Language, Culture, and Cooperation in Scientific and Technical Intelligence

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The following article was adapted from a paper that was a finalist in the 2007 DNI Galileo Competition, a program that awards authors of papers proposing innovative solutions to Intelligence Community challenges.

Summary

The findings of recent studies of Intelligence Community treatment of S&T and weapons issues suggest that the community is ill-prepared to meet its mission of mitigating technological surprise. Author Lily Johnston of the CIA argues that the IC must better understand the challenges posed by today's global scientific and technological environment and adjust to meet them. Until the IC rewards fluency in the language of this dynamic field and culture, it will not learn about or understand new foreign S&T developments in their social, political, or military contexts.

Johnston proposes paths for improvement, including the fostering of greater S&T expertise, better understanding of the consequences of dual-use technologies, creating proficient S&T collectors, effectively leveraging combined S&T expertise in teams, and seamlessly integrating analysts, collectors, and subject matter experts.

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Introduction

> *The Intelligence Community [is] particularly vulnerable to surprise by 'rapidly changing and readily available emerging technologies whose use…may result in serious and unexpected threats.' … One senior administration official…described the IC's capability to conduct this kind of all-source S&T and weapons analysis as 'pretty poor' and 'mediocre at best'."*[1]

Sobering comments such as the one above, taken from the report of the WMD Commission of 2005, are the rule, not the exception, in discussions regarding the health of S&T intelligence—i.e. the ability of this community to collect and analyze foreign intelligence and to produce the products that generate policy options. The commission's report and the work of other Intelligence Community study boards spurred reform efforts across the com-

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munity, and S&T intelligence processes seem to be improving as a result. However, two things must happen if we are to do more than optimize a system that is fundamentally flawed.

- First, we must understand that the world of science and technology has a culture and a language of its own, and we must expand the number of people capable of living and communicating in that culture. In effect, we must put "S&T" alongside Mandarin, Pashto, and Farsi in importance as we recruit and develop people to work in traditional hard-target fields.

- Second, we must redefine cooperation at three levels—between analysts and collectors, among IC components, and between IC components and academia and industry. This will require creation of a new system in which S&T language and culture experts retain their skills and credentials in order to gather and make sense of foreign scientific and technical intelligence.

The solution I propose—creation of integrated teams of multi-disciplinary S&T officers, doing both collection and analysis—is a hard approach to a hard problem. My recommendations invoke the spirit of the recommendations of the WMD Commission and IC study boards and build on them in the hope of addressing potential pitfalls and several concerns.

These recommendations are also made in the recognition that no single solution exists to meet the challenge of improving work in scientific and technological intelligence. Efforts on a broad front are needed, and, to the credit of the S&T intelligence community, many tangible and practical matters are being addressed.

The World Isn't Round, the War Isn't Cold: the Changing Nature of S&T

> *We are confronting adversaries who are achieving exponential improvements in their operations through widely available, cutting-edge technology in which their R&D costs are any CEO's dream:* zero.*...We do face a daunting set of challenges in today's world, and they are different challenges from those of the last century—not only because our adversaries are different in kind and character, but also because their weapons and technical resources are different in kind and character.*[2]

Science and technology has and will continue to revolutionize the world we live in—how we do business, how we communicate, even how we conceive of our personal identities. Developments happen so fast that new electronics are a generation old almost immediately after they are purchased, and basic research begins growing stale only a year or two after it is published.

More than ever, new technologies have the potential to be adapted and adopted by our adversaries in undesirable ways. The IC cannot afford to wait until basic research matures into weapons systems or measurable threats before focusing its attention on them. Emerging technologies form a critical part of the IC's S&T intelligence portfolio, but as more emphasis is placed on basic R&D, we are learning that it poses an entirely different set of challenges for analysts and collectors than we are used to.

First and foremost, S&T intelligence is becoming increasingly complicated as more and more commercial technologies with potentially disruptive or unintended applications come to market. The so-called dual-use problem means we cannot simply identify R&D programs, but must also assess their intent. Cellular phones, for example, are nearly ubiquitous in daily life, but it is when the owner intends to use one as part of a detonator for an explosive device that it becomes disruptive.

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Capability assessments without indications of intent are nearly meaningless in the world of dual-use technology. However, determining intent is by far the harder problem, one that relies more heavily on human and signals intelligence than on any other INT. Therefore, it is more important than ever that the S&T intelligence community come together to find solutions to our shortfalls in this area.

Ironically, though we are dying of thirst for HUMINT and SIGINT on intent, we are simultaneously drowning in vast, ever-increasing amounts of open source S&T information. Three principal characteristics can describe the change in the global practice of science and technology: *expansion*, *acceleration*, and *convergence*. Expansion and acceleration are the most intuitive: there is more information available (expansion), and it is accumulating faster and faster (acceleration). Convergence describes two or more disciplines coming together to solve problems at the junctions between them, sometimes resulting in new, discrete fields of study.

Expansion and Acceleration.

Science and technology, more so than other domains of interest to the IC, faces an exponential increase in the amount of baseline information openly available.[3] Like all analysts, S&T analysts monitor new developments—players moving pieces on a game board. Less common to other analytic disciplines is that the rules of the game change almost as quickly as players move their pieces. A political, economic, or military analyst trained 10 years ago will have had to keep up with changes in policy, for example, but will not necessarily face having to learn an entirely novel system of governance over those 10 years. Science and technology analysts, however, will, over a decade, certainly face new areas of study, new technologies, and new fundamentals of how the world works.

Regardless of the metric—number of journals, terminal degrees in science and engineering, conferences, or patents—the numbers all say the same thing: the continued growth of S&T activity around the world is undeniable.[4] Yet as the S&T literature expands and is generated increasingly quickly, there are precious few indications within the IC that we have acknowledged the challenge, much less adjusted to address it.

Convergence.

Interviews with leading US scientific experts conducted as part of a National Science Foundation study revealed that "many researchers believe that the most promising research problems now require multiple techniques and perspectives that are beyond the capacity of individual laboratories."[5] Additionally, that: "[R]esearch has become more collaborative in practically all respects. Scientific articles more frequently involve authors from more laboratories, more institutions, and institutions in more countries. Collaborators are more often trained in different disciplines. …Collaborations with researchers in other institutional sectors, especially industry, were becoming more common."[6] As the data, research areas, industries, and centers of excellence multiply and converge, the S&T intelligence community will have to learn to converge with them or risk missing the most innovative developments in science and engineering.[7]

Convergence in basic research (depicted on the next page) is occurring faster than academic training programs can keep up. Therefore, S&T intelligence officers will need to cover topics and areas that will stretch the limits of their training. One (partial) solution to this problem would be to assemble teams of officers with enough overlap in expertise to allow them to help each other provide broader coverage, but not so much overlap that they are redundant. Deliberate assembly of teams is important—it is unlikely to occur by happy accident—to foster environments in which officers come together and create

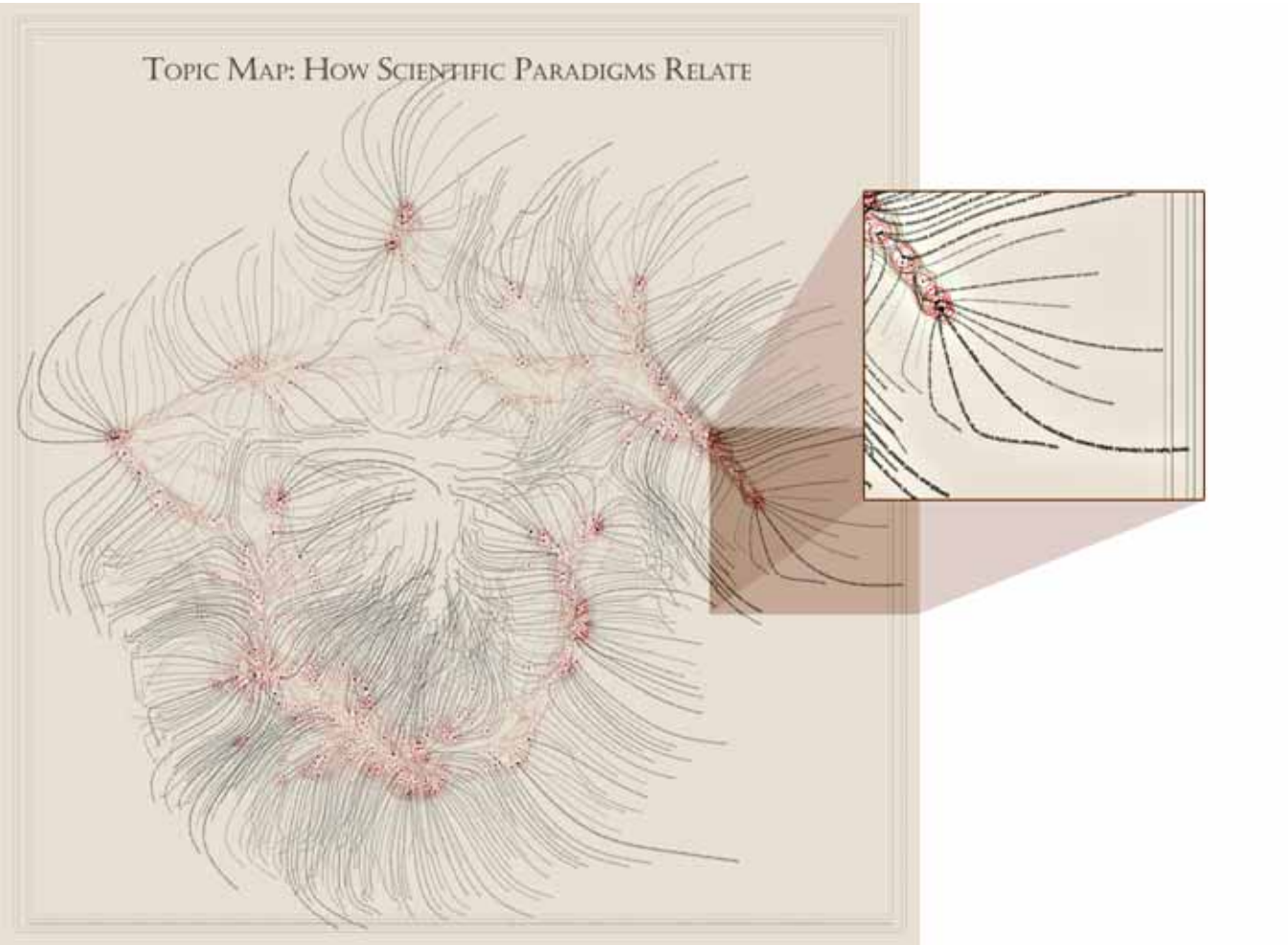
more than the sum of their number in their research and their products.

The point is to suggest that S&T intelligence is different—not harder—than any other discipline. But S&T intelligence becomes harder when those who practice it must, for lack of alternatives, use tradecraft appropriate for other disciplines. Fundamentally different disciplines outside of the IC require fundamentally different ways of evaluating them within the IC.

A Note on Expert Partnerships

> *Although [it] is a successful interaction mechanism with academia and the private sector, it is insufficient compared to what is required. The Intelligence Community needs more consistent advice than that provided by unpaid professionals and more contemporary advice than that provided by intelligence scientists who have not published research in over a decade.*[8]

Perhaps the biggest question this paper must answer is "Why aren't current proposals to improve partnerships with subject matter experts good enough?" To be fair, we have not yet given stronger doses of the current methods much chance to work. However, no current proposal addresses the



A representation of interconnected scientific paradigms (convergence) created by Kevin Boyack and collaborators for an article "Mapping Science" on http://sandia.gov/news/features (accessed 27 May 2008). The graphic portrays 800,000 scientific papers, showing relationships between them and scientific disciplines. The strings emanating from the 776 red clusters of papers are words common to each scientific paradigm reflected in that cluster's papers. See Sandia.gov for a more detailed explanation.

problem of trying to be two places at once.

Being an intelligence officer is often a more-than-full-time job, and cutting-edge S&T is no different. We can ask scientists to try and bridge the gap, but until there is an incentive structure that can adequately compensate them for being only part-time scientists, we will never get the level of effort that is required. Few scientists would risk their careers out of the goodness of their hearts to help the IC, regardless of their belief in our mission. We can ask intelligence officers to do the same, but as I will discuss below, our officers will never truly be accepted (back) in the S&T world and be granted the access they need without a drastic change in the nature of their jobs and in the institutional support they receive.

The Language Barrier

> *Outcome: Establishes incentives for the IC to more quickly attract and hire highly qualified Americans to include first-generation Americans whose native language skills and cultural experiences are indispensable to facing current and future national security challenges.*[9]

The formula on the opening page of this article is an intentionally obtuse equation to make a point. It is known to biochemists as Hill's equation for cooperative binding. The reference might be considered obscure, even by those with backgrounds in the life sciences, but it highlights three points:

- It describes a type of cooperation that I will revisit in the conclusion;
- Scientists and engineers use languages unique to their fields;
- It is a reminder (particularly for those of us who at one time used the Hill equation) that, like all languages, what once was at your fingertips is easily lost, replaced by other knowledge that is tapped more often. The colloquial expression holds: use it or lose it.

Equations and concepts are the building blocks of the language S&T experts use to communicate with one another.

Equations and concepts are the building blocks of the language S&T experts use to communicate with one another. Like a foreign language, it is certainly possible to look up the vocabulary in a book, but nobody will mistake you for an expert if you must use a travel dictionary to translate a lunch order. Moreover, words routinely get added to, subtracted from, and changed in the S&T dictionary. Imagine a 19th century Parisian transported to today's Quebec City—she could make herself understood and would eventually pick up the local dialect and slang, but she would be far from being a native Quebecoise.

That situation is roughly analogous to the one facing the S&T officer who has been sequestered in the IC for 15 years; who has followed a topic in an area outside his primary area of expertise (expertise that would be dated in any case); and who communicates findings primarily to non-scientific audiences. In this circumstance, trying to stay fluent in S&T is like trying to stay fluent in French by skimming Parisian papers twice a week and participating in a weekly language club. It can be done, but it is exceedingly difficult. Myriad incentives exist to develop and maintain foreign language expertise in the IC, but there are no serious, concerted efforts to recruit, maintain, and enhance S&T language capability.

Furthermore, if we add in the challenge of convergence, our metaphorical French-speaker would now be burdened by having to learn the words in Russian, Portuguese, German, and Italian that have suddenly become essential to understanding new developments. It would be unreasonable to expect all officers involved in S&T intelligence to be "fluent," but a cadre of analysts and collectors must be if the IC is to keep up.

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The Culture Barrier

> *Current analysis often fails to place foreign S&T…in the context of an adversary's plans, strategy, policies, and overall capabilities.*[10]
>
> *Failure to think creatively about how to develop an analytic cadre with deep understanding of cultures very different from our own will seriously undermine the Community's ability to respond to the new and different intelligence challenges of the 21st century.*[11]

Establishing bona fides are part and parcel of human interactions, especially in intelligence work. Not everyone can be trusted, but an exchange of information between two parties helps establish a measure of mutual credibility and trust. Likewise, the absence of certain facts or behaviors can betray someone as an outsider instantly. The science and engineering communities are no different: their members can easily distinguish insiders from imposters.

Vocabulary is one mechanism for identifying those who belong, but suppose an IC officer can overcome that obstacle. Far and away, the most common yardsticks for judging S&T prowess are the "Big P's": pedigree, publications, and patents. You are an insider if have: learned from well-respected names in the field; published peer-reviewed original research; or have filed patents in the past year. In some S&T areas, historical relationships with intelligence and defense communities makes interaction easier, particularly if information can be shared at the classified level.

In emerging S&T, where very few scientists have experience with the IC, much less clearances, the experience is different. There, wariness and hesitation to talk to intelligence officers—especially if those officers appear to be unconnected to the R&D community—colors all interactions and generally stymies intelligence gathering.

Without insider-level credibility, officers do not have the access required to know what is happening in emerging S&T in real time—before it appears in peer-reviewed venues, often years after the articles were first researched and written. They instead must rely on open-source literature and research. Imagine trying to do economic analysis for tomorrow's policy decisions with years-old data. That kind of a lag in reporting would be intolerable in any other intelligence area of interest; yet it is the rule in S&T intelligence.

The challenge of gaining insider access is not a new one. Indeed, tacit acknowledgement of it probably explains our systematic reliance on academic and industrial subject matter experts (SME) to report back to the IC. The glaring flaw in this strategy is that the vast majority of our SMEs have little inkling of how the IC works or what would be important to analysts.

It gets worse when, as is typical, our SMEs are reporting to HUMINT collectors who do not have strong backgrounds in S&T and are not equipped to judge what information is of value. Our generalist collectors work hard, but through no fault of their own, they often do not understand the subtleties of the S&T community. We have placed an incredibly unfair burden on collectors, asking them, in effect, to operate in a foreign language and in an environment into which they cannot blend.

Another flaw in the current system is that because we tend most often to interact with US scientists, it is heavily biased by the US scientific culture. Even when such SMEs report observations from overseas, they are like Parisians observing Quebec: their recollections are either without context, or more insidiously, unconsciously interpreted through the lens of US S&T practices.

Few US-based SMEs are intimately familiar with the fund-

ing, tenure, intellectual property, defense S&T, and collaborative climates outside of the United States. Acquisition of this type of knowledge abroad takes time and experience abroad. Managers of other intelligence specialities understand the critical importance of extended time in target countries. So why should S&T intelligence be any different?

Finally, we must address the S&T intelligence culture within the Intelligence Community. Interagency cooperation on S&T issues is probably as strong today as it has ever been, but only through the enormous, largely volunteer, effort of a few individuals. Even with such positive cooperation, however, there still exists a pervasive "agency first, IC second" mentality.

Without question, agencies have differing priorities for S&T intelligence, but it is time to use these differing perspectives as assets rather than excuses to solidify stovepipes. Additionally, IC components often neglect their "blue" or US-based counterparts in the Department of Energy's national laboratories and the Defense Department research labs. Program managers and researchers in these environments often have excellent insights on state-of-the-art R&D and have significantly more freedom to move in the academic and industrial S&T sectors.

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Not only do different perspectives strengthen our analyses, but they also maximize the use of resources by avoiding duplication of efforts and the multiplication of requirements. A shared community-based collection program might go a long way toward supporting the spirit of cooperation that is slowly growing within the S&T intelligence community.

...Require Radical Solutions

[The IC] should develop and manage a range of new overt and covert human intelligence capabilities. In particular, a "Human Intelligence Innovation Center"...should be established to facilitate the development of new and innovative mechanisms for collecting human intelligence.[12]

We found inadequate [IC] collaboration and cooperation, analysts who do not understand collection,...inadequate systematic use of outside experts...[and] a shortage of analysts with scientific and technical expertise.[13]

This fundamental ignorance of collection processes and principles can lead to serious misjudgments, and we recommend that the [IC] strengthen analyst training in this area.[14]

There is a fundamental disconnect between analysts and collectors, and it is particularly pronounced in S&T intelligence. Generally, neither analysts nor collectors have the (S&T) language or cultural credentials to gather and process the information required to adequately cover today's S&T landscape. Increasing, and to some degree formalizing, the interactions between analysts and outside experts alleviates this burden somewhat, but ultimately what we need are inside experts. Additionally, it is not clear that the increased contact with outside experts has affected the collection process measurably (that is, led to more debriefings, more intelligence reports, improved access, etc.).

Why Expert Outreach Only Takes Us So Far

All reform efforts currently underway in the S&T intelligence community are absolutely necessary—they just may not be sufficient to meet the challenges. What more might we try? What follows is a "thought experiment" that presumes an ideal world in which budgetary and bureaucratic impediments are minor. It is offered in the hope that it provides a pathway to real change, but written with the full knowledge that it contains major impracticalities and other shortcomings.

Teams of six to ten officers from IC agencies (or the office of the DNI) would form what could be called S&T Analytic Collection Cells.

Building Blocks

In practice, it may ultimately be more feasible to tackle the problem S&T intelligence faces in smaller pieces. Any proposed solution must contribute to the creation of the following conditions:

- 1. S&T officers become "inside experts," largely by being given better mechanisms to maintain their language and cultural credentials throughout their career—and are rewarded for doing so;
- 2. The importance of intent in dual-use S&T assessments, and therefore the importance of all sources—not just open sources—is understood, and programs are designed accordingly;
- 3.Collectors have proficiency in S&T language and are able to move freely in foreign scientific communities, academic and industrial;
- 4.Teams of S&T officers are assembled to ensure that their combined expertise can cover cutting-edge S&T that may not fit squarely under any single officer's portfolio;
- 5.S&T analysts gain deep understanding of the collection process, and S&T collectors gain deep understanding of analysis;
- 6.Additional mechanisms are created to encourage, if not require, S&T intelligence officers to work across agency barriers in order to maximize resources and the number of perspectives on a given issue.

There will be lots of ways to address some or all of these pieces, but might there be a single model that accommodates them all to some degree? Perhaps it would look something like the following.

One Concept: The Science and Technology Analytic Collection Cell

This concept is inspired by at least two small pilot efforts (not specific to S&T) already underway in the Intelligence Community. Teams of six to ten officers from IC agencies (or the office of the DNI) would form what could be called S&T Analytic Collection Cells (STACCs). Recruited early in their science or engineering careers, these officers would be trained as hybrids, part analyst, part collector, with officers later choosing to emphasize one track or the other.

Following extensive IC training, STACC officers would return to the outside S&T community, rotating back into their careers, but as intelligence professionals as well as subject matter experts. Eventually, the STACC teams would be assembled, and each officer's outside S&T career would migrate overseas in conjunction with those of their teammates. With day jobs in the local S&T community, these officers would be in exceptional positions to unobtrusively observe what is happening in foreign S&T at very granular levels. But the officers would also be able to put developments into the context of the regional S&T environments in which they are working.

These teams could also include venture capital investors, science writers, intellectual property lawyers, and others who would add different and important perspectives to our understanding of S&T systems worldwide. Teams would meet regularly in secure venues to engage their colleagues with other expertise, share observations, brainstorm new intelligence questions, submit reports, and support analysts producing finished intelligence.

Due to the enormous resources and energy that would be required to run and manage these teams, relatively few of them could operate at any given time. They would certainly not be designed to replace any part of the current analysis or collection process. They would only augment it. Such an undertaking would demand an incredible amount from the officers participating, as well as of the support structure to orchestrate it. Neverthe-

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less, we need significant innovation to change how we do business in S&T intelligence, and whether it happens piecemeal or more holistically, as in the STACC model, that innovation will never come without a price.

Conclusion

The IC faces a daunting task in trying to reform S&T intelligence—our old methods are no longer enough to monitor the global S&T environment for disruptive applications. These are untested waters, and whatever course we choose will be risky and difficult. But this cannot be an excuse for not trying. Historically the IC loves nothing more than a hard problem, and likes nothing less than surprise with disastrous consequences. There is no guarantee that if we attempt to tackle the hard problem that we won't be surprised, but leaving S&T intelligence as it stands certainly invites disaster.

Positive cooperativity in enzyme binding, as described by Hill's equation, means that an initial binding event makes more likely subsequent events at other sites. Enzyme binding is an awkward analogy for the practice of S&T intelligence, but it does remind us that some things in nature were optimized for groups, not pieces acting in isolation. We cannot adequately examine S&T issues as individual analysts and collectors any longer, and we cannot solve the S&T intelligence problem as individual agencies.

We must build on the momentum generated by the IC study board and reports of the WMD Commission and find innovative solutions to the problems they pose. Their recommendations are a starting point, but they are evolutionary; alone, they will not fundamentally change the system. It is up to the S&T intelligence community, working from the top and the bottom, to spur the revolutionary changes that we need to keep up with a revolutionary era in science and technology.

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Endnotes

1. *Report of the Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction* (2005), 415. (Hereafter, *WMD Commission Report*.)

2. Remarks by DNI Negroponte to the Woodrow Wilson International Center for Scholars, given September 25, 2006. Available at www.dni.gov/speeches/20060925_speech.pdf. Accessed 6 February 2008.

3. The other domains include politics, economics, military analysis and weapons system analysis. The latter is often lumped together with S&T intelligence. Without debating the issue, for the purposes of this paper, I will assume that S&T intelligence is separate from mature weapons systems intelligence.

4. National Science Foundation. (2007). The changing research and publication environment in American research universities. (Working Paper 07-204). Arlington, VA: Bell, R.K., Hill, D., & Lehming, R.F. "Many study informants said the volume of published scientific journal articles had increased, with the numbers of journals, issues, and articles per journal issue all growing larger."

5. Ibid.

6. Ibid.

7. Ibid. "The study team was often told that biology in particular had become markedly and radically more interdisciplinary, developing increasingly strong links to physics, mathematics, statistics, engineering, and various kinds of environmental science....Computational sciences, including mathematics and statistics as well as computer sciences, were another area where researchers reported substantial growth in interdisciplinary work."

8. *WMD Commission Report*, 510–11.

9. Office of the DNI. *United States Intelligence Community 100 Day Plan for INTEGRATION and COLLABORATION*. 11 April 2007, 7. http://www.dni.gov/100-day-plan/100-day-plan.pdf, accessed 13 September 2007.

10. *WMD Commission Report*, 415.

11. Ibid., 398.

12. *WMD Commission Report*, 370.

13. Ibid, 389.

14. Ibid, 409.

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