 2007/2008*. Released July 2008. See also the original version, Association of American Universities/Council on Governmental Relations. 2004. *Restrictions on Research Awards: Troublesome Clauses, A Report of the AAU/COGR Task Force*.

research centers have also become more dependent on foreign talent. And, in the U.S. workplace, foreign scientists and technology specialists are in great demand.

Over the past 20 years, many corporate research laboratory operations within the United States that focused on fundamental research have been reduced in scope or eliminated entirely. The trend more recently has been to locate corporate research and development operations overseas to take advantage of skilled local researchers, lower wages for research work, and eventually, rising product demand in fast-growing economies. In some cases the ability of a corporation to market its products most effectively in a particular country requires placement of a research laboratory or a manufacturing plant in that country. U.S. and multinational companies now have corporate research laboratories located in China, India, Israel, and Europe.

Alcatel and Bell Labs formed a joint venture in China, Alcatel Shanghai Bell. Chinese researchers exploring 4G wireless systems may collaborate with their colleagues in Alcatel's laboratory in Germany. However, export controls preclude the participation of 4G researchers in Alcatel's New Jersey lab.

SOURCE: Dr. Jeong H. Kim, President, Bell Labs at Alcatel-Lucent, The Impact of Export Controls on the US Economy (via teleconference). COSSP Meeting, March 14, 2008.

An American company that locates facilities in other countries is faced with rules that change based on location. For example, work that is conducted by Chinese citizens in a Chinese facility with no technology or knowledge transfers from a parent U.S. firm would not be subject to U.S. controls, regardless of how sophisticated the design or objective. However, two research teams within the same corporation, one in the United States and one in a foreign country, may not be able to collaborate, even on a project involving rather old technology, due to export control regulations. These situations are independent of whether the company has proprietary protections for its research results that would protect the technology from possible diversion outside the company.

U.S. research universities have been expanding overseas, setting up affiliates or branches in Hong Kong, Singapore, China, Europe, and more recently, India and the Middle East. Similarly, universities in the United States are partnering with universities across the globe. Much of this expansion has been proceeding for more than a decade and involves challenging research collaborations. These overseas operations

are beginning to attract scientific research talent in these host countries that prefers to work at home. U.S.-based researchers benefit from collaboration with researchers in these foreign affiliates. But such linkages further complicate the distinctions that must be drawn under existing regulations between U.S. and foreign institutions.

The influence of foreign universities and foreign government laboratories is increasing. Universities around the world now have the capability to compete effectively for scientific leadership against the U.S. science and engineering establishment in many fields. The best foreign universities now have the research equipment and infrastructure to compete with the best U.S. research universities for students and researchers. Where limitations exist on foreigners studying or working in the U.S. system, foreign universities are well positioned to extend competing offers.

Locations of the Top 100 Research Universities

Country	Rankings THES-QS	SJTU
Australia	7	3
Canada	5	4
China	2	
Europe[a]	36	33
Hong Kong	3	
Israel	1	1
Japan	4	4
Korea, South	2	
New Zealand	1	
Russia		1
Singapore	2	
United States	37	54

SOURCES: Times Higher Education Supplement-Quacquarelli Symonds (THES-QS) "World University Rankings 2008" and the Center for World-Class Universities, Shanghai Jiao Tong University (SJTU) "2008 Academic Ranking of World Universities."

[a]Europe includes: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Sweden, Switzerland, and the United

The United States also depends in significant ways on a global scientific and technological workforce at home. The percentage of science and engineering workers in the United States who are foreign nationals increased from 14 percent to 22 percent from 1990 to 2000. In 2006, more than half the doctorate-level graduating engineers in the United States were foreign-born, as were 45 percent of the PhD recipients in the physical sciences, computer sciences, and life sciences.[47]

Access to foreign scientific talent is controlled by U.S. visa policy, which is based on a statute enacted in 1952 (with major amendments in 1965, 1986, and 1990), and on laws related to non-immigrant visas

[47]The DEAC Report, pp. 65-66.

TABLE
International STEM Scholars by Specialization in the United States

Major Field of Specialization	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Growth 2001/07
Health Sciences	23,568	21,070	17,244	19,630	19,590	23,872	1.3%
Biological and Biomedical Sciences	12,558	14,749	19,234	19,271	22,500	19,353	54.1%
Engineering	9,806	9,945	8,871	10,398	11,056	11,789	20.2%
Physical Sciences	12,042	12,052	10,943	11,832	11,735	11,494	-4.6%
Agriculture	2,925	3,287	2,570	3,316	3,006	3,930	34.4%
Social Sciences and History	3,871	3,456	2,736	3,585	3,491	3,635	-6.1%
Computer and Information Sciences	2,838	2,697	3,067	2,779	3,200	2,947	3.8%
Mathematics	2,236	2,276	1,990	2,151	2,231	2,161	-3.4%
Psychology	860	843	995	1,076	1,164	1,474	71.3%
TOTAL	70,704	70,375	67,650	74,038	77,973	80,654	14.1%

SOURCE: Institute of International Education, Open Doors report, 2007.

that were passed after September 11, 2001.[48] The Immigration and Nationality Act of 1952, as amended over the years, governs who may enter the United States. This law is administered by the Department of State, and as of 2003, by the Department of Homeland Security.

The general visa requirements for entry to the U.S. pre-date the current security climate, which is focused on the potential terrorist threats emanating from non-state and substate actors. Formerly, visa restrictions focused on nation-states and defined the risk of admitting a particular person to the United States with reference to that person's country of origin or current residence.[49] Like the export control system, the visa system as it affects visitors who come to the United States for scientific or technological work or study is based on lists.

- The *Technology Alert List* implements the Immigration and Nationality Act and was created during the Cold War to help consular officers identify areas of science and technology in which exports of technology or information might be controlled. The list itself, which sets out general categories of "sensitive" academic disciplines, is no longer made public. But in the recent past, it has included biotechnology, chemical and biomedical engineering, advanced computer and microelectronic technology, marine technology, robotics, and urban planning. Students and researchers seeking to enter the country to study in these areas are specially reviewed.
- The *Visas Condor Program* (established in 2002) also implements the Immigration and Nationality Act. In addition to specific classified criteria, it sets out 25 countries (including China, India, Israel, and Taiwan) from which anyone applying to enter the United States is specially reviewed.[50]
- The *Visas Mantis Program* (established in 1998) focuses on the applicant's proposed activities in the United States that may have security-related concerns.

[48]After the terror attacks of September 2001, visa rules were almost immediately modified by the USA PATRIOT Act of 2001, and subsequently by the Enhanced Border Security and Visa Entry Reform Act of 2002, the Homeland Security Act of 2002, and the National Intelligence Reform Act of 2004.

[49]Then as now, however, the primary determining factor for allowing foreign nationals into the United States for nonpermanent stays is whether the applicant could demonstrate that they planned to return home.

[50]For both the Technology Alert List and Visas Condor program, see *http://www.travel.state.gov/law/legal/testimony/testimony_797.html*.

Like the export control list system discussed above, over time, the visa list system added general categories of academic disciplines or countries of concern, but rarely took any subject or any country off a list. Like the export control regime, the visa restriction system suffers from all the infirmities of a static, list-based system administered by separate and often competing bureaucracies. Consular officials charged with evaluating visa applications often lack the necessary technical or scientific expertise to determine efficiently whether an applicant is a legitimate scientific researcher or poses a security risk. Up to six different agencies[51] may be involved in the visa clearance for a single individual to visit the United States, whether the visit is for a week to attend a conference or for a multiyear stay as a student.

After the September 11, 2001, attacks, the visa regime was tightened. The interagency review process had been based on a system that allowed entry if no agency raised a specific objection within 10 days. The new process requires an affirmative clearance before a visa is issued, regardless of how long the review process takes.

The scientific community—and particularly, the scientific research community—raised a vigorous protest in 2003 over the post-9/11 visa rules because too many legitimate scholars were being caught in the regulatory net.[52] The State Department responded and within two years, the most draconian rules affecting graduate students were ameliorated significantly. Students and exchange visitors applying for non-immigrant visas were given priority, and the duration for students in the United States with Visas Mantis clearances was extended from one year to a maximum of up to four years for students. However, significant barriers still remain for scholars and researchers seeking visas to attend conferences or for other short-term professional trips in the United States.[53]

[51]For example, the U.S. Embassy located in the country where the researcher has applied for a visa, the CIA, FBI, the Departments of Commerce and Homeland Security, and the Department of Treasury's Office of Foreign Assets Control.

[52]The scientific community protested in a House Science Committee hearing on March 26, 2003, and received the Committee's full support. Two weeks later, in a speech at the AAAS Science and Technology Policy Colloquium, John Marburger, the Director of the Office of Science and Technology Policy, also lent his support to addressing these visa issues. For a summary of the hearing, see "House Science Committee Calls for Review of Visa Policy Changes" by Charlene Porter, available at *http://www.america.gov/st/washfile-english/2003/March/20030327161127retropc0.3604242.html,* and for the text of the director's speech at AAAS, see *http://www.ostp.gov/pdf/jhmaaasvisas.pdf*. Accessed October 15, 2008.

[53]One problem stems from the time it takes to fulfill the requirement from the National Intelligence Reform Act of 2004 that 100 percent of all applicants be interviewed.

The uncertainty surrounding the ability of even prominent members of the international scientific community to acquire visas has obvious negative effects.

- Foreign candidates for corporate jobs or university positions go elsewhere. When foreign nationals develop technologies for foreign companies, the United States loses the advantage of determining how those technologies will be developed and deployed.
- The often prohibiting difficulties of foreign researchers to participate in conferences held in the United States causes conference organizers to seek sites outside the United States.
- When entry restrictions exclude or discourage the best foreign researchers from working for U.S.-based companies, the U.S. military may have access to the world's best work only after it is commercialized in a foreign country.

Dr. Goverdhan Mehta—former director of the Indian Institute of Science and the president of the University of Hyderabad, and current president of the International Council for Science, an organization comprising the national scientific academies of 29 countries including the United States—was invited to give a lecture at the University of Florida in 2006. His visa application was initially delayed pending review in Washington to determine "the potential use of his research in chemical weapons." Although the visa was ultimately issued, Mehta withdrew his application and cancelled his trip to the United States.

SOURCE: Available at *http://www.sciencemag.org/cgi/content/full/311/5765/1229a?rss=1*. Last accessed July 22, 2008.

With the need to "run faster" to remain competitive in the global economy, we need to be doing more, not less, to attract the most highly skilled personnel from all over the world to work in the United States. Current law has the perverse effect of permitting foreign students to enter the United States only if they can prove to a consular officer's satisfaction that they will take what they learn home with them. For most categories of prospective student or scholar, anyone who admits that he or she might want to stay in the United States and contribute to this country's technological competitiveness must—by law—be denied entry. Re-examining and re-calibrating visa restrictions would be an important step toward assuring that the United States is the destination of choice for foreign scientists and students, as well as the leading producer of cutting-edge scientific research. The benefits to national

security appear to be negligible from excluding credentialed, recognized foreign scientists, particularly if they are sponsored by a research institution or credentialed U.S. researchers. More important, the damage to U.S. economic prosperity is significant. The government cannot protect U.S. jobs by denying entry to foreign students and researchers. The jobs will simply go elsewhere. The biggest risk to U.S. jobs is a lack of economic competitiveness. Scientific talent working in the United States, from whatever country, promotes the goal of full employment.

FINDING 4

A new system of export controls can be more agile and effective, recognizing that, under current global conditions, risks to national security can be mitigated but not eliminated.

An important caveat attaches to any discussion of changes in the current system of export controls: there is no "risk-free" solution. Today's system is not risk-free either; in fact, it is arguably becoming more and more dangerous because the inclination to equate control with safety gives a false sense of security.

The national security threats facing the United States from potentially hostile nation-states and actively hostile non-state terrorist groups are numerous, diverse, and wide-ranging. We can minimize the risk from these threats, but no system can avoid them entirely. Somewhere, somehow, our nation's protective systems will be breached in the coming years; in virtually all cases, the means to accomplish these breaches exist in open markets worldwide. There is no realistic prospect of controlling all means of doing physical harm that might be used against us.

The United States should not abandon its high walls around the technologies that can deliver a substantial and sustainable security advantage. There should be strong restrictions on technologies critical to the proliferation of nuclear weapons and on physical access to certain biological pathogens; if used for destructive purposes, both can cause catastrophic consequences. Likewise, there should be strong restrictions on those scientific breakthroughs with uniquely military applications. Stealth is one such example.

But where there is a "civilian" use that is commercially relevant for legitimate productivity or consumption purposes in global markets, we should regulate very cautiously. Where technology is internationally accessible, along with a good market potential for products incorpo-

rating that technology, unilateral export controls enforced only by the United States cannot provide any meaningful protection.

U.S. industry is a major source of military equipment for our allies. When export restrictions are injudiciously applied, the result can be to undermine their confidence that the United States will be a reliable supplier of modern arms. And, as a result, it can stimulate the rise of arms production capability outside the United States. Based on their range and payload, unmanned aerial vehicles (UAVs) are classified as cruise missiles under the multilateral Missile Technology Control Regime whose objective is nonproliferation of weapons of mass destruction. U.S. implementation of the regime using severe restrictions has caused frustration among allied militaries and may be encouraging other countries to develop the very technology being restricted.

Unmanned aerial vehicles (UAVs) are relatively inexpensive aircraft, built from current technology. They are well suited to in-theater surveillance where U.S. and allied forces work closely together. However, export regulations restrict export or exchange of information on UAVs by classifying UAVs as cruise missiles based on range and payload. This is yet another case of export regulations authored in a past era impeding military cooperation today.

Under current global conditions, risks to national security can be mitigated, but not eliminated. A careful balance among interests is required, and the burden of proof must be on those who seek to restrict access, rather than the opposite.

* * *

The committee finds that a clear, over-arching statement of national policy can be a useful means of resolving some important bureaucratic conflicts with respect to export controls. National Security Decision Directive 189, in effect since 1985, is an example of this approach and provides an essential building block for a new export control policy. A 1982 study sponsored by the National Academies concluded that government controls on the publication of results from federally funded research were intruding into the conduct of research to a degree that could adversely affect important advances in science in the United States.[54] By Executive

[54]The Corson Report.

Order, then-President Ronald Reagan required that government agencies determine in advance whether the products of federally funded fundamental research would be classified. If classification was not justified, then these research products would remain unrestricted and could be published by the researcher or sponsoring institution. This policy statement provides protection for the publication of much of the research done in academic institutions. This balancing of national security concerns and the benefits of open publication of scientific work has served the nation well.

The committee finds that a final, competent, neutral decision-making body, external to the competing agencies, can also be a useful means of resolving these vexing conflicts inherent in the current system of export controls. This kind of decision-making body can be adapted for the export control system so that both sides, the would-be exporters and the export controllers (or other interested government agencies), can marshal their evidence and a reasoned decision can be made. If favorable to the exporter, a prompt decision would mean that business exporters are not deprived of a market while foreign competitors move in and researcher "exporters" are not deprived of the opportunities to benefit from international collaborations.

The existing system of export controls is not our only alternative. Nor do we have to abandon export controls altogether in the face of global competitive forces. Numerous studies have made more targeted proposals. This report sets out the high-level changes that need to take place by direction of the President before smaller changes recommended elsewhere can be implemented successfully. The committee finds, however, that a better system is imperative and can be accomplished through a single Executive Order setting the system on a path much more protective of both national security and economic prosperity.

III.

Recommendations

In the committee's view, it is important to act immediately, within the boundaries of the President's executive authority, to make the changes that will stem a serious decline affecting broad areas of the nation's security and economy.

RECOMMENDATION 1

The President should restructure the export control process within the federal government so that the balancing of interests can be achieved more efficiently, and to prevent harm to the nation's security and technology base; as well as promote U.S. economic competitiveness.

A. Recognize the interdependence of national security and economic competitiveness factors in making export control decisions with respect to individual requests for licenses through a principle-based system.

B. Apply "sunset" requirements to all items on export control lists that are controlled unilaterally by the United States, and require findings to be made every 12 months that removing controls on an item would present a substantial risk to national security.

C. Establish as a new administrative entity a coordinating center for export controls, with responsibilities for coordinating all interfaces with persons or entities seeking export licenses and expediting agency processes with respect to the granting or denial of export licenses.

D. Establish an independent export license appeals panel to hear and decide disputes about whether export licenses are required, whether particular decisions to grant or deny licenses were made properly, and whether sunset requirements have been carried out properly.

It is necessary to ameliorate the policy logjam that is the unintended consequence of Congress's inaction over dual-use export controls. The new President needs to resolve the long-standing clash between the cabinet departments that are the guardians of national and homeland security interests, broadly defined, and the cabinet departments that are the promoters of national economic interests. It is only at the presidential level that the competing bureaucratic interests of these two areas can be weighed and the current system reformed, so as to stem the decline that so urgently needs attention. This approach is not an attempt to do an "end run" around one of the branches of government, or to short-circuit political debate, but responds to the marked inability of recent Congresses to address this issue.[1] In the absence of legislation, the International Economic Emergency Powers Act of 1977 gives authority to the President to structure the regulatory framework of the dual-use export controls system.

An export control system that was last significantly updated in the 1980s cannot provide the framework to deal with today's security, economic, and technological realities. Congress will eventually succeed in bringing the export control regime into the twenty-first century. But the health of the U.S. scientific and technological enterprise, and the national security imperative to keep abreast of technological developments worldwide, can no longer wait for Congress to overcome the obstacles it has faced in this arena. This report therefore identifies actions that the President can take under existing legislative authority to initiate necessary reforms. Not only will these reforms support economic vitality and promote national security, but they will create a track record and experience base that Congress can evaluate—and modify as it sees fit—at such time as export control legislation can be successfully addressed there.

In the meantime, it will be important to keep Congress apprised of the actions recommended here and their effects, and to maintain a dialogue on the nature of a future package of legislative reforms. In removing the pressure for Congress to take immediate action, the proposals made can facilitate the longer term legislative process.

Restructuring the export control process does not involve abandoning all export controls. Rather, the committee recommends that two policy changes and two structural changes be made in order to retain

[1]See *United States Export Controls* by William A. Root, John R. Liebman, and Roszel C. Thomsen II, 5th edition. Aspen Publishers, 2007, Chapter 1, pp. 9, 11-12.

needed export controls while shedding the largest obstacles to an efficient system. With these changes implemented in an expedient manner, the United States will stem the loss of technological and economic competitiveness and begin to benefit from carefully targeted and calibrated controls that reflect and meet current challenges that the country faces in protecting both our national security and our economic well-being.

Recognize the interdependence of national security and economic competitiveness through a principle-based system.

Our current circumstances require clear articulation of the principles that underlie our export control decisions. The committee recommends that these principles should be:

Maintain the value of protecting traditional U.S. national security in export control policy. Historically, the goals of U.S. export controls have been to deny the transfer of weapons or weapons-related components and technologies to our adversaries, and to ensure the adequate flow of critical supplies during wartime. These goals have been motivated by core national security values: maintaining military advantage on the battlefield and sustaining the homeland. These are and should remain core values of export control policy. Yet by themselves they are no longer sufficient, because they do not reflect the profound changes to our national security environment that have occurred since the end of the Cold War.

Recognize that today this value must be balanced against the equally important value of maintaining and enhancing the scientific and technological competitiveness of the United States. As discussed in Chapter 1, this post-Cold War era has been characterized by four main developments: the rise of new state and non-state adversaries, economic globalization, the diffusion of scientific and technological expertise, and the fraying of the Cold War consensus among the countries of the anti-Soviet West. In this "flatter" world, the United States now has competitors in science and technology and therefore must be able to compete. This is no longer just an economic maxim; it has become a national security imperative. This means that decisions on controlling items or categories of items should consider with equal weight the potential impact of their control on America's scientific and technological competitiveness and military capabilities.

Allow openness and engagement to prevail unless a compelling case can be made for restrictions. Our market economy, our research enterprise, our collaboration with other nations to defend ourselves, and our democratic system of government all rest on a foundation of openness and international engagement. Questions regarding possible controls and restrictions on science and technology must therefore start with a strong presumption for openness.

Articulate a rational basis for each restriction. Given the inefficiencies associated with restricting openness and engagement, such restrictions can be justified only when they can be implemented effectively and when their security benefits specifically outweigh the harm they will necessarily cause with respect to other values and objectives. Therefore, restrictions on an unclassified technology should be implemented only when:

- The United States alone, or the United States and cooperating allies, possess technology that leads not only to identifiable military advantage, but to an advantage that is likely to persist for a significant period of time (i.e., the time needed to field a system based on that technology);
- The United States, or the United States acting together with allies, control the technology such that they can prevent it from moving into the hands of possible adversaries;
- The restrictions do not impose costs and inefficiencies that are disproportionate to the restrictions' security benefits; and
- Restrictions are re-examined and re-justified periodically to ensure they remain appropriate.

Protect the capability to "run faster." Advances in exploiting technology and in furthering research are typically made when the fundamentals in a field of science are understood—a process that generally takes place in the unclassified and the international communities. The U.S. research and development sectors—public and private research labs and industry—must remain better prepared to anticipate and capitalize on research breakthroughs than those who would use these advances to harm us or compete against us economically.

Treat weapons separately—but define them narrowly and precisely. Every government retains the right to decide to whom it wishes to sell munitions—decisions that may not depend on whether other nations agree, or whether there are economic advantages to be foregone. How-

ever, serious complications can result from attempts to treat weapons components, subsystems, and parts as weapons themselves when those subsystems and components draw from a commercial or global technology base. If weapons are to be controlled under a specialized munitions regime, "weapons" must be delineated from everything else, and that definition should not extend weapons controls to broad swaths of technologies with multiple applications.

Recognize the "global public good" nature of health-related technologies. Even if restricting health-related technologies could be argued to impair an adversary's ability to pose deliberate threats to health, such as by developing biological weapons, in many cases, the global ability to counter naturally occurring disease would suffer as well. All countries are threatened when any of them have difficulty containing and treating disease, so such controls would not be in the United States' (or the world's) interests. Therefore, transfer of technologies and substances needed for public health should not be restricted to legitimate recipients such as public health or research organizations.

When the licensing agency applies principles to decisions about export controls, the focus will stay on *why* items should or should not continue to be controlled rather than on adding to otherwise static lists of controlled items. This kind of governance system can assess each decision as to whether an item should be controlled against the governing principles that have been established within the system. Doing so can ensure that the remaining controlled items are relevant to rapidly changing global conditions and can help ensure that decisions are made in a timely manner. [2]

Apply "sunset" requirements to unilaterally U.S. controlled items on export control lists

No version of the current control system should survive without an effective method for pruning items from the control lists when they no longer serve a significant definable national security interest. The

[2]This set of principles provided the basis for a list of principles that could inform the Militarily Critical Technologies List, as requested by the Office of International Technology Security, Office of the Director of Defense Research and Engineering, Office of the Secretary of Defense. See Appendix I for the proposed list of principles.

method for pruning the lists should be disciplined, regularly scheduled, and based on a presumption that a listed item will be removed from control unless a rational justification can be presented for maintaining it on the list. Items from the lists that are classified weapons systems and those for which the Defense Department provides a compelling exemption rationale would remain controlled. However, component parts of weapons, if available on the open market outside the United States, would be eligible for de-control. Thus, for a listed technology that is implemented at multiple levels of capability, the boundary separating what is and what is not controlled should be frequently evaluated and adjusted using the same principle: if a level of implementation of a technology is available on the open market, then it should not be controlled.

The committee recommends a "sunset" rule under which every item on every list that controls exports will be taken off the list at a specified time during each calendar year unless a justification can be presented—consistent with the principles enunciated above—for maintaining the particular item or category on the list. Any party with a governance or economic interest in the decision to keep an item on the list could appeal to the independent appellate body recommended below. The recent report of the Deemed Exports Advisory Committee contains practical suggestions in this regard.[3]

The pruning exercise will be arduous the first time it is conducted. Thus, the most efficient starting point would be the 128 categories of the Commerce Control List that do not appear on lists of the multilateral control regimes (see Appendix J).

The Coordinating Center for Export Controls

The decision-making authority on export control licenses rests with the Department of Commerce and the Department of State. The Department of State's interests cover weapons-related aspects of national security policy, such as non-proliferation and arms control generally, as well as more traditional foreign policy concerns. The Department of Commerce's role focuses on the tradeoffs between national economic performance and security. Both of these departments have responsibility for interfacing with those seeking export licenses. As a result, the public can receive conflicting advice and direction from the two, whose jurisdictions technically do not overlap, but whose practices in implement-

[3]See, for example, Recommendation #2 of the DEAC Report, pp. 21-22.

ing their control regimes frequently lead to conflicts. The committee recommends a "one-stop shop" for export control licensing as far as interacting with the public is concerned. A new administrative entity, the Coordinating Center for Export Controls, would be established.

This small coordinating entity would be responsible for:

- Receiving all applications for export licenses;
- Determining whether the Department of Commerce or the Department of State should handle the license application and dispatch the application to the appropriate place for decision;
- Maintaining timetables for decision making on license applications so that applications do not languish;
- Receiving decisions on applications from the designated agencies and distributing these decisions to applicants;
- Receiving appeals of licensing decisions and petitions for review of sunset decisions, and delivering these to the appellate panel (see description below);
- Maintaining timetables for decisions on appeal;
- Receiving decisions on appeals and distributing these decisions to the applicants;
- Providing administrative support to the appellate panel (see description below); and
- Monitoring and oversight of the sunset process.

The President's Order would give the director of the Coordinating Center for Export Controls signature authority binding on government civil servants supervising the export control entities within the Departments of Commerce and State. Under this mandate, the signature of the director on an order determining which agency—Commerce or State—should handle a particular application would be binding on both agencies. The Coordinating Center would use existing statutory criteria in making its determination as to the agency to which an application should be assigned. The current statutory criteria are sufficient—they are just interpreted differently by the different agencies. With a single Coordinating Center, the determinations under the statutory criteria would be consistent. The President's Order would provide that no agency could deal with an export control application without first having obtained the signature of the director on such a determination. The decision of the Coordinating Center, with respect to which agency handles the application, would not be appealable until the licensing

decision is made. At that time, the "losing" agency could, if it wished, appeal on the grounds that, under existing statutory criteria, it should have had the assignment. At that time, it can also argue how it would have decided the case had it been given the assignment.

The President's Order would give the director the authority to establish default-to-decision orders with respect to timetables for decisions on licensing applications. Thus, for example, the director could establish that if the timetable is not met, the license will be granted automatically on the terms set out in the application. Similarly, the director would have the authority to establish a default-to-decision timetable under which an item would be removed from the control list if the "sunset" process were not completed in a timely manner by the agency. Under a default-to-decision system, the applicant obtains an order that is enforceable (by general order of the President) unless the agency appeals and succeeds before the Appeals Panel.

The agencies that make decisions on licensing applications have established consultative processes with other agencies that may have an interest in the subject matter. Those consultative relationships would remain in place. The President's Executive Order would facilitate the consultative process by providing for additional transparency. The Coordinating Center would publish, on an appropriate website, the receipt and assignment for decision of all applications, the agency decision, and any appeals filed. Matters that require protection with respect to national security concerns would be made known to agencies with relevant jurisdiction through alternative methods established by the director. Transparency in the assignment process will give researchers, corporations, and agencies with ancillary or subject-matter concerns an opportunity to take part in the initial decision-making process of the Departments of Commerce and State. Similarly, transparency in the appeals process will allow persons and agencies that have not been consulted for some reason, or that oppose a particular decision, an efficient forum in which to be heard.

In this way, the current competition between export control-related units of the Department of State and the Department of Commerce can be mitigated by consolidating all public interface into a single entity external to the two operating departments. The new Coordinating Center for Export Controls will serve as a single entry point for all licensing requests. It would then determine the appropriate agency to handle the licensing request, and would pass it on accordingly. The department to which the request has been submitted would give its

decision to the center, which would provide the response to the license seeker. The center would coordinate the appeals process if objections are raised by interested persons or agencies.

The best organizational home for the Coordinating Center would be within the National Security Council (NSC) structure and with the Coordinating Center's director reporting directly to the National Security Adviser. This placement in the White House structure will ensure the independence of the Coordinating Center and establish its relationship to the President. The Coordinating Center would not necessarily be co-located with the NSC, as this would not be required for an effective exercise of its powers under the Executive Order.

The committee weighed several options before making the recommendation for a new coordinating center and locating it and the Appeals Panel within the NSC. There are five such options: (1) do nothing, which would keep things as they are; (2) create an interagency group; (3) establish a group of private sector individuals; (4) create an agency within one of the cabinet departments that has licensing authority, or which plays a role in the licensing process; and (5) establish an independent center with a separate appeals panel that is housed within a government agency that is not directly involved with licensing decisions.

In the committee's view, doing nothing is simply not viable, as discussed above (see in particular Finding 2). Bureaucratic infighting among the departments that are primarily responsible for licensing will not cease until they are compelled to do so. The second option, to create an interagency group, was rejected because experience supports the conclusion that this would devolve into just another debating society and would not constitute a practical means to improve the existing system.[4] The option to establish a group made up of private sector members was rejected because that alternative would not be acceptable to the government agencies involved. The option to place this responsibility with the Department of Defense was rejected, because Defense, through its management of the Militarily Critical Technologies List, is an important player in the export control regime. Similarly, any placement within any cabinet-level department involved in licensing would also compromise

[4]Several attempts were made in the 1990s to create interagency groups to oversee reforms to export control jurisdiction involving commercial satellites and jet engine "hot section" technology. These various groups were unable to come to any consensus and ultimately the NSC "took control of the process" and was able to draw up a consensus in 1996. See Chapter 9 of the 1999 Cox Commission report, *U.S. National Security and Military/Commercial Concerns with the People's Republic of China*.

the independence of the coordinating center. The option to place these administrative functions with the Office of Management and Budget was also considered. Although neither the NSC, nor the Office of Management and Budget is an operational agency, the committee thinks that the NSC is the better fit because of its focus on national security and economic policy. In addition, the chain of command would have the coordinating center's director reporting directly to the National Security Advisor. The advantage of placing these entities within the NSC is that it would signify the importance of these issues, in terms of both national security and economic policy. It would also serve as a brake on the coordinating center's director, in terms of choosing his or her battles carefully.

The Export License Appeals Panel

An independent, neutral decision-making authority is required to break the logjams in the system caused by philosophical differences and varying interpretations of statutory, regulatory, and executive order language. The agencies of government with licensing authority and policy responsibility have become increasingly unsuccessful at producing relatively uniform export-related policy decisions that favor America's national security, war-fighting capabilities, or economy. This has been due in part to classic bureaucratic infighting, but also in part to the characteristic difficulties that large bureaucracies have in responding to changed conditions "on the ground."

Two kinds of issues can be resolved quickly and effectively using an appellate decision-making panel.

- First, if the agency makes a decision either requiring or not requiring a license, and a party or a government agency believes the matter was wrongly decided, there is an avenue to resolve these differences.
- Second, if the agency fails to remove an item or category of items from the control list under the sunset requirement, or does not act at all within the one-year time period for review of each item on the list, an affected party could appeal either to reverse the agency's determination, or to require the agency to act in a timely way to make the necessary determination.

The committee recommends that an independent export license appeals panel be appointed by the President or the National Security

Advisor.[5] Panel members would serve a five-year term. The panel would be co-located with the Coordinating Center and would be housed, for administrative purposes, under the same organizational umbrella. Appeals panels such as this one are not "directed" by an administrative authority. This kind of panel acts independently and neutrally to resolve disputes. It has no operational responsibility other than to hear disputes and issue opinions.

The panel would consist of seven active or retired federal judges, one of whom would serve as chair. Three members would be assigned by the chair to serve on a panel to hear a particular dispute. Using three-member panels selected by lot or in rotation from a seven-member body would help ensure impartiality, immediate availability, and a breadth of expertise. The seven judges selected to serve on the panel would each have significant experience in deciding disputes involving complicated technical matters. As is common in courts on which numerous judges serve, the judges would meet from time to time in conference with all members present to discuss particular issues or processes that needed a unified approach from the panel.

Although the disputes may involve deeply technical issues, the reasons for recommending a body of judges are the following:

First, experienced judges know how to make a decision-making process work efficiently and fairly. If export control decisions can be challenged quickly, involving all interested agencies and parties, there will be less risk of harm to economic competitiveness or national security.

Second, judges understand the inherent advantage of a coherent body of decisions that are consistent and based on principle to the maximum extent possible. The new export control regime recommended by the committee is based on principles that are readily applied in practical decision-making with respect to export controls.

[5]It is at times difficult to get presidential action on appointments in a timely way, particularly at the beginning of an administration when there are many competing concerns. For that reason, the President's Executive Order would allow 90 days from the date of issuance of the Order for the appointments to be made through the presidential process and after that the appointments would be made by the Chief Judge of the federal Court of Appeals for the District of Columbia Circuit within 30 days. Replacement judges would be selected in the same way. No Senate confirmation is required because this is not a "court"; it is an administrative panel assembled by the President to assist agencies in carrying out their responsibilities. This panel makes decisions among competing interests of agencies the same way the NSC staff makes decisions about the competing interests of State and Defense.

Third, this approach provides the best available method for bringing critical technical expertise to bear on the necessary decisions. No appointed body of subject matter experts can encompass all the technical capabilities required to make correct decisions with respect to export controls, because the number of fields is simply too large and the technology at issue changes too often. Judges are very familiar with the need to have active participation and rational argument from researchers, prospective exporters, government agencies, and others who have important interests in correct export control decisions when complex technical questions must be resolved correctly and fairly. Experienced judges know how to deal with the testimony of dueling experts. In rare cases in which party-appointed experts do not suffice, judges will appoint independent experts to give advice and receive amicus briefs from interested persons or agencies who are not parties to the particular dispute.

Fourth, over the years, judges have dealt very successfully with national security concerns and the need for protection of classified information that may bear upon the decision-making process. There are established methods for protecting testimony and records that may involve national secrets. One-time clearances are used by national security agencies for instances in which outsiders need to be brought within the security clearance circle for a special purpose. Special chambers that have been cleared by security agencies are available when classified national security topics must be explored.

Fifth, judges are truly neutral with respect to the kinds of disputes to be resolved within the export control system, and as such are a better option than the available alternatives such as panels of subject matter experts, government officials, or others who bring specific viewpoints to the table.

Under the appeals system, issues would be presented in these ways. (1) An exporter whose license application was denied could appeal to the panel for a reversal of the agency's decision. The agency that denied the application could present written arguments supporting the denial, and any other interested agency or person could present written arguments on either side of the question. (2) An agency that opposed the grant of an export license (by another agency) could appeal, seeking a reversal of the licensing decision. (3) A researcher, research institution,

or exporter whose activities were affected by the inclusion of an item or category of items on one of the control lists could challenge the decision of the responsible agency not to sunset the listing, or could challenge the failure of the agency to act within one year on particular items on the list. Any agency or person who wanted to maintain the item or category of items on the list could present written arguments to that effect. (4) An agency whose processes were adversely affected or whose responsible officials believed that the national interest was adversely affected by a decision to apply a sunset requirement to a particular item from a list could appeal the decision to take the item off the list. As necessary, the panel could hear the testimony of subject matter or national security experts with respect to technical aspects of the issues presented.

The panel will make what might be characterized as "policy" decisions insofar as it is deciding whether a particular item or technology should be exported to a particular end user and, in some cases, whether that end user might reasonably be expected to divert the exported item in a way that is not allowed under U.S. law. However, with the principle-based system recommended by the committee, the general guidance for making these decisions is clarified, and with the participation of all interested parties and agencies, the panel will have before it all the relevant considerations. In the end, almost all governmental decisions are "policy" decisions in one respect or another. An independent, neutral panel of the type recommended can make proper decisions in this regard. Efficient operation of the entire export control regime can happen only if a fair mechanism like this for breaking bureaucratic deadlock is built into the system.

The panel would operate on a part-time basis, meeting only when appeals were pending. The panel would hear a matter within 60 days and issue a decision within 30 days. Like the rule on Presidential vetoes, there would be a default-to-decision rule that if the panel did not act within the required time limits, the decision of the agency would be affirmed. However, judges are accustomed to acting within time limits, particularly in the criminal context where due process requirements dictate a speedy trial, so timely action is unlikely to be a problem. The President's Executive Order would provide that the panel's decision would be final, except for provision for an appeal by any party to the President through the NSC within 15 days when extraordinary issues of national security or economic competitiveness were at stake. Finality of a decision means that the export license is either granted or denied, or

the control-listed item is either continued on the list or taken off the list, upon the issuance of the opinion and the passage of the 15-day appeal period. Exporters granted a license by a decision (or operating under the de-listing of an export item) would need no further action from the agency in order to export. The panel's order would provide the required documentation.

The panel's unclassified hearings would be open to the public and its unclassified rulings would be published on an appropriate website immediately upon issuance so that all interested parties would be informed. Classified hearings and rulings would be summarized in a way that protects classified information and published in that format. This is the same general procedure that judges follow in ordinary cases when materials relevant to a case are sealed to protect minors, for privacy reasons, or for national security concerns.

The committee recommends that the Coordinating Center and the Appeals Panel be put into operation quickly and efficiently so that the necessary changes in the current export control system can get under way without delay. Bureaucratic delays over administrative matters can kill any good idea. These objectives can be met if the Coordinating Center and the Appeals Panel are a relatively inexpensive operation, requiring little institutional support or operational funding. The committee recommends that the two entities be housed together; that the Coordinating Center provide the necessary administrative support for the Appeals Panel so that no separate staff need be assembled for that purpose; and that maximum use be made of digital automated systems for the processing and publishing of matters by both entities. The committee recommends that these new entities be located in space within an existing agency that has no connection to the Commerce Department, the State Department, or the Defense Department, but that is involved in handling and resolving disputes so that the necessary facilities for judicial functions will be available immediately on a part-time basis.

The Federal Trade Commission, the International Trade Commission, and the Department of Justice have well-suited existing facilities, and possibly, the Office of Science and Technology Policy might also be a suitable venue. It is important to assemble the small staff for the Coordinating Center and the panel of judges within a short time and to begin operations right away in "borrowed" facilities. This approach does not require any substantial infrastructure; only a clear mandate, a small transitional budget, and an accelerated timetable for becoming fully operational. This would provide a "neutral" site, not associated with any of

the agencies primarily involved in the export license process. Neutrality is an important aspect of the panel's processes, and having an independent physical location within an agency already set up for appellate proceedings will be a very substantial advantage for the panel in establishing its *bona fides* for all participants in the export control process.

RECOMMENDATION 2

The President should direct that executive authorities under the Arms Export Control Act and the Export Administration Act be administered to assure the scientific and technological competitiveness of the United States, which is a prerequisite for both national security and economic prosperity.

A. Maintain the Fundamental Research Exemption as provided by National Security Decision Directive 189 that protects unclassified research, and ensure that it is properly implemented.

B. Create an economic competitiveness exemption that eliminates export controls on dual-use technologies where they, or their functional equivalents, are available without restriction in open markets outside the United States.

The Fundamental Research Exemption

The President should reaffirm, in its current form, the Fundamental Research Exemption set out in National Security Decision Directive 189. This policy statement has worked well since its inception in 1985.

The policy statement defines fundamental research broadly in these terms:

> "Fundamental research" means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons.[6]

This policy is intended to provide a bright line: if fundamental research is not classified through application of the normal classifica-

[6]See footnote 44, Chapter 2, p. 48.

tion system provided for protection of national security secrets, then its conduct and its reporting should not be restricted. Normally, universities separate their research activities so that only open research is done at campus facilities and any classified research is done at off-campus facilities, or is not undertaken at all.

The committee recommends that the Fundamental Research Exemption be maintained, adhered to, and properly implemented. Universities and other research institutions have worked under this regime successfully and have in place the necessary mechanisms to comply with the exemption.

The Economic Competitiveness Exemption

The committee recommends that a second overarching principle should be incorporated into the export control system by presidential directive. With the development of global markets and very significant scientific and technological centers in foreign countries, the United States can no longer realistically control dual-use items that are, or soon will be, legally available in open markets overseas. Controls on these kinds of items cause far more harm to national security and economic prosperity than they afford protection from threats emerging from foreign sources. When a hostile state or non-state terrorist group can find information or buy components or products on the open market in foreign countries, then the United States gains no significant protection by prohibiting legitimate U.S. companies from exporting these items to legitimate overseas purchasers.

The President should create, by Executive Order, a new Economic Competitiveness Exemption. This exemption would provide as follows:

> It is the policy of this Administration to foster and support the competitiveness of American science and technology on a world-wide basis to the maximum extent possible. Scientific and technological information, components, and products may be controlled for export or deemed-export purposes only if the information, component, or product (1) has received national security classification; (2) has been generated or produced under a federally-funded grant or contract subject to written provisions, agreed at the outset of the grant or contract, restricting export or deemed export; (3) is controlled under standards recommended by a recognized professional body; or (4) has not been published or, by embodiment in a process or product, is not readily available in the open public market outside the United States. Information, components or products that are sufficiently close to becoming available in the open public

> market outside the United States so that it is in the best interests of national economic competitiveness to allow export, may also be exempted. However, nothing in this exemption prevents the Department of State from declaring certain hostile countries, terrorist organizations, or individuals as ineligible to obtain exports from the United States.

The committee's recommendation with respect to the Economic Competitiveness Exemption provides another bright line and takes account of five important factors.

First, as with the Fundamental Research Exemption, this exemption would recognize the primacy of classification for national security reasons. Any information, component, or product that is classified should not be exported (except as part of a country-to-country exchange of classified information, as is currently the case). As pointed out below, the classification system needs an intensive review and overhaul, but that is not the subject of this report. The existing classification system can be accommodated within the committee's recommendations, and the committee does not address any changes in that system.

Second, this exemption would recognize that federally funded programs or projects may be governed by contracts or terms, agreed on by the recipient of federal funds in advance, that impose export controls where the funding agency elects to do so. So long as legitimate and defensible ground rules are established in advance, and the recipient of the federal funds knows that export controls may be imposed, then the choice to accept those controls is freely made.

Third, this exemption incorporates a voluntary corollary to the Fundamental Research Exemption to cover situations in which a protocol recommending constraints has been developed by responsible professional bodies.[7] One example of this kind of voluntary system is

[7]For example, the National Science Advisory Board for Biosecurity proposes that the following criterion be used to describe dual use research of concern: "Research that, based on current understanding, can be reasonably anticipated to provide knowledge, products, or technologies that could be directly misapplied by others to pose a threat to public health and safety, agricultural crops and other plants, animals, the environment, or materiel." *Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential Misuse of Research Information. A Report of the National Science Advisory Board for Biosecurity (NSABB).* June 2007. p. 17. Available at *http://www.biosecurityboard.gov/Framework%20for%20transmittal%200807_Sept07.pdf*. Last accessed July 25, 2008.

the response by the scientific community to the perceived risks associated with gene-splicing research.[8] Another example is the work of the advisory board established to provide reassurance that advances in biotechnology with potential applications for bioterrorism or biological weapons development would receive responsible oversight.[9] When professional bodies develop voluntary standards, the government could use those standards to impose related export controls.

Fourth, when U.S. companies have a competitive edge, and information, components, or products are not yet readily available on the open market overseas[10] but shortly will be, a balancing test would be applied to determine if export is in the best interests of the United States. The determination with respect to a particular export license would rest on considerations such as allowing a U.S. company to become the leader in the field and preempt foreign competition by selling overseas; fostering the use of U.S. products rather than another country's products (so that the content of these products is known in the United States should that become important for homeland security or other national security purposes); or maintaining U.S. competitiveness in a particularly important field.

Fifth, this exemption recognizes that the Department of State must continue to have the option to deny exports for foreign policy reasons to countries whose policies and behavior are considered inimical to the interests of the United States and its citizens and private corporations, as well as to private entities or individuals known to have dealings with hostile states or with terrorist organizations. The Department of State has long had the ability to impose foreign policy export controls, and

[8]This refers to the 1975 Asilomar Conference on recombinant DNA research that led to "specified laboratory practices for constructing and handling recombinant DNA (rDNA) molecules and organisms containing them." Available at *http://www.accessexcellence.org/RC/AB/IE/NIH_Revised_Guidelines.php*. Last accessed June 16, 2008.

[9]The National Science Advisory Board for Biosecurity was established in 2004 "to provide advice and guidance to the federal government regarding biological research yielding information and technologies with the potential to be misused to pose a biologic threat to public health or national security (i.e., dual use research)." Available at *http://www.biosecurityboard.gov/faq.asp#2*. Last accessed June 16, 2008.

[10]Availability as defined in the Export Administration Regulations, part 768.2, states that an item is readily available outside the United States if an item is of "comparable in quality to an item subject to U.S. national security export controls, and is available-in-fact to a country, from a non-U.S. source, in sufficient quantities to render the U.S. export control of that item or the denial of a license ineffective."

these have always been considered to be entirely separate from national security export controls. As such, they neither require nor are they based on the identification of an immediate, demonstrable threat to U.S. national security for their justification.

The Classification System

Both the existing Fundamental Research Exemption and the proposed Economic Competitiveness Exemption recognize the primacy of the classification system. The current classification system is not a subject of this study. However, as a result of its work, the committee notes that it would be very useful to have a presidential commission review of this system, seeking a substantial overhaul as it affects government funding and control of private sector activity. For the private sector, only a very select set of materials and technologies that could threaten the nation's capability to function should be controlled or classified. Beyond this, the committee suggests that there be no assertion of types of control other than classification on the conduct or reporting of science and technology development under either the Fundamental Research Exemption or the Economic Competitiveness Exemption.

The semi-classification systems of "sensitive" information that have previously been known as Sensitive But Unclassified and For Official Use Only also are not a subject of this study.[11] The committee notes that these categories are appropriate only to protect information exchanged between government entities and should not be applied to dealings with the private sector other than through government contracts.

The government contracting system is not a subject of this study. The government may elect to do classified or restricted research as it deems necessary, and universities or corporations may agree to classification restrictions as their own policies dictate.[12] In conjunction with its recommendations in this report, the committee suggests that there should be no ex post facto controls on publication of research; if the work has

[11]On May 9, 2008, the White House released a memorandum on the Designation and Sharing of Controlled Unclassified Information (CUI). Available at *http://www.whitehouse.gov/news/releases/2008/05/20080509-6.html*. Last accessed June 16, 2008.

[12]A memorandum issued in June 2008, by Undersecretary of Defense John J. Young, Jr., states that "DoD will not restrict disclosure of the results of contracted fundamental research, as herein defined, unless the research is classified for reasons of national security, or as otherwise required by statute, regulation, or Executive Order." This memorandum was prompted largely by the National Academies 2007 report, *Science and Security in a Post 9/11 World*. Available at *http://www.fas.org/sgp/othergov/dod/atl062608.pdf*. Last accessed July 21, 2008.

not been classified from the outset, then publication of the work should not be restricted.

RECOMMENDATION 3

The President should maintain and enhance access to the reservoir of human talent from foreign sources to strengthen the U.S. science and technology base.

A. Streamline the visa process for credentialed short-term visitors in science and technology fields.

B. Extend the duration of stay for science and engineering graduates with advanced degrees.

C. Include expert vouching by qualified U.S. scientists in the non-immigrant visa process for well-known scholars and researchers.

D. Institute skills-based preferential processing with respect to visa applications.

Traditionally, the United States had to worry about science and technology flowing out of the country. Under today's conditions, the United States must make sure that advanced science and technology will continue to *flow into* the country. The visa regulations as applied to credentialed foreign scientists should be changed to ensure that the United States. has access to the best talent. Science and engineering degree-holders who prefer, after graduation, to work in the United States, should have ready access to permission for long-term stays. Granting this access for highly trained technical and scientific personnel is an important way of augmenting the workforce. The United States cannot protect U.S. jobs by denying entry to foreign professionals; jobs will simply go elsewhere. It is important to both the national security and to our country's economic prosperity to maintain the flow of human talent into the United States.

Streamlining the Visa Process

The committee recommends the President's Executive Order require that a non-immigrant visa applicant who is a graduate student, researcher, or professional in any field of science or technology, and whose application is supported by a qualified university, scientific body, or corporation receive a determination on the visa application within

30 days.[13] This will allow access for credentialed academic researchers to work with U.S.-based colleagues and in U.S.-based programs, and will facilitate work done in U.S. science laboratories.

Provision of Automatic Extensions

The committee recommends the President's Executive Order provide a one-year automatic visa extension to international students to remain in the United States to seek employment or acceptance into further advanced study on receipt of advanced degrees in science, technology, engineering, mathematics, or other fields of national need at qualified U.S. institutions.[14] If these students are offered jobs by U.S.-based employers and pass security screening measures, they should be provided automatic work permits and expedited residence status. If students are unable to obtain employment within one year, their visas would expire.[15]

Vouching by Qualified U.S. Scientists

The committee recommends that the President's Executive Order allow qualified U.S. scientists to vouch for the technical credibility and legitimacy of visa applicants who are in the same or a similar field as part of the visa process. A more interactive application review procedure would permit those with expertise in the relevant scientific fields

[13]The average wait time for "students and exchange visitors" is posted as 15 days. The Department of State website explains that "Processing wait time DOES NOT include the time required for additional special clearance or administrative processing. These procedures require additional time. Most special clearances are resolved within 30 days of application. When additional administrative processing is required, the timing will vary based on individual circumstances of each case. Processing wait time also does not include the time required to return the passport to applicants, by either courier services or the local mail system (emphasis in the original)." Many students and exchange visitors seeking to come to the United States for short-term scientific research or for a science-themed conference are precisely those most likely to require "additional special clearance." Thus this recommendation seeks to require that which is already common practice. Available at *http://travel.state.gov/visa/temp/wait/tempvisitors_wait_result.php?post=Beijing&x=110&y=19*. Last accessed July 25, 2008.

[14]In proposing an automatic visa extension to advanced international graduates who are not yet employed, this recommendation differs from the *Optional Practical Training Interim Final Rule* (released and implemented in April 2008) that would extend the training period from 12 to 29 months for "available to F-1 students with a degree in science, technology, engineering, or mathematics who are employed by businesses enrolled in the E-Verify program." Available at *http://www.dhs.gov/xnews/releases/pr_1207334008610.shtm*. Last accessed July 25, 2008.

[15]*Rising Above the Gathering Storm*, Action C-5.

(and personal knowledge about the expertise of the individual whose application is being reviewed) to aid consular officials in accurately and efficiently determining the existence of a real security threat.

Skills-Based Preferential Processing for Visas

The committee recommends that the President's Executive Order institute a new skills-based, preferential processing with respect to visa applications. The visa applications of scientists and engineers should be given priority. Graduate-level education and science and engineering skills should substantially raise an applicant's chances and priority in obtaining U.S. citizenship.[16]

[16]*Rising Above the Gathering Storm,* Action C-6.

IV.

Conclusion

Visa regulations and export controls are not issues that provoke the attention of the nation's citizens, and for that reason, have a seemingly "quiet" impact. Nevertheless, the combined effect of these controls over the last 20 years has been to corrode the very institutions they were developed to protect—our national economic security and well-being. We recognize that neither elected officials nor policy makers have incentives to spend political capital on issues that seem arcane and persist below the public's radar screen. However, almost all of these serious problems can be corrected with one Executive Order from the President. For this reason, the committee has undertaken this study from the point of view of a presidential order and has confined its recommendations to the essential elements of such an order. As a nation, we cannot, and should not, abandon well-conceived efforts to keep dangerous technology and scientific know-how out of the hands of those who would use this knowledge to create weapons of mass destruction and other, equally dangerous military systems. However, such knowledge and technology represent a very narrow and limited set of goods, technology, and know-how. Our former unilateral strategy of containment and isolation of our adversaries is, under current conditions, a self-destructive strategy of obsolescence and declining economic competitiveness. A strategy of international engagement is a path to prosperity that can be coupled with a smart approach to security using an adaptive system of government regulation and incentives. The committee recommends the issuance of an Executive Order that implements the recommendations it has outlined as one of the first orders of business in 2009.

Appendix A

Committee on Scientific Communication and National Security Roster

John L. Hennessy (Cochair), President, Stanford University, Stanford, CA
Brent Scowcroft (Cochair), President and founder, The Scowcroft Group, Washington, DC
David Baltimore, President Emeritus and Robert Andrews Millikan Professor of Biology California Institute of Technology, Pasadena, CA
Craig R. Barrett, Chairman of the Board, Intel Corporation, Chandler, AZ
William F. Ballhaus, Jr., Retired, President and CEO, The Aerospace Corporation, El Segundo, CA
Alfred R. Berkeley, III, Chairman, Pipeline Trading, New York, NY
Paul Berg, Cahill Professor of Biochemistry, Emeritus, Stanford University Medical Center, Stanford, CA
Claude R. Canizares, Vice President for Research and Associate Provost, Massachusetts Institute of Technology, Cambridge, MA
Jared Cohon, President, Carnegie Mellon University, Pittsburgh, PA
France A. Córdova, President, Purdue University, West Lafayette, IN
Ruth A. David, President and Chief Executive Officer, Analytic Services Inc., Arlington, VA
Viet D. Dinh, Professor of Law, The Georgetown University Law Center, Washington, DC
Gerald Fink, Whitehead Institute for Biomedical Research, Massachusetts Institute of Technology, Cambridge, MA
John Gage, Partner, Kleiner, Perkins, Caufield & Byers, Menlo Park, CA
John A. Gordon, Independent Consultant, Alexandria, VA

MRC Greenwood (ex officio), Chancellor Emerita, UC Santa Cruz, Chair, Graduate Group in Nutritional Biology, Professor of Nutrition and Internal Medicine, Department of Nutrition, University of California, Davis, Davis, CA
Margaret Hamburg, Senior Scientist, Nuclear Threat Initiative, Washington, DC
John Hamre, President and CEO, Center for Strategic and International Studies, Washington, DC
B.R. Inman, LBJ Centennial Chair in National Policy, University of Texas, Austin, Austin, TX
Adel A.F. Mahmoud, Professor, Department of Molecular Biology, Princeton University, Princeton, NJ
Judith A. Miller, Sr. Vice President & General Counsel, Bechtel Group, Inc., San Francisco, CA
C.D. Mote, President, University of Maryland, College Park, MD
Norman P. Neureiter, Director, Center for Science Technology and Security Policy, American Association for the Advancement of Science, Washington, DC
Elizabeth Rindskopf Parker, Dean, McGeorge School of Law, University of the Pacific, Sacramento, CA
John S. Parker, Senior Vice President, Science Applications International Corp., Alexandria, VA
Suzanne D. Patrick, Independent Consultant, Washington, DC
Phillip A. Sharp, Institute Professor and Director, Center for Cancer Research, Massachusetts Institute of Technology, Cambrdige, MA
Deanne Siemer, Managing Director, Wilsie Co. LLC, Washington, DC
Mitchel B. Wallerstein, Dean, The Maxwell School of Syracuse University, Syracuse, NY

Project Staff

Patricia Wrightson, Study Director
Ryan Zelnio, Research Associate
Mahendra Shunmoogam, Sr. Program Associate (through 12/07)
Pushkar Joshi, Christine Mirzayan Science and Technology Policy Graduate Fellow
Michael Tu, Christine Mirzayan Science and Technology Policy Graduate Fellow

Appendix B

The Committee on Science, Security, and Prosperity Biographies

John L. Hennessy (Cochair)
John Hennessy is the President of Stanford University. He joined Stanford's faculty in 1977 as an assistant professor of electrical engineering. He rose through the academic ranks to full professorship in 1986. He served as chair of computer science from 1994 to 1996 and in 1996 was named dean of the School of Engineering. Dr. Hennessy was inaugurated as Stanford University's 10th president in October 2000. In 2005, he became the inaugural holder of the Bing Presidential Professorship. A pioneer in computer architecture, Dr. Hennessy in 1981 drew together researchers to focus on a computer architecture known as RISC (Reduced Instruction Set Computer), a technology that has revolutionized the computer industry by increasing performance while reducing costs. In addition to his role in the basic research, Dr. Hennessy helped transfer this technology to industry. In 1984, he cofounded MIPS Computer Systems, now MIPS Technologies, which designs microprocessors. In recent years, his research has focused on the architecture of high-performance computers. Dr. Hennessy is a recipient of numerous medals, including the 2000 IEEE John von Neumann Medal and the 2000 ASEE Benjamin Garver Lamme Award. He is a member of the National Academy of Engineering and the National Academy of Sciences, and he is a fellow of the American Academy of Arts and Sciences, the Association for Computing Machinery, and the Institute of Electrical and Electronics Engineers.

Brent Scowcroft (Cochair)
Brent Scowcroft (Lt. General U.S. Air Force–Retired) is the President and founder of The Scowcroft Group. He has served as the National

Security Advisor to both Presidents Gerald Ford and George H.W. Bush. From 1982 to 1989, he was Vice Chairman of Kissinger Associates, Inc., an international consulting firm. In this capacity, he advised and assisted a wide range of U.S. and foreign corporate leaders on global joint venture opportunities, strategic planning, and risk assessment. A graduate from West Point, his 29-year military career in the Air Force included service as Deputy National Security Advisor; as Professor of Russian History at West Point; as Assistant Air Attaché in Belgrade, Yugoslavia; as Head of the Political Science Department at the Air Force Academy; in Air Force Long Range Plans; in the Office of the Secretary of Defense International Security Assistance; as Special Assistant to the Director of the Joint Chiefs of Staff; and as Military Assistant to President Nixon. Out of uniform, he continued in a public policy capacity by serving on the President's Advisory Committee on Arms Control, the Commission on Strategic Forces, and the President's Special Review Board, also known as the Tower Commission. He currently serves on numerous corporate and nonprofit boards. He earned his masters and doctorate degrees in international relations from Columbia University.

Ronald M. Atlas

Ronald Atlas is Professor of Biology and Public Health, and Co-director of the Center for Health Hazards Preparedness at the University of Louisville. He received his BS degree from the State University at Stony Brook, his masters of science and doctorate degrees from Rutgers the State University, and a DSc (honoris causa) from the University of Guelph. He was a postdoctoral fellow at the Jet Propulsion Laboratory where he worked on Mars Life Detection. He is chair of NASA's Planetary Protection Subcommittee, co-chair of the American Society for Microbiology (ASM) Task Force on Biodefense. He previously served as President of ASM, was a member of the NIH Recombinant Advisory committee, was on the Board of Governors of the Council of Graduate Schools (CGS), and was a member of the DHS Homeland Security Science and Technology Advisory Committee. His early research focused on oil spills and he discovered bioremediation as part of his doctoral studies. Later he turned to the molecular detection of pathogens in the environment which forms the basis for biosensors to detect biothreat agents. He is author of nearly 300 manuscripts and 20 books. He is a fellow in the American Academy of Microbiology and has received the ASM Award for Applied and Environmental Microbiology, the

ASM Founders Award, and the Edmund Youde Lectureship Award in Hong Kong.

William F. Ballhaus, Jr.
William Ballhaus is the retired President and CEO of the Aerospace Corporation. Prior to joining Aerospace Corp, Dr. Ballhaus served as Corporate Officer and Vice President, Engineering and Technology at Lockheed Martin Corp. and previously served as president of two Martin Marietta businesses. Before joining Martin Marietta, Dr. Ballhaus served as Director of NASA's Ames Research Center at Moffett Field and Edwards Air Force Base, California, from 1984 to 1989. Dr. Ballhaus published more than 40 papers on computational aerodynamics in the 1970s and 1980s. Dr. Ballhaus is a member of the Defense Science Board and the NOAA Science Advisory Board. He is a member of the National Academy of Engineering and is serving as Vice Chairman of the Space Foundation. Dr. Ballhaus is a member of the International Academy of Astronautics and is an Honorary Fellow of the American Institute of Aeronautics and Astronautics (AIAA) and the Royal Aeronautical Society. He serves on the JPL Advisory Council. Dr. Ballhaus served on the Air Force Scientific Advisory Board from 1994 to 2001 and was board co-chair from 1996 to 1999. Dr. Ballhaus has participated in a number of national-level independent reviews of troubled space and missile programs. He also served on the Defense Science Board study on the Acquisition of National Security Space Programs and on the Missile Defense Agency Independent Review of missile defense system test failures in the mid-2000s. Dr. Ballhaus has won numerous awards and honors.

Alfred R. Berkeley, III
Alfred Berkeley, III is currently Chairman of Pipeline Trading Systems, LLC, an Alternative Trading System for equity block trades. Previously, he was President and then Vice Chairman of the NASDAQ Stock Market, Inc. from May 1996 to July 2003. Prior to NASDAQ, he was managing director and senior banker in the Corporate Finance Department of Alex, Brown & Sons, Inc., financing computer software and electronic commerce companies. Berkeley joined Alex, Brown & Sons in 1972 as a research analyst and became a general partner in 1983. From 1985 to 1987, he served as Head of Information Services for the firm. In that capacity, he was responsible for all corporate information services, including both the firm's back and front office technology. Berkeley then

moved to Alex, Brown's Merger and Acquisition department where, from 1987 to 1989, he developed the firm's technology practice. He is a Trustee of Johns Hopkins University, Kintera, Inc., and Webex, Inc. He is a member of the National Infrastructure Assurance Council and serves on several other non-profit and for-profit boards.

Claude R. Canizares

Claude Canizares is the Vice President for Research and Associate Provost at MIT and the Bruno Rossi Professor of Physics there. He has overall responsibility for research activity and policy at the Institute, overseeing more than a dozen interdisciplinary research laboratories and centers, including the MIT Lincoln Laboratory, the Broad Institute, the Plasma Science and Fusion Center, the Research Laboratory of Electronics, the Institute for Soldier Nanotechnology, the Francis Bitter Magnet Laboratory, the Haystack Observatory, and the Division of Health Sciences and Technology. He oversees several offices dealing with research policy and administration, and he chairs the Research Policy Committee and serves on the Academic Council and the Academic Appointments committee, among others. His service outside of MIT includes the Council of the National Academy of Sciences and the National Research Council (NRC) committees on Science Engineering and Public Policy and on Science Communication and National Security. He is also on the Board of Directors of the L-3 Communications, Inc. Professor Canizares is a member of the National Academy of Sciences and the International Academy of Astronautics and is a fellow of the American Academy of Arts & Sciences, the American Physical Society, and the American Association for the Advancement of Science.

Gail H. Cassell

Gail Cassell is Vice President, Scientific Affairs and Distinguished Lilly Research Scholar for Infectious Diseases, Eli Lilly and Company in Indianapolis, Indiana. She is the former Charles H. McCauley Professor and Chairman of the Department of Microbiology at the University of Alabama Schools of Medicine and Dentistry at Birmingham. She obtained her BS from the University of Alabama in Tuscaloosa and in 1993 was selected as one of the top 31 female graduates of the 20th century. She obtained her doctorate in microbiology from the University of Alabama at Birmingham and was selected as its 2003 Distinguished Alumnus. She is a past President of the ASM. She was a member of the NIH Director's Advisory Committee and a member

of the Advisory Council of the National Institute of Allergy and Infectious Diseases of NIH. She is a member of several boards, including the original Board of Scientific Councilors of the Center for Infectious Diseases, Centers for Disease Control and served as Chair of the Board. She recently served a three-year term on the Advisory Board of the Director of the Centers for Disease Control and as a member of the Secretary of Health and Human Services Advisory Council of Public Health Preparedness. Since 1996 she has been a member of the U.S.-Japan Cooperative Medical Science Program (U.S. State Department and Japan Ministry of Foreign Affairs). She has served on several editorial boards of scientific journals and has authored over 250 articles and book chapters. Dr. Cassell has received national and international awards and an honorary degree for her research in infectious diseases. She is a member of the Institute of Medicine (IOM) of the National Academy of Sciences and is currently serving a three-year term on the IOM Council, the governing board.

France A. Córdova

France Córdova is President of Purdue University. Her career has spanned academia, national research labs, and government organizations: as Professor of Physics, and Vice Chancellor for Research at the University of California, Santa Barbara; as Head of the Department of Astronomy and Astrophysics at the Pennsylvania State University; as Chief Scientist at the National Aeronautics and Space Administration (NASA); and as Deputy Group Leader and Staff Scientist at the Los Alamos National Laboratory. Dr. Córdova's scientific contributions have been in the areas of observational and experimental astrophysics, multispectral research on x-ray and gamma-ray sources, and space-borne instrumentation. She has published 150 scientific papers. Dr. Córdova currently serves on the advisory committee for the National Academies' Policy and Global Affairs Division, and served on numerous committees of the National Academies and governmental agencies. She has been awarded NASA's highest honor, the Public Service medal, and is a year 2000 Kilby Laureate. Dr. Córdova is a National Associate of the National Academies, and is a fellow of the American Academy of Arts and Sciences and the National Science Board. She has degrees from Stanford University and the California Institute of Technology, and an honorary degree from Loyola-Marymount University.

Ruth A. David

Ruth David is President and Chief Executive Officer of Analytic Services Inc., a nonprofit research institute focusing on national security, homeland security, and public safety issues. She initiated a corporate focus on homeland security in 1999 and established the ANSER Institute for Homeland Security early in 2001; today the corporation operates the Homeland Security Institute, a federally funded research and development center sponsored by the Department of Homeland Security, in addition to the ANSER business unit. Before assuming her current position in 1998, David was Deputy Director for Science and Technology at the Central Intelligence Agency (CIA). As technical advisor to the Director of Central Intelligence, she was responsible for research, development, and deployment of technologies in support of all phases of the intelligence process. Dr. David is a member of the National Academy of Engineering (NAE) and currently serves on the NAE Council, as well as several committees of the NRC. She chairs the NRC Standing Committee on Technology Insight—Gauge, Evaluate, and Review (TIGER). She is a member of the Homeland Security Advisory Council, first established to advise the President, and now advising the Secretary of the Department of Homeland Security. She also serves on the National Security Agency Advisory Board, the Hertz Foundation Board, the Wichita State University Foundation National Advisory Committee, and is a member of the Draper Corporation. Previously, David served in several leadership positions at the Sandia National Laboratories, where she began her professional career in 1975. David received a Bachelor of Science degree in electrical engineering from Wichita State University and a Master's of Science degree and a doctorate in electrical engineering from Stanford University.

Gerald L. Epstein

Gerald Epstein is Senior Fellow for Science and Security in the Homeland Security Program at the Center for Strategic and International Studies, where he is working on issues that include biological weapons threats and potential tensions between the scientific research and national security communities. He is also an adjunct professor in the Security Studies Program at Georgetown University's School of Foreign Service. He came to CSIS from the Institute for Defense Analysis, where he was assigned to the Defense Threat Reduction Agency. From 1996 to 2001, he worked at the White House Office of Science and Technology Policy (OSTP), serving for the final year in a joint appointment as

Assistant Director of OSTP for National Security and Senior Director for Science and Technology on the National Security Council staff. Prior to his White House service, he held positions at the Congressional Office of Technology Assessment, Harvard University's Kennedy School of Government, and Princeton University's Woodrow Wilson School of Public and International Affairs. Dr. Epstein is a member of the editorial board for the journal *Biosecurity and Bioterrorism* and serves on the Biological Threats Panel of the National Academy of Sciences' Committee on International Security and Arms Control. He is a coauthor of *Beyond Spinoff: Military and Commercial Technologies in a Changing World* (Harvard Business School Press, 1992) and holds a doctorate in physics from the University of California at Berkeley.

John Gage

John Gage is one of the founders of Sun Microsystems and served as Chief Researcher and Director of the Science Office of Sun until this year. Today, he is a Greentechnology partner at Kleiner Perkins Caufield and Byers, a Silicon Valley venture capital firm that helped create Sun, Google, Netscape, Genentech, Ausra, Bekon, and many other technology pioneers. He was a Fellow at the Kennedy School of Government, in the Joan Shorenstein Center on the Press, Politics and Public Policy. Mr. Gage has served on the Mathematical Sciences Education Board of the National Academy of Sciences, on the Board of Regents of the United States Library of Medicine, and on numerous boards and advisory panels, including those for FermiLabs, NetDay, Schools On-Line, The Markle Foundation Task Force on National Security, the United States Institute for Peace, the Malaysian Multimedia Supercorridor, and the Tegla Loroupe Peace Foundation in Kenya.

B. R. Inman

B. R. Inman (Admiral USN–Ret.) is the Lyndon B. Johnson Centennial Chair in National Policy at the University of Texas at Austin. Admiral Inman graduated from the University of Texas at Austin in 1950, and from the National War College in 1972. He became an adjunct professor at the University of Texas at Austin in 1987. He was selected as the Lyndon B. Johnson Centennial Chair in National Policy in August 2001 and also served as the Interim Dean at the LBJ School of Public Affairs for the 2005 calendar year. Admiral Inman served in the U.S. Navy from November 1951 to July 1982, when he retired with the permanent rank of admiral. While on active duty, he served as Director of the National

Security Agency and Deputy Director of Central Intelligence. After retiring from the Navy, he was Chairman and Chief Executive Officer of the Microelectronics and Computer Technology Corporation (MCC) in Austin, Texas, for four years and Chairman, President, and Chief Executive Officer of Westmark Systems, Inc., a privately owned electronics industry holding company for three years. Admiral Inman also served as Chairman of the Federal Reserve Bank of Dallas from 1987 to 1990. Admiral Inman's primary activity since 1990 has been investing in start-up technology companies such as Gefinor Ventures, where he is now a managing director. He is a member of the board of directors of several privately held companies. He serves as a Trustee of the American Assembly and of the California Institute of Technology. He is a Director of the Public Agenda Foundation and is an elected Fellow of the National Academy of Public Administration.

Anita Jones

Anita K. Jones is a University Professor and the Lawrence R. Quarles Professor of Engineering and Applied Science at the University of Virginia. She came to the university in 1988 to serve as chair of the Department of Computer Science. The Honorable Anita Jones served as the Director of Defense Research and Engineering for the U.S. Department of Defense from 1993 to 1997, where she managed the department's science and technology program. She has served on the boards of several government organizations, including serving as the vice chair of the National Science Board. She is a member of the National Academy of Engineering, the Defense Science Board, the Charles Starke Draper Foundation, the board of trustees of InQTel, the governing board of Science Foundation Arizona, and the MIT Corporation Executive Committee. Professor Jones is a fellow of several professional societies and she has been awarded honorary doctorate degrees by Carnegie Mellon University and Duke University. She has been awarded the Department of Defense Award for Distinguished Public Service, the Ada Lovelace Award from the Association of Women in Computing, and the Founder's Award of the Institute of Electrical and Electronics Engineers. The U.S. Navy named a seamount in the North Pacific Ocean (51° 25′ N and 159° 10′ W) for her.

Judith A. Miller

Judith Miller is Senior Vice President of the Bechtel Group, general counsel, and a member of the board of directors. Prior to joining the

Bechtel Group in 2006, she was a partner with Williams & Connolly LLP. Her practice included a wide range of complex civil litigation and business-related criminal litigation, corporate and individual officer counseling, internal investigations, and issues affecting the defense industry. She returned to the firm in January 2000, after having been the longest-serving general counsel of the Department of Defense (1994 to 1999). As general counsel she had responsibility for advising the Secretary of Defense and his leadership team on the breadth of legal and policy issues that came before the department, including mergers and acquisitions, international affairs and intelligence matters, operations law, acquisition and business reform, major procurements, significant litigation, and investigations. Ms. Miller is the Chair of the American Bar Associations Section on Litigation.

Norman P. Neureiter

Norman Neureiter is the Director of the AAAS Center for Science, Technology and Security Policy, having started the Center at AAAS in 2004 under a grant from the MacArthur Foundation. He received a bachelor's degree in chemistry from the University of Rochester in 1952 and a doctorate in organic chemistry from Northwestern University in 1957. He spent a year (1955 to 1956) as a Fulbright Fellow in the Institute of Organic Chemistry at the University of Munich. In 1957 he joined Humble Oil and Refining Co. (now part of Exxon) in Baytown, Texas, as a research chemist, also teaching German and Russian at the University of Houston. On leave from Humble in 1959, he served as a guide at the U.S. National Exhibition in Moscow, subsequently qualifying as an escort interpreter for the Department of State. In 1963 he joined the International Affairs Office of the National Science Foundation in Washington and managed the newly established U.S.-Japan Cooperative Science Program. Entering the U.S. Foreign Service in 1965, he was named Deputy Scientific Attaché at the U.S. Embassy in Bonn. In 1967, he was transferred to Warsaw as the first U.S. scientific attaché in Eastern Europe with responsibility for Poland, Hungary, and Czechoslovakia. Dr. Neureiter returned to Washington in 1969 as Assistant for International Affairs to the President's Science Advisor in the White House Office of Science and Technology. He left the government in 1973 and joined Texas Instruments (TI), where he held a number of staff and management positions including Manager, East-West Business Development; Manager, TI Europe Division; Vice President, Corporate Staff; and Vice President of TI Asia, residing in Tokyo from 1989 to

1994. After retirement from TI in 1996, he worked as a consultant until being appointed in September 2000 as the first science and technology adviser to the U.S. Secretary of State. Finishing the three-year assignment in 2003, he was made a Distinguished Presidential Fellow for International Affairs at the U.S. National Academy of Sciences and in 2008 was awarded the Academy's Public Welfare Medal.

John S. Parker

John S. Parker (Major General, U.S. Army–Ret.) is Senior Vice President and Technical Fellow, Science Applications International Corporation (SAIC). John S. Parker, M.D., joined SAIC to lead its efforts to support the national homeland defense initiatives in the areas of chemical and biological defense, public health, and bio-surveillance. An expert in biological defense and medical research, Parker recently retired as commanding general of the United States Army Medical Research and Materiel Command (MRMC) in Fort Detrick, Maryland, where he was responsible for the Army's medical research, product development, technology assessment, rapid prototyping, medical logistics management, health facility planning, medical information management, and advanced technology. Dr. Parker held a variety of senior-level positions in the Department of Defense health system during his 37-year career on active duty, including Assistant Surgeon General for Force Protection; Deputy Chief of Staff for Operations, Health Policy and Services; Lead Agent for the Military Health System's TRICARE Region 8; Surgical Consultant to the U.S. Military European Theater Commander-in-Chief; and Commander of Fitzsimons Army Medical Center, Aurora, Colorado. His professional affiliations include Diplomat status in the General Surgery Board and the Thoracic Surgery Board. He is a Fellow of the American College of Surgeons and of the American College of Chest Physicians. Dr. Parker is an Associate Professor of Surgery at the Uniformed Services University of the Health Sciences. He serves on numerous boards and non-profit institutions, with the exception of the National Functional Genomics Center where he serves as chairman.

Suzanne D. Patrick

Suzanne Patrick is a consultant on aerospace, defense, and national security matters. She is the former Deputy Under Secretary of Defense for Industrial Policy. In that position, Patrick was responsible for all decisions regarding mergers and acquisitions, domestic and foreign, affecting the U.S. defense industry; the Department's relations with NATO

defense and aerospace industries; and the overall health of the U.S. defense industrial base. She brought to this position more than 20 years of experience in aerospace industry finance and weapons systems acquisition for U.S. and NATO forces. Patrick began her career at the Naval Air Systems Command as program manager for the Royal Netherlands Navy P-3 antisubmarine warfare aircraft project. She also worked on the staff of the Deputy Chief of Naval Operations (Air Warfare), where she was responsible for all international aviation programs and associated technology transfer issues. In 1985 she joined the staff of the Secretary of the Navy as Deputy Director for the Congressional Liaison and Weapons Systems Acquisition for the Navy's $10 billion research and development budget. From 1987 to 1990, she worked with Sanford C. Bernstein & Co. Inc., providing investment recommendations on the aerospace and defense industry to portfolio managers. Patrick is an honors graduate of Randolph-Macon Woman's College in Lynchburg, Virginia, where she was a George C. Marshall Scholar. She also has a master of arts degree in national security studies from Georgetown University, as well as certificates in international relations and aerodynamic design from, respectively, the Institut d'Études Politiques in Paris and Virginia Polytechnic Institute and State University.

Elizabeth Rindskopf Parker

Elizabeth Rindskopf Parker is Dean of the McGeorge School of Law of the University of the Pacific. Rindskopf Parker joined McGeorge from her position as general counsel for the University of Wisconsin system. Dean Rindskopf Parker's expertise in national security and terrorism comes from 11 years of federal service, first as general counsel of the National Security Agency, from 1984 to 1989; then as Principal Deputy Legal Adviser at the U.S. Department of State, from 1989 to 1990; and as general counsel for the CIA, from 1990 to 1995. From 1979 to 1981, she served as Acting Assistant Director for mergers and acquisitions at the Federal Trade Commission. In addition to this experience managing government legal offices, Dean Rindskopf Parker also served as Director of the New Haven Legal Assistance Association, Inc. While at the international law firm of Bryan Cave, LLP, Dean Rindskopf Parker counseled clients on public policy and international trade issues, particularly in the areas of encryption and advanced technology, U.S.-Sino relations, and nuclear non-proliferation. Dean Rindskopf Parker is a leading expert on anti-terrorism law. Her expertise includes law of national security and terrorism, international relations, public policy and technology develop-

ment and transfer, and commerce and litigation in the area of civil rights and liberties.

Deanne C. Siemer

Deanne Siemer is Managing Director for Wilsie Co. LLC, Washington D.C., and works primarily in the field of corporate and government strategy consulting. The company provides consulting advice with respect to strategic planning, options, including risk assessment and valuation of potential outcomes, and management of strategic alternatives. Wilsie Co. also provides pro bono consulting services to public service organizations. Prior to joining Wilsie Co. in 1995, Ms. Siemer was in private law practice for 15 years as a partner at the Washington, D.C., firm of Wilmer, Cutler & Pickering and in the Washington office of Pillsbury Winthrop Shaw Pittman. She also serves as a neutral mediator, evaluator, and arbitrator in court-sponsored and private assignments. Her government experience includes service as General Counsel, Department of Defense; special counsel to the President of the United States; consultant to the Department of Justice; and economist, Office of Management and Budget. Her responsibilities as general counsel included defense procurement, oversight of foreign intelligence and counter-intelligence activities within the Defense Department and coordination with other agencies, and management of the defense justice system. For her service at the Defense Department, Ms. Siemer was awarded the Secretary of Defense medal for Distinguished Public Service. Since returning to the private sector, she has undertaken representation and consulting assignments with respect to defense and intelligence matters. Ms. Siemer is an elected member of the American Law Institute and serves as a trustee of the National Institute for Trial Advocacy. She has published 12 books in the fields of strategy, trial practice, and post-World War II political history.

Mitchel B. Wallerstein

Mitchel Wallerstein is Dean of the Maxwell School of Citizenship and Public Affairs of Syracuse University and Professor of Political Science and Public Administration. Before joining the Maxwell School, Dr. Wallerstein was Vice President of the John D. and Catherine T. MacArthur Foundation, where he directed the Program on Global Security and Sustainability. He served from 1993 to 1997 as Deputy Assistant Secretary of Defense for Counterproliferation Policy and Senior Defense Representative for Trade Security Policy. For his contributions, he was

awarded the Secretary of Defense medal for Distinguished Public Service in 1996, and The Bronze Palm to that award in 1997. Prior to joining the Department of Defense, Dr. Wallerstein was the Deputy Executive Officer of the National Academies' NRC. While at the NRC, he directed a series of highly acclaimed studies for the U.S. government on national security export controls. Earlier in his career, Dr. Wallerstein served on the faculty at MIT, and from 1991 to 1997, he was an adjunct professor at the Paul H. Nitze School for Advanced International Studies of the Johns Hopkins University; and he was Distinguished Research Professor at the National Defense University from 1997 to 1998. Dr. Wallerstein is the author of numerous books, articles, and reports on technology and national security matters. He is a member of the Council on Foreign Relations and the International Institute for Strategic Studies, and a Fellow of the National Academy of Public Administration.

Appendix C

Background on the Roundtable/ Commission on Scientific Communication and National Security

In partnership with the Center for Strategic and International Studies, the National Academies in 2003 established the Roundtable on Scientific Communication and National Security, representing a broad cross-section of the national security and scientific communities. The Roundtable provided a structured opportunity for the identification and discussion of the challenges posed by the potential conflicts between openness in science and requirements for enhanced national security. The roundtable format—a neutral discussion forum—enabled members of diverse and sometimes opposing institutions to engage in a continuing dialogue, and it provided them with the opportunity to build ongoing relationships that could, over time, facilitate collaboration. Consistent with National Academies' policy, the roundtable did not make policy recommendations.

At the same time, the Commission on Scientific Communication and National Security was created at the Center for Strategic and International Studies with the same membership. Acting independently of the Roundtable, the Commission had the objective of generating actionable recommendations for public policy. The Commission produced two White Papers: *Security Controls on Scientific Communication and the Conduct of Scientific Research* (June 2005) and *Security Controls on the Access of Foreign Scientists and Engineers to the United States* (October 2005).[1]

[1]Available at *http://www.csis.org/media/csis/pubs/0506_cscans.pdf* and *http://www.csis.org/media/csis/pubs/051005_whitepaper.pdf*.

GOALS

The roundtable convened four times over a two-year period to discuss and study these issues as well as other urgent and ongoing issues associated with the central relationship between advancements in science and the preservation of security. The specific aims of the collaboration were:

- To foster dialogue between the science and technology and security communities as part of the process of formulating national policies regarding scientific collaboration and communication;
- To establish a focal point for unbiased and deliberative consideration of solutions to the dilemmas posed by balancing the need for open scientific communication with the need for protecting national and homeland security; and
- To propose policy-relevant research and analysis in this area.

David Baltimore, then President of the California Institute of Technology, and Harold Brown, former Secretary of Defense, co-chaired both the roundtable and the commission. The roundtable was dissolved in spring 2005 and was reconstituted the following fall as the Committee on Scientific Communication and National Security, a standing committee of the National Research Council. David Baltimore and Robert Gates, then President of Texas A&M University, co-chaired the committee until May 2007 and December 2006, respectively.

Appendix D

Recent Studies and Initiatives Outside the National Academies

U.S. GOVERNMENT

Congressional Export Control Working Group (Congress)

The *Defense Trade Controls Performance Improvement Act of 2007* (H.R. 4246), as amended, is now Subtitle A of Title I of the *Security Assistance and Arms Export Control Reform Act of 2008* (H.R. 5916). Sponsored by Donald Manzullo (R-IL), Reps. Bradley Sherman (D-CA), Joseph Crowley (D-NY), and Roy Blunt (R-MO).

Congressional Research Service

The Export Administration Act: Evolution, Provisions, and Debate, Updated January 9, 2008, Ian F. Fergusson, Specialist in International Trade and Finance, Foreign Affairs, Defense, and Trade Division, RL31832.

Foreign Science and Engineering Presence in U.S. Institutions and the Labor Force, Updated July 2008, Christine M. Matthews, 97-746.

Military Technology and Conventional Weapons Export Controls: The Wassenaar Arrangement, Updated September 29, 2006, Richard F. Grimmett, Specialist in National Defense Foreign Affairs, Defense, and Trade Division, RS20517.

Deemed Export Advisory Committee, a technical advisory committee of the Bureau of Industry and Security, Department of Commerce, Washington, D.C.

The Deemed Export Rule in the Era of Globalization. Released December 20, 2007.

Executive Office of the President

Presidential Export Controls Directive to "ensure that U.S. defense trade policies and practices better support the National Security Strategy of the United States, " January 21, 2008.

Government Accountability Office

Export Controls: Challenges with Commerce's Validated End-User Program May Limit its Ability to Ensure that Semiconductor Equipment Exported to China Is Used as Intended. Report to the Committee on Foreign Affairs, House of Representatives. Released September 2008.

Export Controls: State and Commerce Have not Taken Basic Steps to Better Ensure U.S. Interests Are Protected. Testimony Before the Subcommittee on Oversight of Government Management, the Federal Workforce, and the District of Columbia, Committee on Homeland Security and Governmental Affairs, U.S. Senate. Released April 2008.

Defense Trade: State Department Needs to Conduct Assessments to Identify and Address Inefficiencies and Challenges in the Arms Export Process. Report to the Committee on Foreign Affairs, House of Representatives. Released November 2007.

Defense Technologies: DOD's Critical Technologies Lists Rarely Inform Export Control and Other Policy Decisions. GAO-06-793. Washington, D.C.: July 28, 2006.

Export Controls: Improvements to Commerce's Dual-Use System Needed to Ensure Protection of U.S. Interests in the Post 9-11 Environment. GAO Report 06-638. Washington, D.C.: June 2006.

Export Controls: Issues to Consider in Authorizing a New Export Administration Act. GAO-02-468T. Washington, D.C.: February 2002.

Nonproliferation: Strategy Needed to Strengthen Multilateral Export Control Regimes. GAO-03-43. Washington, D.C.: October 2002.

U.S.-U.K. and U.S.-Australia Defense Trade Cooperation Treaty

Signed by administration in 2007 and currently pending ratification in the Senate.

NONGOVERNMENTAL ORGANIZATIONS

American Association for the Advancement of Science. Washington, D.C.

"Recommendations for Enhancing the U.S. Visa System to Advance America's Scientific and Economic Competitiveness and National Security Interests." Released May 2005.

Association of American Universities/Council on Government Relations. Washington, D.C.

"Restrictions on Research Awards: Troublesome Clauses 2007/2008." Released July 2008.

Center for Strategic and International Studies. Washington, D.C.

"Toward a U.S. Export Control and Technology Transfer System for the 21st Century," May 15, 2008.

"Briefing of the Working Group on the Health of the U.S. Space Industrial Base and the Impact of Export Controls," February 2008.

"Trusted Partners: Sharing Technology within the U.S.-U.K. Security Relationship," May 26, 2006.

"Security Controls on the Access of Foreign Scientists and Engineers to the United States," October 2005.

"Security Controls on Scientific Information and the Conduct of Scientific Research," June 2005.

Center for International and Security Studies, University of Maryland

Controlling Dangerous Pathogens. Authors: John D. Steinbruner, Elisa D. Harris, Nancy Gallagher, Stacy M. Okutani. Released March 2007.

Coalition for Security and Competitiveness (a coalition of trade associations and related organizations, including the U.S. Chamber of Commerce)

Letter to the President on Export Control Modernization, March 2007.

Defense MOU Attachés Group (DMAG)

The DMAG's Vision of the Ideal U.S. Export Control Regime, 2008.

The Hudson Institute, Washington D.C.

Export Controls and Technology Transfers: Turning Obstacles into Opportunities. Author: Maria Farkas. Released 2007. Report from the conference *Defense Coalitions and the Global Character of the New Defense Industry*, Hudson Institute, December 6, 2006.

Institute for Defense Analysis, Alexandria, VA

Export Controls and the U.S. Defense Industrial Base. Project leader: Richard Van Atta. Released January 2007.

NAFSA: Association of International Educators, Washington, D.C.

Restoring US Competitiveness for International Students and Scholars. June 19, 2006.

NATO Industrial Advisory Group (NIAG)

2007-2008 Study on Transatlantic Defence Industrial Cooperation.

RAND Corporation, Santa Monica, California

U.S. Competitiveness in Science and Technology. Authors: Titus Galama, James Hosek. Released June 2008.

Security Defense Agenda in Brussels

Cutting through the Transatlantic Tangle of Defence Equipment Export Controls, an SDA Monthly Roundtable Report, January 2007.

Appendix E

Principal Studies Sponsored by the National Academies That Address the Impact of National Security Controls on the Conduct of Science and Technology

TABLE 1 Summary of Areas of Recommendation for National Academy Reports (1982-2007)

NRC Report	Bio-security	Classifi-cation	Export Controls	Risk Assess-ment	Scientific Commu-nication	VISA Controls
Space Science and the International Traffic in Arms Regulations (2008)		√	√	√	√	
Science and Security in a Post 9/11 World (2007)	√		√	√	√	√
Globalization, Biosecurity, and the Future of the Life Sciences (2006)	√				√	
Critical Technology Accessibility (2006)						
Rising Above the Gathering Storm (2005)			√			√
Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States (2005)						√

continued

TABLE 1 Continued

NRC Report	Bio-security	Classifi-cation	Export Controls	Risk Assess-ment	Scientific Commu-nication	VISA Controls
Assessment of Department of Defense Basic Research (2005)		√			√	
Avoiding Surprise in an Era of Global Technology Advances (2005)						
Seeking Security: Pathogens, Open Access, and Genome Databases (2004)	√		√		√	
Biotechnology Research in an Age of Terrorism (2004)	√		√		√	
Making the Nation Safer: The Role of Science and Technology in Countering Terrorism (2002)	√	√		√		
Balancing Scientific Openness and National Security Controls at the Nuclear Weapons Laboratories (1999)		√			√	
Understanding Risk: Informing Decisions in a Democratic Society (1996)				√		
A Review of the Department of Energy Classification Policy and Practice (1995)		√		√		

continued

TABLE 1 Continued

NRC Report	Bio-security	Classifi-cation	Export Controls	Risk Assess-ment	Scientific Commu-nication	VISA Controls
Finding Common Ground: U.S. Export Controls in a Changed Global Environment (1991)			√			
Global Trends in Computer Technology and Their Impact on Export Control (1988)			√			
Balancing the National Interest: U.S. National Security Export Controls and Global Economic Competition (1987)			√			
Scientific Communication and National Security (1982)			√		√	

Appendix F

U.S. Government Agency Jurisdiction and Export Decision Tree

The following two tables are reprinted by permission from the book: United States Export Controls, Fifth Edition by William A. Root, John R. Liebman, and Roszel C. Thomsen II (Aspen Publishers, 2007)

TABLE 1-1
U.S. Government Agencies Controlling Exports

Agency	*What Is Controlled*	*Statutory Authority*	*Regulations*
Department of State	Munitions	Arms Export Control Act	22 C.F.R. § 120 *ff.*
	Visas		22 U.S.C. § 2751 *ff.*
Department of Treasury OFAC	"COCOM-proscribed" destinations	Trading with the Enemy Act 50 U.S.C. App. 5	31 C.F.R. § 500
	Cuba	International Emergency Economic Powers Act 50 U.S.C. § 1701 *ff.*	31 C.F.R. § 505
	Narcotics Traffic		31 C.F.R. § 515
	Sudan		31 C.F.R. § 536
	WMD proliferators		31 C.F.R. § 538
	Iran		31 C.F.R. § 539
	Rough Diamonds		31 C.F.R. § 560
	Specially designated global Terrorists		31 C.F.R. § 592
	Specially designated terrorists		31 C.F.R. § 594
	Foreign terrorist organizations		31 C.F.R. § 595
Nuclear Regulatory Commission	Nuclear equipment and materials	Atomic Energy Act 42 U.S.C. § 2011 *ff.*	31 C.F.R. § 597
Department of Energy	Nuclear weapons	Atomic Energy Act 42 U.S.C. § 2011 *ff.*	10 C.F.R. § 110
	Restricted Data		10 C.F.R. § 810
	Sensitive nuclear technology	Natural Gas Act	10 C.F.R. §§ 205.300-379
	Natural gas	Federal Power Act	10 C.F.R. § 590
	Electric energy		

TABLE 1-1 (CONTINUED)
U.S. Government Agencies Controlling Exports

Agency	*What Is Controlled*	*Statutory Authority*	*Regulations*
Department of Justice/BATF	Munitions imports and Firearms exports	18 U.S.C. § 40	27 C.F.R. §§ 447, 478, 479
Department of Justice/DEA	Narcotics and dangerous drugs	Controlled Substances Import and Export Act 21 U.S.C. § 951 *ff.*	21 C.F.R. §§ 1312, 1313
Environmental Protection Agency	Hazardous wastes	Resource Conservation and Recovery Act 42 U.S.C. § 6938 *ff.*	40 C.F.R. § 262.50 *ff.*
	Listed chemicals	Toxic Substances Control Act 15 U.S.C. § 2611(b)	40 C.F.R. § 707.60
	Insecticides, pesticides	Federal Insecticide, Fungicide, and Rodenticide Act 7 U.S.C. § 1360(a) & (b)	40 C.F.R. § 168.75
Consumer Product Safety Commission	Hazardous substances	Consumer Product Safety Act	16 C.F.R. § 1010 16 C.F.R. § 1019
		Federal Hazardous Substances Act 15 U.S.C. §§ 1191, 1193	15 U.S.C. § 2067 15 U.S.C. § 126
Food and Drug Administration	Foods, drugs, biological products, devices	FDA Export Reform and Enhancement Act	21 C.F.R. § 312.110

		Drug Export Amendments Act of 1986 21 U.S.C. § 301 *ff.* 42 U.S.C. § 262	
Department of Agriculture	Tobacco seeds and plants	Tobacco Seed and Plant Exportation Act 7 U.S.C. § 516 *ff.*	
Department of Interior	Endangered fish and wildlife	16 U.S.C. § 1531 *ff.* 16 U.S.C. § 703 *ff.* 16 U.S.C. § 668	50 C.F.R. § 17.21 *ff.*
Department of Transportation	American carriers		44 C.F.R. § 403
Maritime Administration	Vessels		46 C.F.R. § 221
Patent and Trademark Office	Patent applications for filing in a foreign country	35 U.S.C. §§ 6, 181 *ff.*	37 C.F.R. § 5
Various	Classified information		Executive Order 12,356
Various	Technical data		Contractual restrictions
Department of Commerce BIS	All other	International Emergency Economic Powers Act 50 U.S.C. § 1701 *ff.*	15 C.F.R. §§ 710-774

TABLE 1-2
U.S. Jurisdiction Not Exercised[1]

Type of Transaction	*Portion Uncontrolled*	*15 C.F.R. §*	*22 C.F.R. §*
a) Export from U.S.	Publicly available technology and software[2]	734.3(b)(2,3) 744.6(a)(2,3) 732.2(b)(1)	125.1(a,b) 125.4(b)(13) 124.1(a) 124.13(e)
	To Canada[2]	738 Supp. 1 742.11(a), 742.13(a)(1) 744,754	126.5(b)
	To USG agency	740.11(b)(2)(i,ii)	126.4
	In-transit[2]	740.9(b), 736.2(b)(8)[3]	
	Returned to source	740.9(b)	125.4(b)(7)
b) Transfers within U.S.		764.2(h)[3] 772 Transfer	120.17(2-5)[2]
c) Reexport of U.S. origin	Between Switzerland and Liechtenstein	740.16(g)	
	Return to U.S.	740.16(e)	
	To Canada	740.16(f)	
	From or to former COCOM, Austria, Finland, Hong Kong, Ireland, South Korea, New Zealand, Sweden, or Switzerland	740.16(a, b)	
	Computers to Computer Tier 1	740.7(c)(2)	

	To Rwanda by other than a U.S. person	746.8(b)(1)	
d) Retransfer in a foreign country		764.2(a)[3] 744.6(a)(1)[3]	123.10(a)[3]
e) Reexport of U.S. components	Less than specified U.S. content	734.4[2]	
f) Reexport of product of U.S. technology		736.2(b)(3)[3]	
g) Export of non-U.S.-origin from foreign country	If not controlled by Treasury and missile or CBW use not known	744.6(a)(2,3)[3] 744.6(b)[3]	

[1] Commerce License Exceptions or no license required (NLR) provisions included in Table 1-3 (and others omitted from that Table because not constituting broad transaction types) are still "subject to the EAR" with respect to export clearance requirements and to the possibility of recontrol through suspension or revocation of the License Exception or NLR.

[2] Subject to some restrictions.

[3] Describes exercised jurisdiction.

TABLE 1-3
Decision Tree to Determine Agency Jurisdiction

1) Is the proposed transaction any of the types listed in Table 1-2?
   - If yes: It is not subject to U.S. export controls.

2) If no: Is it
   a) a visa application?
   b) refusal by a U.S. person to do business with a boycotted country?
   c) supporting trade with a targeted country?
   d) classified information? or
   e) subject to a restriction in a U.S. government contract?
   - If yes: It is subject to the jurisdiction of the following:
     (a) State,
     (b) Commerce,
     (c) Treasury or Commerce,
     (d) State or Energy, or
     (e) Agency which established the contractual restriction. It may also be subject to another export control.

3) If no: Is it
   a) an export of non-U.S.-origin by a U.S. person from any foreign country to Cuba, Iran, or Sudan; or for a known missle or CBW use?

TABLE 1-3 (CONTINUED)

b) an export arranged by a person in the United States of an item subject to controls under the Arms Export Control Act or the Atomic Energy Act from a country neither a former-COCOM-member nor a cooperating country to a former COCOM-proscribed country or Cambodia?

→ If yes: Treasury, State, NRC, **Energy, or Commerce.** It may also be subject to a control administered by the exporting country.

4) If no: Is it an export from a foreign country of U.S. content in a foreign-made product:

a) to North Korea, Cuba, Iran, Sudan, or Libya, and more than 10% U.S.-origin content? or

b) to any other destination and more than 25% U.S.-origin content?

c) controlled for national security reasons, being exported to a former COCOM-proscribed destination, Cambodia, Cuba, Iraq, or Libya or and the direct product of U.S.-origin technology or software?

d) the direct product of encryption items eligible for License Exception ENC 740.17(a)(1) or (b)(1)?

→ If yes: It is subject to Commerce jurisdiction, but may be eligible for a Commerce License Exception or no license required (NLR) provision. It may also be subject to a control administered by the exporting country.

TABLE 1-3 UNITED STATES EXPORT CONTROLS

TABLE 1-3 (CONTINUED)

5) If no: Is it a retransfer in a foreign country affecting an end-user or end-use specified in the approval of an export from the U.S.?

If yes: It is subject to the jurisdiction of the agency which approved the export from the U.S. It is unlikely to be subject to a control administered by the exporting country. It is likely that country would not recognize U.S. jurisdiction.

6) If no: Is it a transfer, whether in the United States or abroad, to a foreign person of
   a) an aircraft, vessel, or satellite on the U.S. Munitions List?
   b) technical data on that List?
   c) a defense service described on that List? or
   d) an item on that list to a foreign embassy or other agency of a foreign government?

If yes: State.

7) If no: Is it a transfer whether in the United States or in a foreign country of software source code or technology not on the U.S. Munitions List?

If yes: It is subject to the jurisdiction of Commerce (or both Commerce and Energy), but it may be eligible for a Commerce License Exception or NLR. It is unlikely to be subject to a control by the foreign country where the

TABLE 1-3 (CONTINUED)

transfer takes place. That country is likely not to recognize U.S. jurisdiction.

8) If no: Is it a reexport of a U.S.-origin item from a foreign country to Sudan or, if of specified items, to Iran?

If yes: Treasury or Commerce. It is unlikely to be subject to a control by the exporting country. That country is likely not to recognize U.S. jurisdiction.

9) If no: Is it a reexport from a foreign country of a U.S.-origin commodity or of U.S.-origin technology or software other than:
   a) to the U.S.?
   b) to Canada, except for items shown on the Control List as requiring a license to Canada or for end–user or end–use controls described in 15 CFR § 744?
   c) from and authorized by a former COCOM participating country, Austria, Finland, Hong Kong, Ireland, New Zealand, Sweden, or Switzerland controlled for national security reasons; not subject to nuclear, chemical, biological, missile, significant item (SI), or crime control export controls; and either to a former COCOM-proscribed destination or to a country not embargoed, not formerly COCOM-proscribed, and not controlled for nuclear, chemical and biological, or missile reasons, provided a license is not required to a former COCOM member?

TABLE 1-3 UNITED STATES EXPORT CONTROLS

TABLE 1-3 (CONTINUED)

d) to or among former COCOM participating countries, Austria, Finland, Hong Kong, Ireland, New Zealand, Sweden, or Switzerland of a commodity which is not controlled for nuclear or missile reasons?

e) between Switzerland and Liechtenstein?

If yes: It is subject to the jurisdiction of Commerce, although it may qualify for a Commerce License Exception or NLR. Whether or not it qualifies for a Commerce License Exception or NLR, it may be subject to a control administered by the exporting country.

10) If no: Is it an export from the U.S. to Iran or Sudan?

If yes: Treasury.

11) If no: Is it:

a) Natural gas or electric energy?

b) Tobacco seeds or plants?

c) Endangered fish or wildlife? or

d) Patent application for filing in a foreign country?

If yes: It is subject to the jurisdiction of the following:

a) Energy,

b) Agriculture,

c) Interior, or

d) Patent & Trademark Offfice.

TABLE 1-3 (CONTINUED)

12) If no: Is it:
- a) Nuclear equipment or materials?
- b) Nuclear technology?
- c) Drugs or hazardous substances?

→ If yes: It may be subject to the jurisdiction of the following:
- a) NRC,
- b) Energy, or
- c) BATF, EPA, CPSC, FDA, or DEA.

13) If not controlled by NRC or Energy: Is it
- a) a defense article on the U.S. Munitions List? or
- b) arguably on both the U.S. Munitions List and the Commerce Control List?

→ If yes: State.

14) If no: Is it a transaction of any type intended to evade an export control?

→ If yes: It is subject to the control it is intended to evade.

15) If no: Is it non-U.S.-origin in transit through the U.S. and qualifying for 15 C.F.R. § 740.9(b)?

→ If yes: No U.S. control.

16) If no: Is it an export from the United States:
- a) to Canada, other than for the items shown on the Control List as requiring a license to Canada or for end-user or end-use controls per 15 C.F.R. § 744? or
- b) personal or official use by U.S. Government personal or agencies per 740.11(b)(2)(i,ii)?

→ If yes: No U.S. control.

TABLE 1-3 UNITED STATES EXPORT CONTROLS

TABLE 1-3 (CONTINUED)

17) If no: Is it an export from the United States to a foreign country?

If yes: It is subject to Commerce jurisdiction, although it may be eligible for a Commerce License Exception or NLR.

18) If no: No U.S. control.

Appendix G

Possible Topics for Future Research

1. Determining Global Leadership in Military Critical Scientific Fields. The list of specific technologies or areas of scientific research in footnote # 6[1] (repeated below) is at best a snapshot of America's lost dominance, for how, when, and where scientific advances occur has become fluid in today's globalized world. What are the standards that should be used to determine whether a country is leading in a militarily critical field of science or technology? What are the political, military, and economic impacts for the United States in particular, of losing or gaining dominance in a particular area of science and technology?

2. Envisioning Multilateral Regimes for a Post-Cold War Era. Current multilateral export control regimes are legacy agreements based on Cold War threats. Specifically, these regimes are built around the assumption of unanimity among participating countries, a coherent enemy with easily predicted technological shortcomings, and technology bases for commerce and defense that are predominantly separate rather than interconnected. The realities of today's world undermine these assumptions and, by extension, threaten the viability of multilateral regimes built with the old system in mind. Multilateral regimes remain an essential pathway

[1]Footnote #6 (Chapter 2, p. 21): The 2007 report to Department of Commerce Secretary Carlos Gutierrez from the independent Deemed Export Advisory Committee (hereafter referred to as the DEAC Report) has listed the following areas in which the United States has lost its scientific and engineering leadership: "polymer composites (Germany), 3D optical memories (Japan), bulk metallic glass (Japan), biostatistics/multivariate statistics (France), population biology (UK), adaptive dynamics (Germany/Switzerland), theoretical biology (Netherlands), and solar energy (Japan/Germany)." The DEAC Report, p. 11.

to ensure national security, but their focus, structure, and application should be evaluated and reformed in light of current realities.

3. An "Immune System" to Replace the "Hermetic Seal." Ashton Carter has described the U.S. strategy of keeping secrets during the Cold War as a "hermetic seal" model: denying "technology to others by seeking to put an impermeable barrier around the American defense technology base."[2] In a globalized world, he explains, militarily critical technology advances occur "outside the barrier as well as inside" and therefore it is no longer in the U.S. interest to try to build a hermetic seal. He recommends an "immune system" model "that can sense dangers and combat the most dangerous ones selectively." What would it mean to operationalize this idea? What steps are necessary for implementing such a system, and what will it look like in application? Is this the way to build "high walls around narrow areas" in a globalized world?

4. Sharpening the distinction between weapons and their dual-use applications. The structure of today's export controls, both multilateral and unilateral, depends upon categorizing technologies in two broad categories: munitions and dual-use. Significant gray areas between the two complicate export controls, lengthen and confound licensing procedures, and there remains a lack of a clear framework that separates a munition from its related dual-use technology. Better understanding of the term "munitions" and the controls that must be applied to them, which lie on the other side of this contention, would aid our clarification of the system as a whole. Closer study and the development of clarified working definitions for "munitions" and "dual-use" as they apply to export controls is necessary to clarify and expedite any and all export control regimes that are built upon either or both of these definitions.

5. Streamlining the Government Classification System. Following the terror attacks of 2001, the default practice has become to classify government data. While a rather-safe-than-sorry approach is prudent, overclassification weakens the system.[3] In addition, the use of the "sensitive

[2] *Keeping the Edge: Managing Defense for the Future*. Edited by Ashton Carter and John P. White. Cambridge, MA: The MIT Press, 2001.

[3] As Justice Potter Stewart said during the Pentagon Papers case, "when everything is classified, then nothing is classified, and the system becomes one to be disregarded by the cynical or the careless, and to be manipulated by those intent on self protection or self-promotion." Available at *http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB48/supreme.html*. Accessed October 29, 2008.

but unclassified" (SBU) designation introduces additional confusion that can potentially lead to adverse results, including publication restrictions and a less robust scientific foundation in the very areas that need to be understood. Reconsideration of the application of SBU designations, and other aspects of the system, is necessary to ensure the integrity and effectiveness of government classification system as a whole.

6. Global Supply Chains and Militarily Critical Technologies. What are the critical technologies that have global supply chains? How dependent is the United States on the foreign components in critical technologies? How interconnected is the global community that designs and produces the components that go into American systems?

Appendix H

ITAR and CCL Control Lists by Category

The U.S. Munitions List, administered by the Department of State, is divided into 20 categories:

1. Firearms, Close Assault Weapons and Combat Shotguns
2. Guns and Armament
3. Ammunition/Ordnance
4. Launch Vehicles, Guided Missiles, Ballistic Missiles, Rockets, Torpedoes, Bombs, and Mines
5. Explosives and Energetic Materials, Propellants, Incendiary Agents, and their Constituents
6. Vessels of War and Special Naval Equipment
7. Tanks and Military Vehicles
8. Aircraft and Associated Equipment
9. Military Training Equipment
10. Military Electronics
11. Protective Personnel Equipment
12. Fire Control, Range Finder, Optical and Guidance and Control Equipment
13. Auxiliary Military Equipment
14. Toxicological Agents, Including Chemical Agents, Biological Agents, and Associated Equipment
15. Spacecraft Systems and Associated Equipment
16. Nuclear Weapons, Design and Testing Related Items
17. Classified Articles, Technical Data and Defense Services Not Otherwise Enumerated
18. Directed Energy Weapons
19. [Reserved]

20. Submersible Vessels, Oceanographic and Associated Equipment
21. Miscellaneous Articles

The Commerce Control List, administered by the Department of Commerce, is divided into 10 categories:

0 = Nuclear Materials, Facilities and Equipment (and Miscellaneous Items)
1 = Materials, Chemicals, Microorganisms and Toxins
2 = Materials Processing
3 = Electronics
4 = Computers
5 = Telecommunications and Information Security
6 = Sensors and Lasers
7 = Navigation and Avionics
8 = Marine
9 = Propulsion Systems, Space Vehicles, and Related Equipment

Each category is then divided into 5 product groups:

A. Systems, Equipment and Components
B. Test, Inspection and Production Equipment
C. Material
D. Software
E. Technology

Appendix I

Principles to Underpin the Militarily Critical Technologies List (MCTL)

Alan E. Haggerty, former Deputy Undersecretary of Defense, International Technology Security, asked COSSP to examine and recommend principles to underpin the MCTL. The committee derived the following principles from those outlined in Recommendation 2:

1. Justify and limit each restriction: Restrictions can be justified only when they can be implemented effectively and when their security benefits clearly and specifically outweigh the harm they will necessarily impose to other values. Therefore, restrictions on a technology—which should include consideration of classification—should be implemented only when
   a. The United States alone, or the United States and cooperating allies, possess technology that leads not only to identifiable military advantage, but to an advantage that is likely to persist for many years (i.e., the time needed to field a system based on that technology);
   b. The United States, or the United States acting together with allies, control the technology such that they can prevent it from moving into the hands of possible adversaries;
   c. The restrictions do not impose costs and inefficiencies that are disproportionate to the restrictions' security benefits;
   d. Restrictions are re-examined and re-justified periodically to ensure they remain appropriate.
2. Define technologies narrowly and precisely: Serious complications can arise from treating system components, subsystems, and parts as critical technologies themselves when those subsystems and components draw from a commercial or global

technology base. If a technology is to be defined as militarily critical, the system must be clearly delineated from everything else, and that definition should not extend controls over broad swaths of technologies with multiple applications.

3. Partner with Allies: The United States needs to create a basis for cooperative control of shared technology with friendly nations, that assures that timely agreement can be reached on what to control, and that all relevant parties have control systems that are as secure as our own. If controls on shared technology cannot be agreed and implemented on a multilateral basis, they cannot be effective.
4. Run faster: Advances in exploiting technology and in furthering research are typically made when the fundamentals of a field are understood, a process that takes generally place in the unclassified and the international communities. The United States must prevent technological surprise by being better poised to anticipate and capitalize on research breakthroughs than those who would use these advances to harm us or compete against us economically. The leading technology edge for militarily critical technologies should be delineated and re-examined on a periodic basis.

Appendix J

Export Control Legislation in the 110th Congress

1. H.R. 6828: Export Control Improvements Act

Sponsor: Rep. Brad Sherman (D-CA)
Cosponsors: Rep. Judy Biggert (R-IL), Rep. Donald Manzullo (R-IL), Rep. Adam Smith (D-WA), Rep. Gerald Weller (R-IL)

H.R. 6828 was introduced before the House on August 1, 2008, and was referred to the House Committee on Foreign Affairs the House Committee on Homeland Security. The bill did not make it out of committee.

H.R. 6828 would require electronic filing of export data through the Automated Export System, would set up conferences with mandatory participation by the secretaries of State, Defense, Homeland Security, and Treasury for information sharing and exporter education, would establish Automated Export System electronic registration for license filers, and would set up a judicial appeal process for contesting license decisions.

2. H.R. 5916: Security Assistance and Arms Export Control Reform Act

Sponsor: Rep. Howard Berman (D-CA)
Cosponsors: Rep. Joseph Crowley (D-NY), Rep. Donald Manzullo (R-IL), Rep. Ileana Ros-Lehtinen (R-FL), Rep. Brad Sherman (D-CA)

H.R. 5916 was introduced before the House on April 29, 2008. The bill passed in the House of Representatives on May 15, 2008, by voice vote.

The Senate referred the bill to the Senate Committee on Foreign Relations, but no subsequent action was taken.

H.R. 5916 directs the President to conduct a comprehensive review of the export controls system by March 31, 2009. H.R. 5916 attempts to improve license review by setting time limits for the review process, by capping the number of allowable unprocessed applications, and by allowing special licensing for spare and replacement parts to NATO, Australia, Japan, New Zealand, Israel, and South Korea. H.R. 5916 also authorizes a review of the United States Munitions List to possibly add additional controls.

3. H.R. 3633: To provide for export controls of certain times relating to civil aircraft

Sponsor: Rep. Donald Manzullo (R-IL)
Cosponsors: Rep. Todd Akin (R-MO), Rep. Earl Blumenauer (D-OR), Rep. Dan Burton (R-IN), Rep. Russ Carnahan (D-MO), Rep. Joseph Crowley (D-NY), Rep. Jeff Flake (R-AZ), Res.Com. Luis Fortuño (R-PR), Rep. Phil Hare (D-IL), Rep. Darlene Hooley (D-OR), Rep. Michael McCaul (R-TX), Rep. Ted Poe (R-TX), Rep. Ileana Ros-Lehtinen (R-FL), Rep. David Scott (D-GA), Rep. Adam Smith (D-WA), Rep. Ellen Tauscher (D-CA), Rep. Diane Watson (D-CA)

H.R. 3633 was introduced before the House on September 24, 2007, and was referred to the House Committee on Foreign Affairs. The bill did not make it out of committee.

H.R. 3633 moves export control on civil aircraft, aircraft engines, and propellers, and all components and related technologies, to Export Administration Act authority. These items would then be relieved of military export controls under the Arms Export Control Act.

4. S. 3563: To authorize appropriations under the Arms Export Control Act and the Foreign Assistance Act of 1961 for security reasons for fiscal years 2009 and 2010, and for other purposes

Sponsor: Sen. Christopher Dodd (D-CT)
(no cosponsors)

S. 3563 was introduced on September 24, 2008, and referred to the Senate Committee on Foreign Relations. The original measure was then reported by committee to the Senate on September 24 and placed on the Senate Legislative Calendar, but no vote was ever taken.

S. 3563 casts a wide net in improving reporting and safeguards. S. 3563 would increase appropriations for administering the Arms Export Control Act, for overseeing IAEA safeguard, and for global pathogen surveillance. In addition, S. 3563 includes provisions for international military education and foreign assistance and authorizes payments for the International Space Station.

5. S. 2000: Export Enforcement Act of 2007

Sponsor: Sen. Christopher Dodd (D-CT)
(no cosponsors)

S. 2000 was introduced on August 3, 2007, and referred to the Senate Committee on Banking, Housing, and Urban Affairs. The bill did not make it through committee.

S. 2000 primarily deals with penalties through two provisions: (1) setting a five-year statute of limitations for proceedings involving civil penalties and other sanctions; and (2) subjecting items lawfully seized to forfeiture. S. 2000 also amends the Export Administration Act to place the Office of Foreign Availability under the Under Secretary of Commerce for Industry and Security.

Appendix K

Commerce Control List Overlap with Multilateral Agreements

Heading	Technology	Total ECCN	Various Export Control Regimes													
			WML		WDUL		MTCR		IAEA		AG		EU-DUL		CCL Only	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%
0	Nuclear Materials, Facilities & Equipment (and Miscellaneous Items)	36	3	8%	0	0%	0	0%	15	42%	0	0%	13	36%	19	53%
1	Materials, Chemicals, Microorganisms, and Toxins	124	22	18%	25	20%	42	34%	54	44%	13	10%	86	69%	26	21%
2	Materials Processing	76	5	7%	15	20%	21	28%	32	42%	12	16%	47	62%	23	30%
3	Electronics	46	0	0%	17	37%	6	13%	13	28%	0	0%	32	70%	14	30%
4	Computers	19	0	0%	7	37%	3	16%	0	0%	0	0%	9	47%	11	58%
5a	Telecommunications	15	0	0%	4	27%	3	20%	0	0%	0	0%	7	47%	8	53%
5b	Information Security	7	0	0%	4	57%	0	0%	0	0%	0	0%	4	57%	3	43%
6	Sensors and Lasers	52	0	0%	20	38%	16	31%	10	19%	0	0%	33	63%	18	35%
7	Navigation and Avionics	40	4	10%	17	43%	33	83%	2	5%	0	0%	34	85%	4	10%
8	Marine	13	3	23%	8	62%	0	0%	0	0%	0	0%	8	62%	4	31%
9	Propulsion Systems, Space Vehicles and Related Equipment	71	16	23%	29	41%	48	68%	1	1%	0	0%	57	80%	11	15%
	TOTAL	**499**	**53**	**11%**	**146**	**29%**	**172**	**34%**	**127**	**25%**	**25**	**5%**	**330**	**66%**	**141**	**28%**

NOTE: Export Control Classification Numbers (ECCNs) are listed in accordance with the numerical index of the Commerce Control List (CCL). Entries with overlap on the Wassenaar Munitions List (WML), Wassenaar Dual-Use List (WDUL), Missile Technology Control Regime (MTCR), International Atomic Energy Agency Trigger List and Nuclear Suppliers Group (IAEA), Australia Group (AG), and EU Common Dual-Use List (EU-DUL) were then denoted and counted. The percent of overlap was determined (a) within each of the 10 ECCN headings within the CCL; and (b) for the entire CCL as a whole. ECCNs with no overlap and that are represented only on the CCL were then identified and similarly enumerated. ECCNs were taken from the EAR Commerce Control List Supplement No. 1 to Part 774—Index 49 ("Numerical Index to the Commerce Control List") dated November 5, 2007. Data for WML, MTCR, IAEA, and AG overlap were taken from Appendix 4-2 ("Cross-References Between Multilateral and U.S. Item Numbers") in Root, Liebman, and Thomsen, United States Export Controls, 5th edition with 2007 Supplement. Items not appearing in this reference were investigated independently for overlap using the most recent list of controlled technologies for each multilateral agreement. Cross-referencing for WDUL and EU-DUL was done manually and was based upon the conformity in the numbering systems of these lists with reference to the CCL.