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Washington, D.C. 20505

5 September 2018

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Sincerely,

Allison Fong
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Enclosures

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Intelligence Science Board
Task Force Report

on

The State of Science and Technology Analysis in the Intelligence Community

April 2004

Office of the Director of Central Intelligence
Washington, D.C. 20505

This report is a product of the Intelligence Science Board (ISB).

The ISB advises the Director of Central Intelligence and senior Intelligence Community leaders on emerging scientific and technical issues of special importance to the Intelligence Community. Statements, opinions, conclusions and recommendations in this report do not necessarily represent the official position of any agency of the Intelligence Community.

This report is SECRET/[redacted] (b)(3)

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The Director of Central Intelligence
Washington, D.C. 20505

NIC

[redacted] (b)(3)

5 February 2003

MEMORANDUM FOR: Deputy Director of Central Intelligence for Community Management

FROM: Lawrence Gershwin
National Intelligence Officer for Science and Technology

SUBJECT: Intelligence Science Board Study on Science and Technology Analysis [redacted] (b)(3)

1. (U//FOUO) I request the formation of an Intelligence Science Board Task Force to address issues related to maintaining an adequate science and technology (S&T) analysis work force and capability for the Intelligence Community. Since the end of the Cold War, the number of S&T analysts in the IC has decreased dramatically, and the threat to national security comes from an ever-increasing number of state and non-state actors. Currently, much information concerning foreign S&T resides in the public sector.

2. (U//FOUO) The proposed study will help us make decisions on allocating resources related to S&T analysis. I have reviewed and approve the attached Terms of Reference.

[redacted] (b)(3)

Lawrence Gershwin

Attachment:
As stated

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Approved for Release: 2018/09/04 C01223258

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TERMS OF REFERENCE
INTELLIGENCE SCIENCE BOARD TASK FORCE
SCIENCE AND TECHNOLOGY ANALYSIS CAPABILITY

(U//FOUO) The Intelligence Science Board (ISB) is requested to establish a task force to address the issues related to maintaining an adequate science and technology (S&T) analysis work force and capability for the Intelligence Community (IC).

(U//FOUO) Since the end of the cold war, the number of S&T analysts in the IC has decreased dramatically, and the threat to national security comes from an ever-increasing number of state and non-state actors. Currently, much information concerning foreign S&T resides in the public sector. Technological advances with security implications, such as information technology, nanotechnology, and biotechnology, are driven by the commercial market and commercial research and development (R&D) funds. The global economy tends to disperse this cutting edge technology to all parts of the world, creating a much different and potentially more dangerous environment than that which existed during the relatively well-defined Cold War years.

(U//FOUO) There have been a number of recent studies and reviews performed by the IC to define and address the level of S&T analysis, such as work of the Science and Technology Intelligence Committee (STIC) and programs such as the Science and Technology Expert Partnership (STEP). The capability to do the necessary intelligence S&T analysis in the current environment will require a combination of knowledgeable IC analysts and access to the commercial S&T community.

(U//FOUO) The S&T Analysis Task Force should:

- Review the current status of the S&T analysis work force using information recently generated by the IC.
- Analyze the appropriate role for the S&T intelligence analyst in today's global environment with its complex and well-paid technology work force.
- Analyze an appropriate manpower level for S&T analysts in the IC.
- Construct and assess appropriate paradigms to meet S&T analysis capability needs for the IC. Consider the STEP process, MEDEA, and other means to provide the IC requisite S&T capabilities.

(U//FOUO) This study will be sponsored by the National Intelligence Officer for

 (b)(3)

Science and Technology (NIO/S&T). The Task Force should convene in February 2003 and report its results within six months with interim briefings as appropriate. Task Force reports shall be submitted to the NIO/S&T with copies provided to the Director of Central Intelligence (DCI), the Deputy DCI for Community Management, the Assistant DCI for Collection, the Assistant DCI for Analysis and Production, and the Director, DS&T.

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[redacted] TASK FORCE MEMBERSHIP (b)(3)

[redacted] *TASK FORCE MEMBERS* (b)(3)

[redacted]

RAND Corporation (b)(3)
Raytheon (b)(6)
NTI
CENTRA Technologies, Inc.
NGIC, STIC
Los Alamos National Laboratory

[redacted] *PARTICIPANTS* (b)(3)

[redacted]

The MITRE Corporation (b)(3)
The MITRE Corporation (b)(6)

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Approved for Release: 2018/09/04 C01223258

[redacted] EXECUTIVE SUMMARY (b)(3)

[redacted] *INTRODUCTION* (b)(3)

[redacted] Dr. Lawrence Gershwin, National Intelligence Officer (NIO) for Science and Technology, tasked the Intelligence Science Board (ISB) to review the state of Science and Technology (Intelligence) (S&T(I)) within the Intelligence Community (IC), including issues related to the work force. (b)(3)

[redacted] In the years following the end of the cold war the threat from a single bad actor (the Soviet Union) has been replaced by a threat to national security from an ever-increasing number of state and non-state actors, many with current or near-current access to weapons of mass destruction (WMD)—or perhaps weapons of mass hysteria (WMH). Technology has become the engine for global change, with the most important drivers (information technology (IT), biotechnology, nanotechnology, advanced materials, etc.) being pursued by global commercial enterprises. This raises new concerns about advanced technology in the service of foreign intelligence and terrorism in non-weapon ways (communications, covert influence, collection, dissemination, etc.). Much of the information about technology development and potential applications is reported in the open press, further complicating the S&T(I) analysts' mission, even while the actual number of S&T(I) analysts has decreased significantly in the last decade. (b)(3)

[redacted] With this as a background, the ISB S&T(I) Task Force was asked to examine the state of S&T analysis, to determine the adequacy of the current S&T(I) work force in terms of rough numbers of analysts, and to investigate the need for any new paradigms to address S&T(I) analysis capabilities in the current and future threat environments. The Task Force was also charged with developing recommendations that the IC could readily implement. (b)(3)

In the main body of this report we demonstrate why technology is such an important driver in national security affairs. We review the many actions taken and programs generated by the IC to address S&T analysis across the board. With respect to commercial technologies we observe that if the IC does nothing fundamentally different it will continue to provide little of use to its consumer base in current intelligence and do nothing to reduce the probability of technological surprise. (Technological surprise is defined as both the application of known technologies in unexpected ways and the use of unforeseen technological breakthroughs not under U.S. control.) In fact, considering the complexity of commercial technologies, the lack of expertise in these technologies within the IC S&T(I) community, and the rapid pace of technological advances, the United States is more likely to be surprised than ever before. Moreover, all this is occurring in today's threat environment, characterized by multiple, dispersed, unpredictable adversaries with demonstrated ability to apply commercially available technology to meet their particular needs and with increasing access to WMD and WMH and their delivery systems. (b)(3)

With respect to the more conventional military S&T(I), where most information is classified, we review the current numbers of analysts and the new tools and programs now available to analyze them. The IC has recently established new initiatives to develop a better understanding of the numbers and capabilities of the S&T(I) work force using state-of-the-art information technology tools that should provide a clearer picture of the IC's S&T(I) census and areas of coverage. (b)(3)

We commend the IC for the many initiatives it has taken to strengthen S&T across the board. Many of our basic recommendations were actually made by the IC in the Director of Central Intelligence's (DCI's) 1999 *Strategic Intent*, which responded to the 1998 review of the IC's S&T program conducted by the President's Foreign Intelligence Advisory Board (PFIAB). These recommendations were just not acted upon in an aggressive enough manner. They fall into the categories of increasing the numbers of scientists rotating through the IC, increasing collaboration, and reinstating the use of competitive analyses. These recommendations (b)(3) are not meant to replace existing programs, nor are they the complete solution to this complex problem. However, they are both crucial to an improved S&T(I) analytic work force and relatively easy to implement, and would be welcomed across a broad community of the IC and its consumer base.

[redacted] *OBSERVATIONS AND RECOMMENDATIONS* (b)(3)

(U) While the IC has made significant progress in all parts of its S&T program since its response to the 1998 PFIAB report, the S&T(I) effort devoted to foreign S&T has not kept pace with the advances in and globalization of critical emerging technologies, and some remedial action is urgently needed.

[redacted] **Observation 1** (b)(3)

[redacted] The IC's S&T(I) capability is not what it could be and not what the nation needs. This is particularly true in areas where rapidly changing, commercially driven, emerging technologies intersect intelligence interests, including those directly and indirectly related to WMD. Strengthening the intelligence analyst's ability to fully appreciate the impact of emerging technologies is critical if we are to limit the probability of future technological surprise and increase our margin of warning. One way—and there are many—to achieve this is to borrow techniques already used successfully within the Department of Defense (DoD) and sporadically within the IC to rotate non-government experts such as scientists and engineers into government service for periods of approximately two years (perhaps more in some cases). (b)(3)

[redacted] Leading-edge scientists from commercial and government laboratories can be located, recruited, cleared, and assigned to various offices and elements within the IC. They can "live" with the IC S&T analysts, sharing their profound knowledge of the technology in question and in turn becoming familiar with intelligence needs. Through their knowledge of the outside community they can empower IC analysts to make more effective use of existing IC outreach programs: to become smarter buyers for external (b)(3) participation by identifying the most valuable conferences, lectures, or research studies and papers in a given field and grasp the implications of current foreign technological developments more quickly. The scientists would then return to their outside jobs, clearances intact, and remain available sources of interaction with the IC S&T analysts and the external, commercially driven S&T community.

[redacted] Locating, recruiting, and clearing such experts is a daunting task, especially for individual IC analysts or their particular offices or divisions. Yet the DoD has done this effectively and is currently expanding its efforts as it strengthens its own S&T intelligence capabilities. The IC can and must do so as well if it is to give its customers a better chance of limiting technological surprise. The cost is modest, to say the least, and, given the potential benefits and what is at stake, the impact, if the effort is successful, would help reverse the disturbing trend of S&T(I) analysis, especially as regards emerging technologies in areas directly and indirectly related to WMD. (b)(3)

[redacted] Recommendation 1 (b)(3)

[redacted] **Set up a community function to locate, recruit, and clear leading-edge scientists from the "outside" and make them available to the relevant elements within the IC.** These experts should be required to spend a minimum of two years within the IC and to maintain their clearances when they return to their non-government careers. This recommendation is modeled on successful efforts used within the Defense Department and, sparingly, within the IC. Implementing this program will strengthen the IC's own career S&T staff and provide them continued access to the cleared scientists who return to their outside careers in critical areas. Establishing a community function to accomplish this will relieve the individual IC elements from the rather daunting tasks of locating, clearing, and managing ongoing relationships with appropriate candidates. The authority to perform this function already resides within the office of the Chief Technology Officer. (b)(3)

[redacted] Observation 2 (b)(3)

[redacted] S&T(I) analysts do not adequately share the benefits of many of the new outreach efforts among different agencies or even among offices within any given agency. This is clearly wasteful. One program now under development will use modern information technology tools to collect and make available knowledge of domestic and foreign scientific conferences. In this day and age, when commercial services flash breaking news headlines and stock market prices across the screen of any desktop computer, the IC can certainly do a more effective job of permitting collaboration and sharing knowledge. (b)(3)

[redacted] Recommendation 2 (b)(3)

[redacted] **Provide all relevant IC elements with the opportunity to become aware of and, if appropriate, share the benefits of the many recently developed and funded outreach efforts of individual IC elements.** Collaboration and networking techniques and support systems should be implemented to spread the benefits from all outreach efforts to the relevant analysts across the entire IC. The ADCI (A&P) has initiated an effort to collect and distribute information concerning foreign conferences to appropriate analysts. This would a natural office to expand the application of advanced IT tools to achieve some significant level of collaboration amongst the various outreach activities. (b)(3)

[redacted] Observation 3 (b)(3)

[redacted] Our judgment, supported by all information available to date, is that while we have concern about quality, the IC must also seek some increase in the numbers of S&T(I) analysts. However, the appropriate level is difficult to quantify, although our sense is that the required increase is modest, perhaps several dozen. The "numbers argument" has been advanced by others using the simple expedient of comparing "numbers" during the cold war years to current "numbers," although we do not believe this to be a terribly meaningful metric to apply to this problem. (b)(3) [redacted] Other issues with the S&T(I) work force came to our attention. Some of the S&T (I) accounts go back to cold war days. It may be useful to reexamine the currency of these accounts formally and on an annual basis. Some will remain the same, but others will undoubtedly change—not necessarily in content, but in the manner in which they are organized, addressed, and analyzed. This may be particularly relevant to many of the emerging technology threats, such as the cyber threat. In order for the consumer to understand the magnitude and implications of this emerging S&T threat the IC needs to develop and present a complete picture. Piecemeal intelligence bits (especially some current-intelligence bits) only leave the consumer confused as to the seriousness of the threat. (b)(3)

[redacted] Recommendation 3 (b)(3)

[redacted] **Rapidly apply newly available census information (such as the Analytic Resources Catalog (ARC)) to monitor in detail the staffing levels being applied across S&T(I) issues.** Having current visibility into the numbers, along with regular assessments of product quality, will facilitate making more informed judgments as to the true shortage in S&T(I) analysts (in light of competing priorities). Such judgments, conducted by experienced and capable analysts, should be based upon coverage required on crucial areas rather than on a simple comparison of numbers. If the current ARC does not contain enough detail on individual S&T areas, additional census information may be required.[1] This approach should be used to redefine the "accounts" as necessary. It should also be used as a systems tool to organize different S&T(I) accounts under broad threat categories so that the consumer can readily appreciate the impact of individual pieces of threat analysis. This is particularly critical in current-intelligence estimates, especially in the emerging commercial area where "tidbits" of raw intelligence appear in the world press. (b)(3)

[redacted] Observation 4 (b)(3)

[redacted] The problem of "failed assumptions," or blind spots, plagues not merely the IC, but all aspects of our society. This was pointed out in a recent speech by the Associate Deputy Director of Intelligence (b)(3)

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[1] The ARC does not go into detail on S&T areas. For example, everyone who works on "Emerging and Disruptive Technologies" is captured in one "bin."

and in a recent speech by the DCI, who stated that intelligence is "never all right or all wrong." This issue can be especially vexing in S&T analysis, because the number of analysts who have technical expertise in any particular subject area tends to be very small (often one), thus limiting the possibilities that alternative assumptions will emerge.

[redacted] When a basic assumption is taken as "truth" the consequences may include failure to recognize and/or request information that would support an alternative path and might lead ultimately to an alternative assessment. Some corrective measures recently instituted, such as external and internal pre-publication reviews, may help in this regard, although a more certain approach involves competitive analysis at all levels of the analytic process. Competitive analysis requires not just enough capability to produce one finding but enough analytic expertise across domains to produce independent analysis and findings. (b)(3)

[redacted] The IC must ask itself if it is doing everything possible to limit the number of times it is wrong. This would increase its credibility, which is essential to supporting our current pre-emptive national security strategy. (b)(3)

[redacted] Recommendation 4 (b)(3)

[redacted] **Develop a program within the S&T community to introduce an appropriate level of competitive analysis into its intelligence production, one that truly challenges basic assumptions before they are elevated to "truths."** Any competitive analysis program should be carried out in a substantive, sustained manner, both to limit misjudgments and to improve consumers' confidence in IC S&T(I) products. A useful learning experience in this regard would be to revisit selected controversial cases from the recent past, hypothesize different base assumptions, and determine if a defensible, alternative analysis can be developed. <u>This activity warrants the personal and continuous attention of the Chairman of the National Intelligence Council.</u> (b)(3) [redacted] **Recommendation 5** (b)(3)

[redacted] **IC management should take the necessary steps with respect to career growth to ensure that the S&T work force is encouraged to make the basic changes recommended above.** Career paths and career growth were paid lip service in the response to the PFIAB report. Some specific goals and milestones need to be established before this will happen. (b)(3)

[redacted] Beyond these observations and recommendations, there is a larger and less conventional view of the question of S&T(I) that may warrant more attention than the Task Force has devoted to it. Consider as an example the rapid, commercially driven and globally based growth in the world of genetics and genetic engineering. It is reasonable to believe that all information of value concerning this technology, its future prospects and growth, where it is being developed, and to whom it is accessible exists in the public literature, including in the professional literature shared among the world's experts in this subject matter. In such an example the IC, no matter how much better it gets, is ill-positioned to be the community that advises/warns the policy maker of the future threats this technology poses to our national security in the broadest sense. Obviously, additional examples have the same characteristics and there is no reason to believe that if current trends in globalization, commercial support of critical technologies, outsourcing, etc., continue this new paradigm will not develop further. (b)(3)

[redacted] One member of our Task Force has offered a minority view. He suggests that for these emerging conditions, the nation's S&T community should be given a much broader mandate to address the S&T aspects of future threats more fully. The organizational arrangements would have to be worked out. This is discussed further in Appendix A. (b)(3)

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[redacted] IMPLICATIONS FOR INTELLIGENCE OF SCIENTIFIC AND TECHNOLOGICAL CHANGE (b)(3)

[redacted] In his book *The Art of the Long View* Peter Schwartz notes: "The most frequent failure in the history of forecasting has been grossly underestimating the impact of technologies."[2] This view is central to the concern that created this Task Force. The challenges for our Task Force were assessing whether the Intelligence Community (IC), in its analytical efforts, may be underestimating the need to assess these effects, whether the IC is positioned to assess these effects, and how the IC might alleviate any deficiencies. (b)(3)

[redacted] Currently, science and technology (intelligence) (S&T(I)) analysts in the IC are the "front line" for conducting S&T impact assessments. S&T(I) analysts are charged with assessing and forecasting how technology developed by, absorbed by, or stolen by foreign entities is already affecting, or will affect in the future, the security of the United States. They must understand multiple technologies well enough to recognize ways in which imaginative opponents may apply them to harm U.S. interests; and, of course, they must understand the culture, economics, and other characteristics of the particular state and non-state actors that are today's dominant threat to U.S. national security. (b)(3)

[redacted] S&T(I) analysis was a sufficiently daunting job during the cold war years when the critical technologies (i.e., elements of missiles, submarines, bombers, and space systems) were funded and controlled by the two superpowers, and essentially all the experts on these subjects were within the respective governments. Then the pace of technological advancement was slower than it is today, and deterrence was a strategy that both superpowers appreciated. Now, the most critical and most rapidly evolving technologies — information technology (IT), nanotechnology, biotechnology, energy, aerospace, etc. — are driven by a commercial marketplace that is (b)(3)

[2] Schwartz, Peter, *The Art of the Long View: Planning for the Future in an Uncertain World* (New York: Currency Doubleday, 1995).

increasingly global in nature and readily available to foreign state and non-state actors. At the same time, not only has the number of S&T(I) analysts been reduced, but the availability to the IC of critical skills in emerging technologies, i.e., non-IC research scientists who fully appreciate the capabilities of the technology, is also limited.

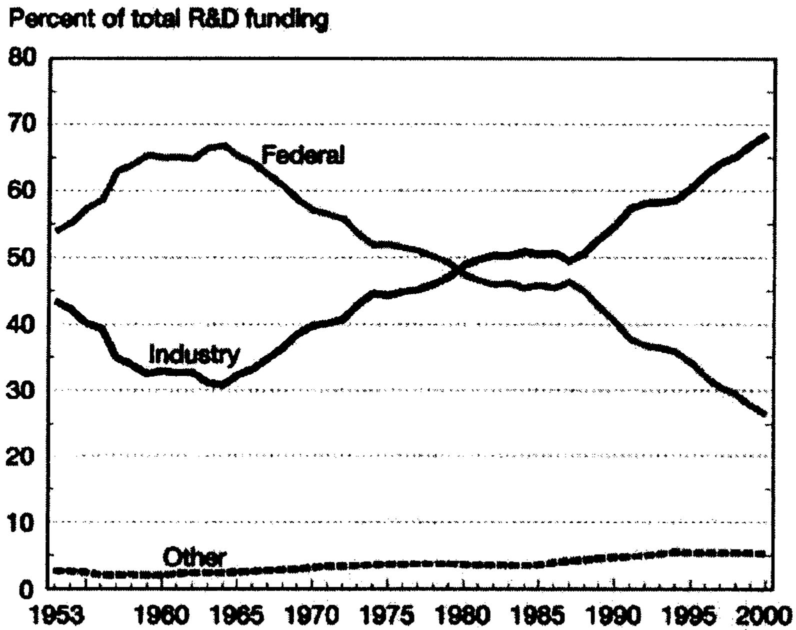
[redacted] This section outlines why the changing nature of S&T has significant (yet sometimes obscure) import for intelligence, especially when dealing with future problems that have not become current intelligence crises. ***The IC must not be caught off guard in the future from grossly underestimating today how S&T affects national security.*** (b)(3)

[redacted] The Nature of S&T Has Changed! (b)(3)

[redacted] The S&T environment of today is very different from that of decades past. S&T is in a kind of global technology revolution. S&T developments are both accelerating and being absorbed globally to the extent that they are revolutionizing the world. A National Intelligence Council (NIC)-funded study outlines many of these S&T trends out to 2015.[3] Appendix B of this report contains some highlights from a National Science Board (NSB) report on science and engineering indicators. (b)(3)

[redacted] One significant change involves the decreasing importance of U.S. R&D funding from the federal government, with an increasing share provided by industry. This change is often identified with the end of the cold war, although, as Figure 1 shows, the trend has been decades in the making, with the peak in the federal share occurring in the early 1960s. (b)(3)

[3] Antón, Philip S., Richard Silberglitt, and James Schneider, *The Global Technology Revolution: Bio/Nano/Materials Trends and Their Synergies with Information Technology by 2015*, RAND Corporation, MR-1307-NIC, Santa Monica, California, 2001. URL: http://www.rand.org/publications/MR/MR1307/



[redacted] **Figure 1** (b)(3)

[redacted] **Changing Sources of R&D Funding in the United States** (b)(3)

[redacted] Commenting on this trend, the National Science Foundation's NSB stated: "Indeed, the most significant trend among the G-7 and other OECD countries has been the relative decline in government R&D funding in the 1990s. In 1998, less than one-third of all R&D funds were derived from government sources, down considerably from the 45 percent share reported 16 years earlier."[4] (b)(3)

[redacted] Not only has U.S. R&D funding become more of a private sector responsibility, but it has also become more globalized. For the period 1989–1999, Figure 2 shows the funding of U.S. R&D in two categories, performed in the United States by U.S. affiliates of foreign companies (Foreign R&D), and performed abroad by foreign affiliates of U.S. companies (Overseas R&D). (b)(3)

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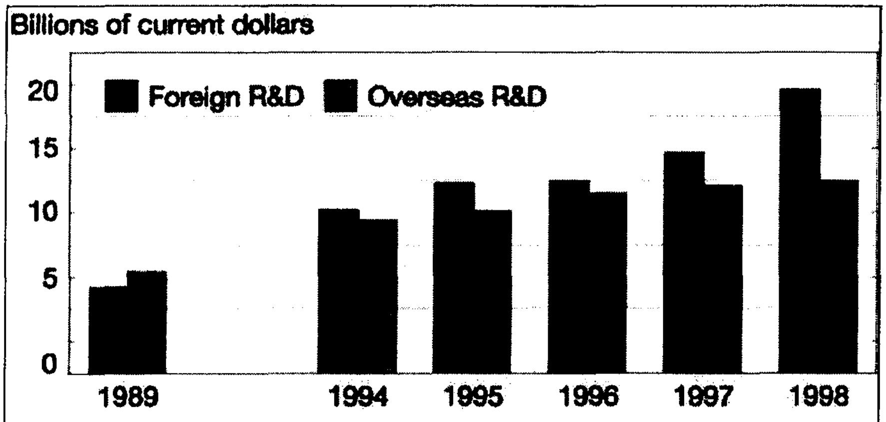
[4] National Science Board [hereafter NSB], *Science and Engineering Indicators – 2002* (Washington, D.C.: National Science Foundation, 2002).



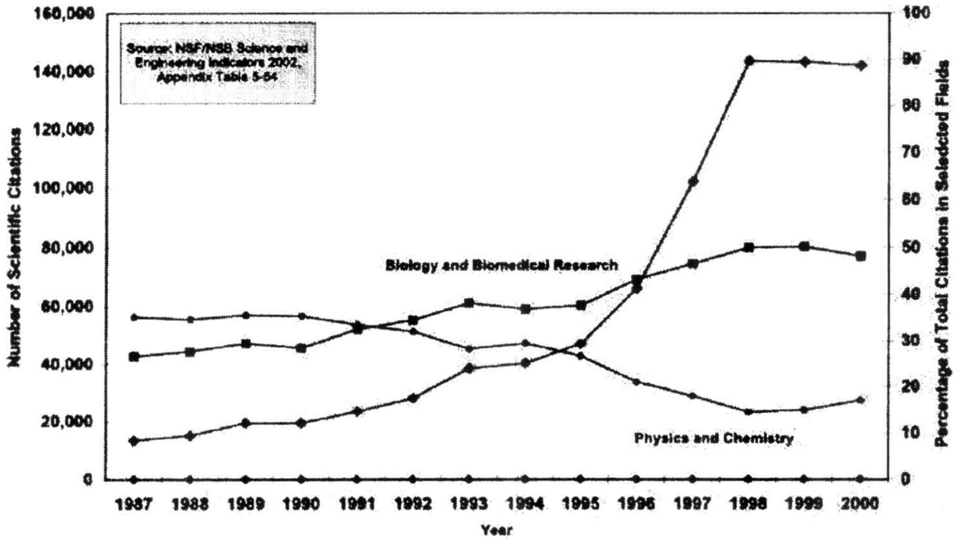
NOTES: Foreign R&D refers to R&D performed in the United States by U.S. affiliates of foreign parent companies. Overseas R&D refers to R&D performed abroad by foreign affiliates of U.S. parent companies.

[redacted] **Figure 2** (b)(3)

[redacted] **Globalization of U.S. Industrial R&D** (b)(3)

[redacted] While Overseas R&D has risen by about a factor of two, Foreign R&D has risen about fourfold. The former is an indicator of increasing capabilities abroad to conduct R&D, while the latter presumably indicates both a desire by foreign affiliates to capture U.S. technology and the financial attractiveness of investments in U.S. firms during this period. (b)(3)

[redacted] For our purposes, a key issue is not only the status of R&D, but also the rapidity with which scientific discoveries are absorbed into practical, available technology. This difficult-to-measure quantity was addressed by the National Research Board (NRB) using the proxy of the number of scientific research papers (citations) appearing in patent applications in the United States. The NRB, stating, "...citations of scientific and technical articles provide an indicator of the growing link between research and innovative application...," provided the data appearing in Figure 3 (red curve). (b)(3)



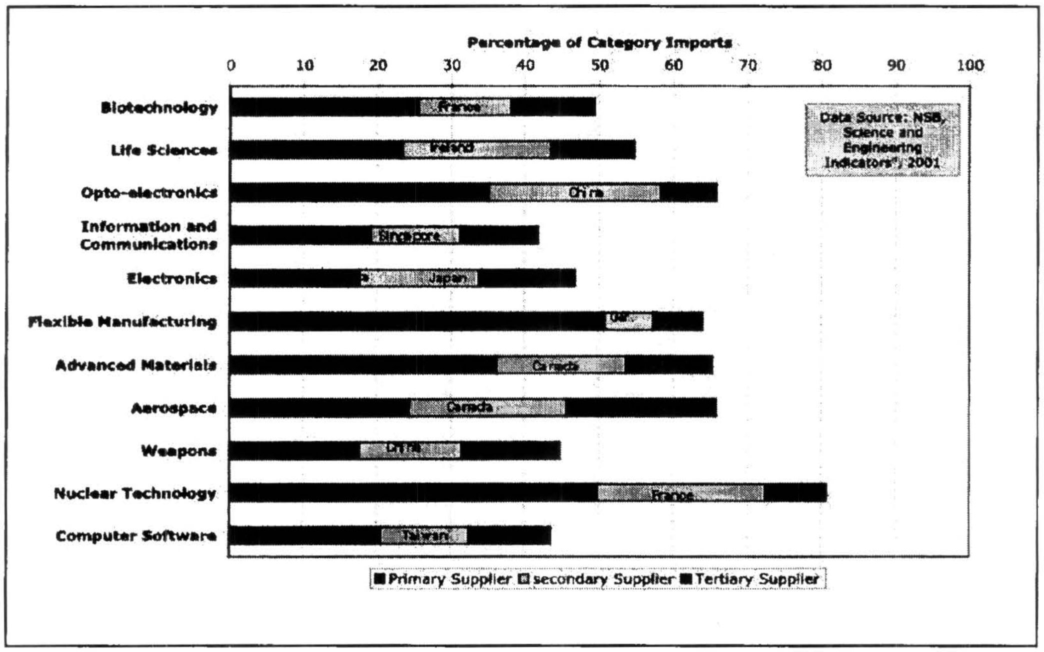
[redacted] **Figure 3** (b)(3)

[redacted] **Growing Number of Scientific Citations in U.S. Patents** (b)(3)

[redacted] Most noteworthy is the rapid growth in the mid-1990s. The same source also provides the percentages of citations by major field, with Figure 3 showing (blue curve) the contributions from physics and chemistry together, as well as biology and biomedical research together. It should be noted that a number of factors in addition to the growing breadth of S&T may have contributed to the increase in citations shown in Figure 3 (e.g., shifts toward topics that publish in smaller elements). This figure illustrates another point that is particularly relevant to the S&T(I) community today: namely, the rapid developments in biological applications.[5] (b)(3)

[redacted] The growing engagement in S&T of nations abroad, and the growing breadth of technological capabilities, are indicated by Figure 4, which shows the top three foreign sources of imports to the (b)(3)

[5] This effect appears not just in research, since here we have citations appearing in patent applications.

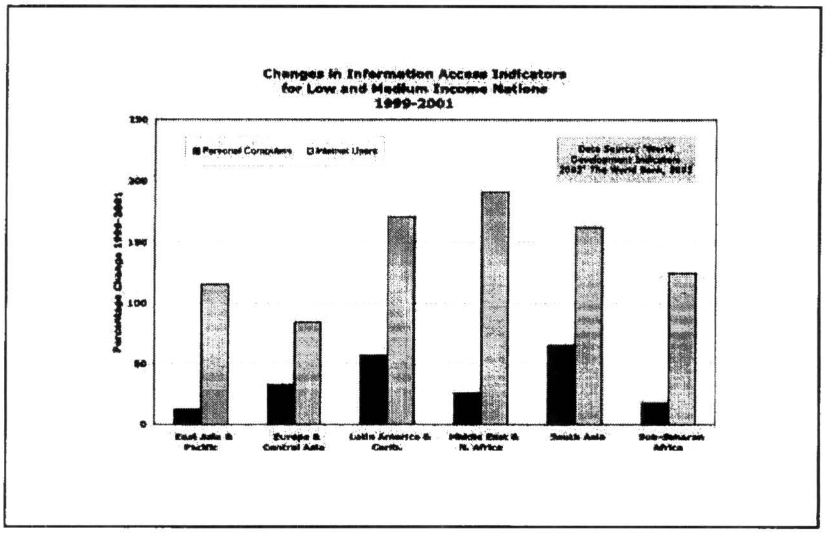


[redacted] **Figure 4** (b)(3)

[redacted] **Top Three Technology Suppliers to the United States in 11 Categories** (b)(3)

United States across 11 categories of technology. Most noteworthy is the large number (15) of nations involved in just this "top three" list.

[redacted] Finally, some sense of the diffusion of technology across the globe can be gained by examining the appearance in societies of personal computers and use of the Internet. Figure 5, drawing on data published by the World Bank in its *World Development Indicators, 2003*, shows the percentage changes during 1999–2001 in the numbers of personal computers and Internet users by region for low- and medium-income nations (gross national income per capita). We see that in some regions the number of Internet users grew particularly rapidly: about 200% for the Middle East and North Africa over this brief period. It should be noted that these data, shown in terms of percentages, do not imply that previously undeveloped regions are (b)(3)



Source: World Bank, World *Development Indicators, 2003*

[redacted] Figure 5 (b)(3)

[redacted] Changes in Information Access Indicators for Low- and Medium-Income Nations, 1999–2001 (b)(3)

seeing an increasingly significant portion of global computer and Internet users, only that their individual growth rates are high.

[redacted] The foregoing and other familiar data show that today's revolutionizing S&T environment includes the following S&T characteristics: (b)(3)

- It is increasingly ***pervasive***.
  - Global (both R&D and production)
  - Affects multiple areas of broad interest to the IC (e.g., telecommunications, weapons, food production, energy, health, social impacts, social unrest)
  - Enables both terrorism as well as state security and countermeasures
- It is influenced by the increasing ***pace*** of technological change and absorption.

- It has shifted from government-dominated to ***commercially dominated*** R&D investments.
  - Reduced government control of R&D results
- Technological know-how (e.g., genetic manipulation capabilities) is ***widespread*** and often inexpensive.
- It has ***increasing breadth.***
- It is ***increasingly multidisciplinary***.
- It is ***increasingly complex*** and thus harder to maintain capabilities in (i.e., due to multidisciplinary character, breadth, and pace).
- ***Proliferation*** of previously contained weapons technology (especially nuclear but also for refined areas of chemical, biological, and radiological weaponry) is increasing.
- ***Increasingly diverse social situations***, especially after the fall of the Soviet Union (e.g., diverse number of unaligned states and groups; continued rise in militant extremist fundamentalist groups), affect how S&T is applied.

Despite these changes, there are still some ways in which S&T has not changed dramatically, principally that weapons technology remains cheap and widely available.

[redacted] All told, many of the effects of technological change are evident even at the level of the average citizen. Communication technology has greatly improved our productivity and changed the way we interact and conduct our lives. The Internet is revolutionizing business and personal situations.[6] Biotechnology is enabling widespread genetic manipulation for improved food and chemical production. Improved computer hardware performance and reduced costs are driving innovation and pervasiveness. What may be less evident is the impact of technological change on our national security, and still less evident is the impact on the S&T(I) community.

[6] See, for example, the NIC-sponsored work on the so-called information revolution: Richard O. Hundley, Robert H. Anderson, Tora K. Bikson, and C. Richard Neu, *The Global Course of the Information Revolution: Recurring Themes and Regional Variations*, MR-1680-NIC, http://www.rand.org/publications/MR/MR1680/, Santa Monica, California, 2001.

[redacted] The Changing Nature of S&T Affects S&T Analysis (b)(3)

[redacted] The changing nature of S&T has a significant effect on national security beyond the obvious threat from new and more pervasive weapons. Advances in information and communication technology, for example, increase the ability of adversaries to communicate and coordinate across the globe, and our ability to monitor all such channels is becoming increasingly strained. Moreover, mechanisms for hiding messages—steganography for example—are more sophisticated, and therefore more challenging. Thus, it is difficult for S&T analysts to assess the varied ways that adversaries (especially non-state adversaries) may be acquiring command, control, and communication capabilities. In another example, social scientists need to assess the cultural predisposition of adversary groups (such as radical religious or nationalist groups) to use various technological means to shape both intent and potential means. (b)(3)

[redacted] S&T is an enabler. It allows adversaries to conduct more sophisticated operations with less visibility. The breadth of S&T opportunities available to adversaries multiplies both their choices and our monitoring challenges. Moreover, early indicators of potential weapons use tend to lie in small technical details that could seem meaningless to those outside the particular S&T field. (b)(3)

[redacted] The pervasiveness and commercial dominance of technology also mean that many capabilities can be easily acquired through legitimate channels (e.g., commercial or academic), a factor that greatly complicates S&T(I) analysis. For example, equipment for the production of biological weapon agents has legitimate dual uses for commercial pharmaceutical production. The differences (if any) tend to be minor and require the trained eye (and the expertise to drive a well-tuned intelligence collection strategy). However, even if some meaningful intelligence has been collected, a very high level of technical analytical expertise may be required in order to properly appreciate clues that could distinguish biological warfare (BW) weapons development from a benign pharmaceutical industry. Such advanced expertise can easily exceed what is available inside the IC. It is such concerns that lead us to conclude that successfully (b)(3) addressing today's S&T threat will require the IC to more aggressively augment its in-house S&T expertise with outside talent by a number of different and complementary methods.

[redacted] The pace and diversification of S&T mean that the IC must have a diverse set of changing expertise (or at least an ability to tap intelligently into a growing network of external experts). No longer can a relatively short list of weapon and system specialists suffice. This pace and diversification have also extended analytic demands into areas where the IC has traditionally had little expertise. For example, the increased importance of biotechnology and nanotechnology is placing great demands on the IC despite its limited in-house expertise in these fields. (b)(3)

[redacted] In another example, the fall of the Soviet Union has changed the threat from a monolithic super-system to a multitude of social and cultural situations, requiring a diverse set of social science capabilities within the IC. (b)(3)

[redacted] All told, S&T(I) analysis is more challenging today, not less. The pace of technological change is constantly accelerating, the potential for diverse non-state actors to exploit both low and advanced technologies to our detriment is high, and the center of gravity of many particularly threatening technologies has shifted from government to the private sector. The IC needs to become S&T literate, and to have a continuing education process in place. This is important to enable the IC not only to become a smart buyer of S&T expertise inside and outside of government, but also to become a smart collector of S&T-related intelligence. These and other factors suggest that the S&T(I) challenge requires close scrutiny and even drastic remedies. (b)(3)

[redacted] There Are Indications That the IC Is Falling Behind the S&T Power Curve (b)(3)

[redacted] If global S&T poses such a threat, are there any indicators that the IC is falling behind? (b)(3) [redacted] The Task Force spent a great deal of time grappling with this question. Part of the problem is that we are dealing with *future* effects of technology. The ramifications of those effects will not be seen in current intelligence threats but in future threats. We will not know that we did not prepare sufficiently until we are caught off guard. (b)(3)

[redacted] Part of the problem is also that technology is generally an *enabler* of actions. Thus, the threat is not the technology itself but whether adversaries can use technology to enable their threats. The effects of enabling technologies are well understood by technology specialists but are hidden from non-specialists. (b)(3)

[redacted] There are additional indications that the current IC S&T system is failing. The IC's inability to comprehensively assess the condition of the Iraqi weapons of mass destruction (WMD) capabilities in 2003 was due in part to a systematic inability to collect, recognize, and assess S&T intelligence. The existence or non-existence of WMD and the associated programs is, at its core, a problem in S&T(I). The clearest example of a failure of S&T(I) in the Iraqi WMD controversy relates to the much-discussed aluminum tubes, which may or may not have been intended for use in radioactive isotope separation. It appeared to this Task Force that the IC did not bring a sufficient level of expertise into the center of the analytical effort—expertise that did exist. Specifically, in this case, the IC had access to numbers of cleared experts in nuclear weapons production at the National Laboratories. The information we were provided strongly suggests that if several well-respected scientists from the nuclear weapons community had been brought into the inner councils that were debating status of Iraq's efforts to acquire nuclear weapons, the matter might have been resolved objectively without public controversy. (b)(3)

[redacted] Implications for the IC (b)(3)

[redacted] Given the massive challenges facing current intelligence, the Task Force grappled with the major question: so what? How do we know if we are simply worrying about an area in which we have experience and expertise, but which the IC is handling well enough given its other challenges? Are the seemingly valid arguments and (b)(3) issues outlined above simply theoretical concerns that do not rise to the level of requiring real change of direction?

[redacted] The Task Force could not identify a strong current intelligence shortfall that rises to a national crisis at the level of the President's Daily Brief (PDB). In some sense, that is the problem, although it is understandable, since the PDB, the highest priority publication by the IC, has a current intelligence focus. Yet the ways in which S&T shapes economies and intersects national security issues constitute the long-term problems that S&T(I) analysis is all about. S&T(I) analysis is supposed to assess and help remediate issues *before* they rise to the level of current crisis; in other words, it tends to inform strategic rather than tactical intelligence. This is not consistently true. Problems such as the Iraqi WMD and the anthrax attacks are examples of current intelligence problems—and problems that we did not anticipate and did not prepare for well. (b)(3)

[redacted] The increasing importance of S&T across the globe implies that the IC must deal with S&T(I) or else fall prey to continued surprises and inabilities in the future. The question is one of strategic vision, not near-term expediency. Moreover, the issue facing the IC is not a simple "numbers game" to determine how many analysts are needed to cover what S&T areas. The IC needs to become *S&T literate* and to have a continuing education process in place to remain so. This is important so that the IC can become not only a "smart buyer" of S&T expertise inside and outside the IC, but also a smart collector and processor of S&T-related information. (b)(3)

 (b)(3)

[redacted] SCIENCE AND TECHNOLOGY AND THE INTELLIGENCE COMMUNITY

(b)(3)

[redacted] The end of the cold war resulted in significant declines in the "numbers" of reported S&T analysts in the IC. This, in turn, was assumed to be the principal cause of the decline in the IC's S&T intelligence capability. The President's Foreign Intelligence Advisory Board (PFIAB) study of the late 1990s initiated an S&T capability rebound in the IC. (b)(3)

[redacted]

(b)(3)

(b)(1)
(b)(5)

Approved for Release: 2018/09/04 C01223258

[redacted] (b)(1) (b)(5)

[redacted] In discussing new and innovative approaches to ensure that needed talent is available to the IC with minimal red tape it was suggested that "the program should consider concepts such as the S&T Reserve Corps, two-way rotational assignments and increased use of National Laboratories personnel." (b)(3)

[redacted] Finally of relevance we note that as part of the DCI's 1999 *Strategic Intent* one of the major enterprise-wide objectives is "Unify the community through collaborative processes." The impact of this plan on the IC S&T community has been significant. However, the increase in the actual numbers of S&TI analysts has been very modest—47 billets in FY02-05—and this issue still needs to be addressed. Especially in light of the nature and impact of technology in today's complex world, some additional effort is required, in particular: (b)(3)

- Increased rotational assignments that bring experts in to the community
- Competitive analyses that are truly competitive, and

- Collaboration, especially as it relates to some of the excellent progress in outreach activities.

[redacted] The STIC Demographic Survey of S&TI Analysts (b)(3)

[redacted] In 1998 and again in 2002 the Community's Science and Technology Intelligence Committee (STIC)surveyed the IC's S&T personnel assets. The STIC examined ten-year personnel trends using data from 1991, 1996, and 2001 for ten of the IC's member organizations. Some of the observations, illustrated in Figures 6–8 below) were: (b)(3)

- In-house S&T personnel shortfalls continue.
- There is low coverage in some key technology areas.
- The overall educational levels of S&T personnel appear to be inadequate.
- The S&T workforce is aging.[7]

[redacted] These numbers do not appear to be static, but rather to represent part of a continuing trend. One trend that has probably changed by now is that new employees are finally being hired, and the result will be a bimodal age distribution. The STIC study concludes by asking whether we are laying ourselves open for technological surprise. (The PFIAB and the other previous studies asked the same question.) The STIC report offers the following conclusions/recommendations: (b)(3)

- Partnering and collaborating, both within the government-wide R&D community and with the private sector, are key.
- Sustained funding for external assistance is required.

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[7] The *Health of Scientific and Technical Intelligence: A Study Conducted by the Scientific and Technical Intelligence Committee*, STIC 98-001, April 1998, Figures 9-14).

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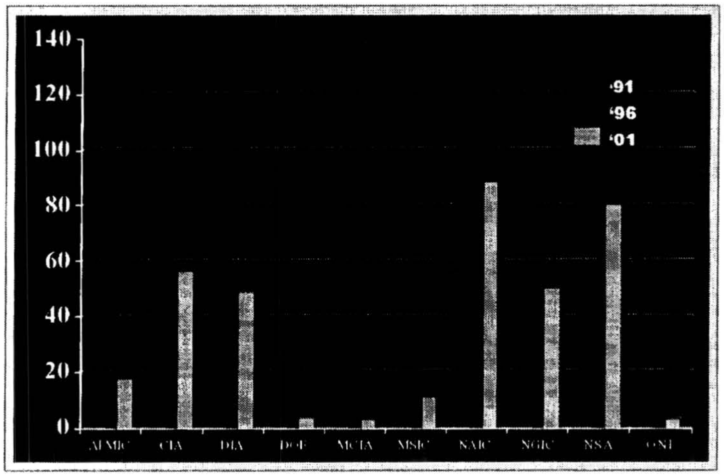
(b)(3)



(U) Figure 6
(U) STIC Survey: S&T Resident Manpower

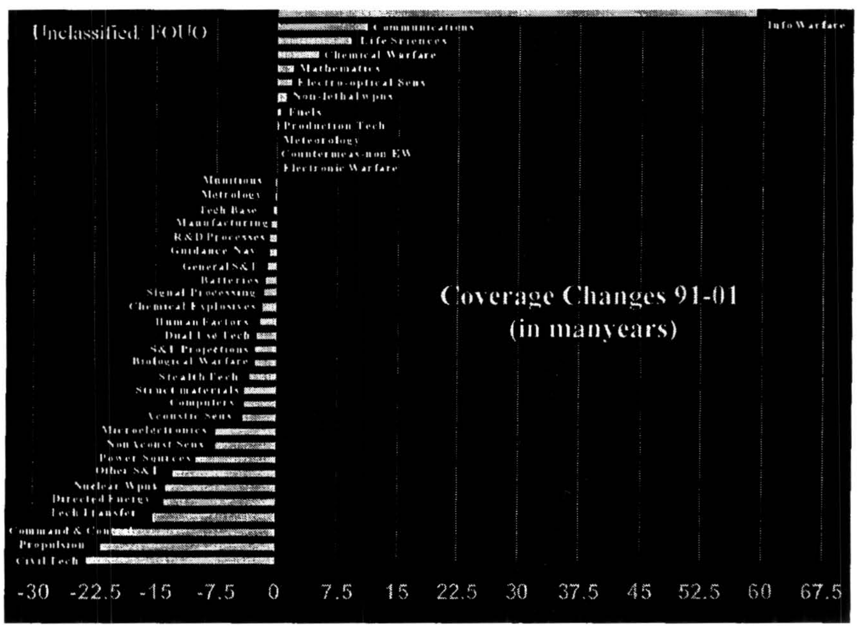
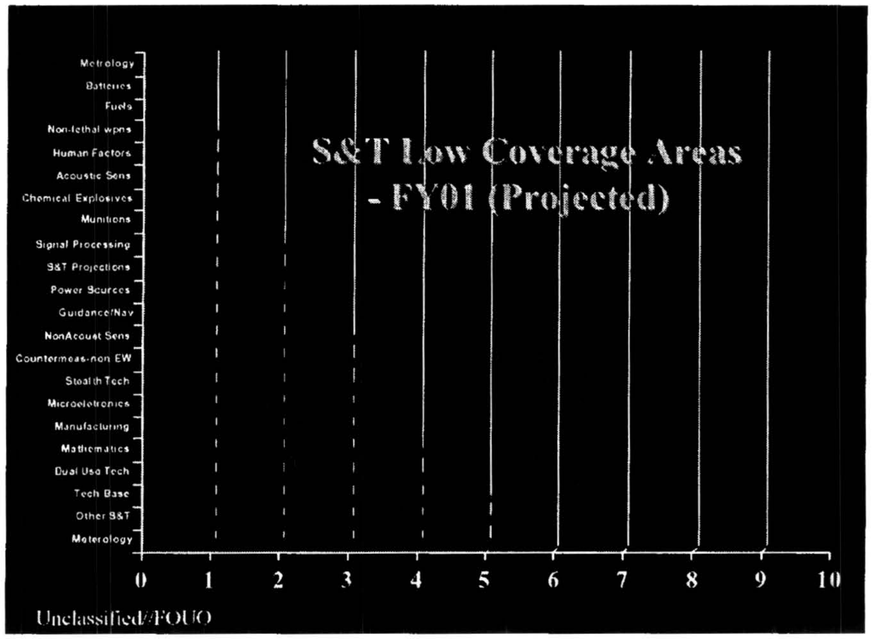


Figure 7
Coverage Changes, 1991–2001

(b)(3)
(b)(3)

(b)(3)



[redacted] **Figure 8**

[redacted] **S&T Low Coverage Areas**

(b)(3)
(b)(3)

- The in-house base needs to be increased.
- A career development plan for in-house S&T personnel is needed.

[redacted] The STIC S&T Analysis Quality Survey

(b)(3)

[redacted] In June 2003 the STIC, as Topic Manager for "Emerging and Potentially Disruptive Technologies" under the DCI's National Intelligence Priorities Framework (NIPF), conducted a survey of the many dozens of analysts associated with the various STIC working groups. The purpose was to gain an understanding of how good a job the people most closely involved in S&T analysis thought they were doing and the quality of support they were getting from the broader IC. The survey was carried out by all the topic managers, all using the same five questions:

(b)(3)

- **Performance:** How would you rate the overall performance of the Intelligence Community in satisfying the needs of the consumer on this issue?
  - o Rarely (1),
  - o Occasionally (2) or
  - o Routinely (3)

  satisfies consumers' needs.

- **Available Information:** How would you rate the adequacy of the information that is available on this topic?
  - o No information (1),
  - o Little information (2)
  - o Some but not enough (3),
  - o Good information for many requirements (4),
  - o Excellent information on most requirements (5), or
  - o Rich and adequate for all requirements (6).

- **Analysis:** How would you describe the IC's analytical ability in your topic area?
  - o Little or no analytic coverage of this area (1),
  - o Analytic coverage is superficial (2),
  - o In-depth analysis is conducted on limited targets (3),
  - o High priority issues covered (4),
  - o Deep coverage of high priority issues (5), or
  - o Adequate (6).

- **TPED:** How would you rate the ability of the Tasking, Processing, Exploitation and Dissemination (TPED) systems to provide the support you need to serve your customers?
  - o Current TPED system does not help me (1),
  - o Current TPED system is cumbersome and not supportive (2),
  - o I can work through the current system (3),
  - o Few barriers and most required support (4),
  - o Almost always supports my needs (5), or
  - o Fully supports my needs (6).

- **Prospects:** Given all you know about the Community's current and future capabilities, how would you rate the prospects for the future in providing support to the consumer on your topic?
  - o Inadequate now & in the foreseeable future (1),
  - o Inadequate & improving (2),
  - o Adequate & declining (3),

- Adequate and stable (4),
- Adequate & increasing (5),
- Strong but declining (6), or
- Strong now and in the future (7).

(U) Most analysts provided personal assessments on only one or two specific technologies of interest to the IC—usually technology issue areas in which they were directly tasked to produce analytic assessments within their parent agency. Several technologies were originally surveyed as multiple issues (e.g., power storage and power generation) and those results were merged in the line items so noted below. Because the five metrics were based on different scoring scales, the results shown in Table 1 below have been renormalized to a 1-to-10 scale to simplify interpretation of the entire data set. (b)(3)

[redacted] Table 1

[redacted] Technology Issue Areas (b)(3)

[redacted]

(b)(1)
(b)(3)

(b)(5)

[redacted]

(b)(1)
(b)(3)

(b)(1)
(b)(3)

[redacted] (b)(5)

[redacted] The Analytic Resources Catalog (b)(3)

[redacted] In an attempt to gain a better and continually updated picture of the IC's overall analytic expertise, the Assistant Director of Central Intelligence for Analysis and Production (ADCI/A&P) sponsored the creation of the Analytic Resources Catalog (ARC), a centralized, limited-access database containing information on education, expertise, and experiences of IC analysts and producers. Its purposes are to: (b)(3)

- Identify and track the IC's analytic expertise and posture,
- Identify gaps in analytic capabilities in accordance with national intelligence priorities,
- Assist in the development of Community-level strategies to mitigate analytic risk, and
- Facilitate access to data required for Congressional reporting.

[redacted] The database is populated and updated by the individual agencies. It currently is almost complete, with most agencies having made at least one complete submission. Some of the data elements include: (b)(3)

- Biographical information (name, organization, contact information, etc.)
- Education
  - Formal (degree, major, year)
  - Professional (institution, course, year)
  - In-country experience (country, year)

- Expertise
  - Analyst field of specialization
  - Regional/country expertise
  - Foreign language expertise

[redacted] The ARC was created, in part, to be a key component of the newly revised NIPF. As such, the data element showing the analysts' fields of specialization is keyed to the subject areas contained in the NIPF. This causes some difficulty in using the ARC as a resource to better understand the specific situation of S&T analysts. Thus, for the sake of this report, the Task Force defines an S&T analyst within the ARC database as anyone working on one or more of the following NIPF areas: (b)(3)

- WMD
- Cyber
- Bio
-
- .... Etc.

[redacted] We also differentiate between a "full time" and a "part time" S&T analyst by defining "full time" as an individual working at least 75 percent of the time on one or more of the above "S&T" subject areas; and a "part time S&T analyst" as someone working less than that in those specific areas. (b)(3)

[redacted] At present the ARC database is unavailable for publication. Its intended form and content are illustrated by Tables 2 and 3 below. (b)(3)

[redacted] To evaluate experience the Task Force searched the ARC database for analysts with a "hard science" educational background: that is, having advanced degrees in such areas as physics, mathematics, chemistry, engineering, etc. We also examined how this population was currently being utilized: whether they were engaged full or part time doing S&T analysis, or in fact were not working in any S&T area. While the database does not contain the total number of years an individual has worked in a group of areas (such as all (b)(3)

SECRET/ [redacted] (b)(3)

[redacted] **Table 2** (b)(3)
[redacted] **ARC Form** (b)(3)

Organization	Number of Analysts	Number of Full-Time S&T Analysts	% of Total	Number of Part-Time S&T Analysts
CIA				
DIA				
NSA				
NGA				
NRO				
etc.				
TOTALS				

Table is UNCLASSIFIED

[redacted] **Table 3** (b)(3)
[redacted] **ARC Content** (b)(3)

	Total	Doctorate (Hard Science)	Doctorate (Other)	Masters (Hard Science)	Masters (Other)	Average Years as an Analyst	Average Years in Current Area
Total Number of IC Analysts							
Number of S&T Analysts working in S&T areas							
Number of S&T analysts **not** working in an S&T area							
TOTAL							

[redacted] (b)(3)

those comprising our definition of "S&T"), it does allow us to determine how many years an individual has been working on the current assignment.

[redacted] The Task Force expects that the IC can base quantitative recommendations concerning the numbers and utilization of the current S&T work force on these statistics, and can draw the appropriate conclusions as to what number of S&T analysts, with what specific skill sets, should represent the final goal. (b)(3)

[redacted] Development of the IC Outreach Effort (b)(3)

[redacted] Significant effort and funds have been devoted to the development of so-called outreach efforts whereby the IC reaches out to the non-government sector in a variety of disciplines, including S&T. (b)(3)

[redacted] The Office of Transnational Issues and the Strategic Assessment Group (SAG) in the Central Intelligence Agency's (CIA's) Directorate of Intelligence (DI) have since 1998 committed $28 million to support a variety of outreach efforts including expert scholars, conferences, workshops and games, all of them drawing on academics, laboratories, and private industry. The DI itself has allocated $34 million over five years to aid its internal staff in the areas of gaming, modeling and simulation, expert analysis, and conferencing and. While these outreach efforts cover all areas of IC analysis, some portion is available for S&T (I) analysts to use as needed. (b)(3)

[redacted] The Science and Technology Expert Partnership (STEP) was formed in 2000 by the National Intelligence Council (NIC) and the STIC to address shortfalls in the IC's internal S&T analysis capability. In four years of operation, STEP has completed 95 separate projects on key science, technology and weapons issues, bringing to bear the highest quality expertise from academia, industry, and government labs. Annual funding for STEP is in the range of $2 million – 2.5million. (b)(3)

[redacted] The National Ground Intelligence Center (NGIC) has established the University Experts Program. Under this program NGIC has obtained the authorities it needs to hire faculty members from universities such as the University of Virginia, Virginia Military Institute, and the State University of New York at Buffalo, to mention a few. NGIC arranges for full clearances and the experts serve as part-time federal employees (salaried without benefits) for no more than 130 days per year. (b)(3) [redacted] The National Reconnaissance Office (NRO) Industrial Fellows Program has the authority to pay a flat sum to companies that then send a fellow to work on a year-long project at the NRO. (b)(3)

[redacted] The Defense Intelligence Agency (DIA), as part of its BioChem 2020 Program, uses outside experts, usually scientists performing cutting-edge biochemical and biological research, to write short unclassified papers on pre-determined topics as a means to mitigate technological surprise. (b)(3)

[redacted] Many individual offices within the IC utilize National Laboratory personnel in rotational assignments referred to as Intergovernmental Personnel Act assignments. (b)(3)

[redacted] There are many other such programs within the IC initiated and administered by the using organization. (b)(3)

[redacted] CONCLUSIONS, OBSERVATIONS, AND RECOMMENDATIONS (b)(3)

[redacted] *CONCLUSIONS* (b)(3)

[redacted] Although the IC has made significant progress in all parts of its S&T program since its response to the 1998 PFIAB report, the S&T(I) effort devoted to foreign science and technology has not kept pace with the advances in and globalization of critical emerging technologies. (b)(3)

[redacted] With respect to commercial technologies, if the IC does nothing fundamentally different it will continue to leave its consumer base seeking context for current intelligence beyond what is available in the press and may do nothing to reduce the probability of technological surprise. In fact, considering the complexity of commercial technologies, the lack of expertise in these technologies within the IC S&T(I) community, and the rapid pace of technological advances, the United States is more likely to be surprised than ever before. There is no "silver bullet" to solve this problem, but we believe there are several credible approaches that the IC should implement not in place of but in addition to its current efforts in the area. (b)(3)

[redacted] With regard to the very credible IC response to the PFIAB report, the stated plans concerning rotational assignments to augment S&T capability, competitive analysis, and collaboration when applied to the S&T(I) analysis problem need to be implemented aggressively enough to make the difference needed for today's threat environment. (b)(3)

[redacted] *GENERAL OBSERVATIONS* (b)(3)

[redacted] The IC has a primary role in analyzing foreign activities—both overt and covert—that affect national security. Restricted information about these activities has historically been the IC's realm (b)(3) and its dominant focus, but open and gray sources of information are becoming increasingly important as emerging technologies are commercially and globally funded. Purely open analyses are becoming more useful (consider, for example, *Global Trends 2015*,[8] a publication in the NIC's Global Trends 2020 program) and may indicate a new trend in the IC toward informing the broader public about the scope of threats facing the country.

[redacted] *Catastrophic threats* are the most compelling and obvious S&T threats. They may include weapon development and delivery (e.g., biological or nuclear attacks) as well as new threats to our country's economic infrastructures (e.g., attacks on our cyber or energy infrastructures, sources, and networks). Each of these threats has an S&T basis that must be understood and connected to the broader economic, social, political, and cultural factors that make them relevant. Despite the very low probability of such events, even the possibility of loss of life in the millions can be overwhelming. September 11 has demonstrated the ripple effects throughout our political and economic systems from a significant but not widespread loss of life and property. (b)(3)

[redacted] Surprise often stems from our inability to foresee foreign intent and capability rather than from an inability to foresee detrimental S&T applications. Thus, S&T analysts need not only to understand the range of potential S&T threats, their indicators, and the scope of potential effects on U.S. security, but also to assess the likelihood of these potential threats through indicators of adversary intent, capability, and social and cultural factors that may encourage or preclude their employment. Just as it is easy to fall into the trap of thinking like "us" instead of like "them" (known as mirror imaging), it is also easy to develop a single hypothesis for how adversaries will buy, steal, or apply technologies. In either case the probability of technological surprise will remain unacceptably high. (b)(3)

[redacted] The technology areas currently of most concern are those related to WMD threat capabilities and to rapidly changing and (b)(3)

[8] National Intelligence Council, *Global Trends 2015: A Dialogue About the Future With Nongovernment Experts*, NIC 2000-02 (Washington, D.C.: Central Intelligence Agency, December 2002), [On-line]. URL: http://www.cia.gov/cia/reports/globaltrends2015/

readily available emerging technologies whose use by state and non-state actors, in as yet unanticipated ways, may result in serious and unexpected threats. The most compelling S&T topics might include:

- BW attacks (anthrax, smallpox, designer BW agents, agricultural attacks)
- Nuclear threats (including novel ways of refining nuclear materials, dirty bombs, and new approaches that can produce lower-yield weapons)
- Disease (e.g., ways to determine if an epidemic of Severe Acute Respiratory Syndrome (SARS) was started deliberately)
- Global warming
- Chinese technical leapfrogging
- Energy availability, trends, and foreign manipulation
- Space: attacks, access, dependence, foreign use (weapons, intelligence)
- Cyber
  - U.S. dependence on cyber infrastructure; vulnerabilities to and foreign capabilities for physical and electromagnetic attack, hardware chipping, software plants, and hacking
  - Information technology trends and their effects on foreign culture, foreign business and personal lives, foreign adoption rates and barriers, effects of denied access on foreign competitiveness and instability
- Effects of commercial S&T on other nations, cultural tensions, leapfrogging, intelligence, dual-use capabilities
- Biometrics
- Deception detection.

[redacted] This list is, of course, illustrative rather than comprehensive, but it highlights areas of importance for which we need a significant and reliable S&T analytic capability. (b)(3)

[redacted] S&T issues have both immediate and evolving consequences. Immediate and very near-term threats are those most likely to require presidential attention and thus be covered in the PDB. Evolving consequences are those that the United States should engage early on, *before* they turn into immediate threats or require remediation. These often require the attention of mid-to-lower-level policy makers rather than the President. Thus, using inclusion in the PDB as the sole metric for analysis products prevents important problems from being addressed early by those below the President. (b)(3)

[redacted] Again, commercial technologies provide a new set of problems for the S&T(I) analyst. What amounts to "raw intelligence" concerning advances in these technologies, both U.S. and foreign (it is often inappropriate to distinguish between the two), is available to the IC's consumers through the open literature on a daily basis. To this open press reporting of bits and pieces of what might constitute a threat the S&T(I) analyst must add any other relevant information not accessible to open sources. Even more important, the analyst must put the openly available information into the context of a broad threat system if the consumer is to have any chance of understanding the national security implications and ensuing risks. (b)(3)

[redacted] Currently there is no way to calculate the levels of S&T analytic capability that the IC actually needs. Members of the S&T analytic community have used historical levels and qualitative concerns about coverage as the basis for claiming that today's levels are too low, but no quantitative method for estimating the needed level has been offered. Some senior IC executives agree that some increase is important, but the extent of that increase is unclear; in any case, other pressing problems (e.g., counter-terrorism) are consuming most of their attention. The IC does not track the numbers or kinds of S&T intelligence questions it receives that go unanswered or are addressed inadequately. Even the simple questions of how many S&T analysts there are in the IC and what their specialties are cannot easily be answered by the IC's human resources departments. (Efforts (b)(3) recently instituted by the Assistant Director of Central Intelligence for Analysis and Production (ADCI (A&P), specifically in the ARC program, have led to some progress, but results are not available to the Task Force at this time.)

[redacted] Ideally, the IC would adjust its levels of S&T analytic capability to meet intelligence needs emanating from two sources: (1) intelligence consumers' demands, and (2) the IC's own initiative to invest and hedge against uncertain futures by providing consumers with the intelligence they do not yet realize they need. Large-scale gaps in either of these categories are difficult to quantify. (b)(3)

[redacted] Nevertheless, the Task Force did identify troubling indicators that current levels of analytic capability, as well as the organizational mechanisms to use both internal and external S&T expertise effectively, are insufficient. The National Intelligence Officer (NIO) for S&T (perhaps *the* major S&T analysis consumer in the IC) has stated that he and his staff often cannot find sufficient S&T analysis capabilities within the IC to meet their needs. In addition, anecdotal evidence indicates that in at least some cases the IC has important contrary views on particular problems, such as BW, available in house or through external expertise. However, no well-organized method exists to ensure that the best experts are tapped, and thus knowledge of important uncertainties and viable contrary views are lost in an ad hoc consultation system. (b)(3)

[redacted] Despite these shortcomings, the IC has made considerable progress in strengthening its S&T(I) analysis capabilities. It has instituted so-called "outreach" programs, such as: (b)(3)

- The CIA's DI and SAG outreach effort [redacted] (b)(3)
- DIA's BioChem 2020 Program
- NGIC's University Experts Program
- NIC's Science and Technology Expert Partnership (STEP)
- NRO's Industrial Fellows Program
- CIA's DS&T Post Doctoral Program.

[redacted] There are undoubtedly others that the Task Force did not have the opportunity to review, as well as many continuing education programs for current S&T analysts. While each of these programs strengthens the capability of the individual sponsoring office or agency, there are no means available for sharing access to these experts or even their results with relevant S&T(I) analysts in other parts of the IC. (b)(3)

[redacted] Individual efforts across the IC apply modern information technology and techniques to announce upcoming events and preserve findings, evaluate different procedures within the IC for S&T outreach, and catalogue the needs and activities of IC personnel. Putting these pieces together should be both useful and feasible with modest investments. (b)(3)

[redacted] S&T analysis has always relied to some extent on outside expertise, but that hitherto unsystematic reliance cannot by itself solve the IC's needs. While expert consultants are often technically current and well networked into labs and academia, they are less likely to think diabolically about unorthodox uses of S&T and to understand foreign cultures and mindsets well enough to ask the right questions. (b)(3)

[redacted] Thus, even in areas where the IC is weak, it cannot rely solely on external individuals or organizations to govern themselves and inform the IC. For example, researchers in biology and biotechnology pursue the benefits of their efforts and often do not think of the negative, "dark" sides of their breakthroughs; IC analysts, by contrast, need to look for potential dark sides and leverage external expertise to explore their viability. Moreover, breakthroughs often come from unexpected quarters and lines of study; therefore, they are hard to control independently if the negatives seem to outweigh the positives. Finally, the tools of biotechnology are mostly dual use, cheap, and commonly available. The cat is already out of the bag. (b)(3)

[redacted] The sheer number of threats that could in theory result from the misuse of S&T by adversaries requires prioritization and analysis to focus attention on the most potent concerns. The IC should adopt a systems approach to review potential threats periodically, (b)(3) considering a number of perspectives. The process should address broad threat areas (e.g., cyber threat, BW threat) and relate S&T(I) analysis of individual events within a broad threat category to others in order to provide some context or "meaning" for the event. For example:

- Is an event that takes down some set of commercial or government computer systems a nuisance or a potential catastrophe when compared with other aspects of the cyber threat?
- How does the intelligence consumer who may read about this in the press relate it to national security priorities?
- Is there effective collaboration between all elements of the IC addressing this broad area of cyber security?

(U) The IC should generate a set of potential S&T topics of concern annually for subsequent analysis and prioritization. The set could be divided into two categories and mapped to capabilities and cultures as follows:

1. Catalogue commonly available advanced technology today and map it to each region's investment and capitalization.

2. Identify where specific investments are significant or greater than U.S. investments.

(U) *Strategic Prioritization:* The IC should apply the newly developed NIPF to organize topics according to top-down priorities.

(U) *Intelligence-Driven Concerns*: In addition to addressing current priorities in the NIPF, the IC should conduct an annual review of puzzling intelligence related to S&T to identify potential emerging trends that would inform subsequent NIPF priorities as well as emerging concerns that warrant lower levels of attention.

(U) *Capabilities-Based and Cultural-Based Threat Analysis*: Subsequently, more specific priorities should be guided by analysis of specific threats, taking into account their interests, investments, activities, intents, motivations, cultural modifiers of S&T use, capabilities, technology transfer capability, business development capability, low-tech alternatives, intelligence, etc.

[redacted] *Hedge Accounts*: Finally, the IC should maintain a small but continuing effort to understand potentially catastrophic threats—even if they have not reached the current priorities in the NIPF or obvious threat status. The effort should be small and kept in perspective, but should help identify possible future concerns, their indicators, the IC's confidence in its assessments, and the level of plausibility for such threats. Examples may include nanotechnology enrichment of nuclear materials, antimatter weapons, gun launch into space, cybernetics (e.g., mind control, enhanced performance, brain-machine interfaces), and ethnic weapons (RNAi, gene therapy vectors, etc.). (b)(3)

[redacted] As indicated in the systems approach, the key to effective S&T analysis is the engagement and integration of S&T expertise combined with strong IC analytic capabilities in social sciences and in foreign cultures and regions to understand not only the realm of the possible but also the scope of the probable. Even if the IC hired a thousand new S&T analysts, the remaining non-S&T analysts would not necessarily know how to draw on their expertise and would not on their own integrate and recognize S&T problems. Thus, general (non-S&T specialist) IC analysts must become *smart users* of S&T intelligence. To do so, they must be continually trained to recognize potential S&T-related issues, must know what kinds of S&T experts to consult and when to consult them, and must have access to those S&T consultants, whether within or outside the IC. (b)(3)

[redacted] *Specific Observations and Recommendations* (b)(3)

(U) The following set of recommendations are in no priority order. In the spirit of our charge from Dr. Gershwin, we offer the first two as easily implemented at a modest cost. They are not meant to be solutions in and of themselves, but the many interviews we have carried out lead us to believe that they would produce welcome improvements for the S&T(I) work force and the consumer base.

[redacted] Our first two recommendations address rotational personnel and information sharing/collaboration of outreach activities across the IC. (b)(3)

[redacted] Observation 1 (b)(3)

[redacted] Strengthening the intelligence analyst's ability to fully appreciate the impact of emerging technologies is critical if we are to limit the probability of future technological surprise and increase our margin of warning. Our recommendation is to strengthen programs to rotate non-government personnel such as scientists and engineers into government service for periods of approximately two years (perhaps more in some cases). Leading-edge scientists from the outside world would be located, recruited, cleared, and assigned to various offices and elements within the IC. They would "live" with the IC S&T analysts, sharing their profound knowledge of the technology in question and in turn becoming familiar with intelligence needs. Through their knowledge of the outside community they would also empower IC analysts to make more effective use of existing IC outreach programs: to be smarter buyers for external participation, whether that participation take the form of conferences, lectures, or research studies and papers. The scientists would then return to their outside jobs, clearances intact, and remain constant sources of interaction with the IC S&T analysts and the external, commercially driven S&T community. (b)(3)

[redacted] Locating, recruiting, and clearing such personnel is a daunting task, especially for individual IC analysts or their particular offices or divisions. Yet the DoD has done this effectively and is currently expanding its efforts as it strengthens its own S&T intelligence capabilities. The IC can and must do so as well if it is to give its customers a better chance of limiting technological surprise. The cost is modest, to say the least, and the impact, if the effort is successful, would reverse the disturbing trend of S&T(I) analysis, especially as regards emerging technologies in areas directly and indirectly related to WMD. (b)(3) [redacted] To test the credibility of this approach we have discreetly made many visits to senior officials both within and external to the IC. We have tested this hypothesis with staff at the National Security Council, the House Permanent Select Committee on Intelligence, and the Senate Select Committee on Intelligence. Their response was overwhelmingly positive, even embarrassingly so. We have also spoken to individual staff members within the CIA and, with the provision that "someone" would do the dirty work of locating and clearing outsiders, their responses were positive as well. Many of them noted the importance of having the expertise on hand and of the prospect of cleared, knowledgeable individuals back at their laboratory benches when their two-year rotation was over. We believe the best way to make this happen is for the Director of Central Intelligence (DCI) to direct the appropriate office or offices within the community to "make it so." (b)(3)

[redacted] Recommendation 1 (b)(3)

[redacted] **Set up a community function to locate, recruit, and clear leading-edge scientists from the "outside" and make them available to the relevant elements within the IC.** These experts should be required to spend a minimum of two years within the IC and to maintain their clearances when they return to their non-government careers. This recommendation is modeled on successful efforts used within the Defense Department and, sparingly, within the IC. Implementing this program will strengthen the IC's own career S&T staff and provide them continued access to the cleared scientists who return to their outside careers in critical areas. Establishing a community function to accomplish this will relieve the individual IC elements from the rather daunting tasks of locating, clearing, and managing ongoing relationships with appropriate candidates. The authority to perform this function already resides within the office of the Chief Technology Officer. (b)(3)

[redacted] Observation 2 (b)(3)

[redacted] The IC has made significant progress in reaching out to the external community for help in all areas of expertise, including S&T. These so-called outreach programs reside in many of the different IC agencies we visited, including the CIA's Directorate of Intelligence, (b)(3)

DIA, NRO, NGIC, the National Geospatial-Intelligence Agency, and many others we did not have the opportunity to visit. What is unfortunate is the lack of any substantive information sharing/ collaboration between different agencies and even between different offices within the same agency. An analyst with an account in bio-terrorism has no way of knowing when an expert has been recruited to write a paper, give a lecture, or participate in a conference or game. He/she has no way of even gaining access to whatever final product was obtained.

[redacted] Tools in the commercial community flash breaking news and stock market quotes across the screens of any Internet user who invites the information flow. There is little reason why a significant portion of the outreach programs currently funded cannot share their output across the IC. (b)(3)

[redacted] Recommendation 2 (b)(3)

[redacted] **Provide all relevant IC elements with the opportunity to become aware of and, if appropriate, share the benefits of the many recently developed and funded outreach efforts of individual IC elements.** Collaboration and networking techniques and support systems should be implemented to spread the benefits from all outreach efforts to the relevant analysts across the entire IC. The ADCI (A&P) has initiated an effort to collect and distribute information concerning foreign conferences to appropriate analysts. This would a natural office to expand the application of advanced IT tools to achieve some significant level of collaboration amongst the various outreach activities. (b)(3)

[redacted] Observation 3 (b)(3)

[redacted] All information available to date suggests that some increase in the numbers of S&T(I) analysts is clearly required. However, the appropriate level is difficult to quantify using the simple expedient of comparing "numbers" during the cold war years to current "numbers." That comparison is troubling, especially when we consider the increased impact and pace of technology and its globalization compared to the cold war years. (b)(3) [redacted] The ADCI (A&P) recently stated: (b)(3)

> We do not have enough analysts. The intelligence community is 23 percent smaller than it was ten years ago, because we went through ten years of no growth and cannibalization. Nothing is ever going to recover those numbers. There is no quick fix to that. That's why our average experience number is as bad as it is. What's going to happen is that people whom we're taking in now are going to have a lot of room at the top as older people leave. They're suddenly going to be in a situation where we don't have the colonel and brigadier general equivalents who have come up through the system. They're just not there. They never showed up. They're the missing classes, so we're going to start promoting people above their experience levels, because we're just not going to have any other choice.[9]

[redacted] As noted previously, the Office of the ADCI (A&P) has instituted the ARC, a substantive effort to catalogue the actual numbers and expertise of all analysts in the IC, including those with the title of S&T analyst. The ARC, when completed and available, should provide a more rigorous, quantitative way to assess the actual number of "real" S&T(I) analysts and their areas of expertise and experience. With this information the numbers comparison game can be turned into an analysis that indicates where critical areas of S&T(I) lack adequate coverage. (b)(3)

[redacted] Other issues with the S&T(I) work force came to our attention. Some of the S&T(I) accounts go back to cold war days. It may be useful to "re-look" at some of these. Some will remain the same, but others will undoubtedly change—not necessarily in content, but in the manner in which they are organized, addressed, and analyzed. (b)(3)

[redacted] This latter comment is particularly relevant to many of the emerging technology threats, such as the cyber threat. The cyber threat has many dimensions, including malicious hacking, sloppy system administration, outsourcing of software and hardware with (b)(3)

[9] Lowenthal, Mark M., "Intelligence Analysis," in *Seminar on Intelligence, Command, and Control, Guest Presentations, Spring 2004*, (Cambridge, Mass.: Harvard University Program on Information Resources Policy, in press).

all the obvious implications, and a host of others too numerous to mention here. If the consumer is to understand the magnitude and implications of this emerging S&T threat the IC must develop and present a complete picture. Piecemeal intelligence bits only leave the consumer confused as to the seriousness of the threat.

[redacted] Recommendation 3 (b)(3)

[redacted]) **Rapidly apply newly available census information (such as the Analytic Resources Catalog) to monitor in detail the staffing levels being applied across S&T(I) issues.** Having current visibility into the numbers, along with regular assessments of product quality, will facilitate making more informed judgments as to the true shortage in S&T(I) analysts (in light of competing priorities). Such judgments, conducted by experienced and capable analysts, should be based upon coverage required on crucial areas rather than on a simple comparison of numbers. If the current ARC does not contain enough detail on individual S&T areas, additional census information may be required. <u>This approach should be used to redefine the "accounts" as necessary. It should also be used as a systems tool to organize different S&T(I) accounts under broad threat categories so that the consumer can readily appreciate the impact of individual pieces of threat analysis.</u> This is particularly critical in current-intelligence estimates, especially in the emerging commercial area where "tidbits" of raw intelligence appear in the world press. (b)(3)

[redacted] Observation 4 (b)(3)

[redacted] In a recent speech the Associate Deputy Director of Intelligence (ADDI) reviewed some of the IC's successes and problems, especially in light of the Iraq WMD issue. Among the many issues addressed was one often referred to as "failed assumptions." The ADDI stated: "It means taking a hard look at what you assume to be true. Sometimes it is possible to hang on to a judgment or a model for too long. Look at the recent polls before Iowa….. They firmly held to longstanding assumptions that (b)(3)

(b)(3)

organization was the critical factor....They were dead wrong—and yet they had close to total access in an open society."[10]

[redacted] The "failed assumptions" problems plagues all elements of our society. In the business world the failures of IT pioneers such as DEC and Wang, and the near demise of Apple, are but a few that come to mind. The difference, of course, is that the business community can be self-correcting. Wang and DEC no longer exist. The consequences, while harsh for those directly involved, were certainly not critical to the country or to the country's pursuit of excellence in the field these two companies pioneered. (b)(3)

[redacted] Intelligence is obviously different: the consequences can be devastating. The Iraq WMD issue, for example, could have a critical impact on the political acceptance of today's pre-emptive strategy approach to national security—a strategy that depends on the *credibility* of the intelligence. To accept the strategy, the public must believe that everything possible was done to achieve a credible intelligence product. (b)(3)

[redacted] The ADDI also recalled a statement that the DCI made in the course of his 2004 testimony before Congress: "We will never be 'all right' or 'all wrong.'" Recognizing that this is the nature of intelligence and that national security concerns now more than ever before depend on credible intelligence predictions and projections, the real question is: *Are we doing everything possible to limit the times we will be wrong?* (b)(3)

[redacted] We have reviewed and commented favorably on many of the IC's efforts to strengthen S&T in general and S&T(I) in particular. Recently the IC has instituted new measures to strengthen the review process, such as a final pre-publication review by internal and external expert groups before an assessment is released. (b)(3)

[redacted] However, the "failed assumptions" problem remains the sticking point. The only way to remedy this is to encourage and reward alternative thinking—to include challenging the opinions of (b)(3)

[10] Miscik, Jami, "DDI's State of Analysis Speech," All-Hands Meeting, CIA Auditorium, 11 February 2004.

IC management when appropriate. This approach should be instituted at all levels, from the individual analyst to the broader community. In intelligence as in the business community, broad assumptions must be questioned and alternative paths considered. Especially in intelligence analysis, alternative paths that result from alternative assumptions may be the only way to accord proper weight to collected information that would be ignored as irrelevant without that alternative path in mind.

[redacted] The IC already uses such procedures at various levels, ranging from TeamA/TeamB approaches to simple Red Team efforts. We do not have a specific answer to what constitutes the appropriate level of true competitive analysis. We recognize that competitive analysis costs money, but we also recognize that if the IC is to improve its performance it must try different approaches. Analysts are most comfortable with deterministic approaches. We believe the S&T(I) community needs to determine the appropriate levels of competitive analysis and the resulting alternative paths if the IC is to have a chance of doing better. (b)(3)

[redacted] Recommendation 4 (b)(3)

[redacted] **Develop a program within the S&T community to introduce an appropriate level of competitive analysis into its intelligence production, one that truly challenges basic assumptions before they are elevated to "truths."** Any competitive analysis program should be carried out in a substantive, sustained manner, both to limit misjudgments and to improve consumers' confidence in IC S&T(I) products. A useful learning experience in this regard would be to revisit selected controversial cases from the recent past, hypothesize different base assumptions, and determine if a defensible, alternative analysis can be developed. This activity warrants the personal and continuous attention of the Chairman of the National Intelligence Council. (b)(3)

[redacted] Recommendation 5 (b)(3)

[redacted] **IC management should take the necessary steps with respect to career growth to ensure that the S&T work force is encouraged to make the basic changes recommended above.** Career paths and career growth were paid lip service in the response to (b)(3) the PFIAB report. Some specific goals and milestones need to be established before this will happen.

[redacted] APPENDIX A: A MINORITY VIEW OF S&T INTELLIGENCE RESPONSIBILITY BY [redacted] (b)(3) (b)(3) (b)(6)

[redacted] There has been much discussion in recent years about how intelligence must change to adapt to the new security environment and the uncertain ones of the future. But underlying this discussion are tacit assumptions about intelligence and its relation to national security, some of which developed out of the cold war experience and are probably wrong. (b)(3)

[redacted] Perhaps the most fundamental of these legacy assumptions is that intelligence can pretty much do the job the nation needs it to do, or *could* do the job if reforms are made. Another assumption, narrower but more directly relevant to S&T intelligence, is that the IC has the central capability for assessing the technological aspects of threats, and thus should have the prime responsibility for doing so. (b)(3)

[redacted] Neither of these assumptions may be valid today or in the future. If they are not, there are profound implications for national security, for the IC as a whole, and for S&T intelligence. We focus here mainly on how the validity or invalidity of these two assumptions, taken together, bear on how S&T intelligence, and estimating and anticipating the technological aspects of threats, are and should be conceived and pursued. (b)(3)

[redacted] The cold war experience led naturally to tacit adoption of both of these assumptions. Several factors contributed. Many of the key issues of the cold war were focused on science and technology: Sputnik, nuclear weapons, ICBMs, etc. In the 1960s, when the cold war paradigm that related intelligence to national security was reaching maturity, most of the research and development (R&D) on the planet was performed by the U.S. DoD and the Soviet Ministry of Defense, and the Soviet military R&D was, in large measure, aimed toward the same general kinds of military capabilities as the U.S. work was. Although we always said we should not mirror image, the fact that we set the standard that the Soviets were trying to emulate allowed us to mirror image without much danger, which in turn allowed the intelligence data to be more nearly sufficient than it might otherwise have been. (b)(3)

[redacted] But today only a small fraction of R&D on the planet is performed for defense purposes, or even by governments. Technology has globalized and commercialized, and there is a much greater diversity of actual and (b)(3) potential adversaries and types of threats. Probably no adversaries or potential adversaries are trying to emulate us, either because they cannot aspire to or do not want to. (A few years ago, a Chinese general told a researcher affiliated with DoD's Office of Net Assessment that the Chinese knew we had it easy during the Cold War because the Soviets had been trying to emulate us, and that it was a deliberate part of China's strategy not to emulate us, so that we would not recognize what we might see.) Also, much of what is important for us to know today—what is in some bathtub in Algeria, for example—is much less observable than, for example, ICBM fields or tests, and is more likely to be ambiguous, in part because of dual use.

[redacted] All these and other changes together suggest a profoundly different intelligence/security paradigm, with at least these two aspects: (b)(3)

- It should not be assumed that intelligence can pretty much do what we need of it, or could if we fix it up with more money, better collection, more and better tools for analysts, better sharing of data/thoughts, more competitive analysis, etc. (Not only should we "expect to be surprised"; we should expect to be surprised a lot.) This has ramifications that go far beyond the IC itself, of course, but it should have ramifications for how the IC does its job that go beyond the menus of fixes normally talked about.
- The ramifications include that estimates, projections, and guesses about the technological aspects of threats must come mainly from the S&T community rather than from the IC. What the IC uniquely brings to the table is collected data and judgments of its believability, but that data now should be expected to be only a small fraction of the total information, knowledge, expertise, and experience that form the basis for threat judgments.

[redacted] At the risk of appearing to diminish profound differences between the old and new paradigms by using the old terminology of evidence-based threats vs. technologically feasible threats, here is a somewhat different way to say it. In the past, intelligence evidence could weigh heavily, or seem to weigh heavily, in threat estimates because the technological feasibility of what the Soviets might have been trying to do was largely demonstrated by what we found we could and could not do with our technology for our purposes. We could collect most of what we needed to collect because the observables were large, and because we (b)(3) didn't need a lot to sort out the small uncertainties remaining from our own technology experience.

[redacted] In contrast, threat estimates and projections must now be based on a much more wide-ranging exploration of technological feasibility, an exploration that is much less guided by what we are doing with our own defense technology. The difficulty of this exploration will be exacerbated by the fact that the technological cultures generating the threats are different from, and generally less advanced than, ours. In this situation, we will *need* to have *more* intelligence data to sort out the uncertainties in technological feasibilities, but we *will* have *less*, because what we need to see is both less definable and less observable. Therefore, assessing the range of feasible technological threats will be both more important and more difficult. (b)(3)

[redacted] Thinking through everything—or anything!—needed to live in this new situation will be a long and difficult job. But it probably means significant structural changes and a fundamentally different relationship between the intelligence world and the world of S&T, possibly including new institutions. For the purpose of illustrating how fundamental the differences might be, consider this possibility: making the Science Advisor to the President (SAP) responsible for the activities and programs for developing judgments about the technological aspects of threats. The SAP would use the full resources of the nation's S&T communities to study, in depth, global science and technology—in part by participating in it—and to estimate/project the S&T dimension of threats. The SAP and the DCI would be jointly responsible for integrating the technology judgments developed in this way with whatever intelligence data there might be that constrains them, and making these integrated judgments available to decision makers, including the President. The vast majority of the work done in this activity would be dispersed throughout the U.S. S&T community, and it would not involve just a few hundred people. The SAP would require a staff, perhaps comparable to the current Office of Science and Technology Policy staff and parallel to it, to support these responsibilities. This activity would be the focal point for "collection" and use of open source intelligence (OSINT), which would no longer be thought of as INT, but as just the infosphere of global S&T, which it is. This activity would develop new techniques for estimating threats from knowledge of S&T, such as many versions of the "chop-shop" that the Ballistic Missile Defense Office (as DoD's Missile Defense Agency was then called) operated for years at Kirtland AFB to estimate what low-tech nations could do in countermeasures to missile defense. There could be a hundred similar activities, and other quite different approaches. The (b)(3)

 (b)(3)

estimated/projected threats developed for the SAP in these ways would be informed and constrained by what little intelligence-collected data there will be, but that data would often not be determining, especially for the further future.

[redacted] The purpose here is not to propose such an arrangement, but rather to drive home the point that radical new departures will be needed by illustrating one possibility. When, at the beginning of the cold war, we saw the need for a new departure, the CIA was established. Something like the new arrangement posited here could be a new departure for this era. (b)(3)

[redacted] Basing the technological aspects of threat estimates essentially on technological feasibility would have ramifications beyond intelligence, for example in DoD's planning and acquisition processes. From hard experience we know that basing threat estimates on technological feasibility has the potential for exaggerating threats (and sometimes for underestimating them), immense waste, bureaucratic/budget game-playing, and so forth. That is why new assessment techniques and new management approaches would need to be developed. But basing threats mainly on technological feasibility now seems inescapable, and we must figure out how to deal with it—not only in the IC. (b)(3)

[redacted] The kinds of changes that might be needed would take a long time to visualize and put in place. But if they are needed, the IC should start working toward them soon, and doing so could be a better vehicle for deciding what is needed than a study. One possible approach is a pilot project, perhaps sponsored jointly by the DCI and the SAP, in which an important but limited question about threat S&T is approached using a very different relationship between S&T intelligence and the nation's S&T community. (b)(3)

[redacted] APPENDIX B: INDICATORS OF THE CHANGING NATURE OF WORLDWIDE S&T (b)(3)

[redacted] In its 2002 report on science and engineering indicators, the National Science Board (NSB) presented significant information on the current status of U.S. technology R&D. Selected relevant sections are reproduced below to provide substantive insights into the changing nature of global S&T. Figure numbers are those used in the original report. The Task Force used this information as background for our report. (b)(3)

[redacted] On the Importance of S&T R&D to the Nation (b)(3)

[redacted] The United States has managed to turn its R&D strengths to its economic and commercial benefit. Industry's recognition of the importance of research and development to profit growth is reflected in the strong expansion of its own R&D spending. Firms have also invested heavily in information and communication technology that enables them to accelerate product development cycles. Industry has formed joint ventures with other companies, universities, and international partners. Moreover, industry spin-offs and underwriting of new ventures have become more common. A large and flexible venture capital industry has provided both capital and managerial assistance for many new enterprises.[11], [12] (b)(3)

[redacted] U.S. preeminence in S&T may erode as competing centers of excellence are established elsewhere. Foreign graduates may find returning home more attractive than staying in the United States after their training, and industry may locate increasingly sophisticated functions overseas.[13] (b)(3)

[redacted] High-technology industries are important to national economies because they produce a large share of innovations, including new products, processes, and services that help gain market share, create entirely new markets, or lead to more productive use of resources. High-technology industries are also associated with high value-added production, success in foreign markets, and high compensation levels. Results of their activities diffuse to other economic sectors, leading to increased productivity and business expansion. The international competitiveness of their products and processes thus (b)(3)

[11] NSB, *Science and Engineering Indicators 2002*, p. O-2

[12] Note that the NSB's data indicated that while R&D expenditures have risen, "...most (71 percent) of industry's funds used to develop products and services rather than to conduct research." (NSB, 2002, p. 4-3).

[13] NSB, 2002, p. O-4.

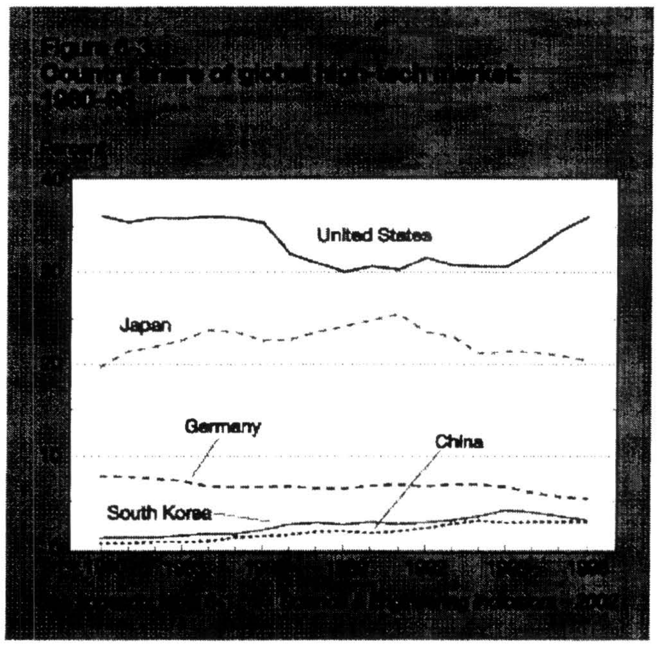
SECRET/[redacted] (b)(3)

provides a useful market-based measure of the performance of a nation's S&T system.[14]

[redacted] Foreign Versus Domestic R&D Investments (b)(3)

[redacted] *Two-Thirds of High-Technology Products Are Produced Outside the United States* (b)(3)

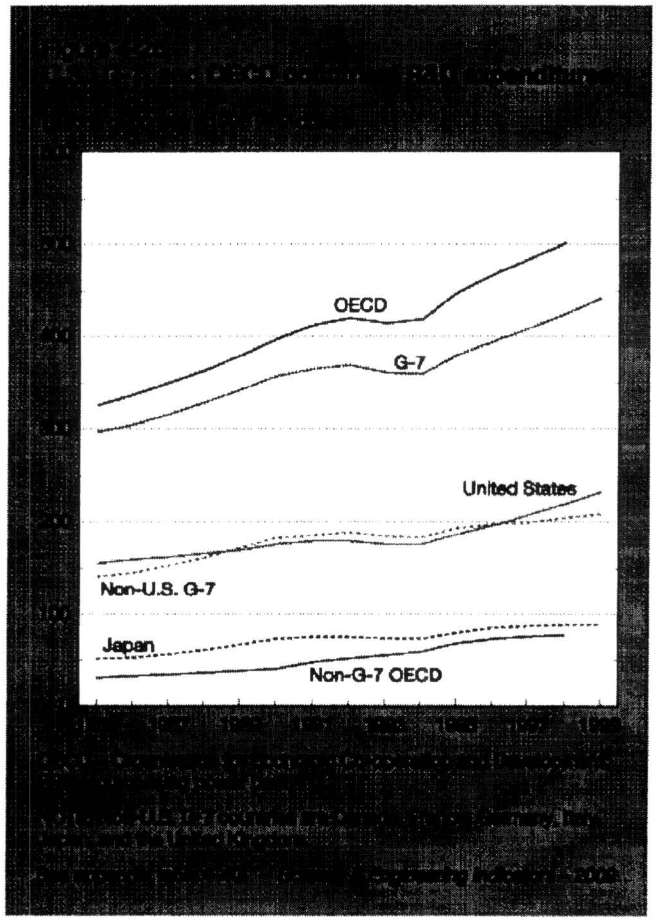
[redacted] While the United States continues to be the leading producer of high-technology products, responsible for about one-third of the world's production, two-thirds of high technology is produced outside the United States.[15] (b)(3)



[redacted] The United States accounts for approximately 44 percent of total R&D expenditures in all Organisation for Economic Co-operation and Development (OECD) countries combined.[16] (b)(3)

[14] NSB, 2002, p. O-8.
[15] NSB, 2002, p. 6-6.
[16] NSB, 2002, p. 4-4.

~~SECRET~~/[redacted] (b)(3)

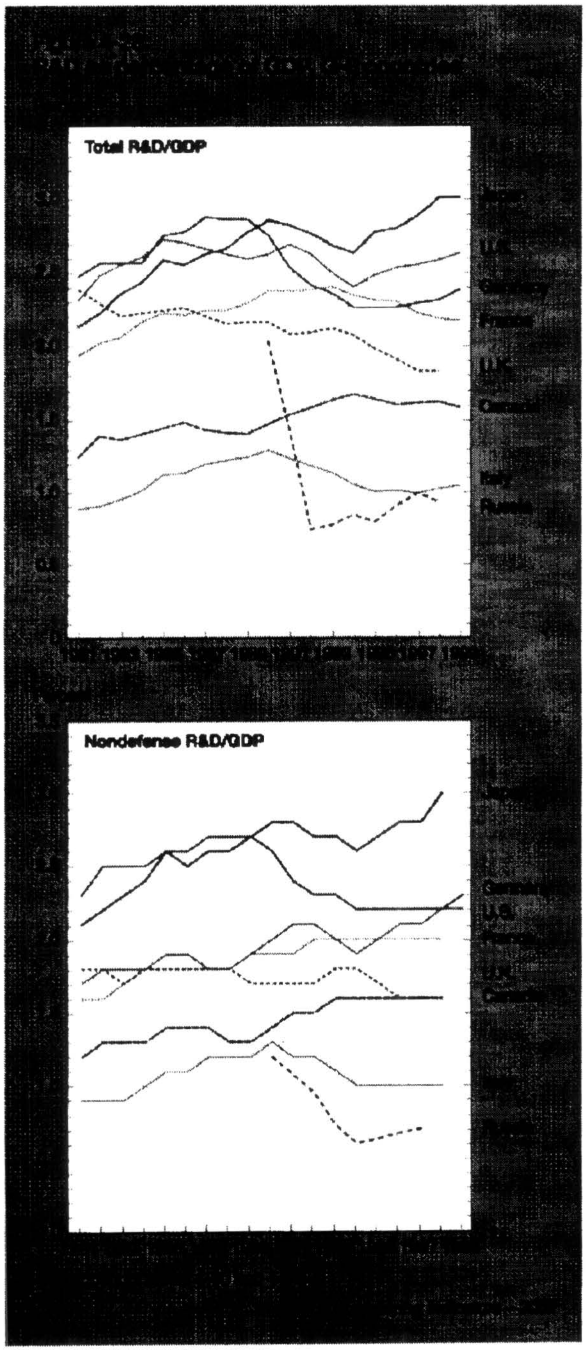


[redacted] *R&D and a Country's Commitment to Growth in S&T* (b)(3)

[redacted] The ratio of R&D spending to gross domestic product (GDP) is one of most widely used indicators of a country's commitment to growth in scientific knowledge and technology development.[17] (b)(3)

[17] NSB, 2002, p. 4-4.

(b)(3)



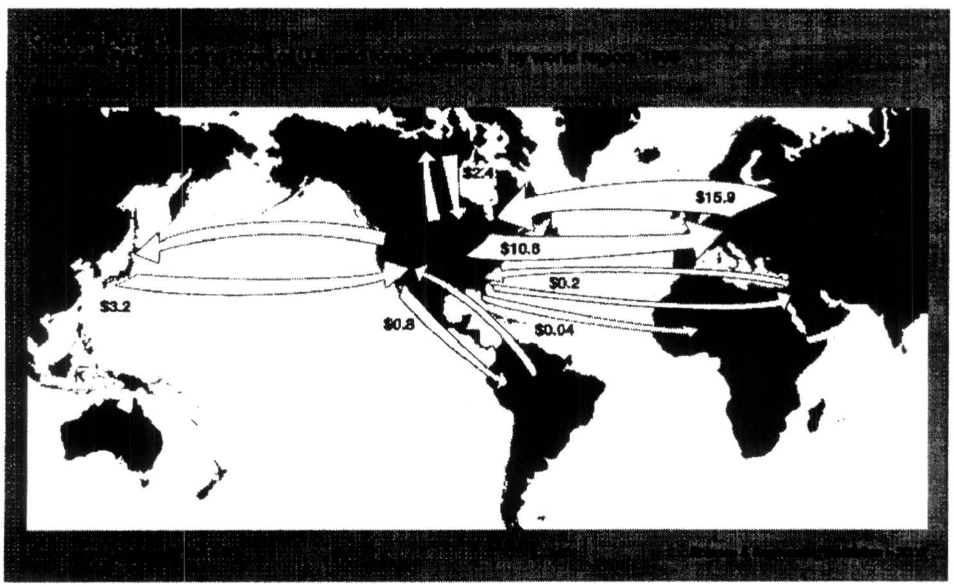
[redacted] *Growing International Conduct of Research* (b)(3)

[redacted] The NSB also described the growth of international involvement in research as follows: (b)(3)

> [redacted] The expansion of R&D efforts in many countries is taking place against the backdrop of growing international collaboration in the conduct of R&D. The decline of global political blocs, expansion of convenient and inexpensive air travel, and advent of the Internet have facilitated scientific communication, contact, and collaboration. More R&D collaborations can be expected to develop with Internet-facilitated innovations such as virtual research laboratories and the simultaneous use of distributed virtual data banks by investigators around the globe. (b)(3)
>
> Indications of this growing international activity can be drawn from the behavior of researchers, firms, and inventors. A rising share of the world's scientific and technical publications have coauthors who are located in different countries. U.S. investigators play a major part in these collaborations, and their coauthorship ties extend to a wider range of countries than those of scientists and engineers in any other nation. (See figure O-18 .) Regional research collaborations are also growing stronger among European and Asian countries.
>
> Greater global collaboration is not limited to the conduct of scientific research. In many countries, foreign sources of R&D funds have been increasing, underlining the growing internationalization of industry R&D efforts. In Canada and the United Kingdom, foreign funding has reached nearly 20 percent of total industrial R&D; it stands at nearly 10 percent for France, Italy, and the European Union as a whole. Foreign R&D funding remains low in Germany, however, and it is negligible in Japan.
>
> The United States is attractive to foreign firms because of its technological sophistication and size of the market. R&D spending in the United States by foreign affiliates rose to a record $22 billion or 15 percent of company-funded R&D in 1998. U.S. affiliates of European companies (including Daimler-Chrysler) accounted for 72 percent of this total, the Asian/Pacific region for 14 percent (four-fifths Japan), and Canada for 11 percent. Foreign-owned subsidiaries of firms in particular countries tend to be concentrated in particular industries (e.g., computer and electronic products for Japan). Also in 1998, 715 R&D facilities were operated in the United States by 375 foreign-owned firms. Japan owned 35 percent of them; Germany and the United Kingdom each owned 14 percent.
>
> U.S. firms are also investing in R&D conducted in other locations. R&D spending by U.S. companies abroad reached $17 billion in 1999, rising by 28 percent over a brief three-year span. (See figure O-19 .) More than half this spending was in the areas of transportation equipment, chemicals (including pharmaceuticals), and computer and

electronics products. Both inflows and outflows of foreign funds are dominated by manufacturing sector R&D. Relatively low levels of service sector R&D spending suggest a greater difficulty in exploiting nondomestic locations.

Globalization is also indicated by the strong growth of international patent families, which are patents filed in multiple countries covering the same invention. Their number has grown from 249 in 1990 to 1,379 in 1998. This development indicates the globalization of both markets and intellectual property. It also suggests increasing access to knowledge and know-how flows on a global scale.[18]



[redacted] *Business Alliances Are Increasingly International* (b)(3)

[redacted] NSF noted that international business alliances are becoming less dominated by U.S. business: (b)(3)

> [redacted] In 2000, 574 new technology or research alliances were formed worldwide in six major sectors: information technology (IT), biotechnology, advanced materials, aerospace and defense, automotive, and (nonbiotech) chemicals....The majority of the alliances involved companies from the United States, Japan, and countries of Western Europe.[19] (b)(3)

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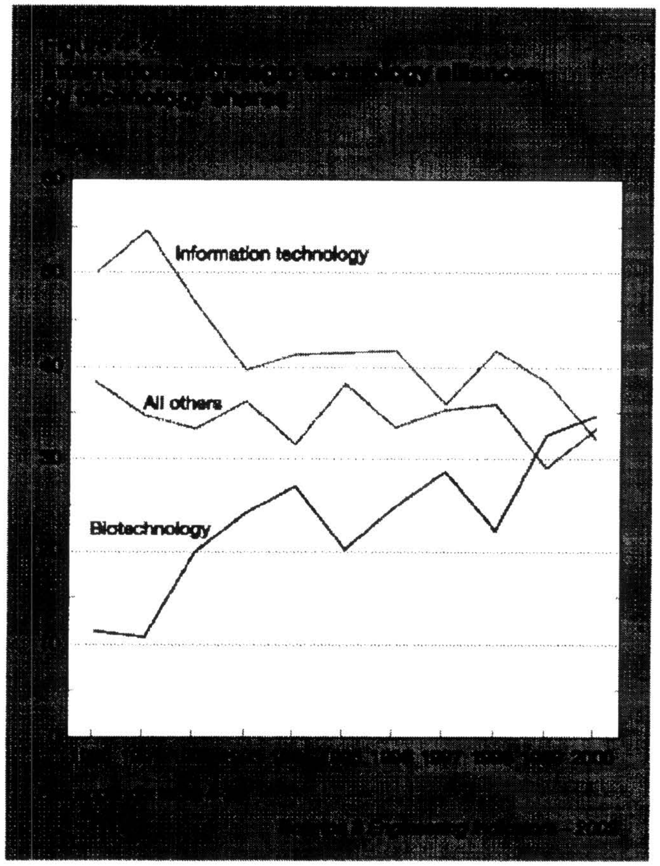
[18] NSB, 2002, pp. O-13–O-14.
[19] NSB, 2002, p. 4-39.

 (b)(3)

[redacted] *Technology Focus* (b)(3)

[redacted] The share of biotechnology partnerships reached an all-time high of 35 percent in 2000 (199 of 574), continuing an increasing trend that began in 1991.[20] (b)(3)



[redacted] *Degree of Internationalization of R&D Spending* (b)(3)

[redacted] The Industrial Globalization R&D (IGRD) index, defined as the average of foreign and overseas R&D spending shares for a given industry, is an indicator of the degree of internationalization of R&D spending. By this measure, chemical R&D flows exhibit the highest degree of internationalization (IGRD index of 25), followed by transportation equipment (IGRD index of 19) and computer manufacturing (IGRD index of 15).[21] (b)(3)

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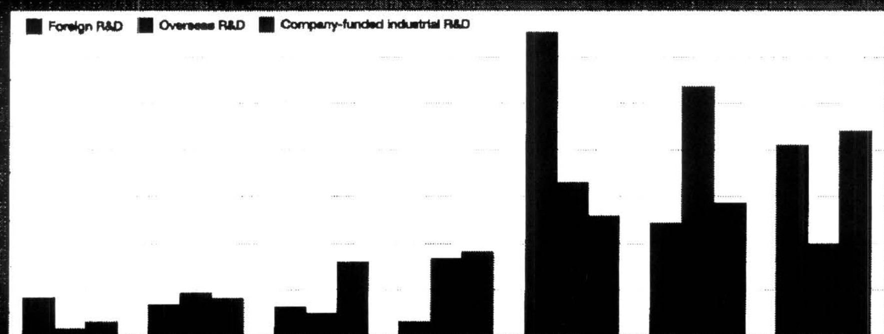
[20] NSB, 2002, p. 4-5.
[21] NSB, 2002, p. 4-5.

SECRET/[redacted] (b)(3)

[redacted] *Foreign Investment and Ties to U.S. R&D Are Strong* (b)(3)

[redacted] Chemicals research, which includes pharmaceuticals and some biotechnology, represented 33 percent of foreign R&D in the United States, twice its 17 percent overseas R&D share. Furthermore, the proportion of chemicals R&D in either foreign or overseas R&D spending is higher than its domestic company-funded R&D share of 13 percent, reflecting a high degree of globalization of R&D activity in this industry.[22] (b)(3)

[redacted]

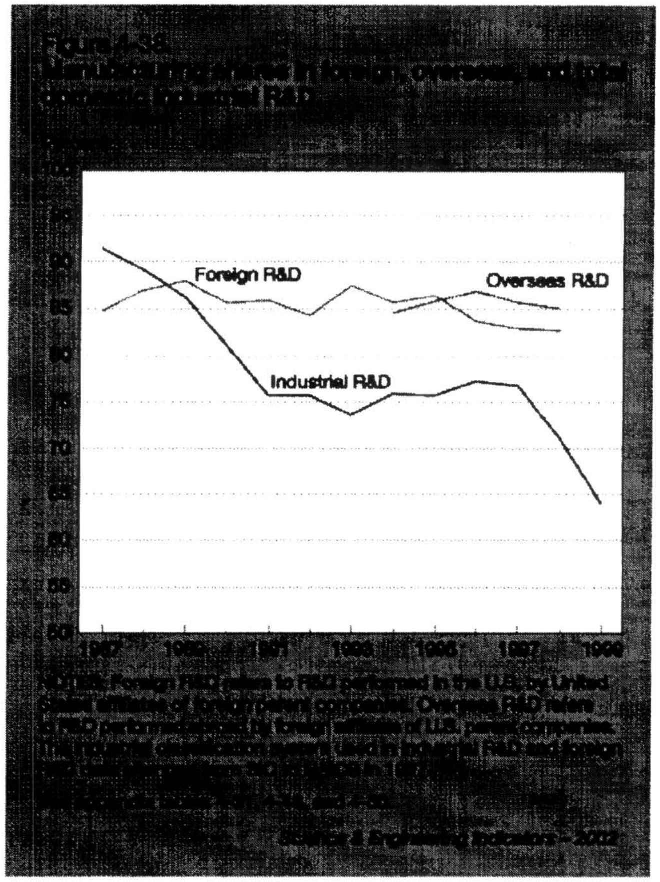


[redacted]

[redacted] Manufacturing activity still dominates trends in total domestic, foreign, and overseas R&D spending, but such dominance has declined in recent years.[23] (b)(3)

[22] NSB, 2002, p. 4-64.
[23] NSB, 2002, p. 4-64.

SECRET/[redacted] (b)(3)



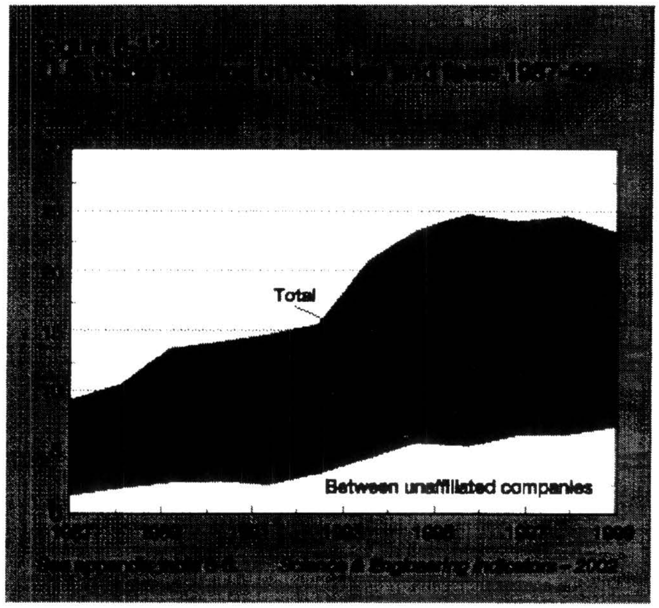
[redacted] *The United States Is a Net Exporter of Technological Know-How Sold as Intellectual Property* (b)(3)

[redacted] While the U.S. has the dominant position in global R&D, it widely shares the fruits of its R&D. (b)(3)

[redacted] The United States has traditionally maintained a large trade surplus in intellectual property. Firms trade intellectual property when they license or franchise proprietary technologies, trademarks, and entertainment products to entities in other countries.[24] (b)(3)

[24] NSB, 2002, p. 6-13.

SECRET/[redacted] (b)(3)



[redacted] Japan is the world's largest consumer of U.S. technology sold as intellectual property, although its share declined significantly during the 1990s. In 1999, Japan accounted for about 30 percent of all such receipts. At its peak in 1993, Japan's share was 51 percent. (b)(3)

[redacted] Another Asian country, South Korea, is the second largest consumer of U.S. technology sold as intellectual property, accounting for nearly 14 percent of U.S. receipts in 1999.[25] (b)(3)

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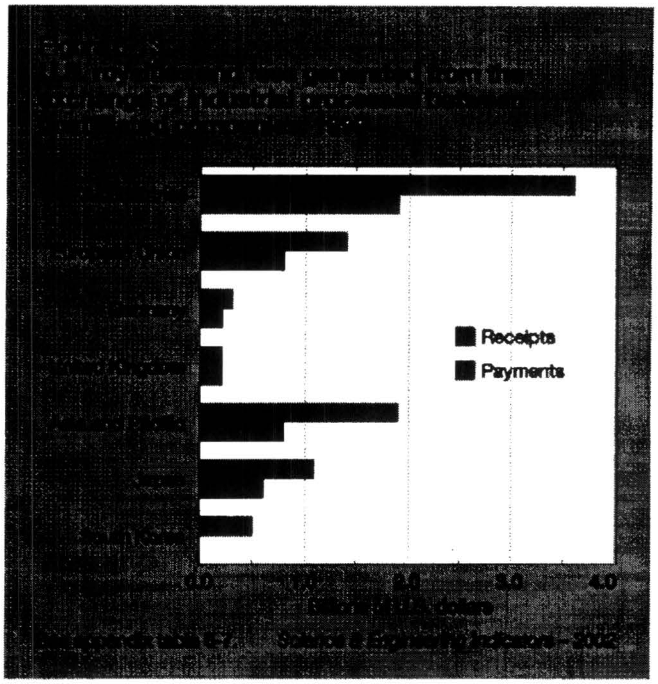
[25] NSB, 2002, p. 6-14.

SECRET/[redacted] (b)(3)



[redacted] In most industrialized countries, the aerospace, motor vehicle, electronic equipment, and pharmaceutical industries conduct the largest amounts of R&D.[26] (b)(3)

[redacted] Private Industry Dominates U.S. R&D Funding (b)(3)

(U) The decline in the share of government funds for R&D is a key trend common to all major industrial nations and many other OECD countries.[9] In the mid-1980s, these nations derived an average of 45 percent of their R&D funds from government sources; by 1998, this figure had fallen to less than one-third. The relative retrenchment reflects the broad growth of industrial R&D, reductions in defense R&D in some key nations, and broader economic and spending constraints on governments. As a consequence, government funding for industrial R&D performance also fell, averaging 23 percent in 1983 but only 10 percent in 1998 for OECD as a whole.[27]

[redacted] Private industry provided 68 percent of total U.S. R&D funding in 2000, paying for most U.S. R&D.[28] (b)(3)

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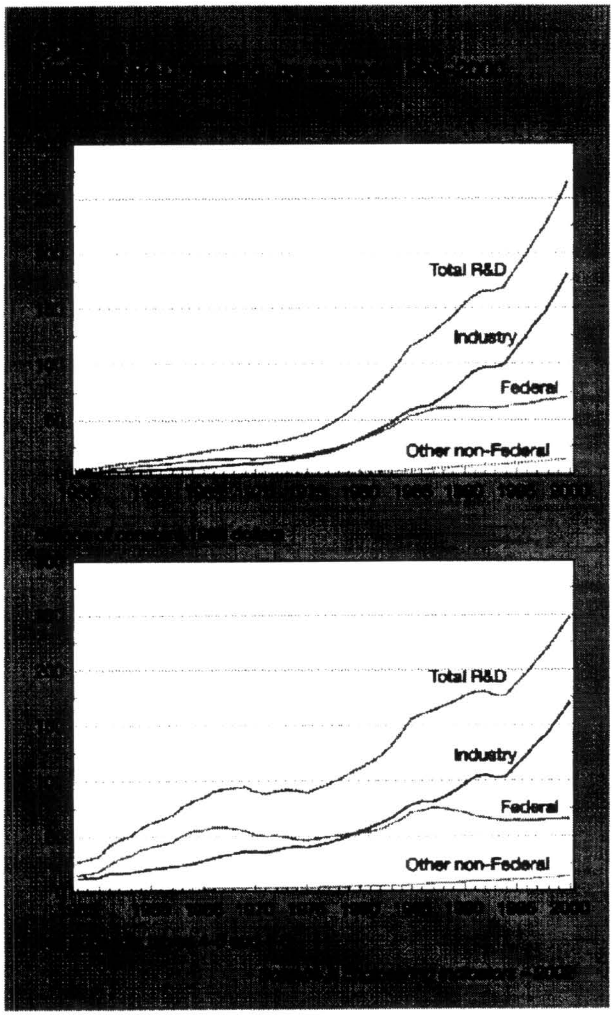
[26] NSB, 2002, p. 6-3.
[27] NSB, 2002, p. O-12.
[28] NSB, 2002, p. 4-3.

SECRET/[redacted] (b)(3)



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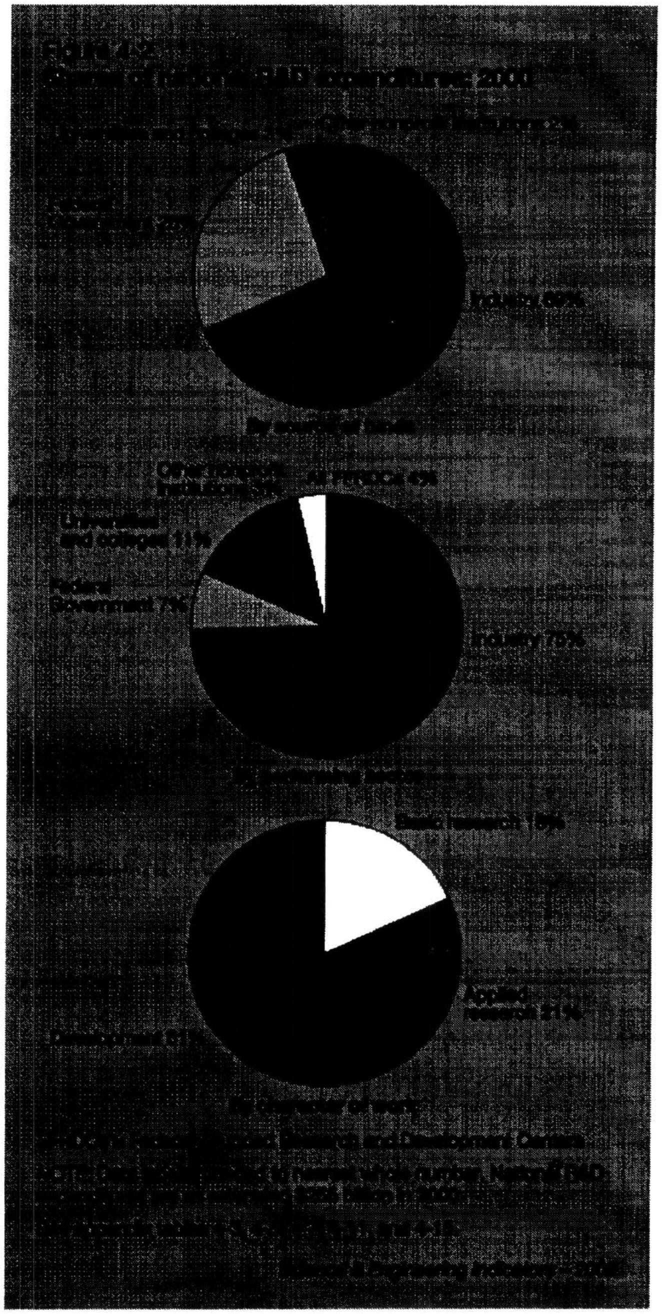

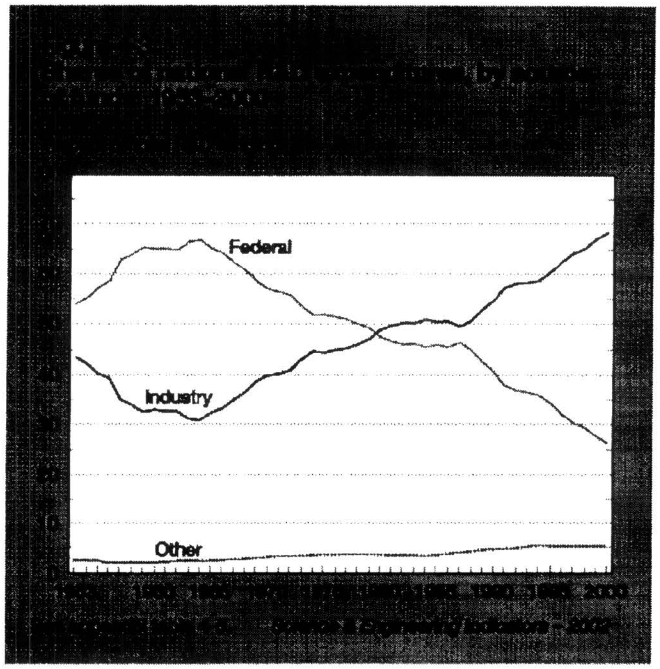
Federal
Industry
Other

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SECRET/[redacted] (b)(3)

(U) APPENDIX D: ACRONYMS AND ABBREVIATIONS

A&P	Analysis and Production
ADCI	Assistant Director of Central Intelligence
ADDI	Associate Deputy Director of Intelligence (CIA)
ARC	Analytic Resources Catalog
BW	biological warfare
CIA	Central Intelligence Agency
DCI	Director of Central Intelligence
DIA	Defense Intelligence Agency
DoD	Department of Defense
DS&T	Directorate of Science and Technology (CIA)
IC	Intelligence Community
ICBM	intercontinental ballistic missile
ISB	Intelligence Science Board
NGIC	National Ground Intelligence Center
NIC	National Intelligence Council
NIO	National Intelligence Officer
NIPF	National Intelligence Priorities Framework
NRB	National Research Board
NRO	National Reconnaissance Office
NSB	National Science Board
PDB	President's Daily Brief
PFIAB	President's Foreign Intelligence Advisory Board
R&D	research and development
S&T	science and technology
S&T(I)	science and technology (intelligence)
SAP	Science Advisor to the President
STIC	Science and Technology Intelligence Committee
WMD	weapons of mass destruction
WMH	weapons of mass hysteria