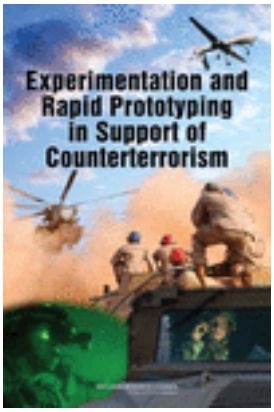

Experimentation and Rapid Prototyping in Support of Counterterrorism

Committee on Experimentation and Rapid Prototyping in Support of Counterterrorism; National Research Council

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Experimentation and Rapid Prototyping in Support of Counterterrorism

Committee on Experimentation and Rapid Prototyping
in Support of Counterterrorism

Division on Engineering and Physical Sciences

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Preface

The Department of Defense's (DOD's) *2006 Quadrennial Defense Review* highlights the need for U.S. military forces to adapt and reorient "to produce a truly integrated joint force that is more agile, more rapidly deployable, and more capable against the wider range of threats," particularly the nontraditional, asymmetric challenges of this new century.[1] For example, in Iraq and Afghanistan, improvised explosive devices (IEDs) have become the weapon most often employed against U.S. (and coalition) forces by insurgents and terrorists, who have shown an ability to exploit available and advanced technologies to carry out such attacks. Furthermore, with access to a wide range of commercially available technologies, insurgents and terrorists have shown a "cycle of adaptation" of less than 12 months to responses by U.S. forces to counter IED attacks.

This constantly evolving threat requires U.S. military forces to adapt and respond more rapidly with modified tactics, technologies, and/or equipment than traditional DOD doctrinal, requirements, and acquisition processes provide for. In particular, experimentation and rapid prototyping have played key roles in the DOD's efforts to develop these new technologies, equipment, and corresponding tactics.

In response to this need for new technologies, the Rapid Reaction Technology Office (RRTO) was established in 2006 under the Director, Defense Research

[1]Department of Defense. 2006. *2006 Quadrennial Defense Review,* Washington, D.C., February 6.

and Engineering, within the Office of the Secretary of Defense.[2] It is focused on developing technologies that can mature in 6 to 18 months for purposes of counterterrorism.[3] In short, the RRTO provides a diverse set of quick-response capabilities for counterterrorism while also attempting to stimulate interagency coordination and cooperation.

While the RRTO has enjoyed what appears to be strong program success according to the committee's review of the projects sponsored and supported by the RRTO, the agency seeks to understand and address barriers to and opportunities for meeting future counterterrorism needs—including the need to accelerate the transition of technologies for counterterrorism with an eye to countering emerging and anticipated threats. This report responds to a request for a review of RRTO approaches and provides a set of recommendations for potential improvements to help meet these needs for rapid technology development.

TERMS OF REFERENCE

At the request of the director of the Rapid Reaction Technology Office, the National Research Council established the Committee on Experimentation and Rapid Prototyping in Support of Counterterrorism.[4] Specifically, the committee was tasked with the following:

- Review the current experimentation and rapid prototyping approaches utilized by RRTO for counterterrorism;
- Identify potential barriers, both within RRTO and outside RRTO, that inhibit accelerating the transition of developments in science and technology to support counterterrorism applications; and
- Recommend potential improvements to RRTO approaches, including areas for future focus that can further accelerate the fielding of affordable, sustainable capabilities and concepts to counter emerging threats.

THE COMMITTEE'S APPROACH

The committee was first convened in October 2008. It held additional meetings and site visits over a period of 4 months, both to gather input from the relevant communities and to discuss its findings and recommendations. The agendas of the meetings are summarized below.

[2]Effective August 21, 2009, the Rapid Reaction Technology Office was subsumed under the new Office of the Director, Rapid Fielding, which will report to the Director, Defense Research and Engineering.

[3]In this report, *counterterrorism* includes efforts to counter insurgency and irregular warfare and to conduct all other associated efforts, but not conventional warfare.

[4]Biographies of its members are provided in Appendix A.

- *October 16-17, 2008, in Washington, D.C.* Inaugural meeting. Briefings on experimentation and rapid prototyping test cases and perspectives: Rapid Reaction Technology Office, Defense Research and Engineering, Office of the Secretary of Defense; Lincoln Laboratory, Massachusetts Institute of Technology; Joint Improvised Explosive Device Defeat Organization; Department of Homeland Security; and Federal Bureau of Investigation.
- *November 18, 2008, in Yuma, Arizona.* Site visit to the Joint Experimentation Range Complex, Yuma Proving Ground.
- *November 20, 2008, in Washington, D.C.* Site visit to the Rapid Reaction Technology Office.
- *December 15-16, 2008, in Washington, D.C.* Briefings on experimentation and rapid prototyping perspectives: Under Secretary of Defense for Acquisition, Technology and Logistics; Under Secretary of Defense for Intelligence; Special Operations Command; U.S. Army's Rapid Equipping Force; Air Force Research Laboratory; Defense Advanced Research Projects Agency; Joint Capability Technology Demonstrations Office; Defense Threat Reduction Agency; and Office of Director of National Intelligence.
- *January 7-8, 2009, in Washington, D.C.* Committee deliberations and report drafting.

The months between the committee's last meeting and the publication of the report were spent preparing the draft manuscript, gathering additional information, reviewing and responding to the external review comments, editing the report, and conducting the security review needed to produce an unclassified and unrestricted report.

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Paul M. Bevilaqua, Lockheed Martin Aeronautics Company,
Gerald G. Brown, U.S. Naval Postgraduate School,
Marion R. Bryson, Mililani, Hawaii,
Ruth A. David, Analytical Services (ANSER), Inc.,
William J. Hurley, Institute for Defense Analyses,
Larry G. Lehowicz, MG, USA (retired), Quantum Research International,
Ronald Sega, Colorado State University Research Foundation, and
Cindy Williams, Massachusetts Institute of Technology.

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by John F. Ahearne, Sigma Xi, The Scientific Research

Society. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

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Summary

Technology and equipment are the warfighter's tools, and operational concepts are the techniques developed by the warfighter to apply those tools to best accomplish the mission. While the missions of the U.S. military are reasonably stable with respect to operational protocol, those of its adversaries are continuously reacting to U.S. operational concepts and to U.S. enabling technology and tools. To be effective, the United States must be able to anticipate those reactions and develop and execute an acquisition and operational approach that enables the definition, development, and fielding of new operational concepts and tools within the cycle time adopted by its adversaries. Doing so requires red teaming,[1] modeling, simulation, and testing combined in an integrated program that includes operational concept development, technology definition, and development; and transfer into fielded equipment with appropriate training and support.

After the attacks on September 11, 2001, the Department of Defense (DOD) began to use different approaches to address these needs, including the creation of new "rapid acquisition programs." The DOD created the Combating Terrorism Technology Task Force (CTTTF) in an effort to help the DOD identify its science and technology (S&T) counterterrorism base. In 2006, the roles and responsibilities of the CTTTF were subsumed by the DOD Rapid Reaction Technology Office (RRTO), which focuses primarily on technologies that can be matured in

[1] *Red teaming* is defined as an activity using a person (or group of people)—sometimes as adaptive simulated enemies—to look for and test vulnerabilities in military plans and/or emerging technical concepts. (See Defense Science Board, 2003, *Defense Science Board Task Force on the Role and Status of DoD Red Teaming Activities,* Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, Washington, D.C., September.)

6 to 18 months for purposes of counterterrorism.[2,3] The RRTO's mission is "to partner with Department of Defense (DOD) offices, other government agencies, industry and academia in order to break the terrorist or insurgency cycle, counter emerging and anticipated threats, and respond to validated joint urgent needs by accelerating the development and fielding of affordable, sustainable transitional and non-traditional capabilities for the warfighter."[4] The RRTO has organized itself to provide a quick-response and diverse set of capabilities for leveraging DOD S&T in support of counterterrorism while also attempting to stimulate interagency coordination and cooperation among other federal agencies.

At the request of the director of the Rapid Reaction Technology Office, the National Research Council established the Committee on Experimentation and Rapid Prototyping in Support of Counterterrorism. Specifically, the committee was requested to:

- Review the current experimentation and rapid prototyping approaches utilized by RRTO for counterterrorism;
- Identify potential barriers, both within RRTO and outside RRTO, that inhibit accelerating the transition of developments in science and technology to support counterterrorism applications; and
- Recommend potential improvements to RRTO approaches, including areas for future focus that can further accelerate the fielding of affordable, sustainable capabilities and concepts to counter emerging threats.

Experimentation and rapid prototyping—both key to accelerating the transition of technologies to the warfighter in support of counterterrorism and counterinsurgency—are approaches employed by the RRTO. Whereas mature technologies can be transitioned to elements of deployed U.S. military forces in the short term, experimentation and rapid prototyping are necessary on the front end of technology development to determine the potential of new technologies and capabilities to mitigate the shortcomings of current operational concepts and systems and to mature those technologies found to be promising.

The ability to spur and leverage technological advances is vital to sustaining the DOD's ability to maintain its edge over current and potential adversaries and to improve or transform the conduct of military operations during irregular warfare. The RRTO role has been and is appropriately targeted on what has been a two-part critical problem in this regard: (1) applying S&T developments that

[2]Effective August 21, 2009, the Rapid Reaction Technology Office was subsumed under the new Office of the Director, Rapid Fielding, which will report to the Director, Defense Research and Engineering.

[3]In this report, *counterterrorism* includes efforts to counter insurgency and irregular warfare and to conduct all other associated efforts, but not conventional warfare.

[4]Defense Research and Engineering, Rapid Reaction Technology Office Web site, available at www.dod.mil/ddre/org_rrto.html. Accessed April 2, 2009.

can be matured in 6 to 18 months and assisting in the transitioning of resulting solutions quickly to combat units in response to very urgent needs, and (2) providing feedback to the S&T community that can help guide longer-term technology efforts.

The information that the committee received in its data-gathering sessions (October through December 2008) identified an array of benefits resulting from RRTO efforts. These include the quicker fielding of technological improvements, potential cost savings, and the identification and development of improved operational concepts and opportunities. These benefits have been enabled by innovative technologies in the DOD's S&T base and also by technologies available from sources outside the DOD. RRTO-sponsored technologies are bringing benefits to warfighters and to other customers involved in nontraditional conflict. Furthermore, the RRTO can be credited both with giving midlevel management and senior leaders the flexibility to address current warfighter needs rapidly and with highlighting potential benefits enabled by smaller technology projects that might otherwise be ignored.

A significant strength developed by the RRTO is the ability to effectively identify and exploit technology programs developed in other federal departments, the industrial base, and academia. The RRTO has also developed and applied tools to allow constructive interactions among various organizations involved in irregular warfare and counterterrorism and has exploited those interactions to improve predictions of likely trends and reactions of adversaries. This approach has been helpful in improving anticipation of future needs. In developing and applying these strengths, the RRTO is serving as a catalyst to better define future needs and also to bring technologies and operational concepts together to address those needs.[5] In the cases where RRTO experiments have not been immediately adopted for transition to the warfighter, these experiments have served to provide critical knowledge that has been employed by others to build capabilities that did work. The key attributes of the RRTO and the essential elements of its business model are summarized in Box S.1.

Several examples of specific activities of the RRTO related to elements of its business model follow from the concepts outlined in Box S.1:[6]

- *Foster communications and form collaborative cross-agency groups:* The biometrics and forensics capabilities developed to permit rapid, if not real-time, identification in a combat theater of "bad actors" that have been previously identified as such by other government agencies or even other governments—as discussed in Chapter 2—are an excellent example of this RRTO strength of using cross-agency inputs and collaborative development efforts.

[5]A detailed discussion of the RRTO's methods of experimentation (including project selection, test planning, conduct, analysis, and reporting process) is provided in Appendix C of this report.

[6]Additional examples of specific RRTO project activities are provided in Appendix D.

BOX S.1
What Defines the Rapid Reaction Technology Office?

During the course of this study, the Committee on Experimentation and Rapid Prototyping in Support of Counterterrorism reviewed the projects sponsored and supported by the Rapid Reaction Technology Office (RRTO) and received briefings from the RRTO's customers, consumers, and collaborators. Drawing on these various sources of information and its own deliberations, the committee summarizes below the six critical attributes of the RRTO and six essential elements of the RRTO's business model that it believes define the RRTO. This view of the RRTO was verified in committee discussions with partner organizations of the RRTO.

Critical Attributes

The Rapid Reaction Technology Office is a catalytic organization that anticipates and responds to emerging threats, with an emphasis on terrorism and irregular warfare. The following are critical attributes of the RRTO:

- Being limited in size (funding and staff)—a small and agile organization;
- Possessing enlightened, risk-tolerant leadership;
- Having highly qualified and motivated staff;
- Being placed at a high organizational level within the DOD;
- Being focused on joint and interagency needs; and
- Serving as an enabler of timely and sufficient rather than optimal solutions—but not executing acquisition and fielding.

Essential Elements of the Business Model

The essential elements of the RRTO's business model are as follows:

- Foster communications and form collaborative cross-agency groups;
- Operate with transparency and openness;
- Anticipate and identify capability needs
  - —Across multiple disciplines, agencies, and organizational stovepipes,
  - —Not seen or addressed within existing individual organizations;
- Create synergy by bringing diverse organizations together to
  - —Recognize needs,
  - —Invent and develop capabilities and concepts of operations,
  - —Gain buy-in from partner organizations through cost sharing;
- Enable close relationships among technical staff, testers, and users to accomplish the following:
  - —Experimentation to gain early insight and knowledge,
  - —Exploration of alternative concepts of operations and determination of effectiveness,
  - —The capturing of and making available unique data sets; and
- Enable multidisciplinary science and technology solutions.

- *Anticipate and identify capability needs:* "Human terrain teams" that permit combat units to better understand and communicate with the foreign nationals of differing ethnic backgrounds are an example of the RRTO's ability to anticipate the need for an improved capability and then to provide a quick solution.[7]
- *Create synergy by bringing diverse organizations together:* The Bluegrass tracking system experiment brought together outputs from the intelligence community's intelligence, surveillance, and reconnaissance (ISR) sensors with outputs from the military's moving target indicator (MTI) radars to potentially identify locations of high-value targets. This effort is an excellent example of the RRTO's creating synergy using capabilities from multiple organizations.
- *Enable close relationships among technical staff, testers, and users:* The RRTO sponsored the development of a test facility within Yuma Proving Ground, Arizona, to examine new systems for counterterrorism. This facility focuses on testing technologies to combat improvised explosive devices (IEDs) and is also used as a training site to help prepare forces prior to their overseas deployment to areas with terrorist threats. The site has become highly valued for testing systems in a realistic environment prior to their fielding. Test results are documented in NAVAIR (Naval Air Systems Command) Quick Look Experimentation Reports; after review by the RRTO these reports are archived and posted on a Web site for sharing with partner organizations. In addition, the RRTO chairs a biweekly secure videoconference with all interested organizations, including field operational personnel who provide valuable feedback on fielded equipment as well as insights relevant to future experiments.

A representative list of RRTO successes with a brief description of each is presented in Appendix D.

ORGANIZATIONAL STRENGTHS AND WEAKNESSES

In addition to identifying potential issues and recommending areas of improvement with respect to the RRTO's approach to rapid technology implementation, the committee also discussed the organizational strengths and weaknesses of the organization. Three key RRTO strengths, as perceived by this committee, can be summarized as follows:

1. *Current workforce:* A major strength of the RRTO is the high quality of its staff. The RRTO director's handpicking the right set of people to make up a diverse team with different perspectives and appropriate technical qualifications has served to position the RRTO well.
2. *Small organizational size:* The relatively small size of the RRTO is a

[7]The human terrain team efforts are also part of the SKOPE project, discussed in Chapter 2 and Appendix D of this report.

distinct advantage. Because the organization has intentionally been kept small, its director has been successful in personally selecting the high-quality staff consistent with his management style and the RRTO business model.

3. *Current business model:* The RRTO's unique combination of attributes and business model elements (it is multidisciplinary, small, risk-tolerant, transparent, joint) contributes to its key strengths of flexibility and agility that are so important to anticipating and defeating rapidly evolving threats.

The RRTO is a very successful organization in recognizing emerging technology needs. As with any organization, however, there are areas that can be improved. The following list summarizes the RRTO weaknesses identified by the committee:

1. *Contracting delays:* The RRTO can experience contracting delays of 4 to 6 months. For an organization with the name "Rapid Reaction Technology Office," having delays that average many months from the start of a contracting process until the award of the contract is a significant issue. The RRTO does not have its own contracting office but relies on others for contracting support. The committee considered a number of options to improve contracting support and recommends a particular approach.

2. *Maintaining other organizations' awareness:* In briefing the committee, some of the senior leaders of organizations noted that they had limited insight into the many efforts that the RRTO was conducting. This was said to be the case even when significant joint efforts were carried out by the RRTO with elements in such senior leaders' organizations. Because it is important to keep the RRTO staff small and responsive, the director of the RRTO should consider options that are not personnel-intensive for increasing other organizations' awareness of the RRTO.

3. *Ensuring a long-term capability:* Having a long-term capability requires preparing for future staffing and leadership. While some midlevel people are assigned to the RRTO, because the organization is small and outside many of the normal career paths, a greater effort is required to expose a range of people to the RRTO and to provide succession planning.

MAJOR FINDINGS AND RECOMMENDATIONS

In addition to providing a qualitative analysis of the strengths and weaknesses of the RRTO, the committee reviews and discusses other potential issues impacting the organization. Below the committee offers its major findings and recommendations to help guide and maximize future RRTO and DOD efforts to accelerate developments in science and technology to support counterterrorism applications. These are the major findings and recommendations presented in Chapter 4 of the report. Related findings and recommendations are presented in the context of the committee's analysis in Chapter 3.

Finding 1: The Rapid Reaction Technology Office's unique combination of attributes and business model contribute key strengths—flexibility and agility—in anticipating and defeating disruptive threats to this nation and its way of life. These strengths are essential to the Department of Defense, but retaining them requires constant vigilance. The RRTO's capabilities to span organizational boundaries and to work outside conventional modes serve the DOD well.

Recommendation 1: The Rapid Reaction Technology Office should be continued as a separate entity reporting directly to the Director of Defense Research and Engineering (DDR&E), with enhancements as recommended elsewhere in this report but without a substantial change in size or business model. The DDR&E should strongly resist making the RRTO conform to conventional approaches. Doing so would seriously reduce both the RRTO and the DOD's effectiveness. Also, the committee recommends that the RRTO publish for its potential partners a broad guide to the process and criteria that the RRTO uses for project selection. The Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]) should review the RRTO every 5 years to assess its value and whether it should be continued. To continue as an effective organization, the RRTO needs to increase its emphasis on succession planning.

Finding 2: The RRTO has applied a significant portion of its resources in order to anticipate and address emerging and potential needs that have not been formally recognized by others. This effort has enabled the timely fielding of new capabilities that have been successful in countering rapidly evolving threats.

Recommendation 2: The director of the RRTO should continue to devote a substantial portion of the organization's resources to addressing needs that are emerging and anticipated (even though unarticulated) in order to enable timely fielding of new capabilities that will counter or deter rapidly evolving threats.

Finding 3: The committee identified and reviewed seven internal and external issues that could be potential barriers to the RRTO's ability to enable rapid transition of developments in science and technology to support counterterrorism applications. Most of these issues are such that trying to eliminate or reduce the particular barrier involved would have an overall adverse impact on the RRTO's effectiveness. The two issues that the committee believes should be addressed are these:

- The pressure to consolidate the organization with conventional military Service acquisition organizations and/or to conform to institutional acquisition or test methodology, and
- The lack of test site intelligence support at Yuma Proving Ground, Arizona.

The first issue is addressed in Finding 1 and Recommendation 1. The second issue is addressed in Recommendation 3.

Recommendation 3: In supporting the RRTO and Yuma Proving Ground, the Army Deputy Chief of Staff for Intelligence and the commander of the U.S Army Test and Evaluation Command (ATEC) should expand support to the RRTO and its associated test support organizations (i.e., the Naval Air Systems Command and the National Counterterrorism/Counterinsurgency Integrated Test and Evaluation Center) with regard to translating intelligence information into realistic test scenarios. The commander of ATEC should provide for the installation of a secure videoconferencing capability at Yuma Proving Ground so as to enhance communications for the planning of experimentation and the discussion of test results.

Finding 4: Contracting delays have resulted in project delays of as much as 4 to 6 months in some cases and can be a serious issue for the RRTO.

Recommendation 4: To simplify the contracting process and reduce contracting time for rapid-reaction projects, the RRTO should consider implementing one or more of the following: (1) create a small, dedicated contracting element within the RRTO; (2) use "other transaction" authority for the high-importance, time-critical responses; and (3) make the current contracting approach more streamlined and efficient (e.g., by having the USD[AT&L], who is the chief procurement and contracting officer of the DOD, designate a contracting office to give priority attention to requests of the RRTO when needed). The committee prefers the third approach.

Finding 5: The attributes and business model employed by the RRTO are critical enablers of the interagency approach advocated by Secretary of Defense Robert M. Gates in his article entitled "A Balanced Strategy: Reprogramming the Pentagon for a New Age," in the January 2009 issue of *Foreign Affairs,*[8] and they respond to the particular challenges posed by agile, adaptive threats.

Recommendation 5: The Secretary of Defense should make the science and technology director of each of the National Security Council principals—such as the Under Secretary of Homeland Security for Science and Technology—aware of the RRTO, its attributes, and its business model, so that some of the processes and approaches used by the RRTO can be considered for broader adaptation and use in other interagency applications.

[8]Robert M. Gates, Secretary of Defense. 2009. "A Balanced Strategy: Reprogramming the Pentagon for a New Age," *Foreign Affairs* 88(1):1.

1

Introduction

Why was it necessary to go outside the normal bureaucratic process to develop technologies to counter improvised explosive devices, to build MRAPs [Mine Resistant Ambush Protected], and to quickly expand the United States' ISR [intelligence, surveillance, and reconnaissance] capability? In short, why was it necessary to bypass existing institutions and procedures to get the capabilities needed to protect U.S. troops and fight ongoing wars?

—Robert M. Gates, Secretary of Defense[1]

Technology and equipment are the warfighter's tools, and for the warfighter to get the job done, the best resources are needed. For its warfighters to have the best resources, the U.S. military must invest in the right technology at the right time.[2] However, in the Pentagon, the question remains, How can the specialized—and often relatively low-tech—equipment needed for counterterrorism and counterinsurgency missions be procured and fielded quickly? After the attacks on September 11, 2001, the Department of Defense (DOD) began to use different approaches, including the creation of new "rapid acquisition" programs and offices, to answer this question. Currently, there are a variety of such programs and offices concerned with the delivery of new or improved capabilities to the warfighter. They range from science and technology programs within the military Services to newly established organizations such as the Rapid Reaction Technology Office (RRTO), which was established to address a wide range of counterterrorism

[1]Robert M. Gates, Secretary of Defense. 2009. "A Balanced Strategy: Reprogramming the Pentagon for a New Age," *Foreign Affairs* 88(1):1.

[2]Department of Defense. 2008. *National Defense Strategy,* Washington, D.C.

capabilities, and the Joint Improvised Explosive Device Defeat Organization (JIEDDO),[3] which was established to focus specifically on defeating improvised explosive devices (IEDs). Because the JIEDDO provides large-scale fielding of capabilities, its budget is much larger than that of the RRTO. The Rapid Reaction Technology Office is the focus of this report.

EXPERIMENTATION AND RAPID PROTOTYPING

Experimentation and rapid prototyping, approaches employed by the RRTO, are both key to accelerating the transition of technologies to the warfighter in support of counterterrorism and counterinsurgency. Whereas mature technologies can be transitioned to U.S. military forces in the short term, experimentation and rapid prototyping are necessary on the front end of technology development in order to allow the shortcomings of systems to be identified and to enable ways to be found to improve their operational and technical effectiveness as they develop.[4]

Even more importantly, these approaches help in the identification of and quick response to threats presented by adaptive enemies and by their tactical changes, particularly during ongoing operations. To be most effective, rapid prototyping and experimentation must be able to operate inside the adaptive adversary's "observe, orient, decide, and act" (OODA) loop. If an adversary's OODA loop is very short, traditional approaches cannot meet the near-term needs of combatant commanders.

ORGANIZATION OF THIS REPORT

Following the report's Summary and Introduction, its subsequent chapters provide additional background on the Rapid Reaction Technology Office and address the terms of reference for this study. Chapter 2 explains what the RRTO is, what it does, how it works, what makes it different from other acquisition organizations, and what constitutes the keys to its success. Chapter 3 analyzes and discusses the RRTO's strengths and weaknesses, potential issues that could impact the organization's future effectiveness, potential improvements that the RRTO could make to its approaches, and suggested new RRTO initiatives. Chapter 3 also provides an explanation of why the RRTO is needed. Chapter 4 presents the committee's major findings and recommendations.

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[3]Defense Science Board. 2007. *2006 Summer Study on 21st Century Strategic Technology Vectors, Volume IV, Accelerating the Transition of Technologies into U.S. Capabilities*, Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, Washington, D.C., April.

[4]For additional information on military experimentation, see National Research Council, 2004, *The Role of Experimentation in Building Future Naval Forces*, The National Academies Press, Washington, D.C. It is noted that even in cases where such rapid prototyping experiments have not been immediately adopted for transition, when properly documented and communicated these experiments have served to provide critical knowledge employed by others to build capabilities that did work.

Appendix A presents biographies of the members of the committee. Appendix B contains a list of acronyms and abbreviations used throughout the report. Additional background information on the RRTO's test planning, conduct analysis, and reporting; representative projects of the RRTO; and disruptive threats and DOD acquisition are provided in Appendixes C through E, respectively.

2

Rapid Reaction Technology Office

WHAT IS THE RAPID REACTION TECHNOLOGY OFFICE?

Origins

The Rapid Reaction Technology Office (RRTO) was originally formed after the attacks of September 11, 2001, as the Combating Terrorism Technology Task Force (CTTTF). At that time, the Department of Defense (DOD) was trying to determine what science and technology (S&T) capabilities existed that could be applied to address the growing threat of terrorism.

In fiscal year (FY) 2006, the CTTTF migrated from being a task force, which was temporary, to becoming an established organization with its own funding, reporting to the DOD's Director, Defense Research and Engineering (DDR&E). This led to the name change from CTTTF to RRTO and to a more permanent status within the Office of the Secretary of Defense. This shift acknowledged the need for a sustained focus on rapid response to insurgency and irregular warfare.

Mission

The mission statement of the RRTO is "to partner with DOD offices, other government agencies, industry and academia in order to break the terrorist/insurgency cycle, counter emerging and anticipated threats, and respond to validated

joint urgent needs by accelerating the development and fielding of affordable, sustainable transitional and non-traditional capabilities for the warfighter."[1]

The CTTTF/RRTO has responded to its mission in five distinct phases from September 2001 to the present:[2]

- *Phase I (September 2001–February 2002):* The application of technologies for homeland defense and for the initial war in Afghanistan was accelerated.
- *Phase II (May 2002–April 2004):* Technology was delivered in support of the wars in Afghanistan and Iraq.
- *Phase III (May 2003–December 2005):* The RRTO, in conjunction with the Joint Improvised Explosive Device Defeat Organization (JIEDDO), concentrated on identifying and accelerating technology for the protection of deployed forces, with an emphasis on mitigating the effects of improvised explosive devices (IEDs), mortars, and rocket-propelled grenades.
- *Phase IV (December 2005–December 2006):* The RRTO emphasized technologies required to prosecute global counterinsurgency (GCOIN).[3]
- *Phase V (January 2007–present):* Activities include improving the persistence of intelligence, surveillance, and reconnaissance (ISR) with better power sources for sensors; finding threats by countering cover and concealment efforts by insurgents; and examining open-source applications, biometrics, and forensics to enable more effective negation of potential terrorist activities.[4,5]

Charter and Authorities

The RRTO has never had a formal charter or governing document. The organization's guidance and authority come directly from the DDR&E or the Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]), and amount to "execute the mission." The director of the RRTO characterizes the activities of the office as "testing and experimentation to better support the need

[1]Defense Research and Engineering, Rapid Reaction Technology Office Web site, available at www.dod.mil/ddre/org_rrto.html. Accessed April 2, 2009.

[2]The dates provided account for some breaks and overlaps between phases.

[3]*Global counterinsurgency* implies combating threats to the United States or its interests anywhere in the world.

[4]Benjamin Riley, Director, Rapid Reaction Technology Office, "Testing and Experimentation: How to Better Support the Need for Quick Reaction Capabilities in an Irregular Warfare Environment," presentation to the committee, Washington, D.C., October 16, 2008.

[5]Department of Defense, Testimony of Benjamin Riley, Chair, Combating Terrorism Technology Task Force, before the United States House of Representatives, Committee on Appropriations, Subcommittee on Defense, 109th Congress, 1st Session, February 16, 2005.

for quick reaction capabilities in an irregular warfare environment."[6] The breadth of the guidance given to the director provides much flexibility for carrying out his or her responsibilities as the director sees fit.

Organizational Structure

The director of the RRTO reports directly to the DDR&E as well as to the USD(AT&L) as appropriate.[7] This gives the director considerable "top cover" and quick responsiveness in the decision cycle.

The structure of the RRTO, along with its authorized staffing numbers, is displayed in Figure 2.1.[8]

The total RRTO authorized personnel billets number 23, of which 20 were filled with civilian, military, and contractor staff at the time the committee completed its fact finding. The purpose and goals of the subordinate organizations within the RRTO have varied somewhat on the basis of changes in focus areas over time. The current RRTO divisions of Core Projects, Defense Biometrics, Emerging Capabilities, Strategic Multi-Layer Assessment, and Joint Rapid Acquisition Cell and their respective responsibilities are described in Table 2.1.

Funding

Funding for the CTTTF through its Phases I and II came from the Defense Emergency Response Fund (DERF),[9] whereas funding for Phase III derived from reprogramming as well as the Operation Iraqi Freedom (OIF) Supplementals. In FY 2006, a program element (PE)[10] that provided the RRTO its own funding was established in the annual budget; the PE has remained in effect to the present. The FY 2009 funding for the RRTO Core Projects Division is about $50 million per

[6]Benjamin Riley, Director, Rapid Reaction Technology Office, "Testing and Experimentation: How to Better Support the Need for Quick Reaction Capabilities in an Irregular Warfare Environment," presentation to the committee, Washington, D.C., October 16, 2008.

[7]Effective August 21, 2009, the Rapid Reaction Technology Office was subsumed under the new Office of the Director, Rapid Fielding, which will report to the Director, Defense Research and Engineering.

[8]Figure 2.1 displays the structure of the RRTO as presented to the committee in October 2008. In February 2009, the RRTO established the Open Business Cell as part of its organization. A revised organizational chart reflecting the subsuming of the RRTO under the new Office of the Director, Rapid Fielding, referred to in footnote 7, has not yet been publicly released.

[9]DERF was established by Congress in late September 2001 to provide immediate supplemental funding for previously unfunded DOD priorities. This transfer fund allowed the Secretary of Defense to respond to emerging requirements and to move funds into regular appropriations without affecting the normal transfer authority ceilings. DERF was typically used to fund the initial phase of some contingency operations; DERF has since been phased out.

[10]Specifically, Program Element 0603826D8Z is for Quick Reaction Special Projects, which include the Quick Reaction Fund, the Rapid Reaction Fund (RRF), and the Technology Transition Initiative. The RRF (Project 828) is fully executed through the RRTO.

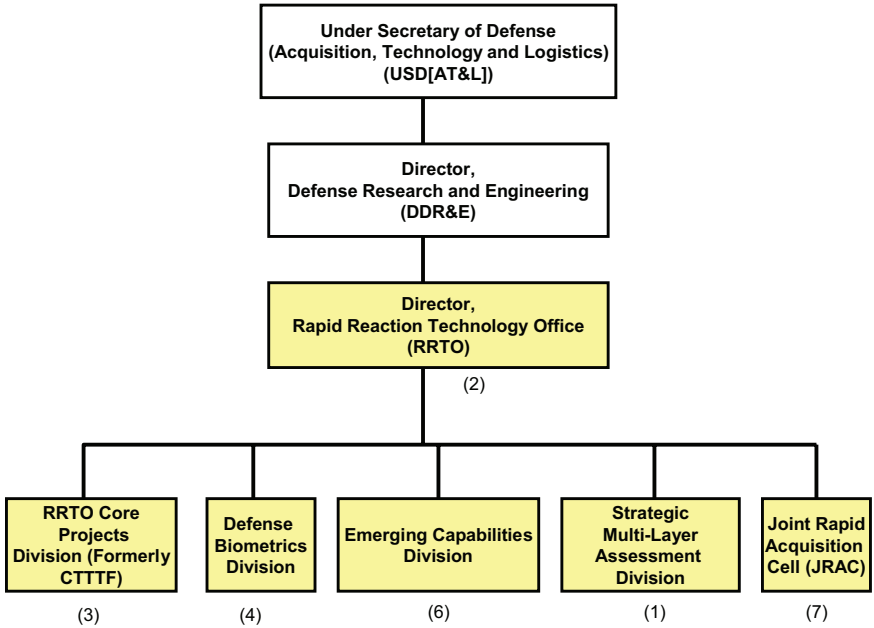

FIGURE 2.1 Organizational chart of the Rapid Reaction Technology Office. Numbers in parentheses indicate authorized staffing numbers (which include clerical support) as of October 2008. SOURCE: Benjamin Riley, Director, Rapid Reaction Technology Office, "Testing and Experimentation: How to Better Support the Need for Quick Reaction Capabilities in an Irregular Warfare Environment," presentation to the committee, Washington, D.C., October 16, 2008. NOTE: CTTTF, Combating Terrorism Technology Task Force.

year; the RRTO also has about $20 million for the Emerging Capabilities Division, $10 million for the Defense Biometrics Division, and about $7 million for programs related to coherent change detection synthetic aperture radar (SAR). Thus, total funding expended by the RRTO is about $90 million per year.[11,12]

The RRTO co-funds many initiatives in conjunction with multiple agencies and organizations, such as the U.S. Strategic Command (STRATCOM) and U.S. Special Operations Command (SOCOM).

[11]Benjamin Riley, Director, Rapid Reaction Technology Office, "Testing and Experimentation: How to Better Support the Need for Quick Reaction Capabilities in an Irregular Warfare Environment," presentation to the committee, Washington, D.C., October 16, 2008.

[12]*President's Budget Request (PBR) for FY09.* 2008. Program Element (PE) 0603826D8Z, PE 0605799D8Z, PE 0603665D8Z, and PE 0603745D8Z, Washington, D.C., February 4.

TABLE 2.1 Organizational Goals and Focus of the Rapid Reaction Technology Office (RRTO), by Division

Project Division	Current Goals and Focus
Core Projects Division	Assumed responsibilities, functions, and projects from the RRTO's predecessor, CTTTF. Manages ongoing projects from the current areas of emphasis, which include multiple initiatives.
Defense Biometrics Division	Development of a defense-wide biometric capability that supports identity management, tactical biometrics and forensic applications, and force protection.
Emerging Capabilities Division	Supports the Joint Capabilities Integration Development System and acquisition processes. Develops prototypes with military utility in targeted areas of technologies and engages in activities for advanced capabilities, leveraging interagency cooperation and coordination.
Strategic Multi-Layer Assessment Division	Provides planning support to combatant commanders and coordinates with the Joint Staff and STRATCOM to support global mission analysis.
Joint Rapid Acquisition Cell (JRAC)	Addresses the rapid resolution of Joint Urgent Operational Needs Statements (JUONSs) and Immediate Warfighter Needs.[a] The JRAC monitors the status of validated JUONSs and assists in the resolution of issues that could result in mission failure or casualties.

NOTE: Acronyms are defined in Appendix B.

[a]Further explanation of rapid acquisition as it applies to resolution of JUONSs and immediate warfighter needs is provided in a 2008 Army AL&T [Acquisition, Logistics and Technology] online article: COL(P) Peter N. Fuller, USA, Commanding General, U.S. Army Research, Development and Engineering Command, "Rapid Acquisition-Developing Processes That Deliver Soldier Materiel Solutions Now," February. Available at http://www.usaasc.info/alt_online/article.cfm?iID=0802&aid=15. Accessed June 16, 2009.

Organizational Interfaces and Alliances

Collaborators, Customers, Users, and Consumers

The RRTO has been and remains actively engaged with an extremely wide range of organizations internal and external to the DOD. In addition to the defense-related S&T community, agencies, and laboratories, it typically works with many other government organizations, such as the Department of Homeland Security (DHS), the Department of Energy (DOE), and the Technical Support

Working Group (TSWG). Outside government, the RRTO maintains relationships with federally funded research and development centers (FFRDCs) and with academia as well as industry on initiatives where it is appropriate.[13]

Also, the RRTO currently is collaborating on projects that include the Departments of State, Justice, and Commerce. Within the intelligence community the RRTO has projects ongoing with the Director of National Intelligence, Central Intelligence Agency, National Security Agency, National Reconnaissance Office, Defense Intelligence Agency, and the National Geospatial-Intelligence Agency.[14] While the list presented here is not intended to be exhaustive, other examples of organizations collaborating with the RRTO include the combatant commanders (COCOMs), the JIEDDO, the Joint Capability Technology Demonstration (JCTD) program, and the Naval Air Systems Command (NAVAIR).

It is noteworthy that the connections that the RRTO has with numerous organizations such as those mentioned above are very informal and are built on well-established working relationships.

An illustrative example of the RRTO's broad collaboration with organizations is its work with SOCOM. The RRTO assists SOCOM's research and development (R&D) activities that are tied to established programs; it also supports SOCOM with nonkinetic technologies such as social network analysis, coalition videoconferencing, language support (including virtual language translation support for the warfighter), and videogame-based training, among other things.

Supporting Organizations

Administrative and Acquisition Support The RRTO uses various other organizations in DDR&E for internal administration—for example, for human resource management, programming and budget, and logistics management. The RRTO obtains contracting support from collaborating organizations. It often bundles projects with the contracting tasks of organizations such as the Department of the Army and/or the military Services' laboratories. Administrative and contracting support for projects is also provided by collaborating organizations that contribute funding to the efforts.

Test Planning, Conduct, Analysis, and Reporting The NAVAIR Special Surveillance Programs Office is funded by the RRTO (and SOCOM) to be the lead agency for overseeing and providing technical expertise for test planning,

[13]Department of Defense, "Testimony of Benjamin Riley, Chair, Combating Terrorism Technology Task Force, before the United States House of Representatives, Committee on Appropriations, Subcommittee on Defense," 109th Congress, 1st Session, DOD Testimony, Office of Legislative Counsel, February 16, 2005.

[14]Benjamin Riley, Director, Rapid Reaction Technology Office, "Testing and Experimentation: How to Better Support the Need for Quick Reaction Capabilities in an Irregular Warfare Environment," presentation to the committee, Washington, D.C., October 16, 2008.

conduct, and analysis for RRTO experiments conducted at the Joint Experimentation Range Complex (JERC). These functions are also supported by the National Counterterrorism/Counterinsurgency Integrated Test and Evaluation Center (NACCITEC), which provides a capability for the experimental testing of technologies to counter terrorist threats, particularly IEDs. The NACCITEC, located at Yuma Proving Ground (YPG), Arizona, is composed of three JERCs: two replicate urban warfare sites in a desert environment, and the third replicates desert mountain roads typical of Afghanistan.

A detailed discussion of the RRTO's methods of experimentation (including project selection, test planning, conduct, analysis, and the reporting process); the role of NAVAIR in these experiments; and the NACCITEC capability is provided in Appendix C of this report.

The study committee visited the NACCITEC at YPG and found that the experimentation planning and execution process in support of the RRTO has unique, positive features that do not exist in a classical DOD experimentation or acquisition environment. Management of the test and evaluation process by NAVAIR combines with Army support from NACCITEC to produce a balanced, objective, technical assessment of the capabilities and limitations of the item being evaluated. This oversight is unique in that neither the RRTO nor the test support organizations are in an advocacy role for the items being evaluated.

Several issues have the potential to adversely impact the testing support that NACCITEC provides to the RRTO. All are discussed in more detail in Appendix C. The primary issues include the following:

- *Infrastructure sustainment:* Range personnel expressed concerns with respect to adequate sustainment funding.
- *Frequency authorization:* NACCITEC's process of obtaining radio-frequency authorization for realistic testing of theater devices and frequencies needs more attention.
- *Realistic intelligence data from Afghanistan:* An apparent shortfall exists in test design due to the lack of support from the intelligence community. Possible contributing factors include the lack of an interface and limited access to secure teleconferencing.

WHAT DOES THE RAPID REACTION TECHNOLOGY OFFICE DO?

Objectives

The RRTO supports the force protection requirements of the military Services in Iraq and Afghanistan and the ongoing efforts to address the needs of irregular warfare. The organization focuses on rapid responses to joint force operational and tactical needs, and it complements the rapid acquisition pro-

cesses implemented by the Services. To drive its efforts and shape its response, the RRTO has developed a chronological list of the critical capability areas for countering the moves of likely adversaries. In the early years of the organization, the list was largely based on kinetic technologies and solutions and on the more traditional military capabilities. Now the RRTO is shifting to equal emphasis on nonkinetic capabilities. The RRTO activities result in fielded products, experimental testbeds, and data and information bases, as well as ideas and applications for alternative concepts of operation (CONOPS). All of these types of products constitute an RRTO portfolio for addressing joint urgent needs and gaps in the counterterrorism and counterinsurgency areas.

Project Highlights

From its inception the RRTO has initiated a number of successful actions and projects. These efforts have impacted many areas. As an example, early initiatives included developing advanced weapons, for which the RRTO and others received the Packard Award.[15] Current areas of focus have included counter-IED applications, the testing and fielding of capabilities for wide-area persistent surveillance and tracking; the standoff detection of explosives; special communications capabilities; and countermeasure capabilities against biological and chemical weapons. The director of the RRTO indicated that approximately 50 percent of the projects that the RRTO pursues actually result in fielded technologies, altered CONOPS, or other concrete changes, often as parts of larger systems. This is a very high percentage for a technology-driven organization. He also indicated that approximately one-third of the projects initially experience resistance from COCOM staff or subordinates, who often believe that an idea will not work and that it does not have an application.[16]

The committee selected a set of projects representative of RRTO endeavors and provided brief descriptions of these projects in Appendix D. Highlights are included here to give the reader a sense of the range and diversity of projects initiated, supported, and partnered by the RRTO over the course of its history. The projects demonstrate success both in their transition to fielded deployments and in their stimulation of and influence on emerging capabilities still in development.

[15]The Packard Award, the DOD's highest acquisition award, is given to DOD civilian and/or military organizations, groups, and teams that have made highly significant contributions or demonstrated exemplary innovations and best practices in the defense acquisition process.

[16]Benjamin Riley, Director, Rapid Reaction Technology Office, "Testing and Experimentation: How to Better Support the Need for Quick Reaction Capabilities in an Irregular Warfare Environment," presentation to the committee, Washington, D.C., October 16, 2008.

Testbeds for Counterterrorism and Counterinsurgency

The RRTO has been at the forefront in recognizing the need for "test" environments to help evaluate the many systems proposed to combat terrorism and insurgency. It has spent significant resources in leading the development of a range of testing environments for use by DOD and non-DOD entities. These testing environments include the NACCITEC and Joint Experimentation Range Complex at Yuma Proving Ground, discussed above in this chapter, with additional information provided in Appendixes C and D. This testing capability is critical for counter-IED applications. To date, 250 systems have been tested at the JERCs under CTTTF/RRTO sponsorship. The RRTO transitioned oversight of the JERC to the U.S. Army in 2006; however, as discussed in Chapter 3, the RRTO still provides a portion of its funding.

The RRTO is also collaborating on a "multi-intelligence" testbed (i.e., deriving its input from multiple intelligence sources) at the Joint Interagency Task Force-South (JIATF-South). This testbed can be used to evaluate emerging technologies and transformational concepts, such as those in the Bluegrass experiment that assessed persistent, wide-area surveillance concepts in a complex rural and urban background.[17] Another example of a testbed is the use of JIATF-South's Stiletto, a low-cost, high-speed ship, to demonstrate the ship's utility in countering illicit activities, such as trafficking in humans or drugs.

These testbeds support the evaluation of experimental capabilities. They also enable participants and other interested parties to access data and information from experiments, providing multisource input and data sharing for addressing complex problems. For instance, the Bluegrass experiment assembled multisensor input and provided a fundamental database for evaluating approaches for detecting and unraveling nefarious activity hidden in realistic clutter. Bluegrass products have been distributed to more than 50 organizations, such as government laboratories, industry, academia, and intelligence organizations, to facilitate development of various ISR capabilities.

Persistent Surveillance and Reconnaissance Systems

Persistent Threat Detection System (PTDS) The Persistent Threat Detection System (PTDS) provides persistent ground surveillance through a tethered aerostat with an embedded camera, an integrated sensor suite, a control module, and the communications to disseminate threat data. When an event of interest is detected, the camera is slewed to the target, which is tracked until reaction forces arrive. The system was developed and exclusively funded by the RRTO and was

[17]For example, the Bluegrass tracking system has a goal to develop algorithms that will allow the handover of vehicle tracking from one system to another; in that way, continuous tracking is provided from urban areas (where electro-optical radar is effective) to rural areas (where ground moving target radar is effective).

deployed to Baghdad in 2004. The PTDS capability was transitioned to the Army and the JIEDDO, which invested substantial funding (hundreds of millions of dollars) and fielded the capability for use in Operation Iraqi Freedom and Operation Enduring Freedom (OEF). The system is now an Army program of record with additional contracts awarded to private-sector contractors to purchase, operate, and maintain the systems.

Sonoma (Renamed "Constant Hawk") The Constant Hawk aerial surveillance capability is able to record activities within a given area of interest so that users can detect the activities and derive tracking information on people or vehicles through postflight analysis. This capability to counter IEDs is a highly successful project that was achieved through partnerships. The RRTO helped the effort progress through a number of iterations in both the design of sensors and the analysis and processing of new and complex information. These efforts transitioned to the Army and JIEDDO and are migrating into significant acquisitions and other spin-off capabilities, such as the development of the previously described Bluegrass project.

Tactical Satellites The tactical satellites capability comprises a series of experimental spacecraft designed to allow military commanders on a battlefield to request and to obtain data rapidly from a reconnaissance satellite. The project has stimulated the development of an entirely new class of satellites that can be quickly built at low cost. The RRTO assumed management of the initiative from the Office of Force Transformation and has funded several satellites and payloads, as well as tools to exploit the data collected. The RRTO also developed the Virtual Mission Operations Center, an initiative to enable the dynamic tasking of satellites. The Operationally Responsive Space Office within the DOD is now charged with moving small satellite capabilities into the hands of warfighters.

Long-Endurance Unmanned Undersea Vehicles Unmanned undersea vehicle (UUV) systems are currently widespread throughout the military. However, real-world operations of many of these systems are yet to be realized, partly owing to the limitations of many vehicles with respect to conducting long-range, long-endurance operations with large payloads. The RRTO sponsored sensor enhancements and battery and power system improvements to large UUV systems that will result in a 2009 operational deployment aboard a U.S. naval vessel for further evaluation.

Biometrics Applications

Biometric Automated Toolset The Biometric Automated Toolset (BAT) is a mobile capability that collects biometrics markers (fingerprints, iris scans, and so on) in order to screen personnel. When deployed to Iraq, the BAT was the first

mobile system to collect and share standard biometrics information on persons of interest. The RRTO was a co-funder of initial efforts and early deployment, and it continues to work with the Army Biometric Task Force and the National Ground Intelligence Center. The Army has fielded BAT systems extensively across Iraq and Afghanistan, and since the first unit was operationally deployed it has been responsible for detecting numerous persons of interest.

Biometric Information Technology Evaluation The RRTO sponsored the creation of a baseline map of biometric systems in operation in theater. This project answered a critical need for an information and analysis environment to support deployed biometric capabilities. The effort has enabled a more rapid assessment of the overall performance of biometric systems in theater, improved the integration of biometrics into the command structure, and facilitated the analysis of gaps and the prioritization of investments. The Biometric Information Technology Evaluation is currently being used by representatives from the Office of Defense Biometrics and the Biometrics Task Force.

Intelligence Support

SKOPE Intelligence Cell The SKOPE is a joint intelligence analytic cell with the National Geospatial-Intelligence Agency (NGA), SOCOM, and STRATCOM. It began with a specific request from military commanders for sensors to help narrow the search space for terrorists and terror groups. The RRTO recommended the development of SKOPE and was the sole funding source for the initial operating capability of the analytic cell. In response to further requests, the RRTO is developing new tools based on experience with the operational capability. The SKOPE cell applies all-source, multi-input intelligence analysis linked to a spot on Earth. Through its application of human terrain analysis,[18] SKOPE incorporates aspects of the U.S. Army's Human Terrain System,[19] a proof-of-concept program to improve the military's ability to understand the highly complex local sociocultural environment in areas of deployment.

Maritime Automated Super Track Enhanced Reporting The Maritime Automated Super Track Enhanced Reporting (MASTER) initiative responds to the need for awareness and threat knowledge in order to secure the maritime domain and prevent adverse events. It is a network system that fuses data from multiple

[18] *Human terrain analysis* is a multi-intelligence, multidisciplinary scientific approach to describe and predict spatial and temporal patterns of human behavior by analyzing the attributes, actions, reactions, and interactions of groups or individuals in the context of their environment, according to the National Geospatial-Intelligence Agency briefing at the U.S. Geospatial Intelligence Foundation GEOINT 2008 Symposium, October 27-28, 2008, Nashville, Tenn.

[19] See http://humanterrainsystem.army.mil for a program overview and a list of relevant publications. Accessed April 15, 2009.

sources, automatically tracks global shipping on vessels of all sizes, associates tracks with cargo, and alerts the analyst to unusual activities. The RRTO supported the initial development and testing of MASTER. After the feasibility of the system was shown, it became a JCTD in 2007 and continues to grow in use. Operational users in the testing and demonstrations include the U.S. Northern Command, U.S. Pacific Fleet, Third Fleet, Office of Naval Intelligence, U.S. Coast Guard Intelligence, and the U.S. Coast Guard Maritime Intelligence Fusion Centers Atlantic and Pacific. Three funded transitions are now in place.

Other RRTO Activities

The prior discussion highlights RRTO projects that provide capabilities for testing, for experiments, and for data collection, as well as for initiatives that have been deployed or that framed the next level of action for emerging capabilities. The RRTO also engages in other periodic types of activities to stimulate ideas and evolve concepts to counter terrorism.

The RRTO sponsors a wide range of conferences and technical exchanges that are open to interested parties, ranging from people with current operations experience to experts in multidisciplinary fields. Emerging issues and challenges are vetted at these sessions, where "roadmaps" of ongoing and past efforts are provided to participants. For instance, the organization recently co-sponsored a conference on wide-area surveillance and one accomplishing a cross-sector technology mapping.

The staff of the RRTO maintains cognizance of technological activities in various laboratories, reviews weaknesses in current military capabilities, and extrapolates to anticipate future threats and technologies potentially useful in combating future threats. The RRTO contracts with the Lincoln Laboratory of the Massachusetts Institute of Technology to assist in monitoring technological advances in selected areas and to review technical ideas. The outputs of these efforts are accessible to appropriate parties, including partners and collaborators of the RRTO. The RRTO staff provides training through its Common Operational Research Environment program to provide exposure to and to educate military officers on irregular warfare methodologies and on the use of advanced technologies for understanding network-based adversaries who operate with irregular warfare.

The Effectiveness of Projects

The committee sought input from several of the RRTO's customers, consumers, and collaborators to solicit their insights regarding the effectiveness of RRTO projects.[20] Representatives from these organizations were generally enthusiastic

[20]See the Preface in this report for a summary listing of the agendas of the committee's data-gathering sessions, held on October 16-17, 2008, and December 15-16, 2008.

and highly positive.

The director of the Joint Capability Technology Demonstration program under the Assistant Deputy Under Secretary of Defense for Advanced Systems and Concepts indicated that 5 of the 45 JCTDs that have been fielded in OIF/OEF were started in the RRTO. Further, he stated that the organization depends on the RRTO for many of the JCTDs.[21]

The JIEDDO deputy director noted that his organization has accepted between 12 and 30 RRTO technologies for application. He indicated that if the RRTO did not exist, JIEDDO would feel the impact. The RRTO advances technologies to the level that has enabled JIEDDO to mature capabilities to which the organization would not otherwise have had access.[22]

The technical director, Force Development for Joint Advanced Concepts of the USD(AT&L) organization, indicated that between 20 and 40 percent of the experiments supported by the RRTO did not work; however, these "failures" provided knowledge critical for others to build capabilities that do work. The RRTO helps the AT&L organization to avoid always playing catch-up,[23] given the proliferation of technologies that the organization needs to investigate.

The senior procurement executive from SOCOM noted that the capabilities which his organization received from the RRTO are more mature than those received from the Defense Advanced Research Projects Agency (DARPA) and more easily fielded and that the RRTO provides SOCOM with technologies that it is able to field and use. SOCOM has benefited as a customer of the sociocultural work from the RRTO. Based on evidence presented to the committee by this customer, the RRTO appears to have the best model for meeting the needs of customers, takes technology further than DARPA, and usually gets technology ready for fielding to SOCOM when needed—if SOCOM can get to the RRTO early enough in the process. An example of this type of experience involves specific counter-IED devices.[24]

The chief of the Technology Innovation Office of the Defense Threat Reduction Agency (DTRA) indicated that during the time that DTRA was working with the RRTO, 65 technologies were developed, 27 of which were fielded from 2001 through 2004.[25]

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[21]John Wilcox, Director, JCTD Program, discussion with the committee on JCTD program overview, Washington, D.C., December 15, 2008.

[22]Robin L. Keesee, Deputy Director, JIEDDO, "JIEDDO Organizational Overview and Responsibilities," presentation to the committee, Washington, D.C., October 17, 2008.

[23]Jay Kistler, Technical Director, Force Development, Joint Advanced Concepts (Acquisition, Technology and Logistics), discussion with the committee on USD(AT&L) perspectives on experimentation and rapid prototyping, Washington, D.C., December 16, 2008.

[24]Dale Uhler, Acquisition Executive and Senior Procurement Executive, SOCOM, discussion with the committee on SOCOM acquisition overview, Washington, D.C., December 16, 2008.

[25]Matthew Holm, Director, Innovation and Systems Engineering, DTRA, "Technology Innovation-Strategic Approach Taken by DTRA," presentation to the committee, Washington, D.C., December 16, 2008.

The Under Secretary of Defense for Intelligence was enthusiastic about the SKOPE cell and was equally positive about the Constant Hawk program.[26] Both of these projects were supported by RRTO efforts (see the discussion in the subsection above titled "Project Highlights").

In reviewing the projects sponsored and supported by the RRTO, the committee saw strong evidence of the effectiveness of the organization. The dissemination and transfer of critical information to counter terrorism and combat irregular warfare through knowledge, piece-parts of capabilities, and/or fielded capabilities are strong aspects of RRTO work. Effectiveness was further substantiated by senior leaders of several organizations that are customers, consumers, and/or collaborators of the RRTO.

HOW DOES THE RAPID REACTION TECHNOLOGY OFFICE WORK?

Management Techniques

The Rapid Reaction Technology Office uses a number of business practices and management techniques to achieve effective performance results. A discussion of key elements of these practices follows.

The RRTO has a highly knowledgeable, intellectually curious, and risk-tolerant senior leadership that deliberately maintains a small organization with well-qualified people. A diverse range of personnel is rotated in and out of the organization to provide new insights on technology and to achieve an early awareness of emerging global problems and operational issues.

The organization uses informal processes and avoids hard-and-fast rules regarding funding strategies and program size and duration. It avoids excessive publicity. The RRTO manages small projects, not large acquisitions. It practices an incremental approach to developments using a spiral development approach over a 6- to 18-month time frame.[27]

The office executes its mission through partnerships and networks. The staff operates with transparency and openness—through both formal and informal information sharing—to facilitate networks of individuals across organizational

[26]James Clapper, Jr., Under Secretary of Defense for Intelligence, discussion with the committee on the role of experimentation and rapid prototyping in support of counterterrorism in the defense intelligence community, Washington, D.C., December 15, 2008.

[27]The *spiral development approach* is "an iterative process for developing a defined set of capabilities within one increment. This process provides the opportunity for interaction between the user, tester, and developer. In this process, the requirements are refined through experimentation and risk management, there is continuous feedback, and the user is provided the best possible capability within the increment. Each increment may include a number of spirals." Memorandum from Under Secretary of Defense E.C. Aldridge, Jr., to the Secretaries of the Military Departments and Others, dated April 12, 2002.

lines, and it develops relationships within the department, the Services, and other agencies and organizations to accomplish longer-term responsibilities.

Critical Attributes and Elements of the Business Model

The office supports and collaborates with other agency efforts. This enables multidisciplinary science and technology solutions for countering new and evolving threats.[28] The organization deliberately forms collaborative cross-agency groups to build the necessary support on key issues. It cooperates to take advantage of potential synergistic efforts on issues and to share or reduce costs.

The RRTO appears to avoid the entanglements of program "ownership" and of competition with programs in the areas of Service expertise; at the same time it strives to complement the activities of other organizations as appropriate, transition its successful efforts to other organizations, or terminate efforts of little promise. Its public posture is that it does not claim or demand credit for activities and successes.[29]

In Box 2.1 the committee has drawn from the material in the three previous sections to summarize six critical attributes of the RRTO and six essential elements of the RRTO's business model that it believes define the RRTO.

DIFFERENCES BETWEEN THE RAPID REACTION TECHNOLOGY OFFICE AND OTHER ACQUISITION ORGANIZATIONS

The RRTO is different in many respects from the typical acquisition organization management entity (e.g., program executive office, program management office, functional-area R&D management office, or technical agency) and from other acquisition entities engaged in rapid fielding in response to urgent operational needs and Joint Urgent Operational Needs Statements (JUONSs). Key differences are discussed below.

RRTO staff members act as catalysts by attracting personnel from other organizations, both inside and outside the DOD, with interests in related areas to join in collaborative efforts. For instance, the RRTO may sponsor and support an initial meeting on a new topic that might be an avenue for attacking an important problem. In doing so, the RRTO reaches out to organizations and individuals that might not normally be considered as government partners. The RRTO then promotes the funding of synergistic efforts by offering funds if other participants will also contribute (the RRTO does not fully fund collaborative efforts even if

[28]While the RRTO focus is science and technology solutions, occasionally its solutions are not consistent with the existing CONOPS, resulting in a CONOPS change.

[29]Benjamin Riley, Director, Rapid Reaction Technology Office, "Testing and Experimentation: How to Better Support the Need for Quick Reaction Capabilities in an Irregular Warfare Environment," presentation to the committee, Washington, D.C., October 16, 2008.

BOX 2.1
What Defines the Rapid Reaction Technology Office?

During the course of this study, the Committee on Experimentation and Rapid Prototyping in Support of Counterterrorism reviewed the projects sponsored and supported by the Rapid Reaction Technology Office (RRTO) and received briefings from the RRTO's customers, consumers, and collaborators. Drawing on these various sources of information and its own deliberations, the committee summarizes below the six critical attributes of the RRTO and six essential elements of the RRTO's business model that it believes define the RRTO. This view of the RRTO was verified in committee discussions with partner organizations of the RRTO.

Critical Attributes

The Rapid Reaction Technology Office is a catalytic organization that anticipates and responds to emerging threats, with an emphasis on terrorism and irregular warfare. The following are critical attributes of the RRTO:

- Being limited in size (funding and staff)—a small and agile organization;
- Possessing enlightened, risk-tolerant leadership;
- Having highly qualified and motivated staff;
- Being placed at a high organizational level within the DOD;
- Being focused on joint and interagency needs; and
- Serving as an enabler of timely and sufficient rather than optimal solutions—but not executing acquisition and fielding.

Essential Elements of the Business Model

The essential elements of the RRTO's business model are as follows:

- Foster communications and form collaborative cross-agency groups;
- Operate with transparency and openness;
- Anticipate and identify capability needs
  —Across multiple disciplines, agencies, and organizational stovepipes,
  —Not seen or addressed within existing individual organizations;
- Create synergy by bringing diverse organizations together to
  —Recognize needs,
  —Invent and develop capabilities and concepts of operations,
  —Gain buy-in from partner organizations through cost sharing;
- Enable close relationships among technical staff, testers, and users to accomplish the following:
  —Experimentation to gain early insight and knowledge,
  —Exploration of alternative concepts of operations and determination of effectiveness,
  —The capturing of and making available unique data sets; and
- Enable multidisciplinary science and technology solutions.

it could do so because it desires a concrete stake in the outcome by the other participants). Consequently, the RRTO can think beyond traditional boundaries and quickly initiate actions within its purview rather than going through a typical bureaucratic coordination process.

In some cases RRTO leadership and staff work with others to define the sources of important national security problems rather than to concentrate only on the symptoms of such problems. For example, getting others to focus on attacking the basic causes of the creation of terrorist networks rather than on their destructive actions was an innovative and essential approach to the IED problems.

Additionally, the RRTO has not limited its horizons only to products that can be deployed rapidly to theaters of operation. It will also sponsor the creation of a data or information base that can be used to develop other intermediate or end-deliverable products. For example, RRTO personnel created experiments with multiple organizations in which each participant could bring particular expertise to the operation and assist in creating a data or information base to use in attacking related problem areas.

The focus of the RRTO is often more on capabilities than on technologies. In this way, it differs from most technically oriented laboratories and agencies. It looks for breakthrough capabilities, not marginal changes. Once a project from the RRTO has gained some acceptance in a partner organization, the RRTO encourages its transfer of responsibility away from the RRTO.

Those responsible for the RRTO have elected to keep it small. The committee was struck by the degree of willingness to limit the organization to the innovative and important things that it can do well, let others do their missions, and not attempt to insert the RRTO where others have more expertise or formally assigned areas of responsibilities. The RRTO staff appears to understand that it is not suited in terms of size, skill, or functionality to manage a large acquisition (from the development of a requirement, through planning and executing a development and production capability with life-cycle support). To date it has not tried to do this.

The RRTO leadership personally selects employees based on needed capabilities and characteristics to accomplish the mission in an innovative fashion. The director said that he has waited months to get a person with the required characteristics (e.g., technical understanding and risk tolerance) rather than fill a position quickly and prematurely.[30]

The RRTO leadership and staff appear to be risk-tolerant. The organization focuses on continuing to come up with new ideas and is willing to accept a success

[30]Benjamin Riley, Director, Rapid Reaction Technology Office, "Testing and Experimentation: How to Better Support the Need for Quick Reaction Capabilities in an Irregular Warfare Environment," presentation to the committee, Washington, D.C., October 16, 2008.

rate on initiatives well below 100 percent[31] to avoid suppressing ideas that might be considered too risky, unconventional, unproven, or inappropriate by other offices.

KEYS TO THE SUCCESS OF THE ORGANIZATION

Of all the management techniques and descriptors indicating how the RRTO is different from most other acquisition organizations, the committee believes that the most important keys to this organizations's success are the following:

- The office has stayed small.
- The leadership within the organization has been very effective.
- The staff members in the organization are personally selected by the leadership to maintain desired technical capability, risk tolerance, and cognizance of national security and operational issues.
- The leadership of the RRTO is willing to transfer and transition to others for completion and execution any successful efforts that it has started. It claims not to seek "turf" or to demand credit for its successful innovations.
- The RRTO reports directly to the DDR&E and can access the assistance of the USD(AT&L) if necessary. This approach provides essential "top-level cover" that enables the organization to achieve its objectives, although the RRTO leadership has rarely required such support.
- The RRTO sees itself as a catalyst. Its success to date stems from its ability to focus on, initiate, and develop new capabilities using broad networks of persons and organizations that would not typically work together.

There are many offices and organizations in the DOD with some assignment or function involving rapid development and/or deployment of technology to combat and support forces. The committee believes that the set of key characteristics listed above, when coupled with the organization's business practices, distinguishes the RRTO from the other acquisition organizations and provides a unique model for success.

[31]As noted earlier in this chapter, between 20 and 40 percent of the experiments supported by the RRTO did not work (see the subsection entitled "The Effectiveness of Projects").

3

Analysis of Current Approaches and Suggested Improvements

The study committee believes that the information garnered in its review of and deliberations on the Rapid Reaction Technology Office (RRTO), coupled with the experience and expertise of the committee, provides a solid foundation for its assessment. The committee first focuses on the strengths and weaknesses that it perceives the RRTO organization to have, identifying issues that could impact its future success, and then follows these analyses with suggestions that the RRTO should consider to further improve its long-term effectiveness.

STRENGTHS OF THE RAPID REACTION TECHNOLOGY OFFICE

Being able to spur and leverage technological advances is vital to sustaining the Department of Defense's (DOD's) ability to maintain its edge over current and potential adversaries and to improve or transform the way that military operations are conducted during irregular warfare. The RRTO's strength has been to focus on three aspects of gaining "the edge": (1) anticipating emerging threats and developing conceptual solutions, (2) working rapidly across the DOD to find partners for science and technology (S&T) developments to mature the concepts to enable deployments in 6 to 18 months—and assisting in transitioning resulting solutions quickly to combat units and to organizations for longer-term support, and (3) providing feedback to the S&T community that can help guide longer-term technology efforts.

A further strength of the RRTO is that it does not become involved in the more formal processes associated with training, logistics, and the providing of long-term sustainment of newly deployed technologies. As a result, the RRTO,

within approximately the same budget profile (over a number of years), continues to adapt to new challenges.[1] As its list of successes illustrates, the RRTO has initiated projects, enabled a path to maturity, and then moved on across a wide range of new capabilities. These capabilities have ranged from countering improvised explosive devices (IEDs), to developing and supporting a wide range of biometric and human terrain efforts, to establishing a proven model for evaluating potential future capabilities. This combination of the RRTO's determination to find solutions quickly and its discipline in preventing the organization from becoming trapped in long-term commitments that sap resources and preclude its being able to respond to emerging threats is a unique strength within the DOD. Further, this flexibility to support a wide range of emerging needs is a strength that Secretary of Defense Robert M. Gates calls for in his new defense guidance.[2]

The feedback that the committee received in its data-gathering sessions (see the summary list in the Preface) has pointed to an array of benefits resulting from RRTO efforts. These include the quicker fielding of technological improvements, potential cost savings, and the identification and development of improved operational concepts and opportunities. These benefits have been enabled by innovative technologies in the DOD's S&T base and also by technologies from sources outside the DOD. RRTO-sponsored technologies are bringing benefits to warfighters and to other customers involved in nontraditional conflict. Furthermore, the RRTO can be credited both with giving midlevel management and senior leaders the flexibility to address current warfighter needs rapidly and with highlighting potential benefits enabled by smaller technology projects that might otherwise be ignored.

Box 2.1, "What Defines the Rapid Reaction Technology Office?," lists six essential elements of the RRTO's business model. Following are some of these elements, which are also salient strengths of the RRTO, and an example of each:

- *Foster communications and form collaborative cross-agency groups:* The biometrics and forensics capabilities developed to permit rapid, if not real-time, identification in a combat theater of "bad actors" that have been previously identified as such by other government agencies or even other governments—as discussed in Chapter 2—are an excellent example of this RRTO strength of using cross-agency inputs and collaborative development efforts.
- *Anticipate and identify capability needs:* "Human terrain teams" that permit combat units to better understand and communicate with the foreign nationals

[1]See OSD RDT&E Budget Item Justification (R2 Exhibit), February 2008. Available at http://www.defenselink.mil/comptroller/defbudget/fy2009/budget_justification/pdfs/03_RDT_and_E/Vol_3_OSD/H_OSD%20PB09%20RDTE%20BA%207.pdf. Accessed July 9, 2009.

[2]Robert M. Gates, Secretary of Defense. 2009. "A Balanced Strategy: Reprogramming the Pentagon for a New Age," *Foreign Affairs* 88(1):1.

of differing ethnic backgrounds are an example of the RRTO's ability to anticipate the need for an improved capability and then to provide a quick solution.[3]

- *Create synergy by bringing diverse organizations together:* The Bluegrass tracking system experiment brought together outputs from the intelligence community's intelligence, surveillance, and reconnaissance (ISR) sensors with outputs from the military's moving target indicator (MTI) radars to potentially identify locations of high-value targets. This effort is an excellent example of the RRTO's creating synergy using capabilities from multiple organizations.[4]
- *Enable close relationships among technical staff, testers, and users:* The RRTO sponsored the development of a test facility within Yuma Proving Ground, Arizona, to examine new systems for counterterrorism. This facility focuses on testing technologies to combat improvised explosive devices (IEDs) and is also used as a training site to help prepare forces prior for their overseas deployment to areas with terrorist threats. The site has become highly valued for testing such systems in a realistic environment prior to their fielding. Test results are documented in NAVAIR [Naval Air Systems Command] Quick Look Experimentation Reports; after review by the RRTO these reports are archived and posted on a Web site for sharing with partner organizations.[5] In addition, the RRTO chairs a biweekly secure videoconference with all interested organizations, including field operational personnel who provide valuable feedback on fielded equipment as well as insights into future experiments.

A representative list of RRTO successes is shown in Box 3.1, and a brief description of each is included in Appendix D. That list of 29 items demonstrates the wide range of the RRTO's accomplishments, its leadership role, and the variety of subject areas in which it operates.

Based on the analysis of projects listed in Box 3.1, three key RRTO strengths as perceived by this committee are summarized as follows:

1. *Current workforce:* The committee found that a major strength of the RRTO is the high quality of its staff. Selecting the right set of people to make up a diverse team with different perspectives and appropriate technical qualifications has served to position the RRTO well. Also, the staff's knowledge of DOD

[3]The human terrain team efforts are also part of the SKOPE project, discussed in Chapter 2 and Appendix D of this report.

[4]In this example, the value of the combined Bluegrass sensory capability for tracking a target continuously through rural and urban terrain is perceived to be greater than the combined value of tracking separately through rural terrain and tracking through urban terrain.

[5]NAVAIR Quick Look Experimentation Reports are summary reports that address test results, capabilities and limitations, test dilemmas and unknowns, and provide overall conclusions and recommendations. Projects are terminated when an application is not adopted by the warfighter or by another science and technology organization. The data from such projects are archived upon project termination for potential future use.

BOX 3.1
Successes of the Rapid Reaction Technology Office

- Airborne Global Information Grid (AGIG)
- Alternative Strategies
- Biometric Automated Toolset (BAT)
- Biometric Information Technology Evaluation (BITE)
- Bluegrass
- Common Operational Research Environment (CORE) Laboratory
- Counter Insurgency Pattern Assessment (CIPA)
- Detection of Unintended Radiation (DURAD)
- Explosives Particulate Analysis (XPAK)
- Jadoo
- Joint Cultural Understanding and Relationship Exploitation (JCURE)
- Joint Intelligence Preparation of the Operational Environment (JIPOE)
- Long-Endurance Unmanned Undersea Vehicles (UUVs)
- Maritime Automated Super Track Enhanced Reporting (MASTER)
- Measuring Progress in Conflict Environments (MPICE)
- Multiple Unmanned Aerial Vehicles (UAVs)
- National Counterterrorism/ Counterinsurgency Integrated Test and Evaluation Center (NACCITEC) and Joint Experimentation Range Complex (JERC)
- National Tactical Integrated Processing System (NTIPS)
- Nova
- Passive Attack Weapon
- Persistent Threat Detection System (PTDS)
- Pollen Identification and Backtracking
- SKOPE
- Sonoma (renamed Constant Hawk)
- Stiletto
- Sudan
- Tactical Infrared Networked Awareness (TINA)
- Tactical Satellites (TacSats)
- Wolf Pack

NOTE: Each of the projects listed in this box is described in Appendix D.

experts, their interests, and whom to contact for purposes of collaborative efforts is a very important aspect of making connections between DOD and non-DOD organizations. This knowledge has been an important determinant of the significance to DOD of the RRTO's work relative to specific projects or collaborations identified by the RRTO to be of critical interest.

2. *Small organizational size:* The committee also found that the relatively small size of the RRTO is a distinct advantage. Because the organization has intentionally been kept small, its director has been successful in personally select-

ing the high-quality staff consistent with his management style and the RRTO business model.

3. *Current business model:* The committee also found that the RRTO's unique combination of attributes and business model elements (it is multidisciplinary, small, risk-tolerant, transparent, and joint) contributes to its key strengths of flexibility and agility that are so important to anticipating and defeating rapidly evolving threats.

PERCEIVED WEAKNESSES

The RRTO is a very successful organization in recognizing emerging technology needs. As with any organization, however, there are areas that can be improved. Three weaknesses identified by the committee are discussed below.

1. *Contracting delays:* The RRTO can experience contracting delays of 4 to 6 months. For a "Rapid Reaction Technology Office," having delays that average many months from the start of a contracting process until the award of the contract is a significant issue. The RRTO does not have its own contracting office but relies on others for contracting support. Further, many sign-offs are required for the contracts, a process that demands extensive coordination. Lastly, many of the RRTO's contracts are for small amounts and are not awarded for the purpose of transitioning to acquisition under the RRTO but rather for examining and potentially validating a possible technical concept; hence the RRTO has a unique set of contracting needs.

Possible means to simplify and reduce the time to contract include the following: creating a small, dedicated contracting element within the RRTO; using "other transaction" authority[6] for the high-importance, time-critical responses; and examining how the current approach can be made more streamlined and efficient (e.g., getting the Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]), who is the chief procurement and contracting officer of the DOD, to designate a contracting office to give priority attention to the RRTO when needed). The committee prefers the third approach.

2. *Maintaining other organizations' awareness:* Some of the senior leaders in other organizations noted to the committee that they had limited insight into the many efforts that the RRTO was conducting. This was said to be the case even

[6]For example, other transaction authority (OTA), enacted under Section 845 of the National Defense Authorization Act for Fiscal Year 1994, is a special vehicle used by federal agencies for obtaining prototypes outside of a contract, grant, or cooperative agreement. An "other transaction" is not subject to the Federal Acquisition Regulation (FAR), to most procurement statutes, or to the government's cost accounting standards. Only those agencies that have been provided OTA may engage in "other transactions." See L. Elaine Halchin, 2008, *Other Transaction Authority*, CRS Report for Congress, Congressional Research Service, Washington, D.C., November.

when significant RRTO joint efforts were carried out with elements in such senior leaders' organizations.

While it is important to keep the RRTO staff small and responsive, the director of the RRTO should consider options that are not personnel-intensive in order to increase awareness of RRTO efforts by the senior managers throughout the DOD and the Services and among other RRTO partners. These options should include creating an RRTO Web site that can be shared with the other organizations, setting up a system to forward the monthly RRTO contract technical summaries to the partnering organizations, and/or having a periodic broadcast e-mail, perhaps quarterly, summarizing activities organized by partnering organizations.

3. *Ensuring a long-term capability:* Ensuring a long-term capability requires preparing for future staffing and leadership. While some midlevel people are assigned to the RRTO, because the organization is small and outside many of the normal career paths, a greater effort is required to expose a range of people to the RRTO. There is also a need to develop a career path for those who are serving in the RRTO.

To help address this need, the committee suggests that the director of the RRTO, with the assistance of the Director, Defense Research and Engineering (DDR&E) if necessary, establish a program to rotate people into the RRTO, including persons with diverse backgrounds in terms of both the skills and the organizations that they represent. Individuals from the junior, middle, and senior ranks should be rotated in for 1- to 2-year tours, which should be credited as joint assignments. Further, technical people from the various government laboratories as well as those with operational experience should be included. These exchanges should be organized in such a way that both the sponsoring organizations and the RRTO benefit.

POTENTIAL ISSUES THAT COULD IMPACT THE ORGANIZATION'S FUTURE EFFECTIVENESS

The committee identified seven potential issues that could represent barriers to the future effectiveness of the RRTO (see Box 3.2). It categorized these potential issues according to whether they are (1) related to internal RRTO operations or (2) external to the RRTO. Each potential issue is discussed below, along with the committee's view as to what type of action, if any, should be taken to address it.

Potential Internal Issues

On the basis of its analysis, the committee identified the following potential issues internal to RRTO methods:

1. *Reliance on external organizations for mission execution:* The RRTO does not execute anything per se. It relies on partners to execute parts of its mission

BOX 3.2
Potential Issues That Could Impact the Future Effectiveness of the Rapid Reaction Technology Office

On the basis of its analysis, the Committee on Experimentation and Rapid Prototyping in Support of Counterterrorism identified potential issues both internal and external to the Rapid Reaction Technology Office (RRTO) that could represent barriers to the future effectiveness of the RRTO. The issues are listed below and discussed in the text of this chapter.

Potential Internal Issues

- Reliance on external organizations for mission execution
- Limited processes for selecting the best projects

Potential External Issues

- Pressure to consolidate the organization with conventional military Service acquisition organizations and/or to conform to institutional acquisition and test methodology
- Immature customer requirements for transitioning acquisitions
- Existing concepts of operations (CONOPS) not always compatible with RRTO initiatives
- Support from sustainment organizations not always clear
- Lack of test site intelligence support at Yuma Proving Ground, Arizona

(e.g., detailed acquisition program management) and on other elements of the DOD to provide internal administrative and other support. The RRTO obtains contracting support from a variety of organizations, and it funds the NAVAIR Special Surveillance program office as the lead agency for overseeing and providing technical expertise for test planning and for the conduct and analysis of RRTO experiments.

This reliance on other organizations can be viewed by some as a potential weakness and an impediment to improved RRTO effectiveness in that the priorities of other organizations and the availability of resources from them may not always match the needs of the RRTO.

The committee believes strongly that expanding the RRTO to add functionality, such as for test management and possibly even contracting, would be a mistake. Creating internal growth in supporting functional areas where others can provide quality services would potentially distract the organization from its mission, decrease agility, and impede its overall effectiveness. The RRTO has intentionally been kept small, and its size has contributed to its agility and suc-

cesses. Consequently, the committee does not recommend any changes related to this potential concern.

2. *Limited processes for selecting the best projects:* The processes of the RRTO for selecting initiatives are minimal and informal. In some cases the organization proceeds as follows: it solicits white papers that are de facto proposals; vets them for responsiveness to urgent needs, capability gaps, and military usefulness; funds approved initiatives with its own resources as well as those of collaborating organizations; monitors their progress; and concludes some efforts with a report and a briefing. In other cases the RRTO identifies a potential opportunity, invites others with expertise in the subject area to discuss its potential, and forms a collaborative project with joint funding by all contributors if there is sufficient interest.

The RRTO has placed great emphasis in its project selection on what can be achieved in the immediate to near term to field useful capabilities. This strategy has been successful in responding to an urgent need without compromising the ultimate outcome. Additionally, the RRTO in some cases identifies projects where it sees a need but there is insufficient engagement by other organizations. These include gaps in technology, in existing concepts of operation (CONOPS), and in the evaluation of promising initiatives.

RRTO partners appear to have responded well to informal, cooperative, voluntary participation as a project management style. The continual addition of new organizations and partners and new focus areas has been a challenge for the RRTO, but the organization's adaptability has added to the range of solution capabilities, brought greater interagency insight, and created opportunities. The organization has exhibited an ability to anticipate needs and to find one or more ways of addressing them with speed.

After reviewing the RRTO's methods, the committee concluded that the informality of RRTO processes has contributed to the organization's agility and success. The RRTO is sensitive to the challenge of facing an adaptive enemy and recognizes the importance of responding quickly to the urgent needs for force protection and for countering terrorism. More formality in processes (e.g., setting firm schedules, requiring a formal operational or systems analysis) would slow responsiveness and constrain adaptability. Consequently, the committee does not recommend change to the RRTO approach for selecting projects.

Potential External Issues

On the basis of its analysis, the committee identified the following external issues that could impact the future effectiveness of the RRTO:

1. *Pressure to consolidate the organization with conventional military Service acquisition organizations and/or to conform to institutional acquisition and test methodology.* The committee believes that with a new administration

there may be tremendous pressure to consolidate organizations with similar functions to "achieve greater efficiency." DOD organizations engaged in acquisition, and even rapid acquisition, are numerous and not always well differentiated by mission and/or objectives. The RRTO can be viewed as nonconforming with regard to some DOD acquisition procedures—a factor that can result in a level of vulnerability in a bureaucratic institution. There may be pressures for the RRTO to be reorganized, restructured, or realigned into more conventional acquisition organizations and to formalize its processes in order to conform. The committee believes that such changes, if applied to the RRTO, not only would be a mistake but also would result in a great loss in capability to the DOD. The committee believes that such changes would diminish if not destroy the RRTO's key strengths of agility and flexibility in anticipating and responding to rapidly adaptable nonconventional threats.

The DOD's acquisition policies and procedures permit tailoring to accommodate various needs and different starting points in the overall formal process as described in DOD Instruction 5000.2;[7] however, current practices tend to be Cold War-based in the sense that rapid response is not considered critical. There is still a need for the more structured, traditional acquisition procedures—applied with more discipline to achieve faster fielding of new technology. However, even if that acquisition process is brought back to its basic essentials, it should not be forced on the RRTO, which has been successful by staying small, flexible, and adaptable.

Secretary of Defense Robert M. Gates has called for new ways to procure and quickly field specialized, often relatively low-tech equipment well suited for stability and counterinsurgency missions.[8] The committee believes that the RRTO provides Secretary Gates just such an essential business model, with a proven record of success including demonstrated innovation, speed, agility, and product risk taking. In summary, the committee believes that the RRTO should be preserved as an entity and not consolidated into a more bureaucratic organization.[9]

2. *Immature customer requirements for transitioning acquisitions:* Some believe that mature customer requirements rather than the identity of key military deficiencies should be key inputs to the acquisition process. When such firm requirements include technical performance factors, interfaces, and sometimes even technical specifications, the ability to be innovative in developing hardware solutions and/or improved operating concepts is severely constrained if not precluded.

The onset of the terrorist threat and insurgency operations has produced a

[7]Department of Defense. 2003. Department of Defense Instruction 5000.2, Operation of the Defense Acquisition System, Washington, D.C., May 12.

[8]Robert M. Gates, Secretary of Defense. 2009. "A Balanced Strategy: Reprogramming the Pentagon for a New Age," *Foreign Affairs* 88(1):1.

[9]Appendix E provides additional discussion of recent research in management supporting the importance of such small, agile, and relatively unconstrained organizational subunits.

volume and velocity of changes incompatible with the "requirements process" as currently practiced for most major acquisition programs. The RRTO is spurred by urgent needs, derived from intelligence data, as well as by capability gaps. RRTO capabilities are developed and deployed typically within 6 to 18 months. The committee believes that while immature requirements may be viewed by some as a barrier in the traditional acquisition process for major acquisition programs, they are not an impediment for the RRTO business model.

3. *Existing concepts of operations (CONOPS) not always compatible with RRTO initiatives:* In general, a CONOPS describes the method of employment of certain capabilities. Typically, a CONOPS is consistent with current Service doctrine or possibly with future Service vision statements and strategies if they differ from current doctrine. In an acquisition program for a major weapons system, the CONOPS provides insight into how a capability to be acquired is planned to be used. The lack of a CONOPS at the initiation of hardware development for such a program would be viewed as an impediment to success.

The RRTO has found cases of promising initiatives not funded by organizations because the initiatives do not conform to existing CONOPS. The director of the RRTO indicated to the committee that one-third of the projects taken on by the RRTO resulted in resistance from partner organizations, often because the initiatives did not fit existing CONOPS.[10] When a promising application of an initiative does not fit within existing CONOPS, the RRTO works to fit the new capability into an augmented or new CONOPS.

The RRTO has delivered some timely and highly specific, unique solutions that did not fit smoothly with a then-current CONOPS. The capabilities were acquired in small quantities, used at the tactical level, and had a positive impact.

The committee believes that the RRTO's actions to anticipate problems, develop solutions involving technical capabilities, and assist in modifying or developing new CONOPS to improve the capabilities of deployed force capabilities are valuable and that their development should not be delayed to wait for CONOPS revisions. The committee also believes that the RRTO is sensitive to the need to work with the military to preclude serious operational problems associated with CONOPS issues. Moreover, the RRTO's decision to not limit technology developments to an existing CONOPS is believed to have spurred significant and productive activities.

4. *Support from sustainment organizations not always clear:* The RRTO has had success in fielding capabilities, as discussed in detail in Chapter 2 of this report. In addition, the RRTO has expanded testing infrastructures, such as those at Yuma Proving Ground (YPG), Arizona, and at the Joint Interagency Task

[10]Benjamin Riley, Director, Rapid Reaction Technology Office, "Testing and Experimentation: How to Better Support the Need for Quick Reaction Capabilities in an Irregular Warfare Environment," presentation to the committee, Washington, D.C., October 16, 2008.

Force-South (JIATF-South). RRTO experiments have resulted in databases of information that are accessible to many organizations for their use in developing, evolving, and evaluating capabilities. All three of these elements convey requirements for sustainment.

Although delivered faster and often focused on providing specific solutions, the capabilities from RRTO programs can have an impact on doctrine, organizations, training, materiel, leader development, personnel, and facilities. The support necessary to sustain new capabilities in the field, manage logistics, supply spare and replacement parts or equipment, and provide training can be allocated to partnering organizations by the RRTO. This is the RRTO's current approach. Nonetheless, the nature and extent of commitment to such support can be unclear when applications of capabilities are emerging and when formal requirements and CONOPS do not exist, as is often the case with RRTO initiatives.

The ambiguities related to the nature and extent of sustainment needed for RRTO projects could become a problem. However, the committee believes that the RRTO is positioned at a sufficiently high level in the Department of Defense to overcome such ambiguities in responsibilities for sustainment. And if its "negotiating with partners strategy" fails in some case(s), the RRTO should be able to involve the Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]) in forcing decisions at that level or above. Consequently, the committee elects not to recommend any changes in the RRTO's business practices in this regard.

5. *Lack of test site intelligence support at Yuma Proving Ground, Arizona:* The committee visited the National Counterterrorism/Counterinsurgency Integrated Test and Evaluation Center (NACCITEC) at YPG. NACCITEC was established to focus on testing technologies to combat improvised explosive devices (IEDs). The work of the center for the RRTO is discussed in Chapter 2 and in Appendix C of this report.

At NACCITEC, a shortfall can exist in certain test designs with regard to the lack of an adequate interface with and support from the intelligence community. There is a need at the center for quick access to intelligence personnel who have an understanding of testing and experimentation and who are able to translate intelligence information based on what is happening on the ground into practical and realistic designs and tests. Near-term support needed by NACCITEC includes the following:

- Vulnerability analyses involving the test community, which is a critical need;
- The ability to obtain real-time intelligence data from Afghanistan; and
- A correction to the current lack of the requisite secure videoconferencing capability, which impedes mission planning as well as other activities.

Given the importance of realistic testing in a critical area of military opera-

tions, the committee believes that Army Intelligence and the Army Test and Evaluation Command should expand their support for the RRTO and its associated test support organizations (i.e., NAVAIR and NACCITEC) with regard to translating intelligence information into realistic test scenarios.

POTENTIAL IMPROVEMENTS

On the basis of the issues identified in the previous section and of the strengths of the RRTO as it perceives them, the committee discussed additional opportunities to improve the approaches of the organization to rapid technology prototyping and implementation.

As indicated in Chapter 2, the most important key to the RRTO's success is its ability to look forward and then to use its small staff as a catalyst to focus on and initiate or develop "game-changing" capabilities using synergistic networks of persons and organizations. After reviewing the organization and the successes discussed in this chapter (and described in more detail in Appendix D), the committee developed Recommendation 1, formally presented in Chapter 4, regarding the continuation of the RRTO as a separate entity without having substantial changes made in its size or business model. The rest of this major section and the next major section address, respectively, (1) potential changes to some of the RRTO's current business methods and (2) new initiatives or actions in the nature of improvements that could enhance the benefits to the nation provided by the small RRTO. In both cases, the number of items in which the committee suggests specific changes for the DOD leadership to consider and/or implement is small. In a few places the committee cautions against the growth or enhancement of some particular initiatives.

Potential Changes to Current Business Methods

To keep the RRTO lean and focused, the committee believes that the office should continue to concentrate primarily on the identification of deficiencies and on partnerships for development rather than on developing equipment in-house or attempting to define specific requirements for equipment solutions to be developed by others. In addition, the RRTO should continue to outsource the management of the experiments and the test facilities used to support the experiments.

The committee also cautions the RRTO to remain very selective about the types of experiments that it undertakes, in terms of both complexity and support requirements. For example, there remains an ongoing need for the testing and modification of military armor and tactical vehicle design, but the RRTO generally should avoid activities such as major modification of vehicles that could result in a significant resource drain and/or move the RRTO into an area of overlap or perceived competition with other organizations.

A potential issue for the RRTO is one of maintaining large test-vehicle assets.

Like large fixed infrastructures, vehicles require "regular care and feeding." Testing in a realistic environment can be absolutely critical to developing new technologies; nonetheless, the larger the vehicle the more caution RRTO should exercise before taking on such assets, because sustaining operating and support costs can be a significant drain on a small organization. Using other government assets or renting privately owned vehicles should be the RRTO's first choice for testing in such circumstances.

An area of strength that the RRTO may be able to improve is its use of conferences to bring together different government organizations and individuals with knowledge and capabilities in particular subject areas and then to build cooperative teams to address important problems and opportunities. Particularly effective over many years have been the wide-area surveillance conference series and the cross-polarization conference series sponsored by the RRTO. These are attended by a very broad range of organizations, from research and development groups to the combatant commands, involving all of the Services and many intelligence organizations. The RRTO acknowledges that several of the conferences that it sponsored were initially successful and then "withered on the vine" owing to a lack of follow-through on the part of the non-RRTO conference organizers.[11] In the two RRTO interest areas of "human terrain" and "social networking," for example, conferences were an excellent way to begin investigations and to build cooperative relationships. In other areas, more suggestions by the RRTO and others to follow up conferences with chat rooms, blogs, and other types of online networking to further the discussions may be an important next step. Continuing to follow up these activities with additional conferences until the target group assumes ownership is a good extension of the model that the RRTO currently uses for prototyping and testing. The RRTO should search for lessons learned from the successes that it and other organizations have had in building teams following initial meetings and conferences and should try to apply them to important subject areas of interest where it has had limited or no success.

Another area for potentially improving existing RRTO business methods is in the sharing of information. The RRTO should continue to partner with Service laboratories to develop more effective counterterrorist equipment and techniques. A good example of this constructive sharing is the development by the RRTO, the NAVAIR support team, and the NACCITEC of a comprehensive understanding of the technologies associated with IED detection. This and other such information should be shared with additional selected laboratories on a regular basis to provide a better catalyst for the development or modification of added systems to counter IEDS or other threats. Simply stated, the RRTO should expand the sharing of technical and other information with additional laboratories with the goal

[11]Benjamin Riley, Director, Rapid Reaction Technology Office, discussion with the committee on current projects, Washington, D.C., December 15, 2008.

of improving its role as a catalyst with respect to development and deployment capabilities against unconventional threats.

The committee also discussed whether or not the RRTO should attempt to formalize some aspects of its relatively broad but general charter and/or to obtain specific added authorities for some functions. Potential areas for improvement include the following:

- Obtaining specific modifications to the existing authority for other transactions for prototyping and grants that would be specific to the RRTO's areas of interest (Section 845/804 of the National Defense Authorization Act for Fiscal Year 1994; see footnote 6 above), and obtaining additional relaxation of or exemption from federal acquisition regulations for small rapid prototyping efforts and for test events;
- Obtaining specific authorities for the RRTO to receive a blanket testing priority similar to what classified programs are sometimes given, in order to help shorten the time between the development and deployment of successful programs; and
- Obtaining specific authorities for the RRTO to obtain appointments under the Intergovernmental Personnel Act (IPA) (1970, Code of Federal Regulations, Part 5, Chapter 334, 3371-3376) and Highly Qualified Expert term appointments and detail authority (as defined under Section 1101 of the National Defense Authorization Act for Fiscal Year 1998).

However, on balance the committee believes that the RRTO should first attempt to use its current business model capabilities to develop teaming or more permanent relationships with other organizations in order to achieve improved contracting and testing results, and that it should use the existing IPA and other authorities that the DDR&E and the USD(AT&L) currently have for obtaining highly qualified technical personnel for their organizations, of which the RRTO is one. Only if these methods fail to achieve improved results would the committee suggest more formal approaches to the above issues.

The committee's concern is that if the RRTO attempts to better define its charter (that is, to be more specific on missions, functions, and authorities for each), including additional authorities peculiar to the RRTO, it will attract more critical review of its methods and become subject to claims that it is competing for resources and special priorities with those that it has been working with, and wants to continue working with, in a complementary teaming fashion. Moreover, the director of the RRTO works directly for the DDR&E. The director of the RRTO has also had access to and the support of each USD(AT&L) with whom he has worked. If the RRTO fails to get the contracting, testing, and personnel support that it needs using its business model and approaches, the director should request that the DDR&E and/or the USD(AT&L) weigh in on individual issues rather than trying to change its charter.

Areas for Future Technology Focus

From the inception of the Combating Terrorism Technology Task Force (CTTTF), which preceded the Rapid Reaction Technology Office, the focus for the organization has been on flexible and rapid responses to the joint forces' operational and tactical needs, and particularly irregular warfare needs, with the goal of complementing, not competing with, the rapid acquisition processes implemented by each of the military Services.

In following its guiding principles, the RRTO has developed a list, derived from experience, of the critical capability areas for countering likely adversarial moves. That list was initially focused on kinetic and the more traditional military capabilities, but it is now shifting to place more equal emphasis on nonkinetic capabilities. The RRTO has initiated programs in a wide variety of areas since its formation, and the focus areas can change significantly as the organization works its business model to anticipate needs and find opportunities for solutions.

From the briefings that the committee received, it is not completely clear how focus areas are selected, prioritized annually, and aligned with the available funding, customer priorities, and manpower. However, it is clear that the focus areas are not, and should not be, constant. If the RRTO had a charter defined by a technology area or mission application area, this flexibility of focus might be leveled as a serious criticism. Instead, the committee sees the function of the RRTO as a continuously evolving bridge between technology and fieldable solutions, in place to address gaps in capability or existing problems and threats.

In today's world, technology changes rapidly. Simplistically, Moore's law has computing power doubling every 18 to 24 months. Every week brings the announcement of some new device or software capability. Similarly, the knowledge and appreciation of threats, future threats, and gaps in the U.S. ability to respond effectively are modified every month by the changing tempo, tactics, alliances, and capabilities of the nation's adversaries. Given an organization whose focus is on the application of science and technology to these emerging threats, there would be no hope of success with a statically defined agenda as to what technologies are appropriate. Instead the committee sees the role of the RRTO to be defined somewhat as shown in Figure 3.1.

On the left side of Figure 3.1 is represented the ever-changing palette of emerging technologies, while the right-hand side represents the changing threat and emerging gaps in U.S. capabilities. It is the job of RRTO to ask regularly, Are there any problems on the right that can now be solved by capabilities on the left with the modest application of time and money? Thus, the proposed project must be likely to show initial success within the 6- to 18-month time frame and fit within RRTO project sizes. Furthermore, since realistic project execution requires effective leadership, there must be a viable candidate organization and leader to carry out the work. With the confluence of all three, a candidate project emerges.

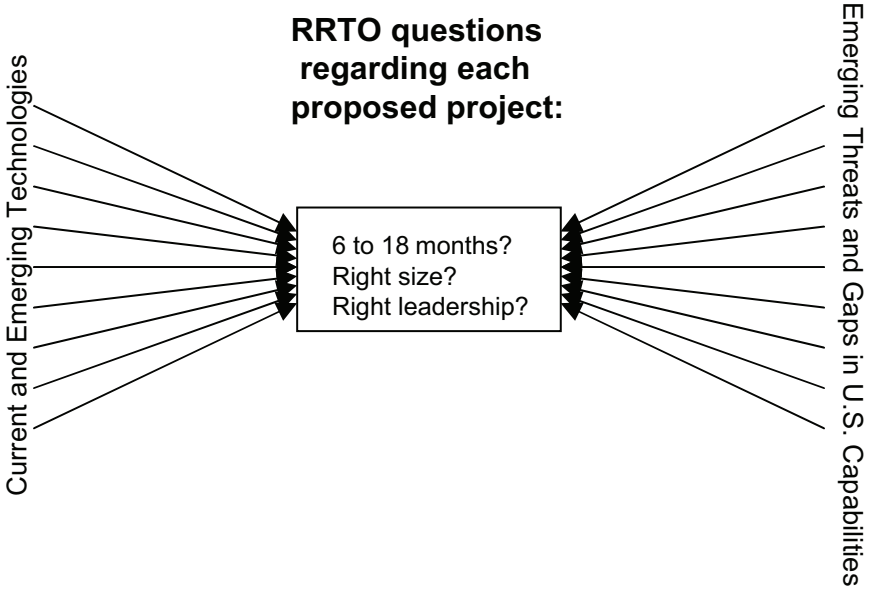

FIGURE 3.1 A committee view of the focus area and project selection process of the Rapid Reaction Technology Office (RRTO). The warfighter is the ultimate customer for RRTO products.

This match may just have become possible—perhaps because a new technological innovation has just reached sufficient maturity, or conversely because a threat or gap has emerged that can be rapidly addressed by the appropriate application of existing, mature technology. Either scenario requires vigilance in observing and understanding both sides of the equation.

If one accepts this role of the RRTO as a matching function between potential solutions and emerging problems, then requiring the RRTO to exhibit a static portfolio of focus areas would be a mistake. Indeed any suggestion that the committee might make today for program focus beyond the next 18 months is likely to be flawed. Long-term abilities to predict the future are at best limited. Scientists and others have proven to be distinctly shortsighted in predicting breakthrough technological innovation and similarly limited in anticipating evolving threats. The RRTO should continue what appears to be an agile selection process that observes and anticipates the threat and matches those needs rapidly with solutions.

In summary, given the rate of change of nonconventional threats and potential technology responses over recent years, the committee decided that it would be presumptuous to attempt to forecast particular technology areas on which the RRTO and others should focus in future years.

ADDITIONAL SUGGESTED INITIATIVES

The committee discussed several additional suggested initiatives that it believes would help sustain the Rapid Reaction Technology Office's benefits to the Department of Defense well into the future.

1. *The RRTO should try to form partnerships with the major military test sites to have them focus on upgrading their sites to support rapid reaction prototyping and counterterrorism testing as a core competency.*

Thus far, the RRTO has avoided the direct ownership of fixed test facilities, which the committee believes is the proper strategy for a small organization within the Office of the Secretary of Defense, because infrastructure costs and operation can create a severe financial drain as well as a management distraction. The RRTO has historically been very successful in seeding new technological developments, organizing a community of interested parties to push the technology forward, and then sponsoring test events and venues in a "build, test, fix, test again" environment. Two examples of this approach to prototype testing are (1) the persistent-surveillance testing that the RRTO conducted in conjunction with interested parties within the DOD and the intelligence community; and (2) the counter-IED testing and facility development that the RRTO started at Yuma Proving Ground and turned over to the Joint Improvised Explosive Device Defeat Organization (JIEDDO) in 2009.

In the first case the RRTO worked with the interested parties to push the technology and facilitated an ongoing series of experiments that are advancing the state of the art in this critical area. These tests employ prototype hardware from a variety of sources and use test facilities that had been established for other purposes. Some limited modifications were made to the facilities, but these will be taken over by interested parties in the DOD and intelligence community as the technology matures. This is a very positive step, as it allows RRTO to begin to focus on the next set of problems.

The other example is the process that the RRTO went through to prototype and test counter-IED technologies. As the prototypes began to bear fruit, the RRTO realized that there was little in the way of test facilities to determine the effectiveness of the prototypes being developed. The RRTO found that it had to develop the test facilities as well as the prototypes to be tested. The RRTO was quite successful in developing the Joint Experimentation Range Complex (JERC) site at YPG to test counter-IED technologies, but the site has a lot of fixed infrastructure that requires a stable cadre of test personnel and has yearly maintenance costs. These costs have little to do with the RRTO's core mission. As a result, the

RRTO has been transferring the JERC to JIEDDO, but it is still funding it at a significant level (i.e., on the order of 20 percent).[12]

When possible, the RRTO should avoid the longer-term costs for obtaining and maintaining large, fixed test sites by developing a firm commitment from a partner agency and/or Service to pick up the bill at some very-near-term point after completion of RRTO testing. The committee recommends that the Army G-2 (Intelligence) Command and the commander of Army Test and Evaluation Command (ATEC) expand support to the RRTO and its associated test support organizations (i.e., NAVAIR, NACCITEC) with regard to picking up RRTO-related fixed-test-site costs. Those two organizations should also expand their support to the RRTO by assisting in translating intelligence information into realistic test scenarios, because the RRTO does not have sufficient knowledge or capability to do so. The RRTO should also work closely with the NACCITEC and other major test outdoor ranges as well as indoor countermeasure test facilities, as appropriate, to have them focus on upgrading their sites to support rapid reaction counterterrorism technology prototyping and testing as a core competency. The required test support has multiple components. First, it requires the rapid development of appropriate test facilities. Second, it requires a contractual arrangement with the range support contractor to provide surge support for periods of intensive 6- to 7-day-per-week operations, to include at times two shifts per day.

If the ranges support multiple test activities, the issue of test priority needs to be addressed to ensure that the rapid reaction technology testing is not adversely impacted. This potential problem is sometimes alleviated or eliminated by a surge support capability at the range, adding extra shifts or temporary personnel.

2. *The Department of Defense and the entire U.S. national security complex could benefit from making the RRTO's attributes (e.g., small size and catalytic function) and its methods of operation known, or better known, to the National Security Council principals and their key staff managers.*

In its review of the RRTO, the committee received briefings from and had discussions with representatives from numerous government organizations. It became apparent to the committee that the leaders of some organizations (including some that had personnel cooperating and/or teaming with RRTO) were not aware of the types of successes that the catalytic RRTO staff had initiated across government organizations. Many of these organizations were not used to working together and/or were not aware of what was going on in other departments that could improve their own efforts. The committee has noted elsewhere in this report that there are many reasons why the RRTO should not be grown into a large organization or lose its agility and innovative business model by being folded in with

[12]Discussion between the committee and NACCITEC personnel during its site visit at the Yuma Proving Ground, Arizona, on November 18, 2008.

other, more typical government organizations that have less flexible mission statements and less ability to adopt new or different business methods and procedures. The committee believes that if other government leaders are made aware of the RRTO's nontraditional attributes and business model, they may be able to apply selected ones to small entities in their departments or agencies.

It is for this reason that the committee recommends that the Secretary of Defense make the National Security Council principals aware of the RRTO, its attributes, and its business model, so that these practices can be adapted and applied to interagency problems.

3. *The RRTO should implement leadership succession planning.*

The director of the RRTO should develop a sustainable succession plan in order to ensure the availability of the leadership and management expertise needed to carry into the future the same level of foresight, flexibility, and ingenuity that exists in the organization today. The director needs either to develop the specifically needed talent within the organization by training or mentoring or to obtain the appropriate level of support from the DDR&E and the USD(AT&L) to acquire the requisite personnel. To date the RRTO's apparent strong and effective leadership is what has put the RRTO in the favorable position that it occupies within the Department of Defense. The DDR&E and the USD(AT&L) need to protect that valuable reputation by sustaining the RRTO's visionary, agile, flexible, and effective style of leadership.

WHY IS THE RAPID REACTION TECHNOLOGY OFFICE NEEDED?

In a recent article in *Foreign Affairs,* Secretary of Defense Gates stated that "support for conventional modernization programs is deeply embedded in the Defense Department's budget, in its bureaucracy, in the defense industry, and in Congress. My fundamental concern is that there is not commensurate institutional support—including in the Pentagon—for the capabilities needed to win today's wars and some of their likely successors."[13] He went on to say in the article that apart from the Special Forces and a few other groups there is no deeply rooted constituency within the Pentagon or elsewhere for establishing the capabilities required to wage asymmetric or irregular warfare or to meet quickly the ever-changing needs of the forces engaged in these conflicts.

One of the primary reasons for the continued existence of the RRTO is that it is both focused on addressing irregular warfare needs and capable of reacting quickly, whereas most of the current DOD acquisition system is failing to provide

[13]Robert M. Gates, Secretary of Defense. 2009. "A Balanced Strategy: Reprogramming the Pentagon for a New Age, *Foreign Affairs* 88(1):1.

the flexible and timely response that the nation needs. The overall DOD acquisition process has provisions that enable tailoring and rapid response, but over the past few decades the management of the system has evolved into one permitting the use of (1) excessive and/or "creeping" requirements with little flexibility for trade-offs in value or time, (2) immature technologies, and (3) unrealistic schedules or cost estimates. Secretary Gates observed that "conventional modernization programs seek a 99 percent solution" when a 75 percent solution may be sufficient for many missions.[14]

As explained in Chapter 2, the RRTO's position within the Office of the Secretary of Defense gives its leadership exceptional flexibility to use its skills in networking and cross-collaboration with agencies across the government.

The RRTO's defining characteristics (see Box 2.1 in Chapter 2) as a catalytic organization that anticipates and responds to emerging threats, and that has a business model which creates synergism by bringing diverse organizations together to invent and develop capabilities and concepts of operation, constitute key elements informing this committee's belief that the nation needs to maintain and sustain the RRTO. In addition, in the intelligence arena, the RRTO has demonstrated a high value for operating in the gaps not covered by cross-community collaboration between various intelligence agencies. Moreover, with respect both to the Services and to the intelligence agencies, the RRTO consciously tries not to compete with their respective major programs, and as a result it is not viewed as a threat in the budgetary fight for resources.

Some RRTO activities overlap with those of other offices and agencies, but they are predominantly complementary and not competitive. For example, while there is some overlap between the RRTO and JIEDDO, which has a very short term or immediate focus, JIEDDO is very supportive of the RRTO and its efforts to meet the longer-term commitment against asymmetric threats and irregular warfare.

There are other agencies, such as the Defense Advanced Research Projects Agency (DARPA), that have essentially no overlap with the RRTO. And while some might argue that DARPA and the RRTO should be integrated in their technological efforts, their roles are different. On the one hand, DARPA has a relatively long time horizon in its efforts to supply technological options for the entire DOD and to be a specialized "technological engine" for transforming the DOD. The RRTO, on the other hand, strives to adapt technology to support less conventional warfighting requirements on a shorter time frame. The director of DARPA stated that he did not see an overlap between his agency and the RRTO.[15]

[14]Robert M. Gates, Secretary of Defense. 2009. "A Balanced Strategy: Reprogramming the Pentagon for a New Age," *Foreign Affairs* 88(1):1.

[15]Anthony Tether, Director, Defense Advanced Research Projects Agency (DARPA), discussion with the committee on the role of experimentation and rapid prototyping from the DARPA perspective, December 15, 2008.

The RRTO will be needed well beyond the current war on terror for other future nonconventional conflicts. There are no indications that the larger established acquisition system within the DOD will be fixed soon enough to eliminate the need for an RRTO to continue its cross-collaboration efforts to meet unconventional conflict needs.

There may be a need to protect the RRTO from institutional biases as well as the probability of bureaucratic infringement within the Department of Defense over time. The RRTO will need the continued support of senior-level DOD officials in order to continue to operate in the same manner that it does today.

The current RRTO is a very small, low-key, nonconfrontational organization that is adept at using the networks that have been built up to identify potential technologies that can be exploited in a rapid manner to address unconventional conflict needs. It is questionable as to whether it would be prudent to increase the stature of the RRTO organization, because it does not want or need the perception that it is in competition with other science and technology (S&T) entities and/or larger acquisition programs within the DOD. It can continue to be very effective in its current operating niche.

The RRTO is functioning very effectively in the current environment, which requires that S&T requirements of the DOD be met quickly in order to respond to rapidly changing threats in the field. The RRTO also provides an example of the kind of organizational model that can successfully deal with the disruptive challenges that the nation faces, as is discussed in more detail in Appendix E. A similar level of innovative capability should be carried over into the interagency arena to benefit the Department of Homeland Security, the Department of State, the Department of Justice, and the intelligence agencies, as well as organizations such as the U.S. Agency for International Development or the Department of Agriculture. Both of the latter have developing missions on the "soft side" of U.S. irregular warfare efforts overseas. Following the same process through cross-collaboration and coordinating initiatives that are now operating, coupled with the discipline to stay within the seams between major programs, the RRTO (or a new interagency entity using the RRTO model) could remain a catalyst for other organizations to develop future innovative solutions that could be fielded quickly to address their problems.

4

Findings and Recommendations

The Committee on Experimentation and Rapid Prototyping in Support of Counterterrorism offers the following major findings and recommendations to help guide future efforts in the development of counterterrorism technology:

Finding 1: The Rapid Reaction Technology Office's (RRTO's) unique combination of attributes and business model contribute key strengths—flexibility and agility—in anticipating and defeating disruptive threats to this nation and its way of life. These strengths are essential to the Department of Defense, but retaining them requires constant vigilance. The RRTO's capabilities to span organizational boundaries and to work outside conventional modes serve the DOD well.

Recommendation 1: The Rapid Reaction Technology Office should be continued as a separate entity reporting directly to the Director of Defense Research and Engineering (DDR&E), with enhancements as recommended elsewhere in this report but without a substantial change in size or business model. The DDR&E should strongly resist making the RRTO conform to conventional approaches. Doing so would seriously reduce both the RRTO and the DOD's effectiveness. Also, the committee recommends that the RRTO publish for its potential partners a broad guide to the process and criteria that the RRTO uses for project selection. The Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]) should review the RRTO every 5 years to assess its value and whether it should be continued. To continue as an effective organization, the RRTO needs to increase its emphasis on succession planning.

Finding 2: The RRTO has applied a significant portion of its resources in order to anticipate and address emerging and potential needs that have not been formally recognized by others. This effort has enabled the timely fielding of new capabilities that have been successful in countering rapidly evolving threats.

Recommendation 2: The director of the RRTO should continue to devote a substantial portion of the organization's resources to addressing needs that are emerging and anticipated (even though unarticulated) in order to enable timely fielding of new capabilities that will counter or deter rapidly evolving threats.

Finding 3: The committee identified and reviewed seven internal and external issues that could be potential barriers to the RRTO's ability to enable rapid transition of developments in science and technology to support counterterrorism applications. Most of these issues are such that trying to eliminate or reduce the particular barrier involved would have an overall adverse impact on the RRTO's effectiveness. The two issues that the committee believes should be addressed are these:

- The pressure to consolidate the organization with conventional military Service acquisition organizations and/or to conform to institutional acquisition or test methodology, and
- The lack of test site intelligence support at Yuma Proving Ground, Arizona.

The first issue was addressed in Finding 1 and Recommendation 1. The second issue is addressed in Recommendation 3.

Recommendation 3: In supporting the RRTO and Yuma Proving Ground, the Army Deputy Chief of Staff for Intelligence and the commander of the U.S Army Test and Evaluation Command (ATEC) should expand support to the RRTO and its associated test support organizations (i.e., the Naval Air Systems Command and the National Counterterrorism/Counterinsurgency Integrated Test and Evaluation Center) with regard to translating intelligence information into realistic test scenarios. The commander of ATEC should provide for the installation of a secure videoconferencing capability at Yuma Proving Ground so as to enhance communications for the planning of experimentation and the discussion of test results.

Finding 4: Contracting delays have resulted in project delays of as much as 4 to 6 months in some cases and can be a serious issue for the RRTO.

Recommendation 4: To simplify the contracting process and reduce contracting time for rapid-reaction projects, the RRTO should consider implementing one or more of the following: (1) create a small, dedicated contracting element within the RRTO; (2) use "other transaction" authority for the high-importance,

time-critical responses; and (3) make the current contracting approach more streamlined and efficient (e.g., by having the USD[AT&L], who is the chief procurement and contracting officer of the DOD, designate a contracting office to give priority attention to requests of the RRTO when needed). The committee prefers the third approach.

Finding 5: The attributes and business model employed by the RRTO are critical enablers of the interagency approach advocated by Secretary of Defense Robert M. Gates in his article entitled "A Balanced Strategy: Reprogramming the Pentagon for a New Age," in the January 2009 issue of *Foreign Affairs*,[1] and they respond to the particular challenges posed by agile, adaptive threats.

Recommendation 5: The Secretary of Defense should make the science and technology director of each of the National Security Council principals—such as the Under Secretary of Homeland Security for Science and Technology—aware of the RRTO, its attributes, and its business model, so that some of the processes and approaches used by the RRTO can be considered for broader adaptation and use in other interagency applications.

[1]Robert M. Gates, Secretary of Defense. 2009. "A Balanced Strategy: Reprogramming the Pentagon for a New Age," *Foreign Affairs* 88(1):1.

Appendixes

A

Committee and Staff Biographies

Paul G. Kaminski, *Chair*, is chairman and chief executive officer of Technovation, Inc., a consulting company dedicated to the development and application of advanced technology. From 1994 to 1997, Dr. Kaminski served as the Under Secretary of Defense for Acquisition and Technology. In this position, he was responsible for all matters relating to Department of Defense (DOD) acquisition, including research and development, procurement, acquisition reform, dual-use technology, logistics, the defense technology and industrial base, and military construction. He has had a continuing career in the development and application of advanced technology in both the private and public sectors. His previous government experience also includes a 20-year career as an officer in the U.S. Air Force, where he directed the development of major stealth systems and national reconnaissance systems. Dr. Kaminski is a member of the National Academy of Engineering, a fellow of the Institute for Electrical and Electronics Engineers and of the American Institute of Aeronautics and Astronautics, and chair of the Defense Science Board. He is a member of the FBI Director's Advisory Board and the Senate Select Committee on Intelligence Technical Advisory Group. His awards include the National Medal of Technology, the DOD Medal for Distinguished Public Service (three awards), and the Defense Distinguished Service Medal.

Charles E. (Pete) Adolph has approximately 50 years' experience in testing and evaluation and acquisition management. He started his career with General Dynamics Convair as a flight test engineer at Edwards Air Force Base, California, in 1956. Following 3 years in the U.S. Air Force, he held a variety of engineering and systems acquisition, technical, and management positions with the Air Force, advancing to technical director, the senior civilian position at the Air Force Flight

Test Center. From 1987 to 1994, he held several positions in the Office of the Secretary of Defense. For most of that period he was director of Test and Evaluation, Acquisition, and Technology. He also served as acting director of Operational Test and Evaluation and acting director of Defense Research and Engineering. He was a senior vice president for Science Applications International Corporation (SAIC) from 1994 to 2000 and served as the manager of the SAIC testing and evaluation group. He is currently an independent consultant.

Alfred O. Awani is director of advanced tactical laser transition at the Boeing Company. His expertise is in large-scale systems integration, engineering analysis, design and development, autonomous systems, directed-energy weapons systems, low-observables testing and evaluation, technology development and management, systems engineering and requirements development, platform integration, and program management. He has held other key management positions at Boeing and was the Boeing Sikorsky Joint Program Office's deputy director of systems engineering and chief of technology for the Boeing Sikorsky team on the Army Comanche RAH [Reconnaissance/Attack Helicopter]-66 program. Before joining Boeing, he was a research engineer at the National Aeronautics and Space Administration's Ames Research Center, involved in various advanced configuration developments. Dr. Awani was a member of the National Research Council's (NRC's) Committee on the Identification of Promising Naval Aviation Science and Technology.

W. Peter Cherry is chief analyst at Science Applications International Corporation. His research areas include project organization, processes and procedures, and models and simulations used to support design and development and testing and evaluation strategies using virtual prototypes at the system-of-systems level. He has contributed to the development and fielding of most of the major weapons systems currently used by the U.S. Army—ranging from the Patriot missile system to the Apache helicopter—and command, control, and intelligence systems. Dr. Cherry is a member of the National Academy of Engineering.

John D. Christie is senior fellow at LMI. He has an extensive background in Department of Defense (DOD) acquisition policy, program analysis, and resource allocation. He was the director of Acquisition Policy and Program Integration for the Under Secretary of Defense for Acquisition from 1989 to 1992. In that position he prepared a comprehensive revision of all defense acquisition policies and procedures, resulting in the cancellation and consolidation of 500 prior separate issuances. Dr. Christie also prepared comprehensive acquisition program alternatives for the Secretary of Defense that resulted in multi-billion-dollar budget reductions. He has served on numerous DOD and NRC advisory committees and recently was a member of the NRC Oversight Committee for the Workshop on Testing for Dynamic Acquisition of Defense Systems.

Lee M. Hammarstrom is assistant to the director of the Applied Research Laboratory/Pennsylvania State University (ARL/PSU). Previously, he was the first chief scientist at the National Reconnaissance Office and chief scientist at the Office of the Secretary of Defense for Command, Control, Communications, and Intelligence. Mr. Hammarstrom has broad expertise in areas ranging from technology development to the testing and deploying of military and intelligence systems. He has served on numerous scientific and advisory committees and is currently a member of the NRC's Naval Studies Board and the NRC Standing Committee on Operational Science and Technology Options for Defeating Improvised Explosive Devices.

Harry W. Jenkins, Jr., retired from the U.S. Marine Corps with the rank of major general and is currently an independent consultant. His background includes naval operations, mine countermeasures, and Marine Corps intelligence operations, in particular, its mission use of command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) systems. He formerly served as director of business development and congressional liaison at ITT Industries-Defense, where he was responsible for activities in support of tactical communications systems and airborne electronic warfare with the Navy, Marine Corps, Coast Guard, and National Guard. During Operation Desert Storm, General Jenkins served as the commanding general of the Fourth Marine Expeditionary Brigade. He formerly served as a member of the NRC's Naval Studies Board and has participated in the work of nine committees, including the Committee on the Role of Naval Forces in the Global War on Terror.

Annette J. Krygiel is an independent consultant with expertise in the management of large-scale systems, particularly in regard to software development and systems integration. She served as a distinguished visiting fellow at the Institute for National Strategic Studies at the National Defense University, where she wrote a book on large-scale system integration. Prior to that, she was director of the Central Imagery Office (CIO), a Department of Defense combat support agency, until CIO joined the National Imagery and Mapping Agency in October 1996. Dr. Krygiel began her career at the Defense Mapping Agency, where she held various positions including chief scientist. Dr. Krygiel previously served as chair of the NRC Committee on the Role of Experimentation in Building Future Naval Forces.

Verne L. (Larry) Lynn is an independent consultant to industry and the Department of Defense. He is the former director of the Defense Advanced Research Projects Agency (DARPA), the principal agency within the DOD for research, development, and demonstration of concepts, devices, and systems for advanced military capabilities. He also served in the DOD as the Deputy Under Secretary of Defense for Advanced Technology. He has extensive knowledge of military

organization and operations for research, development, and acquisition. Mr. Lynn is a member of the National Academy of Engineering and the Defense Science Board and served as chair of the NRC Committee on Strategies for Network Science, Technology, and Experimentation.

Stephen D. Milligan is chief technical officer at BBN Technologies. In that capacity, he has technical oversight and access to all areas of BBN's capabilities. Prior to being named chief technology officer, Dr. Milligan was chief scientist for systems and architectures and has been at BBN for 30 years. His research interests include large-scale system architectures, distributed systems, agent-based systems, and evolutionary algorithms. Most recently, he was principal investigator of the Boomerang Mobile Shooter Detection System, guiding all aspects of design and development and completing the project—from design to delivery—in just over 2 months. Boomerang earned the 2005 DARPA Significant Technical Achievement Award and is now deployed in Iraq.

Arthur A. Morrish is vice president and chief technology officer of the Products Group at L-3 Communications. He has more than 19 years of experience as a manager and developer of technical solutions to DOD challenges. His background includes the management of both people and programs in a high-risk, high-payoff, results-oriented environment. Dr. Morrish has extensive experience in developing and managing multi-million-dollar high-technology defense programs from inception to advanced prototype and then transitioning them to the warfighter community. He also has a strong understanding of Special Operations needs and requirements based on his numerous interactions with that community in areas including unmanned air vehicles, advanced hybrid electric ground vehicles, sensor and detection systems, and sniper weapons. His prior position was as director of the Tactical Technology Office at the Defense Advanced Research Projects Agency. Dr. Morrish has received numerous government performance awards and has served on the Army Science Board.

Stephen M. Robinson is professor emeritus in the Department of Industrial and Systems Engineering at the University of Wisconsin-Madison. His research is in the development of quantitative methods for making the best use of scarce resources, which is part of the broad category of operations research methods. Dr. Robinson is a fellow of the Institute for Operations Research and the Management Sciences and a member of the National Academy of Engineering. He previously served on the NRC Committee on Modeling and Simulation for Defense Transformation and on the NRC's Board on Mathematical Sciences and Their Applications.

Ann E. Speed is a principal member of the technical staff at the Sandia National Laboratories in New Mexico. She is a cognitive psychologist and has a back-

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H. Eugene Stanley is a university professor, professor of physics, and director of the Center for Polymer Studies at Boston University. His expertise includes sensors and polymeric materials, theory of phase transitions and critical phenomena for a wide range of systems including polymers, and applications of statistical mechanics to biology, economics, and medicine. Dr. Stanley is a member of the National Academy of Sciences and was a member of the NRC Committee on the Role of Naval Forces in the Global War on Terror.

Staff

Charles F. Draper is director of the National Research Council's (NRC's) Naval Studies Board. Before joining the NRC in 1997, he was the lead mechanical engineer at S.T. Research Corporation, where he provided technical and program management support for satellite Earth station and small satellite design. He received his Ph.D. in mechanical engineering from Vanderbilt University in 1995; his doctoral research was conducted at the Naval Research Laboratory (NRL), where he used an atomic-force microscope to measure the nanomechanical properties of thin-film materials. In parallel with his graduate student duties, Dr. Draper was a mechanical engineer with Geo-Centers, Inc., working onsite at NRL on the development of an underwater x-ray backscattering tomography system used for the nondestructive evaluation of U.S. Navy sonar domes on surface ships.

Marta V. Hernandez is an associate program officer with the NRC's Naval Studies Board (NSB). Prior to joining the NSB, she worked for the NRC's Air Force Studies Board and National Materials Advisory Board. Ms. Hernandez joined the National Research Council in 2003 after graduating from the University of Maryland with a B.S. in materials science and engineering. Since then she has worked on a variety of projects, including ad hoc committees, standing committees, roundtables, and proposal review panels for various sponsors within the Department of Defense and the materials community.

Billy M. Williams is a senior program officer with the NRC's NSB. Prior to joining the NSB, he served in a similar capacity with the NRC's Board on Army Science and Technology, where he led projects associated with the U.S. Army's Chemical Demilitarization program. Mr. Williams retired as a director of global

research and development from the Dow Chemical Company in 2004 after 30 years of service. His career at Dow included directing analytical sciences and materials science in operations across the United States, Europe, and Asia. He also served as the company's director of external science and technology programs, with responsibility for developing and securing strategic technical partnerships with leading research universities, national laboratories, and federal agencies. Mr. Williams earned an M.S. degree in organic chemistry and has completed executive education programs at Indiana University and Harvard University.

B

Acronyms and Abbreviations

ADSS	Automated Decision Support System
AFRL	Air Force Research Laboratory
AGIG	Airborne Global Information Grid
ATEC	Army Test and Evaluation Command
BAT	Biometric Automated Toolset
BISA	Biometric Identification System for Access
BITE	Biometric Information Technology Evaluation
C4I	command, control, communications, computers, and intelligence
CENTCOM	Central Command
CIA	Central Intelligence Agency
CIPA	Counter Insurgency Pattern Assessment
COCOM	combatant commander
COIN	counterinsurgency
CONOPS	concepts of operations
CORE	Common Operational Research Environment
CTTTF	Combating Terrorism Technology Task Force
DARPA	Defense Advanced Research Projects Agency
DDR&E	Director, Defense Research and Engineering
DEC	Digital Equipment Corporation
DERF	Defense Emergency Response Fund
DHS	Department of Homeland Security
DIA	Defense Intelligence Agency

DNI	Director of National Intelligence
DOD	Department of Defense
DOE	Department of Energy
DTC	Development Test Command
DTRA	Defense Threat Reduction Agency
DURAD	Detection of Unintended Radiation
FADE	Fusion Analysis Development Effort
FFRDC	federally funded research and development center
FY	fiscal year
GCOIN	global counterinsurgency
GMTI	Ground Motion Target Integrator
HBS	Harvard Business School
HTS	Human Terrian System
IC	intelligence community
IDA	Institute for Defense Analyses
IED	improvised explosive device
IP	Internet Protocol
ISR	intelligence, surveillance, and reconnaissance
JCTD	Joint Capability Technology Demonstration
JCURE	Joint Cultural Understanding and Relationship Exploitation
JERC	Joint Experimentation Range Complex
JFCOM	Joint Forces Command
JIATF-South	Joint Interagency Task Force-South
JIEDDO	Joint Improvised Explosive Device Defeat Organization
JIPOE	Joint Intelligence Preparation of the Operational Environment
JRAC	Joint Rapid Acquisition Cell
JUONS	Joint Urgent Operational Needs Statement
LUUV	large unmanned undersea vehicle
MASTER	Maritime Automated Super Track Enhanced Reporting
MPICE	Measuring Progress in Conflicts Environments
MTI	moving target indicator
NACCITEC	National Counterterrorism/Counterinsurgency Integrated Test and Evaluation Center
NAVAIR	Naval Air Systems Command
NGA	National Geospatial-Intelligence Agency

NIPRnet	Non-Classified Internet Protocol Router Network
NORTHCOM	Northern Command
NRC	National Research Council
NRO	National Reconnaissance Office
NSA	National Security Agency
NTIPS	National Tactical Integrated Processing System
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OODA	observe, orient, decide, and act
OTA	other transaction authority
PC	personal computer
PE	program element
PPBE	Planning, Programming, Budgeting and Execution
PTDS	Persistent Threat Detection System
QRSP	Quick Reaction Special Projects
RDT&E	Research, Development, Test and Evaluation
RRTO	Rapid Reaction Technology Office
S&T	science and technology
SIPRnet	Secret Internet Protocol Router Network
SOCOM	Special Operations Command
SOUTHCOM	Southern Command
SSA	Sudan Strategic Assessment
STRATCOM	Strategic Command
TacSat	Tactical Satellite
TINA	Tactical Infrared Networked Awareness
TRADOC	Training and Doctrine Command
TSWG	Technical Support Working Group
UAS	unmanned aircraft system
UAV	unmanned aerial vehicle
UON	Urgent Operational Need
USAID	United States Agency for International Development
USD	Under Secretary of Defense
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology and Logistics
UUV	unmanned undersea vehicle

VMOC	Virtual Mission Operations Center
WMD	weapons of mass destruction
XPAK	Explosives Particulate Analysis
YPG	Yuma Proving Ground

C

Rapid Reaction Technology Office Test Planning, Conduct, Analysis, and Reporting

Two organizations provide primary support for the test planning, conduct, analysis, and reporting for experiments of the Rapid Reaction Technology Office (RRTO) conducted at the Joint Experimentation Range Complex (JERC). The U.S. Naval Air Systems Command (NAVAIR) Special Surveillance Programs Office is the lead agency for overseeing and providing technical expertise for test planning, conduct, and analysis. The National Counterterrorism/Counterinsurgency Integrated Test and Evaluation Center (NACCITEC) provides a capability for experimental testing. Members of the Committee on Experimentation and Rapid Prototyping in Support of Counterterrorism visited the JERC in November 2008 as part of the committee's data-gathering efforts.

OVERVIEW OF THE TESTING AND REPORTING PROCESS

NAVAIR is the integration organization and the point of contact between the test equipment manufacturer and NACCITEC. NAVAIR has developed standard test planning and test reporting templates for use with RRTO projects, and the manufacturer typically drafts a test plan according to the planning templates, with NAVAIR and NACCITEC guidance. Several test plans and reports were reviewed by the Committee on Experimentation and Rapid Prototyping in Support of Counterterrorism and were found to follow a systematic, disciplined process. The RRTO provides funding and oversight; experimentation planning and execution are conducted by NAVAIR.

A variety of experiments are conducted every 7 to 8 weeks on new or modified equipment available for testing. The test plan and program introduction document information (e.g., data requirements, range equipment support requirements)

must be submitted to NACCITEC a minimum of 4 weeks prior to the scheduled test period. From NAVAIR's perspective, ensuring the availability of adequate test support resources and range support experts for some areas, such as range safety for unmanned aerial vehicles (UAVs), is a challenge.

Test results are documented in Quick Look Experimentation Reports, prepared by NAVAIR. These reports address test results, test threat or target specifics, capabilities and limitations, test dilemmas, safety issues, survivability, unknowns, and overall conclusions and recommendations.

After review by the RRTO, the Quick Look Experimentation Reports are archived and posted on a Web site. NACCITEC prepares an "Event Record" for each test, and a "Weekly Battle" report for the JERC, which documents the testing accomplished. Projects are terminated when an application is not adopted by the warfighter or by another science and technology organization. Upon project termination the data from such projects are archived for potential future use. On the basis of information gathered by the committee during its November 18, 2008, site visit, it appears that in cases where initial experiments have not been adopted, the knowledge gained from these documented experiments provides critical data for future experimental use.

A secure videoconference chaired by the RRTO is held biweekly, with all interested organizations participating. Field operational personnel participate frequently and provide valuable feedback on equipment fielded as well as insights into future experiments.

The experimentation planning and execution process in support of the RRTO has unique positive features that do not exist in a classical DOD experimentation or acquisition environment. Management of the testing and evaluation process by NAVAIR and Army support from NACCITEC combine to produce a balanced, objective technical assessment of the capabilities and limitations of the item being evaluated. This oversight construct is unique in that neither the RRTO nor the test support organizations are in an advocacy role for the items being evaluated.

NATIONAL COUNTERTERRORISM/COUNTERINSURGENCY INTEGRATED TEST AND EVALUATION CENTER

In December 2003, the Rapid Reaction Technology Office (then the Combating Terrorism Technology Task Force) began building a capability—the JERC—at Yuma Proving Ground (YPG) in Arizona for experimental testing. The facility began operating in January 2004. NACCITEC was established in 2005 at YPG as a dedicated organization to support the testing and evaluation of technologies to counter terrorist threats. The center currently focuses on testing technologies to combat improvised explosive devices (IEDs), which are today's foremost terrorist

threat. Testing involves explosive devices, triggers, obstructives,[1] and vehicles in tactical emplacements.

NACCITEC is composed of three JERCs. Two of these complexes replicate urban warfare sites in a desert environment, and the third replicates desert mountain roads typical of Afghanistan. The range is heavily instrumented to support counter-IED test activities; essentially all test data are acquired on a real-time basis, facilitating rapid analysis of test results.

The Army, supplemented by a range support contractor, provides onsite personnel support. Test support was initially staffed to provide 24-hour-per-day/7-day-per-week coverage; it is currently staffed to sustain 6-day-per-week/24-hour coverage. Testing is typically conducted on several technologies during 1- to 2-week blocks every several weeks. The range support contractor has approximately 80 temporary on-call employees to support surge operations during intensive test periods. Current staffing is approximately 28 government and 320 contractor personnel. According to information provided to the committee, the size of the workforce is considered by range managers to be about right. However, they would prefer a higher percentage of government personnel.[2]

A test can be initiated through one of two processes: (1) The customer can contact NACCITEC directly by completing a request for test services, which is sent to the U.S. Army Development Test Command (DTC); when the request is approved, the test is initiated in the Army DTC Command Automated Decision Support Systems (ADSS). (2) The U.S. Army DTC can task NACCITEC with testing, and the DTC then initiates the tasks in the ADSS. There are also procedures to accommodate private-industry contracts to determine if a test can proceed at YPG. Once approved, the test is initiated in the ADSS.

The entire test planning and execution process was developed to provide rapid support to critical problems in the theater. However, most efforts in reaction to urgent threats occur without strategic planning. Range personnel stated to the committee that, because of the rapid-reaction nature of their mission, there was an initial tendency to ignore too many rules; however, with time, checks and balances evolved. The "bureaucracy" is increasingly injecting itself by requesting that additional reviews and coordination be accomplished.[3] In general, a key to continued success is having the proper checks and balances to

[1] *Obstructives* are objects used in particular ways to mask or reflect signals or to obscure a line of sight for specific purposes during tests of certain systems.

[2] Discussions between committee members and NACCITEC personnel during the committee's site visit to the Joint Experimentation Range Complex, Yuma Proving Ground, Arizona, on November 18, 2008.

[3] Discussions between committee members and NACCITEC personnel during the committee's site visit to the Joint Experimentation Range Complex, Yuma Proving Ground, Arizona, on November 18, 2008.

ensure adequate technical and safety discipline without unnecessarily impeding rapid response.

Range personnel characterize "then" and "now" approaches to supporting rapid reaction. As described to the committee, initially the test community would use firm requirements and design documents and then test specifications of the end capability. Now they use an urgent operational need statement and a more authoritative concept of operations and test how the operator will use the capability. They continue testing if the capability is in hand and also recommend adaptations of the solution, as appropriate. They also use feedback from the field if available, but this has been sporadic to date.[4]

A "red team" emphasis is employed in test planning for experiments at YPG. The red team's focus is to identify potential countermeasures to defeat operational concepts and technologies. However, range personnel stated that a shortfall in test design is the lack of an adequate interface with the intelligence community. There is a need at the center for quick access to intelligence personnel who have an understanding of testing and experimentation and can translate intelligence information into practical and realistic tests. The biweekly videoconferences chaired by the RRTO are a valuable resource for experimentation planning activities (and necessary for the intelligence interface), but the requisite secure video capability does not exist at YPG, which impedes mission planning as well as other activities. The test community does not involve itself in logistical support considerations for rapid reaction.

Test range priorities, with some exceptions, are not generally a problem because the JERCs are, with minor exceptions (e.g., some time-space-position instrumentation), essentially autonomous, according to NACCITEC personnel. Personnel also observed that priorities become a problem, however, in the construction of new facilities that are managed by the YPG Public Works organization. One JERC has landline power but the other two do not and currently must rely on less reliable generators for power. It is possible to install landlines to the latter two sites, but because of distances and topography it would be relatively expensive.

ISSUES AND CONCERNS REGARDING TESTING THAT WERE RAISED DURING THE COMMITTEE'S SITE VISIT

During the committee's site visit, several issues arose with respect to the support that NACCITEC provides to the RRTO. Issues raised by NACCITEC personnel included the following:

[4]Discussions between committee members and NACCITEC personnel during the committee's site visit to the Joint Experimentation Range Complex, Yuma Proving Ground, Arizona, on November 18, 2008.

- *Infrastructure sustainment:* Range personnel expressed concern with respect to adequate sustainment funding. The NACCITEC ranges currently enjoy a much higher than normal percentage of direct customer-reimbursable funding for range operations (approximately 90 percent); the remaining 10 percent comes from Army institutional funding.[5] In the long term, this funding profile could negatively impact the sustainment of range capabilities, particularly if a downturn in testing occurred. An adverse impact on sustainment funding would also be experienced if the current high level of Office of the Secretary of Defense/RRTO support changed and there was need to compete for a higher percentage of Army institutional funding. The need for sustainment is growing as more sophisticated facilities are developed and are used only sporadically.
- *Frequency authorization:* NACCITEC personnel explained that the process for obtaining radio-frequency authorization for realistic testing of theater devices and frequencies needs more attention. Current operations require testing with actual devices and frequencies used in-theater. The frequencies and power levels of these devices, as well as the jammers to defeat them, are often in conflict with U.S. Federal Communications Commission regulations on frequency allocations and uses. Effective testing requires employing these devices, yet the process for obtaining a rational risk assessment of the devices is problematic. All parties involved in the testing do a "best engineering effort" to mitigate interference, but such engineering efforts cannot resolve this long-standing frequency interference issue.
- *Realistic intelligence data from Afghanistan:* Range personnel stated that a shortfall exists in test design due to the lack of sufficient interface and support from the intelligence community. The issue of insufficient access to intelligence personnel who can translate intelligence information to practical tests based on what is happening on the ground in Afghanistan needs to be resolved. Possible contributing factors include the lack of an interface and limited access to secure teleconferencing.
- *Vulnerability analysis:* A broadening of involvement with the test community is needed.
- *Personnel "burnout":* Center personnel have experienced burnout after 5 years of high-intensity activities

[5]Discussions between committee members and NACCITEC personnel during the committee's site visit to the Joint Experimentation Range Complex, Yuma Proving Ground, Arizona, on November 18, 2008.

D

Representative Projects of the Rapid Reaction Technology Office

The Department of Defense's (DOD's) Rapid Reaction Technology Office (RRTO) has initiated and supported many projects over its many-phased history (see the subsection entitled "Mission" in Chapter 2 for information on the five phases of the organization's history to date).[1] Areas of focus have varied but include the testing and fielding of capabilities for wide-area surveillance and tracking; standoff detection of explosives; special communications capabilities; counter-improvised explosive device (IED) applications; and counter-weapons of mass destruction (WMD) capabilities. The subset of projects discussed here is sufficiently representative to demonstrate the breadth and range of the organization's accomplishments and its influence on fielded and emerging military capabilities.[2]

AIRBORNE GLOBAL INFORMATION GRID

The Airborne Global Information Grid (AGIG) is an operational wireless, high-data-rate, Internet Protocol (IP)-based network for tactical edge users. AGIG modules can be installed on multiple classes of unmanned aircraft systems (UASs) from small (e.g., Manta sized) to midsize craft (e.g., Tiger Shark class). The AGIG system also includes a ground control station. The station can be connected with available infrastructure providing Non-Classified Internet

[1]Information provided to the committee indicates that the RRTO has been actively involved in more than 300 projects since its inception in September 2001.

[2]Project descriptions provided by the RRTO in personal communication with the committee on January 15, 2009.

Protocol Router Network (NIPRnet) connectivity. The system enables networked warfighters by providing access to data on the mobile tactical network. Access includes data from multiple sensor sources and command and control of the data sources, as well as situational awareness. The migration of the AGIG wideband capability to small, expendable UASs has provided increased intelligence, surveillance, and reconnaissance (ISR) capability across the network. AGIG has been transitioned to the Navy and is also a component within the ongoing Zephyr High Altitude Unmanned Aerial Vehicle Joint Capability Technology Demonstration.

ALTERNATIVE STRATEGIES

The Alternative Strategy Initiative has developed over the past 3 years into a school of thought (model) that can be used by the U.S. government and U.S. businesses engaged in what are regarded as a key multiplier in the war against terror and extremism: the social development of civil societies. Current successes build on previous alternative strategy sessions, including the following: the networking of women activists in Iraq and Afghanistan, where women participated as agents of conflict resolution and reconciliation; and a youth forum focusing on conflict resolution and deradicalization. In 2008 the RRTO sponsored a Creative Media Workshop for Fostering Tolerance in the Philippines and a Civil Counter Insurgency (COIN) Under Fire study to maximize the impact of civilian contributions to COIN in violent areas and to minimize security costs. Representatives from the DOD and Department of State have used the results of these alternative strategies. This research is empowering Southeast Asian moderates to use conventional and unconventional media platforms to espouse a more moderate ideology.

BIOMETRIC AUTOMATED TOOLSET

The Biometric Automated Toolset (BAT) is a mobile capability for collecting biometrics markers and screening personnel (see Figure D.1). When deployed to Iraq it was the first mobile system to be able to collect and share standard biometrics information on personnel of interest. The U.S. Army has deployed BAT systems extensively across Iraq and Afghanistan. The Biometric Identification System for Access (BISA) is a semimobile biometrics enrollment station that collects fingerprints, iris scans, and other biometric information on personnel seeking access to a controlled facility. BISA allows for rapid enrollment and queries of biometric databases to screen personnel. The system fuses commercial off-the-shelf biometric enrollment equipment into a module and packets the collected information in a format used to query national databases. Since the first unit was operationally deployed, BISA has been responsible for detecting numerous persons of interest. Additional units are in procurement through the Army's Biometrics Task Force.

FIGURE D.1 Biometric Automated Toolset (BAT). SOURCE: Courtesy of the Office of the Secretary of Defense.

The RRTO co-funded the initial development and early deployment of the BAT. The organization continues to work with the Army Biometrics Task Force and the National Ground Intelligence Center, with thousands of BAT systems deployed to both Iraq and Afghanistan.

BIOMETRIC INFORMATION TECHNOLOGY EVALUATION

Under RRTO sponsorship, the Institute for Defense Analyses created a baseline map of deployed biometric systems currently in operation in theater, including designed and alternative employment modes in the form of a process-oriented flow model. This project answered a critical need for an integrated information and analysis environment to support currently deployed biometric capabilities as well as to enable their future growth. The baseline developed by the Biometric Information Technology Evaluation (BITE) program has enabled more rapid assessment of the overall performance of biometric systems in theater, improved the integration of biometrics into the command structure, and facilitated the analysis of technological gaps and the prioritization of investments. BITE is being used by representatives from the Office of Defense Biometrics and the Biometrics Task Force.

BLUEGRASS

The Bluegrass project assembled multisensor data for the evaluation of persistent, wide-area surveillance concepts in a complex rural and urban background. This experiment provided a fundamental database for evaluating approaches for

detecting and unraveling data on nefarious activity hidden in realistic clutter. Bluegrass products have been distributed to more than 50 organizations (government laboratories, industry, academia, intelligence organizations, and others) to facilitate the development of various ISR capabilities.

COMMON OPERATIONAL RESEARCH ENVIRONMENT LABORATORY

Key objectives of the Common Operational Research Environment (CORE) program are to educate a generation of military officers with respect to the usefulness of irregular warfare methodologies, to leverage advanced information technologies to help users understand and analyze network-based adversaries in the irregular warfare environment, and to stay current with the leading innovations in related analytical technologies. The CORE laboratory is providing much-needed training to military officers who will operate in an irregular warfare environment. The training has been well received by students, and course enrollment has increased significantly.

COUNTER INSURGENCY PATTERN ASSESSMENT

The Counter Insurgency Pattern Assessment (CIPA; see Figure D.2) uses historical data and multiple (hundreds of) geospatial data layers to predict poten-

FIGURE D.2 Counter Insurgency Pattern Assessment (CIPA). SOURCE: Courtesy of the Rapid Reaction Technology Office, Director, Defense Research and Engineering.

tial areas of future activities of interest. CIPA inputs have provided numerous operational users with information vital to employing limited ISR platforms more effectively. The CIPA capability is embedded in various intelligence analysis tools and has been employed in operations in U.S. Central Command (CENTCOM), U.S. Northern Command (NORTHCOM), and U.S. Southern Command (SOUTHCOM).

DETECTION OF UNINTENDED RADIATION

Detection of Unintended Radiation (DURAD) is an electronic surveillance system for detecting and localizing activity of interest. Details of the system are classified. DURAD has been deployed to support SOUTHCOM and CENTCOM. Current efforts are focusing on further enhancing the system. The Defense Intelligence Agency (DIA) has been the proponent for additional development and follow-on deployments.

EXPLOSIVES PARTICULATE ANALYSIS

There have been significant advancements in fluorimetric detection technology through the development of a fluorescent detection "ink" that is able to detect trace amounts of conventional high explosives. This technology has been engineered into the simple-to-use, low-power, portable, and highly robust Explosives Particulate Analysis (XPAK) (see Figure D.3). Using the XPAK, explosives are indicated by the presence of dark spots on a bright blue background. The XPAK is currently forward-deployed in support of DIA and Army units.

FIGURE D.3 Explosives Particulate Analysis (XPAK). SOURCE: Courtesy of RedXDefense, Rockville, Md.

JADOO

Jadoo is a hydrogen fuel cell capability to power payloads aboard tactical unmanned aerial vehicles (UAVs). The fuel cell is reusable and provides cost savings over traditional batteries, and its handling does not require hazardous materials procedures. (There is a significant hazardous materials cost associated with the disposal of traditional batteries.) Navy UAVs with Jadoo power supplies are currently deployed in support of Special Operations Command (SOCOM) units.

JOINT CULTURAL UNDERSTANDING AND RELATIONSHIP EXPLOITATION

Joint Cultural Understanding and Relationship Exploitation (JCURE) was one of the initial DOD efforts to enhance military operations through an understanding of the cultural environment. The initial project focused on a province in Iraq and produced marked positive results. The JCURE results have precipitated significant follow-on investments in human, social, and cultural projects by the Services and the Joint Improvised Explosive Device Defeat Organization (JIEDDO).

JOINT INTELLIGENCE PREPARATION OF THE OPERATIONAL ENVIRONMENT

The Joint Intelligence Preparation of the Operational Environment (JIPOE) leverages the Gallup World Poll to identify the emergence of groups willing to use WMD in order to locate the seeds of hostility as they arise, and to do that on a worldwide basis, thereby affording the United States the opportunity to stop potential problems before they escalate. The Gallup World Poll presents a unique opportunity to mine consistent data gathered globally on a regular basis. Comprising survey (opinion) data, it is complementary to the observational data already being used by Joint Forces Command in producing an initial estimate of "hot spots" and provides insights into popular reactions to local and national environmental factors. JIPOE products have been presented to senior decision makers within the U.S. government.

LONG-ENDURANCE UNMANNED UNDERSEA VEHICLES

Unmanned undersea vehicle (UUV) systems are currently widespread throughout the military (see Figure D.4). However, real-world operations of many of these systems are yet to be realized, partly owing to limitations in the ability of many vehicles to conduct long-range, long-endurance operations with large payloads. The large UUV (LUUV) testbed has been designed to be flexible

FIGURE D.4 Long-endurance unmanned undersea vehicle (UUV). SOURCE: Courtesy of the Applied Research Laboratory at Pennsylvania State University.

and adaptable to allow missions that are significant to the warfighter to be easily demonstrated and refined and ultimately integrated into the available operational arsenal. The RRTO sponsored sensor enhancements and battery and power system improvements to LUUVs that will result in a 2009 operational deployment aboard a U.S. naval vessel.

MARITIME AUTOMATED SUPER TRACK ENHANCED REPORTING

Early recognition that "awareness and threat knowledge are critical for securing the maritime domain and the key to preventing adverse events"[3] led to funding MASTER—Maritime Automated Super Track Enhanced Reporting—as a key enabler for this important capability in protecting the country. MASTER is a network system that fuses data from multiple sources, automatically tracks global shipping of all sizes, associates tracks with cargo, and provides the analyst with alerts on unusual activities. The RRTO supported the initial development and testing of MASTER. After the feasibility of MASTER was shown, it became a Joint Capability Technology Demonstration (JCTD) in 2007 and continues to grow in use. Operational users in the testing and demonstrations include NORTHCOM, U.S. Pacific Fleet, Third Fleet, Office of Naval Intelligence, U.S. Coast Guard Intelligence, and the U.S. Coast Guard Maritime Intelligence Fusion Centers Atlantic and Pacific. Three funded transitions are now in place.

[3]See *The National Strategy for Maritime Security,* 2005, September, p. 16. Available at http://www.dhs.gov/xlibrary/assets/HSPD13_MaritimeSecurityStrategy.pdf. Accessed April 2, 2009.

MEASURING PROGRESS IN CONFLICT ENVIRONMENTS

Measuring Progress in Conflict Environments, the system called MPICE, was developed to provide a basic metrics analysis capability suitable for broad interagency use applicable to any stabilization and reconstruction environment of interest. The system was developed in part through case study application in Afghanistan and Sudan and is being employed in support of the U.S. Department of State's Haiti Stabilization Initiative, as well as in stabilization efforts in Kosovo and Nigeria. The system can be used both as an organizing guide for policy makers and planners and as a comprehensive means of analyzing progress across sectors over time. MPICE allows users to develop a visual story with flexibility to adapt to their particular needs. The MPICE process is being evaluated as the NATO standard to measure metrics in combat environments.

MULTIPLE UNMANNED AERIAL VEHICLES

The Multiple Unmanned Aerial Vehicles (UAVs) project developed a cooperative, multiple, autonomously operating UAV system that provides users with capabilities to continuously collect intelligence, conduct surveillance, and perform reconnaissance for mission planning and execution, protection of friendly forces, and exploitation of enemy weaknesses. The U.S. Air Force Academy completed a multiple-UAV experiment in which four UAVs successfully searched for, detected, and located a ground target cooperatively and autonomously. Using distributed onboard decision-making capabilities, it was the first experiment to be successfully accomplished with real-time onboard control, sensing, and communications systems. Spiral development of this project will bring the autonomous operating capability to unmanned surface vessels.

NATIONAL COUNTERTERRORISM/COUNTERINSURGENCY INTEGRATED TEST AND EVALUATION CENTER AND JOINT EXPERIMENTATION RANGE COMPLEX

The National Counterterrorism/Counterinsurgency Integrated Test and Evaluation Center (NACCITEC) and Joint Experimentation Range Complex (JERC) provide a test capability located within Yuma Proving Ground, Arizona. These facilities are discussed in detail in Appendix C, "Rapid Reaction Technology Office Test Planning, Conduct, Analysis, and Reporting," in this report. The capability was initiated under RRTO sponsorship to help prepare U.S. forces prior to deployment to operating areas with terrorist threats in the civilian infrastructure. Representatives from each Service, numerous government laboratories, and industry have tested at the JERC.

Construction of NACCITEC and JERC began in December 2003, with the first test of a counter-IED capability occurring in January 2004. The JERC grew to include a significant number of buildings, roads, and other infrastructure in

FIGURE D.5 The Joint Experimentation Range Complex (JERC) at Yuma Proving Ground, Arizona. SOURCE: Courtesy of the Rapid Reaction Technology Office, Director, Defense Research and Engineering.

simulated urban and suburban desert environments (see Figure D.5). The site has become highly valued for its ability to test systems in preparation for deployment to Iraq or Afghanistan, with systems being tested on an almost "24/7" basis. Although the RRTO began transitioning oversight of the JERC to the Army in 2006, the office still sponsors regular test periods to evaluate emerging technologies and still provides a significant portion of the JERC funding.

NATIONAL TACTICAL INTEGRATED PROCESSING SYSTEM

The National Tactical Integrated Processing System (NTIPS) was designed to provide multi-intelligence Web enhancements, plug-and-play applications,[4] and new data layers. These developments have been added to the existing infrastructure and used to support military operations within the existing Fusion Analysis Development Effort (FADE) concepts of operations. The FADE previously only supported the warfighter exclusively in the CENTCOM theater of operations. NTIPS/FADE now supports multiple combatant commands, while simultaneously improving support to CENTCOM. The project has improved real-time multiagency oversight and collaborative analytic participation.

[4] *Plug and play* refers to the automatic configuration and recognition of computer hardware devices without user intervention.

NOVA

Nova is an electronic IED pre-detonation capability. It has been deployed to Iraq and has been instrumental in saving coalition lives. Details of the system are classified. Nova has been incorporated into an Air Force program of record.

PASSIVE ATTACK WEAPON

The Passive Attack Weapon was a low-collateral-damage penetrator delivered and completed in less than 100 days for integration into the F-16 aircraft. This work resulted in the project team being named a Packard Award winner for exemplary innovation and defense acquisition best practices. Similar quick-response projects were accomplished in equipping the Marine Corps "Dragon Eye" Advanced Tactical Reece Unmanned Aerial Vehicle with a chemical-biological detector and video system, and with the "Thermobaric Hellfire" that improved the performance of the AGM-114N attack missile.

PERSISTENT THREAT DETECTION SYSTEM

The Persistent Threat Detection System (PTDS) is a persistent surveillance capability consisting of a tethered aerostat with an embedded camera, distributed queuing sensors, and a control module (see Figure D.6). When an event of interest is detected, the camera, in an integrated suite, is slewed to the target and tracks it until reaction forces arrive. Acoustic, infrared, and radar sensors queue an optical sensor aboard the aerostat. The camera can be automatically or manually slewed to the target while the control module communicates with reaction forces.

FIGURE D.6 Persistent Threat Detection System (PTDS). SOURCE: Courtesy of the Rapid Reaction Technology Office, Director, Defense Research and Engineering.

The PTDS was developed and exclusively funded by the RRTO and was deployed to Baghdad in 2004. It has since been taken over by JIEDDO, which has spent approximately $225 million procuring and deploying additional systems into Iraq and Afghanistan. The system has now become an Army system of record.

POLLEN IDENTIFICATION AND BACKTRACKING

An automated shape-comparison and shape-matching system for digital microscopy of pollen was developed. The effort established the world's first central repository for knowledge about pollen and accepts new digital microscopic images of pollen samples for forensic comparison and matching. Now warfighters in the field can quickly screen individuals to see if the pollen on their clothing or in the air filter of their vehicles matches the information derived from other means. Using this system, an unskilled operator can match pollen microscopy, obtaining a clear "yes-or-no" match, and, based on the information in the knowledge base, can offer details about where the pollen(s) might have originated.

SKOPE

SKOPE is a joint intelligence cell with the National Geospatial-Intelligence Agency (NGA), SOCOM, and the U.S. Strategic Command (STRATCOM). It began with a specific request for sensors to help narrow the search space for terrorists and terror groups. The RRTO recommended the development of the SKOPE approach and was the sole funding source for the initial operating capability of the analytic cell. Currently the RRTO is developing new tools in response to specific requests from commanders based on the success and experience with this operational capability.

The SKOPE cell applies all-source, multi-intelligence analysis linked to a spot on Earth. Through its application of human terrain analysis,[5] SKOPE incorporates aspects of the Human Terrain System (HTS), a new proof-of-concept program run by the U.S. Army Training and Doctrine Command and serving the joint community. The near-term focus of the HTS program is to improve the ability of the military to understand the highly complex, local sociocultural environment in areas of deployment. In the long term however, it is hoped that HTS will assist

[5]According to the National Geospatial-Intelligence Agency briefing at the U.S. Geospatial Intelligence Foundation GEOINT 2008 Symposium, October 27-28, 2008, Nashville, Tenn., *human terrain analysis* is a multi-intelligence, multidisciplinary scientific approach to describing and predicting spatial and temporal patterns of human behavior by analyzing the attributes, actions, reactions, and interactions of groups or individuals in the context of their environment.

FIGURE D.7 Stiletto. SOURCE: Courtesy of U.S. Navy.

the U.S. government in understanding foreign countries and regions prior to an engagement within a region. According to the Army Web site, the HTS program represents the first time that social science research and advising have been done systematically, on a large scale, and at the brigade level.[6]

SONOMA (RENAMED CONSTANT HAWK)

The Constant Hawk (originally named Sonoma) aerial surveillance capability can record activities within a given area of interest so that users can detect the activities and derive tracking information about personnel or vehicles through postflight analysis. This capability to counter IEDs is a project that was achieved through partnerships. The RRTO helped the effort progress through a number of iterations in both the design of sensors and the analysis and processing of new and complex information. These efforts transitioned to the Army and JIEDDO and are migrating into significant acquisitions and other spin-off capabilities.

STILETTO

Stiletto is an experimental, high-speed vessel designed to transport operational forces to their missions quickly (see Figure D.7). It has a top speed of more

[6]Additional information is available at http://humanterrainsystem.army.mil/. Accessed April 15, 2009.

than 50 knots. The RRTO's Emerging Capabilities Division has sponsored operational experimentation to explore the military usefulness of concept-technology pairing and other unique capabilities of Stiletto's hull form, speed, wake, draft, configurability, and payload fraction; its command, control, communications, computers, and intelligence (C4I) connectivity; and other characteristics. By offering industry the opportunity to plug hardware and software into its "digital hull," Stiletto has supported and accelerated the development of the tools, technologies, and concepts that will enable other communities to realize better C4I connectivity, proximate command and control, better situational awareness, more robust networking, and the employment of unmanned vehicles. In June 2008, Stiletto was deployed to SOUTHCOM to aid in a demonstration of counter-narcotics efforts. During the 2008 deployment, Stiletto was operationally controlled by the DOD and embarked personnel from the Department of Homeland Security and the Columbian Navy.

SUDAN

The Sudan Strategic Assessment (SSA) Strategic Multilayer Assessment effort focused on how to understand a complex "state" that lacks true borders, that experiences many competing internal and external interests at work, and for which there are comparatively few "vetted" data and analytical products. A unique and critical aspect of the project was that of bringing together two types of social scientists (i.e., quantitative or computational types, or modelers, and qualitative types, or subject-matter experts in regional and/or area studies) with analysts and operational planners in a single venue to maximize the strengths of each group and to mitigate the weaknesses of the individual groups working alone. The key deliverable from the SSA effort was the development of an evidence-based, empirically driven framework for reducing bias and for increasing the understanding of the dynamics of a complex environment and the potential impact of a group of people on that environment through their actions. The actions in this case span the spectrum of the instruments of national power, with particular emphasis on diplomatic, information, and economic aspects and less emphasis on military aspects.

TACTICAL INFRARED NETWORKED AWARENESS

Tactical Infrared Networked Awareness (TINA) provides a tactical overlay and high-data-rate information exchange over tactically significant distances. Data are exchanged by means of laser communications that are difficult to intercept and not susceptible to normal radio-frequency interference. TINA was developed as a product of two separate RRTO-sponsored projects: one to develop high-data-rate communications by means of a laser link and the other to provide easy-to-read tactical information on videoscreens. Details of the program are

classified. TINA is currently deployed in support of SOCOM units. Spiral development in 2009 will bring the TINA capability to U.S. Navy surface vessels and submarines.

TACTICAL SATELLITES

The Tactical Satellites (TacSats) effort has stimulated an entirely new class of satellites that can be built quickly at low cost. This work was initiated by the Office of Force Transformation, and then the RRTO took over its management. The RRTO brought in more government and industry participants and helped establish the Operationally Responsive Space Office, which is now to carry on the TacSats efforts. The RRTO not only funded a number of the satellites and payloads but also supported developing a "Tasking, Collecting, Processing, Exploitation, and Dissemination" set of tools and developed the Virtual Mission Operations Center (VMOC).

Space systems have become an important part of military operations. Most satellites have been developed to support carefully vetted requirements and have taken significant amounts of time and funding. The TacSat concept was developed with the goal of having rapid response times, with tailored payloads and specific tactical theater support. The TacSats initiative became part of the RRTO in 2006. The RRTO supported a range of initiatives such as the following: (1) expanding the payloads, for example, by adding the ship-tracking Automatic Identification System that supports the MASTER worldwide ship-tracking program (discussed above); (2) developing a low-cost VMOC, as well as leveraging the Secret Internet Protocol Router Network (SIPRnet) for rapid tasking and data dissemination; and (3) helping to establish the Operationally Responsive Space Office and transitioning TacSats to a long-term organization. To date, four TacSats have been built, all with reasonable costs and schedules. TacSat-2, launched in December 2006, collected a range of data in 2007. TacSat-3 was launched in May 2009, and TacSat-4, shown in Figure D.8, is scheduled to launch in September 2009.

WOLF PACK

Wolf Pack improves the tactical effectiveness of small combat units by finding, coordinating, integrating, and experimenting with emerging but relatively mature concepts and technologies. These concepts and technologies must be sustainable and deployable and have strong potential to quickly help correct current Army/Marine/coalition capability gaps to support small-unit operations across a spectrum of environments and mission profiles, such as in Iraq and Afghanistan. A variety of mounted and dismounted technologies, including camera systems; a laser range-finder and target designator; a portable, multimodal biometric tool kit; and handheld ruggedized personal digital assistants are connected through a digital backbone. Portions of the Wolf Pack projects have spiraled to operational users.

FIGURE D.8 Tactical Satellite-4. SOURCE: Courtesy of the Naval Research Laboratory, Department of the Navy.

E

Disruptive Threats and Department of Defense Acquisition

Other parts of this report show that the Rapid Reaction Technology Office (RRTO) in the Department of Defense (DOD) has been successful in identifying, evaluating, and promoting technologies to defeat terrorist weapons. That success, compared to the severe challenges facing the DOD elsewhere in the acquisition process, raises the important questions of why this effort has worked so well and whether the DOD might put the lessons learned from that success to work elsewhere. One of the main reasons to put these lessons to work elsewhere is that terrorism poses a *disruptive* threat to the DOD, in a sense made precise below. A substantial body of work on disruptive innovation and its effects on organizations has produced evidence of the danger that such innovation poses, a conceptual structure for understanding why that danger exists, and insight into how an organization can effectively respond—as well as examples of catastrophic failure when an effective response is lacking. This work applies to the DOD, and as is shown here, the formation of units such as the RRTO is one of the key models prescribed for successful responses to disruption.[1]

The work referred to above had its roots in the work of Clayton M. Christensen,[2] a doctoral student at the Harvard Business School (HBS) at the beginning of the 1990s. HBS was sufficiently impressed by that work that it appointed Christensen, a former Rhodes scholar and White House Fellow, to the faculty

[1]Readers of this appendix should be aware that the DOD does not have the freedom or opportunity to dismiss significant "nondisruptive threats" while focusing on the newer disruptive threats, as some organizations in the corporate world might be able to do (i.e., the DOD must still be prepared to deter and combat conventional "nondisruptive" threats).

[2]See http://www.claytonchristensen.com/bio.html. Accessed April 2, 2009.

of HBS on completion of his doctor of business administration degree. He has been a faculty member at HBS since then, and together with his students he has documented this understanding of disruptive innovation in several books.[3,4,5,6,7] *Business Week* recently named the 2008 volume *Disrupting Class* by Christensen and colleagues one of the 10 best innovation and design books of the year.[8]

What distinguishes Christensen's work from previous studies of innovation is his identification of *disruptive* as opposed to *sustaining* innovation. Very roughly put, a *disruptive technology* is the entry into the market of a product or service that is usually *less* effective on prevailing measures of performance than is the current product, but at the same time the disruptive technology is *more* desirable on one or more of several other dimensions: "cheaper, simpler, smaller, and, frequently, more convenient to use."[9] A *sustaining technology,* however, improves on the prevailing model's performance. These categories are independent of the classification of a new technology as incremental or radical: a disruptive or a sustaining technology may be either incremental or radical.

The fundamental new insight that Christensen brought to the subject of technological innovation is the realization that established organizations can generally accept and use sustaining innovations but that they are defenseless against disruptive innovation. His initial work documented this assertion in a series of studies of competitive behavior in such different segments of business as computer disk drives, mechanical excavators, steel production, and retailing. Subsequent studies have extended the scope of that work to nonprofit and public-sector organizations.

Why can an organization not defend itself against disruptive innovation? Christensen has shown that the reason lies in the organization's *value network,* the context within which the organization uses well-understood measures of performance to make decisions about what is desirable and what is not. Factors affecting those decisions typically include profitability criteria for project selection, the need to retain existing customers, and the kinds of personal career attributes that lead to promotion within the organization. A disruptive innovation, being less

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[3]Clayton M. Christensen. 1997. *The Innovator's Dilemma,* Harvard Business School Press, Boston; HarperBusiness edition published by HarperCollins Books, New York, 2000.

[4]Clayton M. Christensen and Michael E. Raynor. 2004. *The Innovator's Solution,* Harvard Business School Press, Boston.

[5]Clayton M. Christensen, Scott D. Anthony, and Erik A. Roth. 2004. *Seeing What's Next,* Harvard Business School Press, Boston.

[6]Clayton M. Christensen, Curtis W. Johnson, and Michael B. Horn. 2008. *Disrupting Class,* McGraw-Hill, New York.

[7]Clayton M. Christensen, Jerome H. Grossman, and Jason Hwang. 2008. *The Innovator's Prescription,* McGraw-Hill, New York.

[8]See http://images.businessweek.com/ss/08/12/1215_best_design_books/4.htm. Accessed April 2, 2009.

[9]Clayton M. Christensen. 1997. *The Innovator's Dilemma,* Harvard Business School Press, Boston, p. xv; HarperBusiness edition published by HarperCollins Books, New York, 2000, p. xviii.

effective in terms of prevailing performance measures, will not appeal to existing customers and will not meet the profitability criteria that a firm requires to be met in order to stay in its existing mode of business. People in the firm will not enhance their reputations by backing unprofitable projects that promise reduced performance. Thus, the organization will reject the disruptive innovation because its management processes will not let it do anything else.

The fatal flaw in this decision process is that the business environment is not static. New competitors, without the preconceptions built in to the old value network, can make the disruptive innovation attractive to new customers previously priced out of the market. They can sell at lower profit margins, and by so doing they can build a business that eventually improves the disruptive innovation to the point that it becomes attractive to the existing (high-end) customers. The firm that could not adapt is then driven out of business. For example, in the late 1970s new firms developed 8-inch disk drives that represented a disruptive innovation to the prevailing 14-inch disk drive technology. Of the original equipment manufacturers successfully making 14-inch drives, two-thirds never introduced an 8-inch model, and the other third introduced 8-inch drives too late. Not one maker of 14-inch drives survived.[10] Many more examples are presented in the other studies mentioned above.

The DOD is a creature of the Cold War, formed in 1947. Its entire history up to the beginning of the 1990s fostered the creation of decision methods, performance criteria, and contractor relationships adapted to that war: that is, a value network. Some of the attributes of that network were slow changes in required technology, long development cycles, and dominance of the acquisition process by existing programs of record.

It is since the end of the Cold War that the acquisition challenges have become intense, especially since the beginning of extensive antiterrorist operations after 2001. Now the DOD is confronted with an enemy that employs cheap, simple improvised explosive devices (IEDs) that have very low effectiveness on some performance dimensions (e.g., they are frequently unreliable and not always difficult to discover; some of them also kill the operator). Yet these devices are very effective at killing and wounding the U.S. military, and their performance is perfectly acceptable to terrorists. To complicate matters, the terrorists do not rely on static technology but rather push its evolution as quickly as they can.

The IED is a disruptive innovation, and though probably the most prominent example of such innovations that the DOD currently faces, it is not the only one. There are many more disruptive innovations in tactics and operational methods, as Secretary of Defense Robert M. Gates recognized when he said:

[10]Clayton M. Christensen. 1997. *The Innovator's Dilemma,* Harvard Business School Press, Boston, p. 15; HarperBusiness edition published by HarperCollins Books, New York, 2000, p. 19.

> Other nations may be unwilling to challenge the United States fighter to fighter, ship to ship, tank to tank. But they are developing the disruptive means to blunt the impact of American power, narrow the United States' military options, and deny the U.S. military freedom of movement and action.[11]

A difference from the industrial situation is that the challenge to the DOD is not how to make better IEDs but how to develop technologies and tactics to defeat them. However, in the development of those technologies and tactics, the DOD encounters the same problem of the value network that the disk drive makers encountered. Developing simple, cheap methods to defeat IEDs does not pay off in the current acquisition value network: it is unlikely to lead to high-profile programs of record that will build reputations and get people promoted; there is not time enough to design a near-perfect product; and the relatively simple, low-margin products that are best suited to quick deployment are unlikely to be very attractive to the major defense contractors that play important roles in the acquisition world.

This is certainly not the first suggestion that the DOD is endangered by disruptive innovation developed by the nation's enemies. For previous examples, see the proposals by Sandra Irwin[12] and by Mark Johnson and Charles McLaughlin,[13] both of which are based on Christensen's work (Johnson is the chair of Innosight, LLC, which he co-founded with Christensen). Irwin's article mentions the Army's Rapid Equipping Force, another example of an organization within the DOD with enough autonomy to do unconventional things.

The research on disruptive innovation shows that an organizational response based on standing up new subunits—which can generate their own business models suited to the new challenges—is much more effective than trying to force the existing organization to change its ways of doing things. Over the course of time those new subunits that succeed will attract more resources and their influence within the parent organization will grow, so that the business model of the parent organization will evolve to reduce or eliminate the danger posed by the disruptive innovation. Christensen provides examples of why this is so: a particularly stark example contrasts the actions of Digital Equipment Corporation (DEC) and IBM in confronting the disruptive innovation of the personal computer (PC). DEC tried *four times* to enter the PC market, and each venture failed to meet the standards of profitability of the parent company: people in DEC perceived PCs

[11]Robert M. Gates. 2009. "A Balanced Strategy: Reprogramming the Pentagon for a New Age," *Foreign Affairs* 88(1):1.

[12]Sandra I. Irwin. 2006. "Defense Stifles Innovation Despite Urgent War Needs," *National Defense,* July.

[13]Mark Johnson and Charles McLaughlin. 2007. "To Defeat Terrorists, Military Services Must Innovate, Disrupt," *National Defense,* January.

as "low-margin products that their customers did not want."[14] By contrast, IBM created a freestanding organization that could and did develop its own business model and that was not constrained by the value network of the parent company. It succeeded, while DEC went out of existence.

The DOD has recently found by hard experience that this principle holds for government just as it does in industry, as Secretary Gates acknowledged when he asked:

> Why was it necessary to go outside the normal bureaucratic process to develop technologies to counter improvised explosive devices, to build MRAPs [Mine Resistant Ambush Protected], and to quickly expand the United States' ISR [intelligence, surveillance, and reconnaissance] capability? In short, why was it necessary to bypass existing institutions and procedures to get the capabilities needed to protect U.S. troops and fight ongoing wars?
>
> The Department of Defense's conventional modernization programs seek a 99 percent solution over a period of years. Stability and counterinsurgency missions require 75 percent solutions over a period of months. The challenge is whether these two different paradigms can be made to coexist in the U.S. military's mindset and bureaucracy.[15]

The DOD had to go outside the normal bureaucratic process for the same reason that, as seen above, it was necessary for IBM to do so when it developed the PC. And, as also seen, the study of disruptive innovation has shown clearly that the two paradigms *do not* coexist well: an organizational response to disruption has far more chance of success if it is managed by a freestanding subunit unconstrained by the existing value network.

[14]Clayton M. Christensen. 1997. *The Innovator's Dilemma,* Harvard Business School Press, Boston, pp. 109-110; HarperBusiness edition published by HarperCollins Books, New York, 2000, pp. 126-127.

[15]Robert M. Gates. 2009. "A Balanced Strategy: Reprogramming the Pentagon for a New Age." *Foreign Affairs* 88(1):1.