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Proposed Missions and Organization of the U.S. Army Research, Development and Engineering Command

Bruce J. Held, Amado Cordova, Elliot I. Axelband,
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Prepared for the United States Army

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PREFACE

In the fall of 2002, the U.S. Army began an effort to reorganize its research and development effort. A loose organization of various laboratories and research centers was consolidated into the Research, Development and Engineering Command (RDECOM), with the intention that the improved coordination and communication possible under one new command would enhance proper resource management, innovation, and forward thinking.

RAND Corporation researchers have been supporting the Army's recent R&D reorganization efforts since they began in the fall of 2002. This documented briefing details the findings of a study aimed at providing guidance on how to organize RDECOM to make the most effective use of the deputy commanding generals that will be assigned to it. A previously unpublished RAND study that focused on one part of RDECOM is included as an appendix to this documented briefing. It is entitled *System of Systems Integration Directorate (SOSI) Mission and Organization*, by Bruce Held, Elliot Axelband, and Jeff Drezner.

The research findings in this report should be of interest to Department of Defense (DoD) organizations involved with science and technology, as well as to other government and private institutions dedicated to research and development.

The research was sponsored by Major General John C. Doesburg, Commanding General of RDECOM. It was conducted and documented within RAND Arroyo Center's Force Development and Technology Program during fiscal year 2004. At the conclusion of that year, Army Materiel Command and the Assistant Secretary of the Army (Acquisition, Logistics, and Technology) announced plans to reorganize the Army's acquisition and materiel support structure in a way that could affect the conclusions of this study. Since the details of those plans were not fully available at the time we documented our research, their impact on our recommendations, if any, are not included here. We recommend that this report be considered along with any plans the Army has concerning the organization of its acquisition and materiel support structure.

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SUMMARY

The Army Research, Development and Engineering Command (RDECOM) was formally established in March 2004 as a component command of the U.S. Army Materiel Command (AMC).¹ It gathers under its authority the existing Army Research Laboratory (ARL), Army Materiel Systems Analysis Activity (AMSAA), a portion of the Simulation, Training and Instrumentation Command (STRICOM), and some AMC staff, as well as the Research, Development and Engineering Centers (RDECs), collectively referred to in this report as the AMC labs. These organizations comprise most of the Army's organic research and development (R&D) capability, excluding the R&D efforts of the Army medical community, those of the Corps of Engineers, the Space and Missile Defense Command, and the Army Research Institute.

Prior to the establishment of RDECOM, AMC's various laboratories and research centers belonged to a number of the AMC's major subordinate commands or were separate organizations that reported to other Army commands. AMC expects that concentrating its technology staff and organizations under one command—i.e., creating a technical and engineering “center of mass”—should make it easier to coordinate and integrate Army research, development and engineering (RD&E), which should in turn enhance innovation, flexibility, and responsiveness.

Since the Army's recent R&D reorganizing efforts began in the fall of 2002, RAND Arroyo Center has provided support, with analysis focused on the best ways to structure R&D organizations. This briefing continues that support.

The Arroyo study discussed in this report was initiated at the request of the RDECOM commander in the fall of 2003. At that time, four general officer slots were authorized for RDECOM: a major general commander and three brigadier general deputy commanding generals (DCGs). The study problem initially

¹ John C. Doesburg, Memorandum for All RDECOM Employees, Subject: Formal Establishment of the Research, Development and Engineering Command, March 1, 2004, <http://www.rdecom.army.mil/letter.pdf> (as of April 16, 2004). RDECOM had been operating as a provisional organization since October 9, 2003. Karen Jolley Drewen, RDECOM Magazine, “Transformation Ceremony Marks New Beginning for RDECOM,” November 2003, <http://www.rdecom.army.mil/rdemagazine/200311/> (as of April 16, 2003).

posed to the Arroyo team was to recommend how best to utilize the three DCGs. However, during the research, the number of DCG slots authorized for RDECOM changed from the initial three to two. The RDECOM commander later asked Arroyo to also provide recommendations for a scenario where there are only two DCGs. Thus, this report presents recommendations to accommodate both three and two DCGs.

RAND ARROYO CENTER APPROACH

Since DCGs will have management responsibilities for some parts of RDECOM, we first needed to determine how RDECOM should be organized to establish what the “parts” should be. We began by looking at the broad RDECOM mission statement and then described four “sub” or component missions that support the main mission. Next, we postulated several organizational designs that would allow RDECOM to fulfill the four component missions. We developed the most promising and identified the lower tiers of the organization.

To achieve these results, the researchers called on their combined expertise, developed from previous Arroyo studies and many years of work on R&D and organizational issues in the Army and the private sector. The team interviewed a variety of experts and staff from the Army and other organizations,² and brainstormed ideas internally and with Army personnel. The team also used the RAND-developed “strategy-to-tasks” framework.³ This framework was originally designed for making resource and task planning decisions, but it was modified to make the organizational decisions required by this study. The modified framework provides a methodical way of thinking about the problem and begins at the top, in a common sense way, by asking: What is it that RDECOM should do? What is its mission? This kind of high-level strategic view is critical for determining how RDECOM should be organized and managed.

² Interviews were conducted with the senior leadership of RDECOM, members of some of its component organizations, and of some of the external organizations with which RDECOM interfaces.

³ Glenn A. Kent, *A Framework for Defense Planning*, Santa Monica, CA: RAND Corporation, R-3721-AF/OSD, 1989.

RDECOM MISSIONS

We worked with what we already knew about the Army and the goals of the new RDECOM to identify four major roles, or component missions, for RDECOM. We also considered RDECOM's stated mission: "To get the right integrated technologies into the hands of warfighters quicker." The four component missions are as follows.

1. RDECOM must provide technical support to all current Army and joint forces operations. This means helping to meet the needs of all commands that are out in the field now, whether they are training, warfighting, or peacekeeping.
2. RDECOM must provide support in the near and middle term to the Army acquisition community (the Army Program/Project/Product Managers [PMs] and others who are responsible for actually acquiring materiel) in matters of science and technology development, engineering, and systems integration. This support includes conducting leading-edge R&D work within the Army and in conjunction with contractors, and acting as consultants to make the Army "a smart buyer" as it chooses what to buy and negotiates contracts with Army suppliers and outside contractors.
3. RDECOM must be part of the process that creates the Army's vision of the future. It will work with Army military scientists and doctrine planners (in U.S. Army Training and Doctrine Command and other organizations) by providing a technical vision that both supports future warfighting requirements and creates opportunities for developing new ideas about how the United States can fight its wars.
4. RDECOM must attend to the planning, management, and oversight of all Army-funded research programs (other than those managed by the Army Corps of Engineers, the Army medical community, the Space, Missile and Defense Command, and the Army Research Institute).

USING A MATRIX ORGANIZATION TO ACHIEVE RDECOM'S MISSIONS

RAND Arroyo Center proposes a matrix organizational structure for RDECOM as the archetype that will best enable it to accomplish its mission. A matrix is one type of structure for arranging teams or groups of people representing various functions of a company or other organization. In a matrix organization,

divisional groups are made up of multi-disciplinary teams and task forces integrated from across many functional groups. Task force and project managers span the boundaries across departments and operate as integrators; they understand the problems of various groups and foster solutions that are mutually acceptable.

The matrix structure was first developed in the aerospace industry. It has been successfully employed in many industries and by many companies, including Pittsburgh Steel, IBM, Unilever, and Ford. Each of these organizations fine-tuned the matrix to suit its particular goals and cultures, as we have done in adapting the generic matrix concept to the missions of RDECOM.

The alternatives to a matrix structure include the traditional functional and divisional organization structures. In the functional organizational structure, departments are created around specific functions, such as marketing, sales, R&D, engineering, and manufacturing. In the divisional organizational structure, departments are created around the organization's intended outcomes, such as products, services, or programs.⁴ High internal efficiency and technical quality are characteristic functional strengths, whereas flexibility, speedy decisionmaking, and high adaptability to environmental changes are qualities of a divisional organization.

A matrix organization that harnesses the advantages of the functional and divisional organization structures can address complex technical issues (via matrix support groups) at the same time that it focuses on the unique requirements of its customers (via mission- or project-dedicated groups). Furthermore, a matrix is an excellent example of an organization with a strong component of lateral decisionmaking and "top-down/bottom-up" information flow (where communication flows from management down through the ranks and from lower-level staff up to management). Such structures enable an organization to become adaptable to continuous changes in its environment.⁵ A matrix organization also:

⁴ Richard Daft, *Organization Theory and Design*, 7th edition, Cincinnati, OH: South-Western College Publishing, 2001, pp. 214–220.

⁵ Jay R. Galbraith, *Designing Organizations: An Executive Briefing on Strategy, Structure and Process*, San Francisco, CA: Jossey-Bass Publishers, 1995, pp. 41–47.

- Leads to a more balanced top-down/bottom-up R&D planning and budgeting process and, as a result, a more strategic view of research, development and engineering (RD&E) for the current and future Army.
- Allows better leveraging and more efficient use of RDECOM resources, such as flexibility of staff deployment in accordance with current needs.
- Allows adaptability and coordination when nonroutine technologies have to be mastered both within and across functions to respond to rapidly changing Army needs, Department of Defense (DoD) policies, and technology trends.
- Promotes the exchange of ideas and networking across RDECOM.
- Breaks up stovepipes—i.e., groups that are organized around narrow, highly specialized functions—and fosters collaboration among diverse functional groups to encourage network-centric and system of systems expertise and approaches.

A matrix organization has a few disadvantages as well. They include potential employee confusion in working for several “bosses” (because they report to one or more project managers *and* the manager of their functional group). Also there is some expense to train the workforce—in particular middle management—in teamwork techniques.⁶ However, we strongly believe that the advantages largely outweigh the disadvantages.

Four Possible Matrix Organizations

We propose four alternative matrix organizational structures: two with three DCGs and two with two DCGs.

Model 1

The first proposed matrix organization has three DCGs.

DCG Operations manages the Army’s technical requirements for current operations and fielded materials, i.e., component mission 1. Under the DCG Operations are the:

⁶ Daft, pp. 228–229, and Stanley M. Davis and Paul R. Lawrence, *Matrix*, Reading, MA: Addison-Wesley Publishing Company, 1977, chapter 6.

- Agile Development Center (ADC). ADC will bear primary responsibility for managing quick-response projects to address immediate warfighter needs.
- Office for Field Assistance in Science and Technology (FAST). The FAST will provide technical personnel to work with Army and joint commands to provide the commanders of those units with technical advice and a gateway to the Army's science and technology (S&T) community.

DCG System of Systems primarily manages RDECOM's mission of supporting materiel acquisition programs that will impact the Army in the near to middle term, i.e., component mission 2. Under the DCG System of Systems are the:

- System and System of Systems Process Institute, which is the Army's repository of best practices and tools for training and certifying systems and system of systems professionals.
- Joint Technology Integration Office.
- Modeling and Simulation and Software Office.

DCG Army of the Future focuses on those mission areas that deal with longer-term materiel and system goals, i.e., component missions 3 and 4. This DCG will be responsible for the:

- Technology Mining Center (TMC).
- Science and Technology Planning, Budgeting, and Oversight (S&T PBO).

Matrix support organizations, namely, the Army Materiel Systems Analysis Activity (AMSAA), the Small Business Innovation Research (SBIR) office, the Army Research Laboratory (ARL), the Army Research Office (ARO), and the six new Research, Development and Engineering Centers (RDECs), will be directly overseen by the commanding general.

Model 2

The second option with three DCGs is identical to the first except for the addition of a Deputy for Engineering and Technology to oversee the functional organizations that are directly under the commanding general in model 1. This will relieve the RDECOM commander of the day-to-day management responsibilities of these functional organizations to better focus on strategic concerns.

Models 3 and 4

The third and fourth options assume the presence of only two DCG positions. We take the view that while having three DCGs would be best, RDECOM could function effectively with only two DCGs. We would merge Operations and System of Systems and assign oversight of both areas and the organizations under each to one DCG, “DCG Systems and Operations.” This arrangement creates an area with substantial responsibility, but the advantage is that it collects those missions that require support and collaboration with program, project, or product managers under one DCG. Funding management is also less complicated because most activities under Systems and Operations are customer funded,⁷ while the Army of the Future’s funding comes primarily from the RDECOM core budget.

What distinguishes between models 3 and 4 is the presence of a Deputy for Engineering and Technology in one but not the other. Just as in model 2, the Deputy for Engineering and Technology will be responsible for the day-to-day management of the matrix support organizations within RDECOM, namely, AMSAA, SBIR, ARL, ARO, and the RDECs, to provide some relief to the RDECOM commanding general.

DCGs Would Promote RDECOM Component Missions

In each of the four proposed matrix organizations, we outline what role each DCG would play in fulfilling the four component RDECOM missions. This outline ensures the most effective use of DCGs, highlights where overlaps occur, and clarifies the relationships among DCGs when overlaps occur; i.e., it specifies who has lead authority and who assumes support responsibilities. For example, for the first two proposed matrix organizations involving three DCGs (models 1 and 2), we allocated missions as indicated in Table 1.

⁷ Customers are typically Army acquisition program managers, though other customers, such as other, non-Army service laboratories and program managers, often request and pay for RDECOM support.

Table 1
Mission Allocation

RDECOM Missions	DCG Operations	DCG System of Systems	DCG Army of the Future
1. Provide technical support to current operations	Primary responsibility	Secondary responsibility	Tertiary responsibility
2. Provide technical support to Army acquisition programs	Primary responsibility (Post-FUE)* Tertiary responsibility (Pre-FUE)	Primary responsibility (Pre-FUE) Tertiary responsibility (Post-FUE)	Secondary responsibility
3. Provide technical vision for the future	Tertiary responsibility	Secondary responsibility	Primary responsibility
4. Attend to the planning and management of future Army research	Tertiary responsibility	Secondary responsibility	Primary responsibility

* After newly developed systems achieve First Unit Equipped (FUE) status, i.e., they have been fielded for the first time with at least one unit.

Impacts of a Matrix-Type Organization

Building a matrix organization for RDECOM will have many important consequences, including the following.

- A top-level consolidation of planning, budgeting, and oversight under the DCGs.
- Improved support for Army acquisition programs by having clear lead authorities assigned to work with program/project/product managers.
- Distribution of the current system of systems integration staff among the DCGs.
- An integrated system and system of systems focus for all program phases.
- Releasing the commanding general from the day-to-day management of the matrix support organizations within RDECOM (in models 2 and 4).

- Focused reporting structure with each DCG responsible for a specific subset of RDECOM missions.
- Adding staff for the DCGs. These personnel would primarily come from RDECOM's laboratories and centers. Adding the DCGs to RDECOM and making them responsible to the RDECOM commander for managing and coordinating the organization's primary missions means that much of this load is removed from the laboratories and centers. As a result, many of the personnel who currently work for the laboratories and centers as marketing specialists, planners, and coordinators should be available to the DCGs.

RECOMMENDATIONS

RDECOM must add value to the Army's R&D efforts for it to succeed. It will do so if it strengthens the Army R&D community's system of systems orientation and the Army's ability to adapt quickly to changes in technology and to warfighting and soldier requirements. We believe that the matrix-type structure we propose would enable RDECOM to provide the research, development and engineering integration, flexibility, and responsiveness critical to our engaged and transforming Army.

A number of strategies should be effective not only for implementation of the matrix model, but to give it every chance to succeed in the long term. In general, these strategies fall into four broad categories: communication; rewarding desired behaviors; establishing metrics to measure success; and allocating adequate resources. Specifically, the Army should consider the following.

- Actively interface with the Army, DoD, other federal agencies, academic and industry organizations, and individuals to influence R&D policy, highlight RDECOM capabilities and successes, and identify and contribute innovative ideas for using technology to address Army needs, among others.
- Make RDECOM an adaptive organization that can stay relevant in a rapidly changing technical world by nurturing the matrix organizational model, providing opportunities for staff to challenge conventional thinking, and creating an institutional culture that rewards improvement and innovation.
- Search for and implement measures to monitor and promote improvement.
- Recruit and maintain a dynamic and highly qualified workforce.

- Plan and invest in Army RD&E infrastructure, and workforce education and training.

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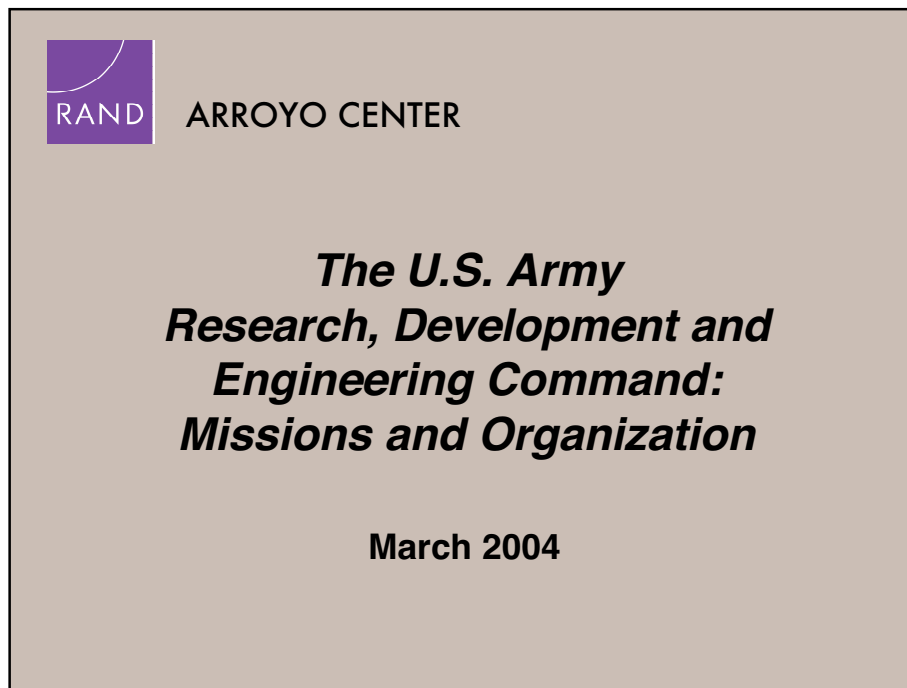
The authors would also like to thank Ms. Renata Price, currently of Booz Allen Hamilton and formerly the Deputy Chief of Staff for Research and Development at the Army Materiel Command, as well as Dr. John (Jed) Peters of RAND. These two individuals provided thoughtful reviews of this report. Their comments enabled the authors to significantly improve the final version.

GLOSSARY

ACTD	Advanced Concept Technology Demonstration
ADC	Agile Development Center
AMC	Army Materiel Command
AMSAA	Army Materiel Systems Analysis Activity
ARDEC	Armaments Research, Development and Engineering Center
ARL	Army Research Laboratory
ARO	Army Research Office
ASA(ALT)	Assistant Secretary of the Army (Acquisitions, Logistics and Technology)
ASTMP	Army Science and Technology Master Plan
ASTWG	Army Science and Technology Working Group
ATD	Advanced Technology Demonstration
AVCI	Army Venture Capital Initiative
CERDEC	Communications/Electronics Research, Development and Engineering Center
DCG	Deputy Commanding General
DoD	Department of Defense
E&T	Engineering and Technology
ECBC	Edgewood Chemical Biological Center
FAST	Office for Field Assistance in Science and Technology
FCS	Future Combat Systems
FUE	First Unit Equipped
IPT	Integrated Product/Process Team
IT	Information Technology
MSC	Major Subordinate Command

NASA	National Aeronautics and Space Administration
NSC	Natick Soldier Center
PEO	Program Executive Officer
PM	Program/Project/Product Manager
R&D	Research and Development
RD&E	Research, Development and Engineering
RDEC	Research, Development and Engineering Center
RDECOM	Research, Development and Engineering Command
S&T	Science and Technology
S&T PBO	Science and Technology Planning, Budgeting, and Oversight
SA&E	System Architecture and Engineering
SBIR	Small Business Innovation Research
SDD	Systems Development and Demonstration
SoS	System of Systems
SoSI	System of Systems Integration
STO	Science and Technology Objectives
STRICOM	Simulation, Training and Instrumentation Command
TARDEC	Tank-Automotive Research, Development and Engineering Center
TMC	Technology Mining Center
TRADOC	Training and Doctrine Command

1. INTRODUCTION



The U.S. Army Research, Development and Engineering Command (RDECOM) was formally established in March 2004 as a component command of the U.S. Army Materiel Command (AMC).¹ This new command gathered under its authority AMC's Research, Development and Engineering Centers (RDECs), the Army Research Laboratory (ARL), the Army Materiel Systems Analysis Activity

¹ John C. Doesburg, Memorandum for All RDECOM Employees, Subject: Formal Establishment of the Research, Development and Engineering Command, March 1, 2004, <http://www.rdecom.army.mil/letter.pdf> (as of April 16, 2004). RDECOM had been operating as a provisional organization since October 9, 2003. Karen Jolley Drewen, RDECOM Magazine, "Transformation Ceremony Marks New Beginning for RDECOM," November 2003, <http://www.rdecom.army.mil/rdemagazine/200311/> (as of April 16, 2003).

(AMSAA), a portion of the Simulation, Training and Instrumentation Command (STRICOM), as well as some of the AMC staff.²

² These activities constitute the bulk of the Army's organic research and development (R&D) efforts related to land combat and support for ground combat. There are also significant Army R&D organizations that reside outside AMC and that primarily have missions that are not directly connected to technology and materiel development for ground combat operations and support to ground combat operations. These include the Army's medical R&D laboratories, the Corps of Engineers laboratories and R&D centers, the facilities of the Space and Missile Defense Command, and the Army Research Institute (which focuses on the behavioral and social sciences).

***New Command Integrates AMC's Research
and Development Capability***

- **Under old structure, research and development (R&D) was stovepiped in AMC's major subordinate commands**
- **Coordination, communication, and collaboration was difficult**
- **Redundancy was inevitable**
- **Long-term planning and visionary thinking was hindered**

RAND

Prior to the establishment of RDECOM, the RDECs all reported to various major subordinate commands (MSCs), and ARL reported directly to AMC headquarters. As a result of this stovepiping, coordinating and integrating AMC research and development (R&D) efforts, as well as developing a long-term technical vision for the Army, was difficult and relatively inflexible. It also made enforcing a system of systems perspective on Army materiel development nearly impossible.

It is expected that the consolidation of AMC's R&D efforts under one command will facilitate communication, collaboration, coordination, and leveraging of resources, as well as innovation and visionary, long-term planning.

RAND Corporation Supported Army Reorganization Efforts

- **Study problem: how best to use three or two deputy commanding generals (DCGs) in RDECOM**
- **Modified strategy-to-tasks approach:**
 - Clarify RDECOM's broad goal or mission
 - Identify "sub" missions
 - Organize RDECOM at the top level to accomplish missions
- **RAND recommendations reflect**
 - Research team's substantial expertise
 - Findings from interviews with Army and private-sector personnel
 - Brainstorming with RAND and Army personnel

RAND

Since the effort to reorganize AMC's R&D organizations began in the fall of 2002, RAND Arroyo Center has provided support with analysis focused on the best ways to structure R&D organizations. This briefing continues that support.

The current study was initiated at the request of the RDECOM commander in the fall of 2003. At that time, RDECOM was authorized four general officer slots: a major general as commanding general and three brigadier generals as deputy commanding generals (DCGs). The study problem initially posed to the Arroyo team was to recommend how to best utilize the three DCGs. Later, in response to a request from the RDECOM commander, we explored the possibilities for organizing RDECOM under only two DCGs.

From the beginning of the study we understood that to answer that question required a determination of what type of RDECOM organization best used the DCGs and all other RDECOM resources, and this required a top-level organizational design effort for RDECOM. We used a modified strategy-to-tasks

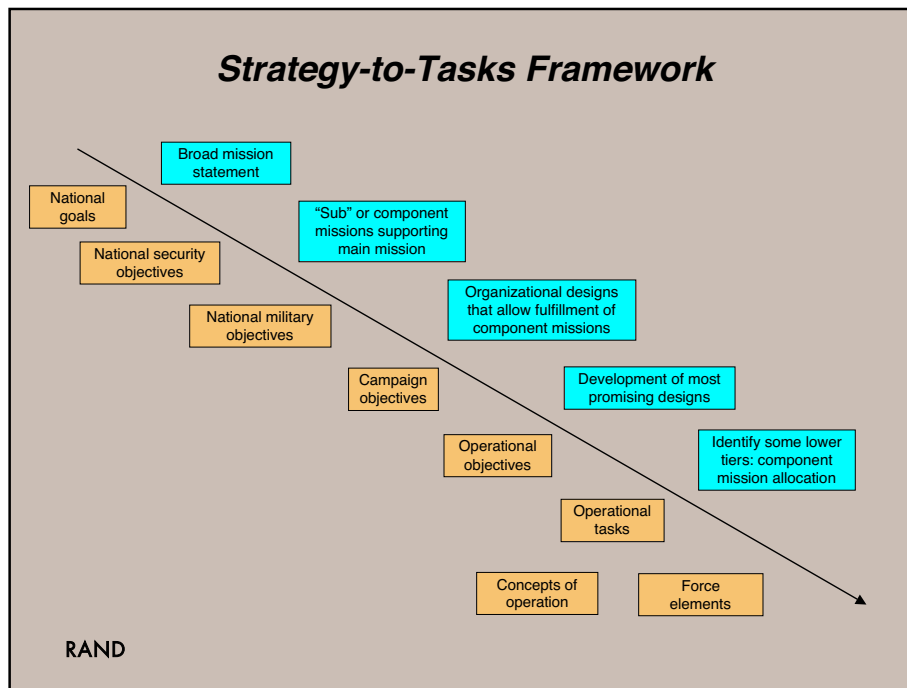
framework for the organizational design exercise.³ In general, a framework provides a logical, methodical way of thinking about a problem. The modified strategy-to-tasks framework begins at the top, in a common sense way, by asking what it is that RDECOM should do. What is its mission? This kind of high-level strategic view is critical for determining how RDECOM should be organized and managed to most effectively accomplish its mission.

Next, we identified and described the major “sub” or component missions of RDECOM based on our interpretation of the RDECOM mission statement. These component missions provide a top-level foundation on which to consider various organizational designs. In effect, this approach derives organizational structures that can be evaluated in terms of their alignment to the organization’s reason for being. We eventually settled on a matrix-type organizational design and developed four iterations of the basic matrix as options. Two models include three DCGs, and two models make do with only two DCGs.

For this work, in addition to using the strategy-to-tasks framework, the Arroyo researchers called on their combined expertise, developed from previous RAND Arroyo Center studies and many years of work on R&D and organizational issues in the Army and the private sector. The team interviewed experts and staff from the Army and other organizations, and brainstormed ideas internally and with Army personnel.⁴ In addition, the team attended various meetings involving the functional organizations and interacted with them so as to be able to understand their views on organizational possibilities and consequences.

³ Glenn A. Kent, *A Framework for Defense Planning*, Santa Monica, CA: RAND Corporation, R-3721-AF/OSD, 1989. The “strategy-to-tasks” framework was originally designed for making resource and task planning decisions, but it was modified in this study to make organizational design decisions.

⁴ Those participating included the senior leadership of RDECOM, organizational managers throughout RDECOM, and senior representatives from key organizations that interface with RDECOM such as TRADOC, TECOM, ASA(ALT), Army G-6, OSD CIO, the Navy Office of the Chief Engineer (CHENG), and the Air Force Center for Systems Engineering.



The “strategy-to-tasks” framework is illustrated in the chart, by the process flow elements appearing below the diagonal arrow.⁵ This framework translates national goals into operational tasks by cascading down through increasingly specific subordinate goals. The process flow elements above the diagonal arrow represent how this original framework was modified within the present study to aid in organizational design. In our modification of the framework, we cascade from a broad mission statement to lower-level mission statements and, rather than develop tasks that accomplish the goals, create organizational designs that can manage the mission set.

⁵ David E. Thaler, *Strategies to Tasks: A Framework for Linking Means to Ends*, Santa Monica, CA: RAND Corporation, MR-300, 1993, p. 4.

2. RDECOM'S MISSION STATEMENT AND COMPONENT MISSIONS

Briefing Outline

- 
- RDECOM's mission statement and component missions
 - The matrix organizational design
 - Reorganizing RDECOM
 - Impact of the RDECOM matrix organization on the Army
 - Strategies for long-term success
 - Concluding remarks

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In this section of the report we describe the four component missions that we developed for RDECOM. Section 3 defines a “matrix,” contrasts it with more traditional designs, and describes its benefits. Section 4 goes into detail about the matrix structures we recommend for RDECOM, using either three or two DCGs. We also describe how specific tasks in support of the missions would be allocated among the DCGs under our proposed models. Next, in Section 5, some of the impacts of implementing a matrix design are discussed. Section 6 suggests some strategies for facilitating the long-term success of the RDECOM matrix. Finally, Section 7 offers some concluding remarks.

***RDECOM Mission Statement Is Complemented
by Four Component Missions***

***“Get the right integrated technologies into the hands of
warfighters quicker”***

- 1. Provide responsive technical support to current Army and U.S. Joint Forces Command operations**
- 2. Provide effective technical support to Army acquisition programs**
- 3. Provide the technical vision for the Army of the future**
- 4. Attend to the planning, management, and oversight of AMC R&D and S&T work**

RDECOM creates an Army engineering and technology center of mass

RAND

The RDECOM mission statement reads, “Get the right integrated technologies into the hands of warfighters quicker.”¹ This deceptively simple mission suggests at least four complementary component missions.

First, RDECOM must provide technical support to all current Army and U.S. Joint Forces Command operations. This means helping to meet the needs of all commands that are out in the field now, whether they are training, warfighting, or peacekeeping.

Second, RDECOM must provide support in the near and middle term to the Army acquisition community (the Army Program/Project/Product Managers [PMs] and others who are responsible for actually acquiring materiel) in matters of science and technology (S&T) development, engineering, and systems integration. This support includes conducting leading-edge R&D work within the Army and in conjunction with contractors, and acting as consultants to the

¹ U.S. Army Research, Development and Engineering Command, Mission, <http://www.rdecom.army.mil/> (as of April 16, 2003).

Army “smart buyers” who choose what to buy and negotiate contracts with Army suppliers and outside contractors. RDECOM must be the Army acquisition community’s dedicated consultant in matters of science, technology development, engineering, and systems integration. In addition, RDECOM must serve as a deep talent pool of technical staff that the Army’s acquisition community can draw on to provide matrixed staff for their management offices and to provide the government with technical representation on integrated product/process teams (IPTs).

Third, RDECOM must work with Army military scientists and doctrine planners to be a part of the process that creates the Army’s vision of the future by articulating future S&T landscapes well into the 21st century in which the future Army will develop and operate.² This will require simultaneously anticipating what future warfighting will require in terms of technology and shaping future warfighting with the development of new technologies.

Fourth, RDECOM must plan, manage, and oversee the actual R&D efforts for which AMC is responsible.

While unstated as a mission, consolidating AMC’s laboratories and research and development centers into one command has a potentially very significant result: it creates an engineering and technology “center of mass” for the Army.³ Creating a technical center of mass is especially important to an Army that is increasingly reliant on technology for its transformation plans.

² This mission implies close coordination with TRADOC, the Army Staff and the Joint Staff.

³ We use “center of mass” as a term indicating concentration of capability.

***Component Mission 1:
Provide Responsive Technical Support to
Current Army Operations***

- **Provide technical advice and support to Army and Joint commands**
 - On site and on call
- **Identify opportunities for rapidly adding or upgrading technology in fielded systems and in support of operations**
- **Provide rapid technical solutions to address time-critical Army and Joint services requirements**
 - Adapt off-the-shelf engineering and products
 - Establish and conduct short-term, in-house RD&E programs
 - Manage short-term RD&E contracts

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COMPONENT MISSION 1: PROVIDE RESPONSIVE TECHNICAL SUPPORT TO CURRENT ARMY AND U.S. JOINT FORCES COMMAND OPERATIONS

RDECOM has the extremely important duty of providing responsive technical expertise in support of ongoing Army and joint forces operations. This support must be available in a number of ways.

First, commanders in the field need ongoing access to technically savvy advisors who can provide counsel on a broad range of technical issues. As the Army's engineering and technical center of mass, RDECOM must be the source for this cadre of experts. In addition to their role as advisors, these experts also need to provide access back to RDECOM and to the broader range of technical capability resident in the organization.

RDECOM support to ongoing operations must be greater than advisory, however. The Army's technical center also needs to proactively seek technology opportunities that will enhance the way our Army and joint forces conduct operations and that improve currently fielded equipment.

Army and joint commanders also need a technical organization they can consult with to solve pressing issues brought to light as a result of the operations they are managing. Since the demands of ongoing operations are almost always exceptionally time-sensitive, RDECOM has the requirement to provide very rapid technical solutions when such solutions make sense. This requires that RDECOM have a number of specific capabilities. These include being aware of technical developments in the commercial sector, defense industry, and overseas. Since the most rapidly available solutions will often be ones that can be adopted off the shelf, the ability to adapt existing technology is a critical RDECOM requirement. Rapid technology development by outside research organizations requires that RDECOM be capable of managing short-term R&D contracts as well.

Finally, the best way to support current operations in a time-effective manner may be through fast, in-house R&D programs, and RDECOM must be capable of carrying out such programs.

***Component Mission 2:
Provide Technical Support to Army
Acquisition Programs***

- **Provide engineering leadership, technical staff as matrix support and integrated process/product team members, and services to Program/Project/Product Managers (PMs) and**
 - Technology and integration planning
 - RFP generation and response evaluation
 - Systems engineering, integration, and design
 - Specialty engineering (reliability, maintainability, supportability, and other “ilities”)
- **Provide sustainment support for fielded systems to the commodity commands**

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COMPONENT MISSION 2: PROVIDE EFFECTIVE TECHNICAL SUPPORT TO ARMY ACQUISITION PROGRAMS

Army PMs are responsible for the development, production, and sustainment of Army materiel. PM offices typically have fairly small staffs, so PMs are forced to rely on personnel from other organizations in the execution of their duties. In particular, Army PM offices rely heavily on RDECOM to provide the technical, engineering, and logistics expertise needed during all phases of acquisition. Evolutionary development makes this kind of support even more critical, since materiel development continues throughout the life cycles of the items being managed.

The nature of Army acquisition programs requires that RDECOM support take a number of forms. This can range from providing technical advice on an as-needed basis to providing technically competent personnel as matrix support, assigned on a reasonably long-term basis to PM offices. Additionally, because a PM's staff is too small to provide the broad assortment of technical skills needed to adequately assess and direct technically sophisticated and complex acquisition programs, RDECOM must be capable of supplying the requisite government

personnel for inclusion on integrated product/process teams, source selection committees, and the writing teams that draft contracts, requests for proposals, and other documents with technical content.

System integration and engineering has grown in importance to the Army in recent years. In current Army acquisition programs, the ability to integrate within and across systems is the most technically challenging aspect to be overcome during materiel development. As systems get more complex and as interconnectedness across the battlefield increases, Army PMs will have to rely to a much greater extent on RDECOM to provide the systems expertise necessary for them to be “smart” architects, buyers, and developers of Army materiel.

Finally, it is also RDECOM’s responsibility to provide technical support to the various Army commodity commands (organizations under AMC that focus on particular products) to assist their mission in providing sustainment support to fielded Army materiel systems.

***Component Mission 3:
Provide the Technical Vision for the
Army of the Future***

- Understand and anticipate global technology trends and developments
- Anticipate, articulate, and manage a vision of future technical capability for the Army
- Participate in future warfighting concept development
- Propose and manage Advanced Concept Technology Demonstrations (ACTDs) and Advanced Technology Demonstrations (ATDs)

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COMPONENT MISSION 3: PROVIDE THE TECHNICAL VISION FOR THE ARMY OF THE FUTURE

For the Army to understand what its future capabilities need to be doctrinally and materially and to plan against future threats, it must maintain and evolve a technical vision of future land combat. As the Army's engineering and technical center of mass, RDECOM must provide that vision. This mission implies several important capabilities for RDECOM.

First, RDECOM must maintain the ability to anticipate and understand the direction of science and technology around the world. RDECOM personnel must first translate that understanding into a vision of what military capabilities need to be from a technology point of view and then communicate that vision so that concepts about future warfighting can be developed and tested. It almost goes without saying that the technical vision must be based on physical and fiscal reality. RDECOM's mission in this area, however, is more than just to pass on a technical vision to doctrine developers. RDECOM must remain actively involved in developing concepts of future warfighting to insure that the technical vision is appreciated, understood, and applied innovatively and effectively.

Importantly, having RDECOM's technical expertise available during warfighting concept development allows for a give and take between the technologists and military scientists that can motivate and refine warfighting concepts and generate a synergistic innovation between the two groups, spurring the creation of novel warfighting concepts.

Finally, an integral part of RDECOM's mission to provide the technical vision for the future is to be immersed in the process of proposing the right Advanced Technology Demonstrations (ATDs) and managing those efforts once they are approved by the Army Science and Technology Working Group (ASTWG). Similarly, RDECOM must be a significant part of the process that develops and advocates ideas for Advanced Concept Technology Demonstrations (ACTDs) that are primarily concerned with land combat. Once approved, RDECOM personnel manage the technical and materiel aspects of ACTDs.

***Component Mission 4:
Attend to the Planning, Management, and
Oversight of Army R&D and S&T***

- **Serve as integral part of the Army's STO and S&T budget processes**
- **Conduct world-class S&T**
 - Maintain and extend the state of the art in S&T important to and/or unique to the Army
- **Partner with other S&T institutions**
- **Participate in setting S&T standards and processes**
 - Set Army-specific standards and procedures
 - Speak for the Army in forums that set relevant technical standards, best practices, and procedures

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COMPONENT MISSION 4: ATTEND TO THE PLANNING, MANAGEMENT, AND OVERSIGHT OF ARMY R&D AND S&T WORK

Together with the Army leadership and staff, the Army's Training and Doctrine Command (TRADOC), and other relevant Army organizations, RDECOM has a significant role in developing the Army's Science and Technology Objectives (STO) and the Army Science and Technology Master Plan (ASTMP), as well as planning an S&T budget that supports the Army's S&T goals. As RDECOM's position as the Army's engineering and technical center of mass gels over the next few years, this role is likely to increase.

As the Army's technologist for ground combat and support, RDECOM exercises the lead role in the execution of technical research aimed at improving the Army's warfighting effectiveness. Maintaining a strong leadership role in the state of the art for S&T and engineering is paramount if this important mission is to be accomplished. RDECOM must be able to manage the challenge of adapting to increasingly more complex and multi-disciplinary S&T and system of systems engineering. The new command must therefore provide internal mechanisms

that allow evolution and adaptation to a rapidly changing world. Such mechanisms must involve continuous exchanges and partnership with government, university, industry S&T institutions, and foreign governments.

Numerous military and nonmilitary, professional, industrial, and scientific organizations and committees have been established for setting and maintaining standards in specific areas of S&T and engineering. RDECOM representatives must be the Army spokespersons and carry the Army's view within these established committees. Moreover, RDECOM must take on the job of establishing new committees on standards and processes as required to meet the *specialized* needs of the warfighter.

3. THE MATRIX ORGANIZATIONAL DESIGN

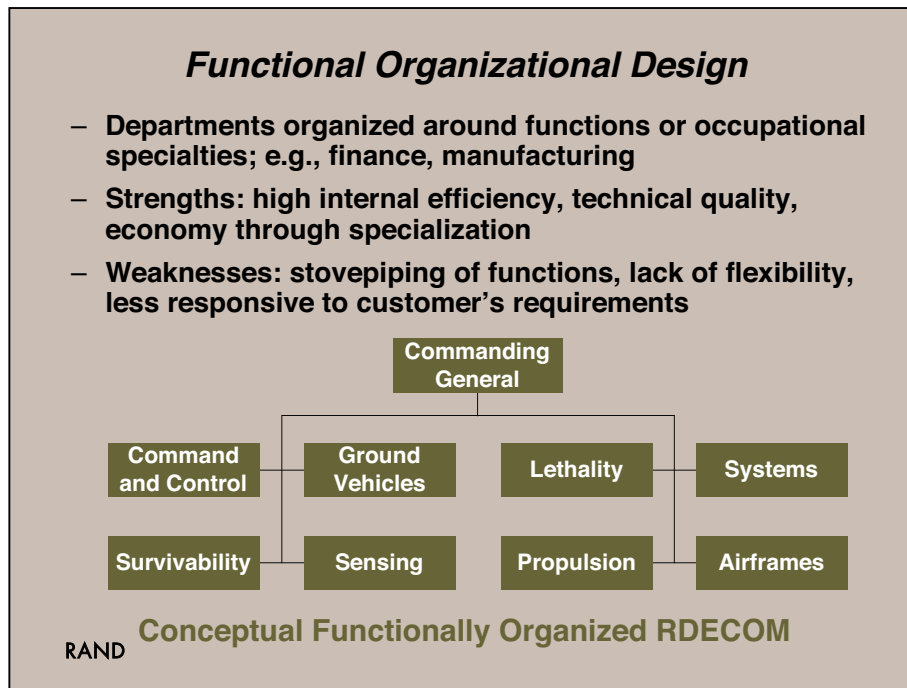
Briefing Outline

- RDECOM's mission statement and component missions
- ➔ • The matrix organizational design
 - Other designs: functional and divisional
 - Definition of a matrix
 - Benefits of a matrix
- Reorganizing RDECOM
- Impact of the RDECOM matrix organization on the Army
- Strategies for long-term success
- Concluding remarks

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RAND Arroyo Center proposes a matrix organizational structure for RDECOM as the archetype that will best enable it to accomplish its mission to “get the right integrated technologies into the hands of warfighters quicker.” The key terms in this mission statement—“right,” “integrated,” and “quicker”—prompted us to look for something beyond the traditional functional or divisional organizational structures. The limitations of traditional organizational structures have spurred many organizations, particularly those in the business sector, to look for new approaches to enhance efficiency and effectiveness.

In this section, we contrast the matrix organizational design with the more traditional functional and divisional designs. We conclude with a discussion of the benefits of a matrix.



FUNCTIONAL ORGANIZATIONAL DESIGN

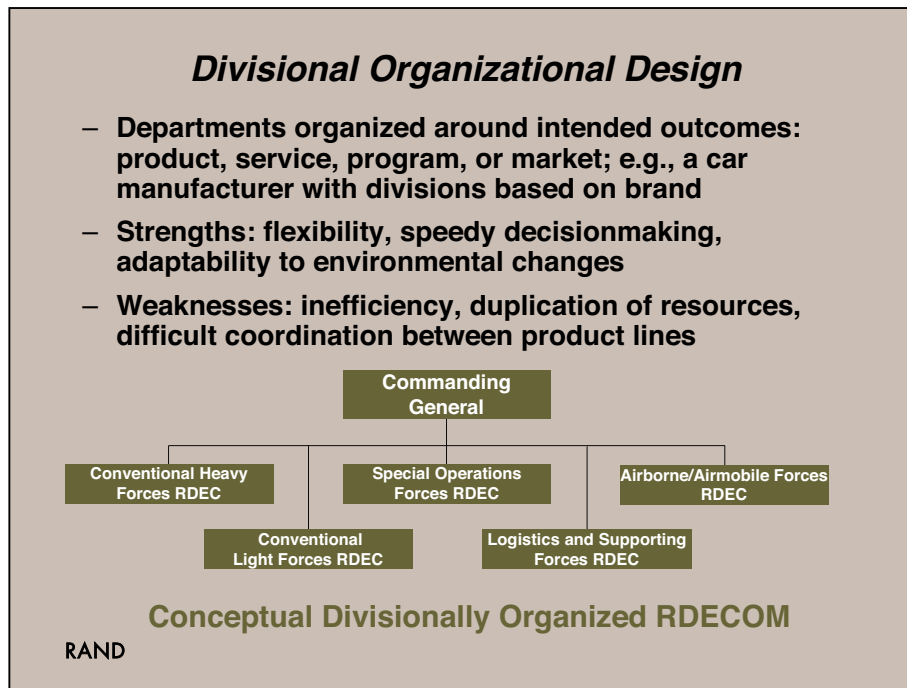
In a functional organization, departments are created around specific functions, or related occupational specialties or processes, such as finance, marketing, sales, R&D, engineering, and manufacturing. In a functionally organized company, the managers of each major function report to the chief executive, who provides overall direction and coordination. In functional organizations, each suborganization manages efforts in its area of specialization. The end products or services that are the larger organization's output are integrated at higher levels or in a suborganization with a systems specialization.

The strengths of the functional organization include high internal efficiency and technical quality. Economy is achieved through specialization. The primary weakness of a purely functional organization is a natural stovepiping of functions. In product development organizations this makes it especially difficult to imbue a systems engineering approach across the larger organization. As a result, products tend toward suboptimization at the level of the functional breakout. Functional organizations also tend to lack flexibility. Each functional manager controls not only the internal processes in the suborganization but, to a

large extent, also the shape of the requirements for the suborganization's output, making the suborganization less responsive to customer requirements and externally driven change.

Organizing RDECOM in a functional manner involves identifying those functions that are important to the development of ground combat and ground combat support materiel. One possible organization includes departments for ground vehicles, airframes, sensing, lethality, survivability, propulsion, and command and control.

This particular functional organization does not adequately address one of the primary concerns that resulted in the creation of RDECOM: the inability to enforce a system of systems viewpoint across AMC's R&D activities. Although we included a department called "Systems" that is responsible for the systems integration necessary in the development of complex Army systems, it remains at the level of the other functional departments. We will shortly describe how this issue is addressed in the current RDECOM design.



DIVISIONAL ORGANIZATIONAL DESIGN

In a divisional organization, departments are created around the organization's intended outcomes, such as products, services, or programs.¹ Another way to think about this is that divisional organizations split around the markets they serve. In this kind of organization, divisions operate relatively autonomously under the larger umbrella as separate business units.²

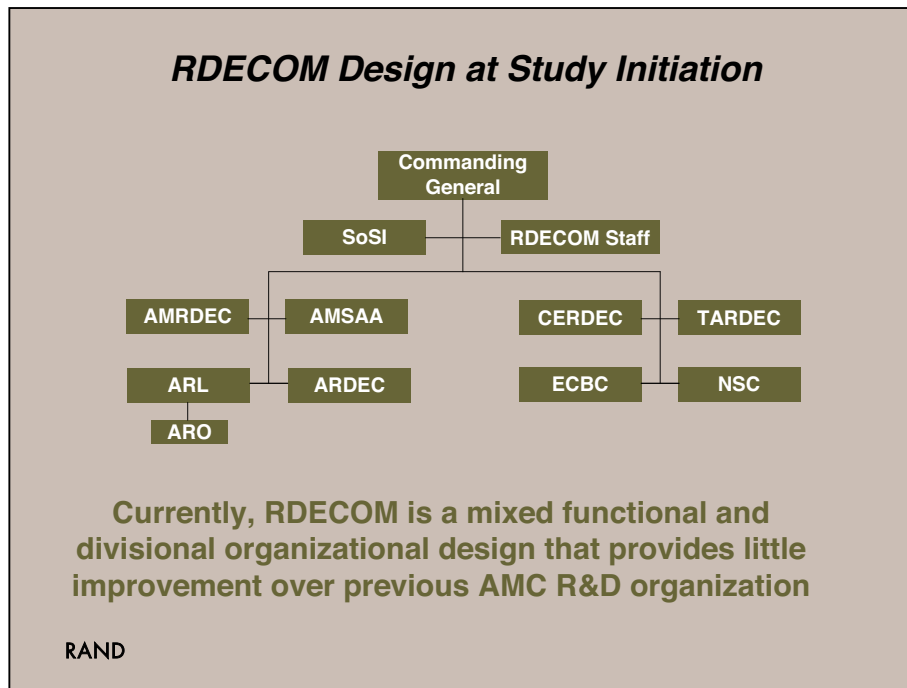
The strength of a divisional organization lies in the fact that by specializing on particular markets, detailed market knowledge can boast flexibility, speedy decisionmaking, and high adaptability to market changes. One major drawback to a divisional organizational scheme is the inefficiency that can result when separate divisions are pursuing similar or overlapping markets. Moreover,

¹ Richard Daft, *Organization Theory and Design*, 7th edition, Cincinnati, OH: South-Western College Publishing, 2001, pp. 214-220.

² <http://www.marketingpower.com/live/mg-dictionary-view1129.php>. In a typical divisionally organized business, each division manager is separately responsible for meeting profit goals.

physical facilities and/or groups with the same specialty have to be duplicated for each product line. Finally, since product lines become separate from each other, coordination among them is difficult.

Organizing RDECOM in a divisional manner involves identifying the products and markets that particular divisions would serve. One possible divisional RDECOM design would differentiate the divisions based on the type of ground combat and ground combat support force being supported. A purely divisional approach to RDECOM organization is clearly inappropriate. This particular proposal for a divisional design would be highly inefficient, as the markets each division supports have large areas of overlap. We were unable to envision any other divisional designs that would be more efficient, and so we disfavor a purely divisional organization for RDECOM.



RDECOM'S CURRENT ORGANIZATIONAL DESIGN

As currently organized, RDECOM reflects a mixed functional and divisional organizational design. Some of the suborganizations, such as ARDEC, ECBC, and CERDEC, have rather specialized functions and, to a large extent, provide subsystem support for larger system development activities.³ Other suborganizations, such as the NSC and TARDEC, could fit into the divisional design proposed earlier with relative ease.⁴

During the conduct of this study, RDECOM's organization remained relatively static and was based principally upon the suborganizations the command inherited from AMC's MSCs. SoSI (System of Systems Integration) is the only

³ E.g., ARDEC supports cannons and ammunition development for larger, more complex systems, CERDEC provides communications equipment, and ECBC specializes in chemical and biological defense.

⁴ E.g., NSC could be modified to be a conventional light infantry support RDEC, and TARDEC could be the conventional heavy forces support RDEC.

significant addition to the organizational chart. The creation of SoSI is an attempt to enforce a system of systems viewpoint on RDECOM, but it is unlikely to be able to do so. Organizationally, SoSI has the appearance of special staff with little real authority. Additionally, SoSI will require substantial development before it has the capability required to provide substantial system of systems integration services, let alone enforce such a view on the other parts of RDECOM.⁵

By itself however, the creation of RDECOM will not address the issues that motivated that creation. For RDECOM to be successful, it must be organized to enforce a system of systems viewpoint to its R&D activities, to enable a joint, holistic, and innovative technical vision and to prove adaptable to changing technical trends and Army missions.

The functional and divisional organizational paradigms have different strengths and weaknesses. When the dual challenge is faced of simultaneously achieving functional and divisional requirements while minimizing the negative aspects of each, the stage is set for evolution toward a matrix construct.⁶

⁵ See the appendix for a discussion of how a more effective SoSI could be organized in the current RDECOM context.

⁶ Daft, pp. 202–203.

What Is a Matrix Organizational Design?

- **A matrix is a structure for arranging teams or groups of people representing various functions of a company or other organization**
- **Specialists come together to work on projects but still remain part of their functional groups**
- **Each group member reports to the project head (for the life of the project) and to their functional head (e.g. the vice president of manufacturing)**

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WHAT IS A MATRIX ORGANIZATIONAL DESIGN?

A matrix is a cooperative organizational structure in which projects cut across traditional boundaries, and the horizontal and vertical intersections represent different staffing positions with responsibility divided between the horizontal and vertical authorities.

The matrix may be used to develop a new product, to ensure the continuing success of a product to which several departments contribute, or to solve a difficult problem. A project group defines what is required and when it is required, and the functional office defines how it is to be done and performs the required work. A project supervisor may call on several functional groups, with different specialties, to complete the project. The project supervisor and functional supervisors may manage many of the same people, depending on the assignment.⁷

⁷ http://www.pmforum.org/library/glossary/PMG_M02.htm.

The idea of the matrix organization was born in the U.S. aerospace industry.⁸ Aerospace employs a matrix organizational structure, with systems engineering directorates corresponding to specific customer programs. The operational groups draw technical support from a central engineering organization, ensuring efficient use of specialized staff members, effective sharing of technical experience, and the application of corporate memory and “horizontal engineering” across programs.⁹

The matrix has been successfully employed by many companies, such as Pittsburgh Steel, IBM, Unilever, and Ford, which have fine-tuned the matrix to suit their particular goals and cultures. In addition to industry, the matrix organizational construct is used in the insurance, securities, and banking markets; by consulting, accounting, and law firms; by retailing and construction businesses; and in federal agencies, hospitals, institutions of higher education, the United Nations Children’s Fund, and the National Aeronautics and Space Administration (NASA).¹⁰

⁸ Stanley M. Davis and Paul R. Lawrence, *Matrix*, Reading, MA: Addison-Wesley Publishing Company, 1977, pp. 3 and 13.

⁹ <http://www.aero.org/overview/nature.html>.

¹⁰ Daft, pp. 229–230; Davis and Lawrence, pp. 155–192.

***A Matrix Offers Several Benefits
for RDECOM***

- **Balanced top down/bottom up planning and budgeting within RDECOM**
- **Facilitates horizontal coordination**
- **Better leveraging and more efficient use of RDECOM resources**
- **Better flexibility and adaptability to rapidly changing Army needs, Department of Defense (DoD) policies, and technology trends**
- **Increased exchange of ideas and networking**
- **Reduced conflict and enhanced cooperation among interdisciplinary teams**
- **Emphasis on system of systems approaches**

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BENEFITS OF A MATRIX

A balanced matrix organization (i.e., one in which functions and projects have the same priority) can harness the advantages of the two traditional organizational structures, since it enables a simultaneous focus on complex technical issues—addressed by functional groups—and on the unique requirements of the customers—addressed by project, or mission, groups.¹¹ The functional groups house the pools of talent and resources, whereas the mission groups represent the working units or centers in charge of bringing about the organization's intended outcomes.

The matrix organizational structure can be a catalyst for attaining balanced top-down/bottom-up (where communication flows from management down through the ranks and from lower-level staff up to management) planning and budgeting within RDECOM, since it fosters the recognition that developing a plan is an interdependent task in which individually developed functional plans

¹¹ Davis and Lawrence, pp. 11–14.

must be shared, differences must be reconciled, and joint agreements reached. Matrix managers consult each other before making decisions, work collaboratively in planning to integrate their different viewpoints, and think about the whole besides their particular functions.¹² A balanced top-down/bottom-up S&T planning and budgeting process within RDECOM will lead to a more strategic view of research, development and engineering (RD&E) for the current and future Army.

The matrix construct will also allow better leveraging and more efficient utilization of RDECOM resources. In a purely functional organization, barriers created between groups having diverse specializations inhibit the cross-functional processes and cross-fertilization of ideas required for new concept and product development. On the other hand, in the purely divisional organization, resources are duplicated and opportunities for sharing them are missed while product divisions “reinvent the wheel.”¹³ Even in traditional organizations capable of acquiring abundant physical facilities and human talent, situations arise that compel the flexible sharing of the available resources. A matrix organization from its inception calls for the sharing of resources and for increased flexibility of staff deployment in accordance with current needs. “The matrix design helps induce the kind of behavior that views rapid redeployment and the shared use of scarce human resources as basic.”¹⁴

The purely functional organization is slow to respond to environmental changes that require detailed coordination among departments, particularly when the relevant technologies are nonroutine and interdependent.¹⁵ The matrix allows adaptability and coordination when nonroutine technologies have to be mastered both within and across functions.¹⁶ Furthermore, the traditional lines of command and directions of information flow in both the functional and divisional structures are vertical. A matrix is an excellent example of an organization with a strong component of lateral decisionmaking and information flow. Such lateral structures enable an organization to become adaptable to

¹² Davis and Lawrence, p. 107.

¹³ Galbraith, pp. 25–28.

¹⁴ Davis and Lawrence, pp. 17–18.

¹⁵ Daft, pp. 214–216.

¹⁶ Daft, pp. 226–228.

continuous changes in its environment.¹⁷ “The matrix is an organic structure that facilitates discussion and adaptation to unexpected problems.”¹⁸ We therefore anticipate that a matrix framework will enable RDECOM to respond with greater adaptability and flexibility to rapidly changing Army needs, Department of Defense (DoD) policies, and technology trends.

The matrix construct will promote the exchange of ideas and networking across RDECOM. A matrix organization induces cross-fertilization of ideas among diverse groups, multi-disciplinary approaches to problem solving, and improved communication and collaboration at all levels within and outside the organization. In traditional organizations, “stovepipes” (groups that are organized around narrow, highly specialized functions) hinder productive networking and exchange of ideas among different functional and/or divisional groups. Mechanisms that lead to the creation of stovepipes are significantly mitigated within a matrix structure. One of the fundamental generators of stovepipe mentality is the attitude of personnel toward redeployment. In traditional organizations, individuals almost invariably develop an understandable resistance to being uprooted and forced to join up with a set of strangers.¹⁹ In their minds, they have to recreate a reputation, relations, and trust over and over again. In a matrix organization, a specialist can be engaged in helping a particular project group that needs his or her particular talents while never losing his or her home base, namely, the functional group. In traditional organizations, other strong generators of the stovepipe mentality are the entrenched patterns of political power, authority, and status. In a matrix structure, new projects, products, and businesses can be phased in and old ones phased out without significantly affecting the overall organization’s structure. Thus, when a new mix of business, projects, or resources arises, personnel status and authority can be retained.²⁰

In a matrix organization, divisional groups are made up of multi-disciplinary teams and task forces integrated from across many functional groups. “Teams and task forces reduce conflict and enhance cooperation because they integrate

¹⁷ Galbraith, pp. 41–47.

¹⁸ Daft, p. 228.

¹⁹ Davis and Lawrence, pp. 22–23.

²⁰ Davis and Lawrence, p. 72.

people from different departments.”²¹ Task force and project managers span the boundaries across departments and operate as integrators, so they understand the problems of various groups and can foster solutions that are mutually acceptable.

Finally, by breaking stovepipes and fostering collaboration among diverse functional groups, the matrix construct will enable RDECOM to acquire an added emphasis on network-centric and system of systems approaches. Indeed, successful implementation of these approaches requires the strong participation and collaboration of multi-functional teams.

Of course, the matrix is not the panacea for all organizational problems. Disadvantages of a matrix organization include potential employee confusion in “reporting to two bosses” (because employees report to a project manager *and* the manager of their functional group) and the expense to train the workforce—in particular middle management—in teamwork techniques.²² However, it is our strong opinion that the advantages of the matrix largely outweigh its disadvantages.

²¹ Daft, p. 501.

²² Daft, pp. 228–229; Davis and Lawrence, chapter 6.

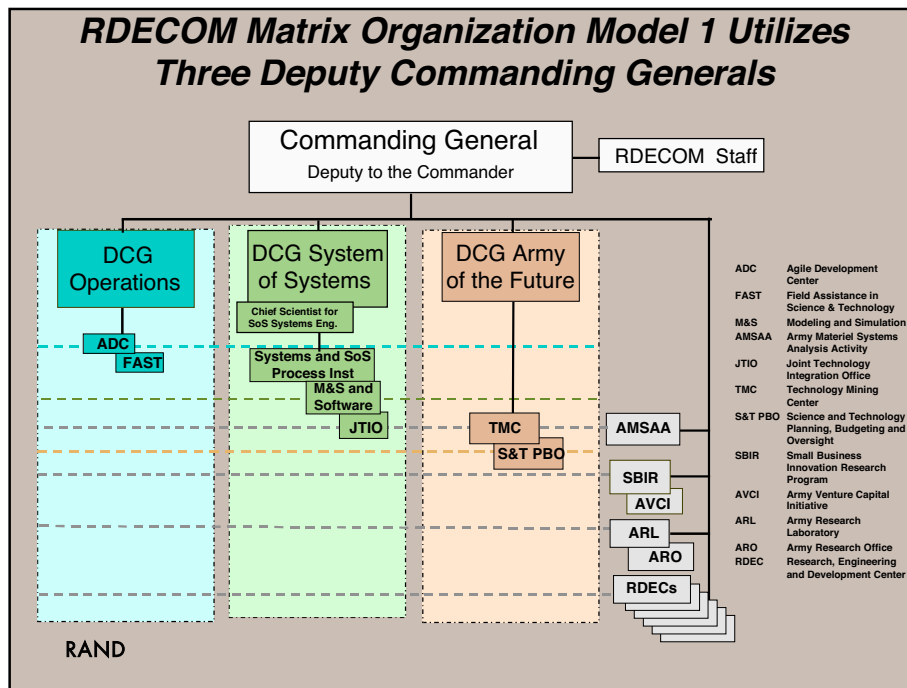
4. REORGANIZING RDECOM

Briefing Outline

- RDECOM's mission statement and component missions
- The matrix organizational design
- ➔ • **Reorganizing RDECOM**
 - With three DCGs
 - With two DCGs
- Impact of the RDECOM matrix organization on the Army
- Strategies for long-term success
- Concluding remarks

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In this section we describe how we would organize RDECOM using a matrix design, with either three or two DCGs, to most effectively fulfill the missions described earlier.



We propose four alternative matrix organizational structures. These leverage Arroyo's previous research findings pertaining to the RDECOM System of Systems Integration (SoSI) Directorate,¹ and capitalize on the availability of either three or two DCGs to lead the various RDECOM centers, depending on the final authorized allowance of general officers for RDECOM. The options for organizing RDECOM as a matrix are represented schematically by columns that represent the centers charged with accomplishing the organization's missions. Each mission center is commanded by one of the DCGs, who is supported by a small staff. The mission centers also include suborganizations whose talents and resources are primarily, but not exclusively, utilized within that mission center. The mission centers also draw heavily from the resources of RDECOM's core science, technology, and engineering organizations. These organizations provide the talent and resources generally required by more than one mission center. They are the professional home for most of RDECOM's engineering and scientific personnel, and they house RDECOM's critical infrastructure and

¹ The appendix to this documented briefing is a copy of the results of that study.

perform and manage the technical R&D.² These organizations are represented down the right side of the charts and include those normally associated with RDECOM: the RDECs, the ARL, the Army Research Office (ARO), and the AMSAA. In addition, we show two other organizations, the Army Small Business Innovation Research (SBIR) office and the Army Venture Capital Initiative (AVCI). The Army SBIR office currently works from inside ARO, while the AVCI is run directly by the Army Staff. We include these two separately here to recognize that there are other Army R&D resources that could provide matrix support to RDECOM's mission centers.

TWO MODELS FOR ORGANIZING UNDER THREE DEPUTY COMMANDING GENERALS

Model 1

The proposed matrix organization shown in the chart above utilizes three DCGs: DCG Operations, DCG System of Systems (SoS), and DCG Army of the Future. These DCGs, and their organizations, are the vertical elements of the chart and are distinguished by market, making the vertical elements of the chart the divisional structure of the matrix. The horizontal elements of the chart, such as the RDECs, are the functional elements, as they are responsible for processes such as design and research, and these complete the matrix. The intersections of the vertical elements and the horizontal elements, where implemented, represent specific projects formed to insure functional support for divisional responsibility. For example, intersections of RDEC horizontal lines with the DCG SoS line will include instances of RDEC support to specific Army programs undergoing Systems Development and Demonstration (SDD).

The Agile Development Center (ADC) and the Office for Field Assistance in Science and Technology (FAST) are part of the DCG Operations' mission center. The ADC is primarily responsible for managing quick-response projects that are designed to address immediate warfighter needs. The FAST provides a cadre of technical personnel who operate with various Army and joint services

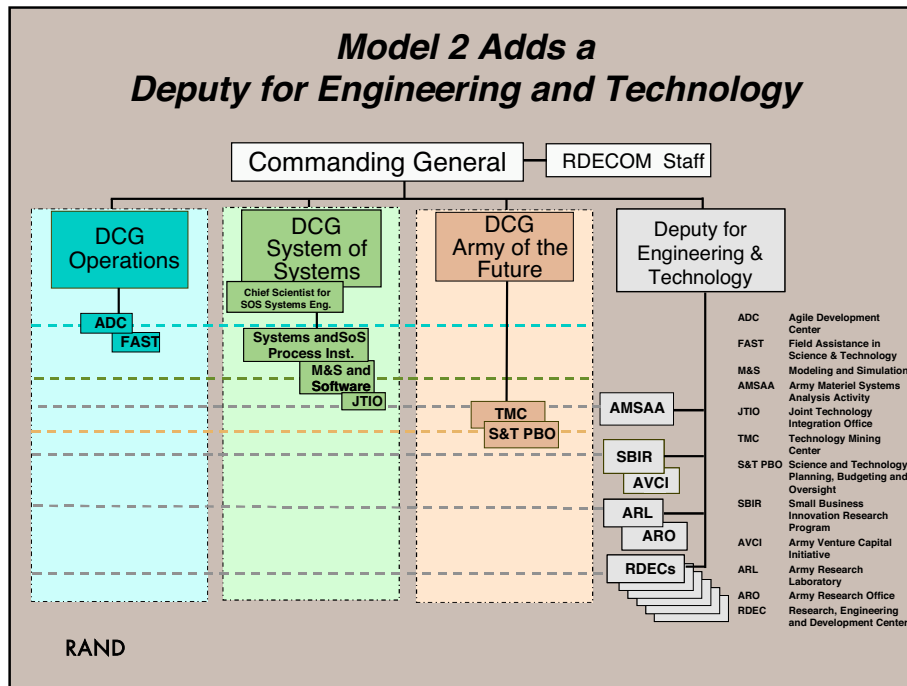
² Not including R&D performed by the Army medical community, the Space Missile and Defense Command, the Army Research Institute, and the civil engineering R&D work undertaken by the Army Corps of Engineers.

commands to provide the commanders of those units with technically related advice and a gateway to the Army's S&T community.

An Army Chief Scientist for SoS works directly for the DCG SoS and also manages the Systems and SoS Process Institute. The Institute is the Army's repository of best practices and tools for managing systems and SoS. It also supports RDECOM and the broader Army in the training and certifying of systems and SoS professionals. Also within the DCG SoS's mission center are the Joint Technology Integration Office and the Modeling & Simulation and Software Office. The Joint Technology Integration Office is responsible for facilitating cross-cutting integrated product/process teams that address groupings of technologies. The Modeling & Simulation and Software Office sponsors the identification, development, verification, and validation of the tools needed by the Army in support of its systems and SoS R&D and acquisition efforts.

The DCG Army of the Future's mission center houses the Technology Mining Center (TMC) and the Science and Technology Planning, Budgeting, and Oversight Office (S&T PBO). The TMC provides the Army with a technology awareness capability that can identify promising technology and potential technology development partners internationally, in the commercial sector, and in other government organizations. S&T PBO supports the RDECOM contribution to the Army's S&T planning and budgeting processes.³

³ The functions and offices described here as part of the various mission centers are described in greater detail in the appendix.



Model 2

In this second model, the matrix supporting organizations are consolidated under a Deputy for Engineering and Technology (E&T). With eight major supporting organizations and three DCGs reporting to the RDECOM commander, effective management of so many subordinate organizations is difficult at best. The vast majority of RDECOM's personnel and resources are located in the supporting organizations, so the day-to-day management of them is a burden that requires a substantial commitment of time and management resources. Without an intermediate management layer, this commitment from the RDECOM commander substantially reduces his or her attention to RDECOM's primary mission areas. A Deputy for E&T can relieve the RDECOM commander of the day-to-day management responsibilities of the supporting organizations, allowing the commander to better direct the organization's strategic direction.⁴

⁴ To be effective, the Deputy for E&T will need to be the senior civilian employee of RDECOM. Additionally, we expect that the Deputy for E&T will need to maintain relationships with the senior-level civilians in other organizations that RDECOM interacts with, such as TRADOC and ASA(ALT). As a result, the Deputy for E&T should be a protocol 5 member of the Senior Executive Service.

<i>The Three DCGs Would Share Responsibility for RDECOM's Component Missions</i>			
<i>Component Missions</i>	<i>DCG Operations</i>	<i>DCG System of Systems</i>	<i>DCG Army of the Future</i>
<i>1. Provide technical support to current operations</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>	<i>Tertiary responsibility</i>
<i>2. Provide technical support to Army acquisition programs</i>	<i>Primary responsibility (after FUE) Secondary responsibility (before FUE)</i>	<i>Primary responsibility (before FUE) Secondary responsibility (after FUE)</i>	<i>Tertiary responsibility</i>
<i>3. Provide technical vision for the Army of the future</i>	<i>Tertiary responsibility</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
<i>4. Plan, manage, and oversee S&T and R&D</i>	<i>Tertiary responsibility</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
RAND			

COMPONENT MISSION AND TASKS ALLOCATION WITH THREE DEPUTY COMMANDING GENERALS

Effective utilization of RDECOM's DCGs requires that RDECOM's missions be carefully allocated among them. In general, the allocation of mission responsibility has a temporal tone to it. DCG Operations manages the Army's technical requirements for current operations and fielded materiel. DCG SoS primarily manages RDECOM's mission of supporting materiel acquisition programs that will impact the Army in the near to middle term. Finally, the DCG Army of the Future, as the name suggests, focuses on those mission areas that deal with longer-term goals.

There is, of course, some overlap. Since the Army envisions future materiel concepts that are largely integrated into networked systems and SoS, the DCG SoS will have a strong supporting role in RDECOM's mission areas that are focused further into the future. However, as these mission areas are typically more technology-oriented, the DCG Army of the Future is their principal manager. As new concepts mature, combine, and evolve into approved acquisition programs, the DCGs' roles shift. After an acquisition program's

Milestone B decision, the requirement to integrate the new equipment into the larger Army implies a system and SoS focus best suited to the DCG SoS. Finally, the DCG Operations becomes responsible for materiel acquisition programs after they achieve First Unit Equipped (FUE) status, i.e., they have been fielded for the first time with at least one unit.

At this point in the materiel life cycle, equipment modifications are likely to be relatively minor or to be required on a very rapid basis.⁵ Likewise, support to ongoing operations demands a skill set that is more focused on rapid adaptation than on detailed integration. Hence, the DCG Operations is the more appropriate person to manage such support, and the DCG SoS will provide support when there are larger system impacts.

⁵ Larger system and system of systems modifications are usually accomplished through more formal acquisition programs. Hence we tend to think of substantial upgrades as new programs. For example, the development of the M1A2 was not just a modification to the basic M1 tank, but a complete acquisition program. Had RDECOM then existed as we are proposing it here, the M1A2 program would have been supported initially by the DCG Army of the Future as technologies were maturing, by DCG SoS after the milestone decision leading to the then Engineering Manufacturing Development phase of the program, and finally by the DCG Operations after FUE.

<i>DCG Operations Would Take the Lead on Mission 1 Tasks</i>				
<i>Component Mission</i>	<i>Tasks</i>	<i>DCG Operations</i>	<i>DCG System of Systems</i>	<i>DCG Army of the Future</i>
<i>1. Provide responsive technical support to Army and Joint Services commands</i>	<i>Provide technical advice and support to Army and Joint commands</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>	<i>Tertiary responsibility</i>
	<i>Identify opportunities for rapid technology insertion</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>	<i>Tertiary responsibility</i>
	<i>Provide rapid technical solutions to address time-critical Army and Joint Services requirements</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>	<i>Tertiary responsibility</i>
RAND				

The DCG Operations organizes technical support to the larger Army by identifying and assigning RDECOM personnel to major Army and joint forces commands. These RDECOM liaison personnel provide general technical support and advice, and they are also critical links between RDECOM and the operational Army it supports.

The DCG Operations has a responsibility to identify opportunities for rapid technology insertions that will provide the warfighter greater effectiveness, more efficient operations, or both. This responsibility requires close collaboration with the PMs who manage fielded equipment and with operational units that could benefit from rapid technology insertion. This collaboration is possible through the substantial support, already described, that RDECOM provides to PMs and to the major Army commands in other mission areas.

When time-critical issues with potential technical solutions arise during current Army operations, the RDECOM commander needs one of the most senior members of the command to take personal charge of managing the solution. The DCG Operations provides the commander with that resource by organizing and leading quick-reaction teams to develop and deploy rapid solutions, and by identifying and allocating the necessary resources required by those teams.

The DCG SoS assists quick-reaction support to the extent that potential solutions are system-level ones or have broader system impacts. The DCG Army of the Future assists these efforts through his or her responsibility to identify technology trends in industry, in other government agencies, and in foreign countries.

<i>DCG Operations and DCG System of Systems Share Responsibility for Mission 2 Tasks</i>					
<i>Component Mission</i>	<i>Tasks</i>		<i>DCG Operations</i>	<i>DCG System of Systems</i>	<i>DCG Army of the Future</i>
<i>2. Provide technical support to Army acquisition programs</i>	<i>Provide engineering leadership, technical staff as matrix support and IPT members and services to PM/PEOs</i>	<i>Pre FUE</i>	<i>Tertiary responsibility</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>
		<i>Post FUE</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>	<i>Tertiary responsibility</i>
	<i>Provide matrix support for sustainment of the logistics communities in the MSCs</i>		<i>Primary responsibility</i>	<i>Secondary responsibility</i>	<i>Tertiary responsibility</i>

RAND

The DCG SoS is responsible for supporting PM/PEO (Program Executive Officer) offices during materiel development prior to FUE. His or her support includes providing engineering leadership or services and technical staff, matrix support to the PM/PEOs, or acting as an IPT member. RDECOM personnel must be capable of providing expertise in all technical aspects of acquisition planning and execution, to include Request for Proposal generation, proposal evaluation, system of systems and systems integration, design, engineering, testing, and oversight. Such support necessarily includes expertise in all the “ilities” such as supportability.

The growing level of complexity of potential solutions to Army problems results in more and more interfaces between interconnected systems and subsystems, in increasing potential for interoperability problems and failures, and in compromised reliability and appearance of unforeseen events. Adequate resolution of these daunting problems, as well as increasing reliance on information technology (IT) solutions, demand adopting systems and SoS-based approaches during all phases of development and fielding. RDECOM assumes leadership in providing such emphasis by giving the responsibility for Army program support to a DCG with a strong systems and SoS expertise within his or her organization.

Using the latest technologies and system trends, the DCG SoS supports the PEO community that conceives new system architectures, evaluates these system architectures from the perspective of the new capabilities they provide and their associated costs and risks, and collaborates with TRADOC and other organizations to understand and incorporate emerging warfighter operational architectures. He or she also insures adequate and competent system architecture and engineering (SA&E) participation in program teams.

The DCG Operations provides similar support to the PM/PEOs following FUE. The DCG Operations also oversees and facilitates RDECOM support of the logistics communities in the AMC commodity commands.

<i>DCG Army of the Future Would Take the Lead on Most Mission 3 Tasks</i>				
<i>Component Mission</i>	<i>Tasks</i>	<i>DCG Operations</i>	<i>DCG System of Systems</i>	<i>DCG Army of the Future</i>
<i>3. Provide the technical vision for the Army of the future</i>	<i>Understand and anticipate global technology trends and developments</i>	<i>Tertiary responsibility</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Anticipate, articulate and manage a vision for future Army technical capability</i>	<i>Tertiary responsibility</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Participate in future warfighting concept development</i>	<i>Tertiary responsibility</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Manage ACTDs and ATDs</i>	<i>Tertiary responsibility</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>
RAND				

The DCG Army of the Future defines and articulates military-relevant technology trends and disseminates these trends throughout RDECOM, the Army, and joint commands involved in planning future national security efforts. Understanding the direction and rate of technological change is a critical aspect of developing a vision for the future Army. By providing a technical vision of the future, RDECOM can work closely with TRADOC and the Army leadership to map out the Army's future. This mapping exercise is an iterative, detailed process that develops approaches for optimizing the way in which soldiers and leaders can use technological enablers for shaping future security environments.

Finally, the DCG SoS exercises primary responsibility for planning, resourcing, and oversight of RDECOM ATDs and ACTDs and also provides technical support to ATDs and ACTDs proposed and led by other agencies. This recognizes that ATDs and ACTDs are more than just technology demonstrators and that their work has a systems character.

<i>DCG Army of the Future Would Have Lead Responsibility for Mission 4 Tasks</i>				
<i>Component Mission</i>	<i>Tasks</i>	<i>DCG Operations</i>	<i>DCG System of Systems</i>	<i>DCG Army of the Future</i>
<i>4. Attend to planning, management, and oversight of Army R&D and S&T work</i>	<i>Serve as integral part of Army's STO and S&T budget processes</i>	<i>Secondary responsibility</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Conduct world-class S&T research</i>	<i>Secondary responsibility</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Partner with other S&T institutions</i>	<i>Secondary responsibility</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Participate in setting standards and processes</i>	<i>Secondary responsibility</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
RAND				

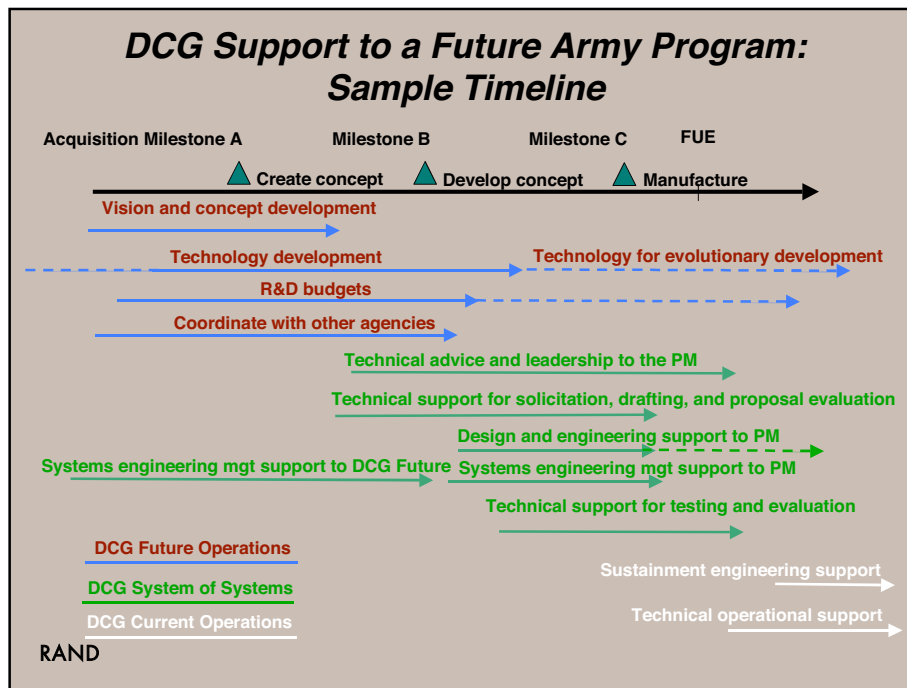
S&T, almost by definition, is work that normally has a longer-term focus. As noted earlier, this means that managing S&T is a responsibility of the DCG Army of the Future in an organizational RDECOM scheme with three DCGs. As a result, he or she coordinates RDECOM inputs to and participation in the development of the ASTMP and the Army's S&T Objectives (STOs). He or she represents RDECOM in the Warfighter's Technology Council and provides the commanding general with support for the ASTWG. Furthermore, the DCG Army of the Future is responsible for aligning and coordinating the actual S&T work in the laboratories and centers with the ASTMP and Army STOs.

The DCG Army of the Future also has primary responsibility for facilitating strong relationships between universities, industry, and other governmental organizations in order to co-develop technology and stay abreast of advances outside the Army. When the organization includes a Deputy for E&T, the job of maintaining outside relationships will most likely be split. The DCG Army of the Future will remain motivated to look for new technology trends that will impact the larger Army, while the Deputy for E&T's primary concern will be to keep his or her organization, staff, and facilities current with the state of the art. Finally, the DCG Army of the Future insures Army participation in associations that develop and maintain Army-relevant standards and processes and is charged

with developing technical standards, processes, and procedures that are specific to the Army. If available, the Deputy for E&T also assists in this function.

The DCGs for Operations and SoS perform a supporting role in this mission area. In particular, the DCG for SoS insures that Army S&T planning is adequately focused at the systems level and that S&T execution is such that systems integration is sufficiently considered. Since he or she is the Army's principal point of contact concerning matters of systems and SoS engineering, the DCG SoS insures that relationships with outside organizations that are centered in this area are nurtured, including those that develop systems engineering standards and processes. Additionally, the DCG SoS provides the Army an understanding of the most recent and emerging versions of the DoD Architecture Framework, systems engineering standards, and certification requirements.

We have not discussed the explicit budgets or budget process that would define the budgets for the DCGs, as we feel this is something that should be done in a more detailed phase of RDECOM's organizational design. Such budgets and RDECOM's core budget planning responsibility and authority must lie with the DCGs if they are to exercise the influence required to make a matrix organizational design effective.



This chart shows RDECOM support for an Army acquisition program throughout its life cycle. As noted earlier, support is managed by different DCGs depending on the phase of the program. The DCG Army of the Future is responsible during early technology and concept development before the Milestone B shown on the chart. The DCG SoS provides the most significant support during SDD, and DCG Operations is the lead DCG after FUE.

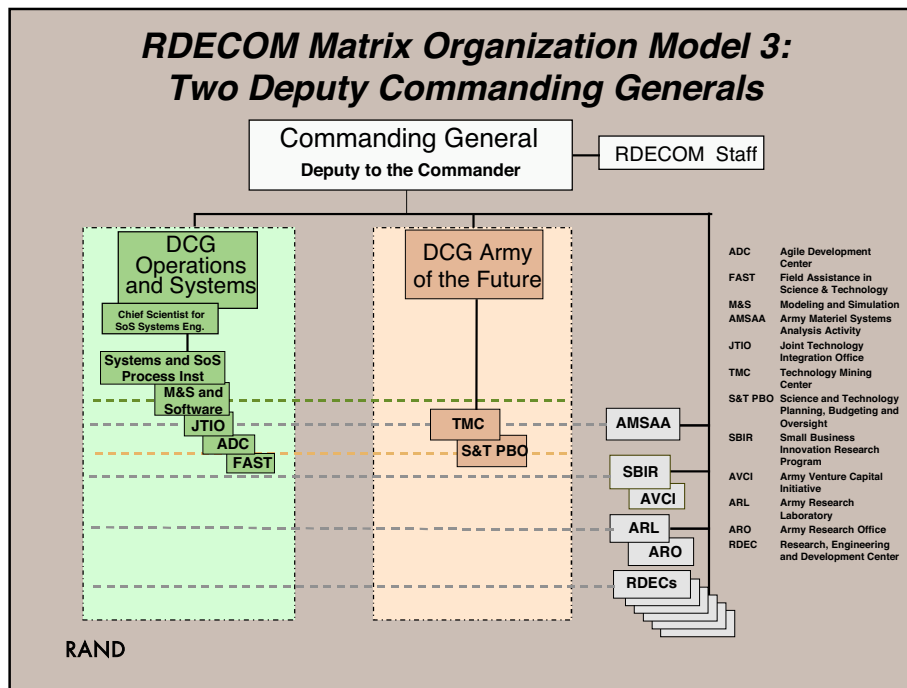
As should have been clear from the earlier discussion, there are two significant differences in how the proposed organization supports the Army's materiel acquisition programs and how they have been supported over the last few decades. First, instead of the individual laboratories and centers coordinating R&D support directly with the PM/PEOs, TRADOC, and the Army Staff, this support is coordinated through RDECOM headquarters, specifically through one of the DCGs, depending on the phase of development.⁶ Managing R&D support

⁶ The DCGs have the management responsibility and authority to insure that the AMC laboratories are coordinated with PM/PEOs, TRADOC, and the Army Staff. However, we expect that there will be other, informal avenues and lines of collaboration that will supplement the

in this manner provides much greater opportunity to integrate the support across the laboratories and centers, eliminate redundant efforts, and find the best solutions and best personnel for each issue.

Coordinating through RDECOM headquarters also leads to the second significant difference. Today and into the future, most Army programs are expected to be network-centric and to have a strong systems and SoS emphasis. Lately, SoS-heavy programs such as the Future Combat Systems (FCS) have presented a unique challenge to the Army RD&E community. Without a strong SoS focus of its own, the Army has had to rely on its contractors (as lead systems integrators) for much of the SoS oversight. While such arrangements can sometimes be made satisfactorily, there remains a danger that, by not having an organic “smart buyer” capability, the Army will lose control of its materiel acquisition programs. The construct proposed in this report advances an Army R&D organization in which the Army retains a strong SoS leading role in future programs, with RDECOM acting as the main enabling force for that vision.

DCGs’ efforts and ultimately make them more effective. As in any organization, however, informal communications and collaborations must not be allowed to run counter to formal, official efforts.



TWO MODELS FOR ORGANIZING UNDER TWO DEPUTY COMMANDING GENERALS

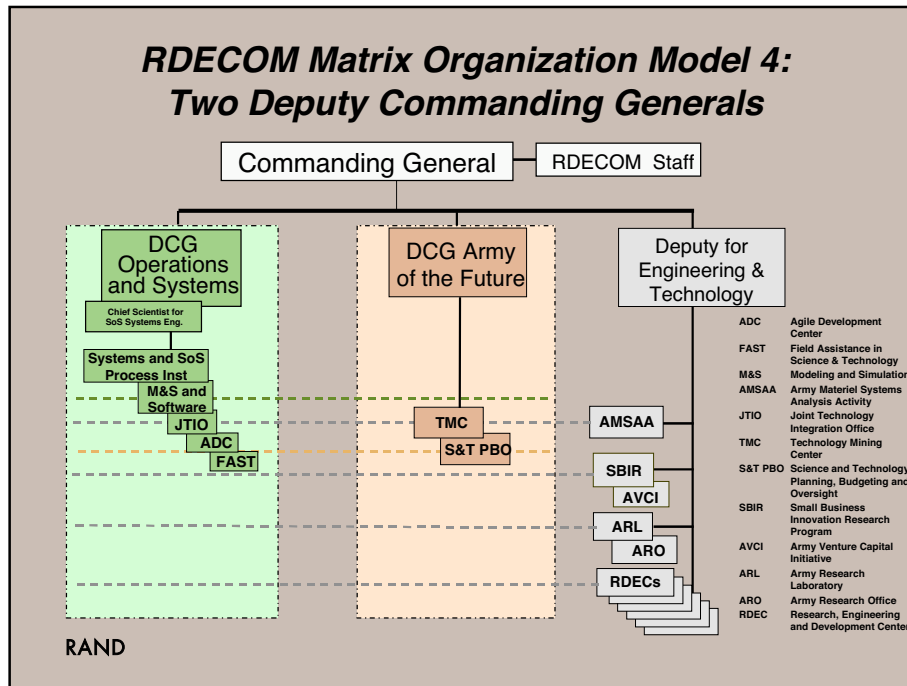
As part of this study, we were asked to consider the impact if only two brigadier general positions are authorized to fill the DCG positions. While having three DCGs is the better solution, RDECOM could function effectively with only two.

Model 3

Original discussions with the RDECOM commander and his staff suggested consolidating the DCG Army of the Future and the DCG System of Systems. However, after some thought it became apparent that the better option was to consolidate the DCG Operations and DCG System of Systems. This creates a mission area with substantial responsibility, but the advantage is that it collects those missions that require support and collaboration with PM/PEOs under one DCG. This also creates a relatively convenient split in terms of funding. Most of the activities managed by the new “DCG Systems and Operations” are customer funded, while the DCG Army of the Future’s funding comes primarily from RDECOM’s core budget. Finally, this mission apportioning will enable the

presence of a strong systems perspective within existing and future acquisition programs.

The heavy load that the DCG Systems and Operations would carry naturally suggests that his or her staff would be large enough to provide effective support. Additionally, we advocate that the DCG Systems and Operations be the senior brigadier general in RDECOM and be supported by a number of senior personnel.



Model 4

As noted earlier, the RDECOM commander has a very large organization with many different pieces. With only two DCGs assisting the commander, it is even more important that the commander have additional help in managing the day-to-day operations of the functional organizations in RDECOM. Accordingly, this model includes a Deputy for Engineering and Technology.

<i>The Two DCGs Would Share Responsibility for RDECOM's Component Missions</i>		
<i>Component Missions</i>	<i>DCG Systems and Operations</i>	<i>DCG Army of the Future</i>
<i>1. Provide technical support to current operations</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>
<i>2. Provide technical support to Army acquisitions programs</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>
<i>3. Provide technical vision for the Army of the future</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
<i>4. Plan, manage, and oversee S&T and R&D</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>

RAND

COMPONENT MISSION AND TASKS ALLOCATION WITH TWO DEPUTY COMMANDING GENERALS

In the construct with only two DCGs, the proposed primary responsibilities are as follows:

- Planning and execution of Army S&T occur under the leadership of DCG Army of the Future.
- Providing the technical vision for the Army of the 21st Century is the responsibility of that same DCG.
- Providing support to Army acquisition programs for both pre- and post-FUE phases is the responsibility of DCG Systems and Operations.
- Supporting current operations is also managed by DCG Systems and Operations.

It is important to point out that this apportionment of responsibilities only pertains to the leading roles, and that the two DCGs do not operate independently of each other. Instead, as subsequent charts show, each DCG plays a strong supporting role with respect to the other.

<i>DCG Operations and Systems Would Have Lead Responsibility for Mission 1 Tasks</i>			
<i>Component Mission</i>	<i>Tasks</i>	<i>DCG Systems and Operations</i>	<i>DCG Army of the Future</i>
<i>1. Provide technical support to current operations</i>	<i>Provide technical advice and support to Army and Joint commands</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>
	<i>Identify opportunities for rapid technology insertion</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>
	<i>Provide rapid technical solutions to address time-critical Army and Joint Services requirements</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>
RAND			

The responsibility for supporting current operations and commanders in the field belongs to the DCG Systems and Operations. Among these tasks is the one to “provide rapid technical solutions to address time-critical Army and Joint Services requirements.” While these requirements do not occur on a constant basis, when they do, managing them takes a focused effort because they are time-sensitive and are typically addressing the urgent needs of field commanders and their soldiers. The DCG Systems and Operations has a full load of duties that cannot be ignored or slighted, even when managing emergency requirements. As a result, he or she will most likely require a relatively senior subordinate who can focus on these missions when they arise.

DCG Operations and Systems Would Take the Lead on Mission 2 Tasks

<i>Component Mission</i>	<i>Tasks</i>		<i>DCG Systems and Operations</i>	<i>DCG Army of the Future</i>
<i>2. Provide technical support to Army acquisitions programs</i>	<i>Provide engineering leadership, technical staff as matrix support and IPT members and services to PM/PEOs</i>	<i>Pre FUE</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>
		<i>Post FUE</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>
	<i>Provide matrix support for sustainment of the logistics communities in the MSCs</i>		<i>Primary responsibility</i>	<i>Secondary responsibility</i>

RAND

Support to Army acquisition programs and sustainment support to fielded systems is the responsibility of the DCG Systems and Operations under the two-DCG RDECOM design. As before, the DCG Army of the Future provides support as needed, primarily through knowledge of technology development outside the Army and among its contractors.

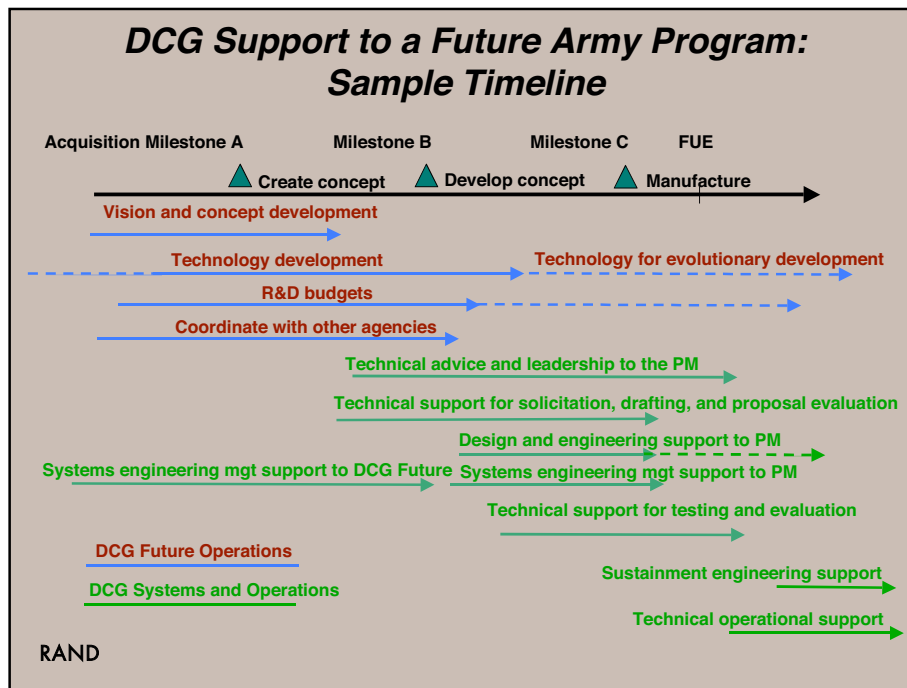
<i>DCG Army of the Future Would Have Lead Responsibility for Most Mission 3 Tasks</i>			
<i>Component Mission</i>	<i>Tasks</i>	<i>DCG Systems and Operations</i>	<i>DCG Army of the Future</i>
<i>3. Provide technical vision for the Army of the future</i>	<i>Understand and anticipate global technology trends and developments</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Anticipate, articulate, and manage a vision for future technical capability for the Army</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Participate in future warfighting concept development</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Manage ACTDs and ATDs</i>	<i>Primary responsibility</i>	<i>Secondary responsibility</i>
RAND			

The primary responsibility for collaborating with TRADOC, the Army Staff, and other organizations in the formulation of long-term visions and plans for the Army remains the responsibility of the DCG Army of the Future under a two-DCG design. Management responsibility for ACTDs and ATDs falls to the DCG Systems and Operations.

<i>DCG Army of the Future Would Take the Lead on Mission 4 Tasks</i>			
<i>Component Mission</i>	<i>Tasks</i>	<i>DCG Systems and Operations</i>	<i>DCG Army of the Future</i>
<i>4. Plan, manage, and oversee S&T and R&D</i>	<i>Serve as integral part of Army's STO and S&T budget processes</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Conduct world-class S&T research</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Partner with other S&T institutions</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
	<i>Participate in setting standards and processes</i>	<i>Secondary responsibility</i>	<i>Primary responsibility</i>
RAND			

The DCG Army of the Future's role in the planning and conduct of Army S&T is essentially the same as described earlier under the three-DCG scheme.

The DCG Systems and Operations performs a supporting role to the DCG Army of the Future with regard to the planning and conduct of S&T. One of his or her primary roles is to insure that the S&T program is overlaid with systems and SoS perspectives.



With two DCGs, support to Army systems is very similar to that shown earlier, but the DCG for Systems and Operations takes on the entire support responsibility after Acquisition Milestone B.

5. IMPACT OF THE RDECOM MATRIX ORGANIZATIONAL DESIGN ON THE ARMY

Briefing Outline

- RDECOM's mission statement and component missions
- The matrix organizational design
- Reorganizing RDECOM
- ➔ • Impact of the RDECOM matrix organization on the Army
- Strategies for long-term success
- Concluding remarks

RAND

Applying a matrix organizational design to RDECOM will affect its:

- Planning, budgeting, and oversight
- Support of its PM/PEOs
- Staffing
- Delegation of commanding general responsibilities and reporting structure
- Ability to create an engineering and technical center of mass.

These consequences are discussed further below.

***Matrix Affects Planning, Budgeting,
PM/PEO Support, and Staffing***

- **Consolidates planning, budgeting, and oversight**
 - Support for system of systems and current operations
 - DCGs for SoS and Operations (three DCGs)
 - DCG Systems and Operations (two DCGs)
 - S&T - DCG Army of the Future
- **Manages PM/PEO support coordination through**
 - DCGs for SoS and Operations (three DCGs)
 - DCG Systems and Operations (two DCGs)
- **Changes staffing arrangements**
 - Distributes current SoSI staff among DCGs
 - May require additional staff to support DCGs
 - Permanent
 - Temporary and/or virtual

RAND

An important consequence of having RDECOM organized within a matrix framework is a top-level consolidation of planning, budgeting, and oversight under three or two DCGs as shown in the chart.

A second important consequence is better-coordinated support for Army acquisition programs.

Third, staff currently under the Systems of Systems Integration Directorate is to be reassigned among the DCGs depending on functions and skill set. The Agile Development Center and the Field Assistance in Science and Technology group will operate under the leadership of the DCG Operations. The Systems and SoS Process Institute and the Joint Technology Integration Office proposed in RAND Arroyo Center's System of Systems Integration Directorate study, as well as the Modeling and Simulation group, stay under the DCG SoS. The Technology Mining Center and the S&T Planning, Budgeting and Oversight office are transferred to the DCG Army of the Future.

Additional staff for the DCGs will be required. These personnel would come primarily from RDECOM's laboratories and centers. Adding the DCGs to RDECOM and making them responsible to the RDECOM commander for managing and coordinating the organization's primary missions means that

much of this load is removed from the laboratories and centers. As a result, many of the personnel who currently work for the laboratories and centers as marketing specialists, planners, and coordinators should be available to the DCGs. Finally, if RDECOM is to become AMC's engineering and technical center of mass, a greater degree of coordinated work with other Army agencies such as TRADOC and the Assistant Secretary of the Army (Acquisition, Logistics and Technology) will be needed. This will require more cross-assignment with these organizations and will occur on a permanent, temporary, virtual, or rotational basis, as the needs and demands on the command evolve.

***Matrix Redistributes Responsibilities and
Creates an AMC Engineering and Technical
Center of Mass***

- **Delegates commanding general responsibilities and focuses reporting structure**
 - DCGs responsible for different aspects of Army support
 - Other Army RDE programs (AVCI and SBIR) integrated into broader RDECOM efforts
 - Distribution of current SoSI functions across DCGs
- **Establishes RDECOM as the Army's engineering and technical center of mass for combat and support systems**
 - Provides focused and continual technical support to TRADOC for planning the Army's future
 - Provides focused and dedicated technical support for fielded materiel, current operations, and soldiers
 - Gives RDECOM more responsibility for Army S&T planning and execution
 - Enforces a systems view on the development of the future Army

RAND

In the existing RDECOM organization, close to a dozen different functional organizations report directly to the commanding general. Two of the proposed matrix organizations (models 2 and 4) delegate the commander's day-to-day management and oversight responsibility of these organizations to a Deputy for Engineering and Technology. Moreover, a focused reporting structure is generated under the leadership of the DCGs, each one of them being responsible for a different subset of the RDECOM mission. The proposed organizational changes also bring the Small Business Innovation Research (SBIR) and the Army Venture Capital Initiative (AVCI) to RDECOM as additional R&D resources. They also reassign the functions of both the System of Systems Integration Directorate proposed by the prior RAND Arroyo Center study and the current System of Systems Integration Directorate across the DCGs to realign them with the proposed DCG mission allocations.

The proposed construct fosters strengthening of RDECOM's relationship with the Army and other organizations by making RDECOM the Army's engineering and technical center of mass. Doing so allows more focused technical support for generating the vision of and planning for the future Army. It also provides committed and dedicated technical support to fielded units by providing a single gateway to the Army's technical community. Consolidation of AMC's technical

organizations and greater focus on the RDECOM missions should eventually result in a more integrated approach to S&T planning as RDECOM takes a greater role in that planning. Finally, by giving the DCGs the responsibility for managing RDECOM's main mission areas and making the laboratories and centers responsive to the DCGs as technical service suppliers, a system of systems viewpoint can more easily be enforced.

6. STRATEGIES FOR LONG-TERM SUCCESS

Briefing Outline

- RDECOM's mission statement and component missions
- The matrix organizational design
- Reorganizing RDECOM
- Impact of the RDECOM matrix organization on the Army
- ➔ • Strategies for long-term success
- Concluding remarks

RAND

In the previous section, we discussed some of the immediate consequences of implementing a matrix organizational structure within RDECOM. Certainly during the implementation period and in the near term, the Army will need to be attentive to tried-and-true change management practices: encouraging open communication, providing adequate training and resources, etc. But what can the Army do to ensure that RDECOM fulfills its goals and achieves success in the long term? As it turns out, many of the same strategies apply. RAND Arroyo Center recommends that the Army focus on four key areas:

- Communication
- Rewarding desired behaviors
- Using metrics to evaluate success
- Allocating adequate resources to attract and train talented staff, maintain infrastructure, etc.

These are discussed in more detail below.

***Communication Is Key to Knowledge
Interchange and Knowledge Generation***

- **RDECOM should actively interface with Army, DoD, and other government agencies, academic and industry organizations, and individuals to**
 - **Maintain knowledge of and make contributions to the state of the technical art**
 - **Identify innovative ideas for using technology to address Army needs**
 - **Influence R&D policy**
 - **Promote RDECOM's capabilities and successes**
 - **Evaluate RDECOM performance**

RAND

R&D organizations like RDECOM depend on knowledge interchange to achieve knowledge generation. Achieving knowledge interchange obviously mandates interfacing with customers, competitors, and other R&D organizations. Effective communications and contacts with these other organizations will help keep RDECOM's staff knowledgeable about the state of the art in technical areas of potential military significance and will also provide the opportunity for RDECOM to make contributions to and influence that state of the art. Effective interfaces also provide a potentially rich source of innovative ideas for addressing Army needs. Working well with outside organizations is also necessary when these organizations control the resources coming into RDECOM. Failure to do so will result in reduced resources and an inability to affect the Army's overall S&T policy. Finally, discourse with other organizations is absolutely required as a means of promoting RDECOM and understanding how well the command is perceived as performing its mission.

***Build in Rewards for Individual and Group
Innovation and Improvement***

- **Make RDECOM an adaptive organization that can stay relevant in a rapidly changing technical world**
 - Utilize a dynamic organizational model
 - Create an institutional culture that rewards improvement and innovation
 - Provide opportunities for “heresy”

RAND

Today's Army is characterized by very rapid change. The expected operational environments are different than just a few years ago, new technologies are being incorporated—or faced—at ever-increasing rates, and even the basic warfighting organizations are changing. To stay relevant, RDECOM must be an adaptive organization that can adjust rapidly. This means that the organizational model for RDECOM must be a dynamic one. At the organizational level, incentive and response structures must be built into the organizational model so that innovation and improvement is rewarded, while stasis is discouraged. The matrix organizational model helps achieve this through the use of “market” forces to allocate budget. It requires the functional organizations to compete for resources that are controlled by the DCGs, who are responsible for overall mission accomplishment. If functional organizations fail to perform adequately or lose relevance to the overall mission, they lose in the competition for resources. At the individual level, professional advancement and other personnel incentives should be tied to improvement and innovation. Self-improvement efforts by RDECOM personnel at all levels of the ladder should be rewarded.

Finally, as the Army's engineering and technical center of mass, RDECOM should be a place that nurtures “heresy” and defines the cliché “out-of-the-box thinking.”

***Establish Metrics That Measure RDECOM
Performance Against Goals and Over Time***

- **Search for and implement measures to monitor and promote improvement**
 - Identify and use appropriate metrics
 - Utilize measures to improve and optimize processes

RAND

An institution that strives for excellence adopts adequate metrics to continuously assess improvement. As such an institution, RDECOM must establish a comprehensive set of metrics that measure RDECOM performance against its stated missions and are adapted over time to changing circumstances. Developing adequate metrics, maintaining them, and using their results takes significant leadership attention as well as understanding at all levels of the organization being evaluated. Further, the organizational culture must view these metrics not as a burden to be gamed, but as a tool for improvement. The effort is well worth it. All modern management techniques, from Six-Sigma to the Balanced Scorecard, emphasize the critical role of effective metrics for making continual improvement in organizations.

***Allocate Adequate Resources to Maintain
RDECOM State-of-the-Art Capabilities***

- **Manage a dynamic and highly qualified workforce**
 - **Attract and hire talented scientists and engineers**
 - **Provide constant opportunity for workforce education**
 - **Formal and informal**
 - **Develop, manage, and improve the Uniformed Army Scientist Program**
- **Plan and invest in Army RD&E infrastructure**

RAND

Maintaining state-of-the-art capabilities within RDECOM requires attracting and sustaining a highly motivated cadre of talented scientists and engineers.

Attracting talented technical personnel requires a combination of interesting work, adequate compensation, and a challenging work environment. While this is largely a common sense statement, making it happen is often difficult and requires resources. Sustaining the workforce also requires resources.

Technicians and engineers should periodically participate in specialized training that gives meaning to their work. Education for all researchers should be encouraged, as should support for well-established academic programs that lead to advanced degrees. As the primary employer of active and reserve scientists in uniform, RDECOM must play an active role in managing and improving the Uniformed Army Scientist Program.

The second strategy is to plan and invest in research, development, and engineering infrastructure. The creation of RDECOM should improve the Army's ability to prioritize funding for R&D infrastructure, making the distribution of funds less a "pie-cutting" exercise among AMC's major subordinate commands and more an exercise in putting resources where they are needed most.

All the points made on this chart require an investment of time and money. More than many other types, however, R&D organizations are very sensitive to how well their physical and intellectual capital is maintained; failure to invest results in a rapid decline of effectiveness. State-of-the-art R&D requires state-of-the-art infrastructure. More importantly, if the environment for conducting R&D stagnates within an organization, the best and most creative minds will leave and new talent will hesitate to join.

We have not elaborated on the budget and budget allocations required to bring the redesigned RDECOM organization to fruition. This would be addressed in the next—more detailed—phase of RDECOM redesign, and would depend upon which of the four organizational models discussed in this report is chosen. However, we have gone to lengths to define the responsibilities of the DCGs and Deputy (where it applies), and these would be given budget authority commensurate with their responsibilities, since without this, the redesigns would not work.

7. CONCLUDING REMARKS

Briefing Outline

- RDECOM's mission statement and component missions
- The matrix organizational design
- Reorganizing RDECOM
- Impact of the RDECOM matrix organization on the Army
- Strategies for long-term success
- ➔ • Concluding remarks

RAND

We now finish the briefing with a few concluding remarks.

Concluding Remarks

To succeed, RDECOM must add value to the Army's RD&E efforts. It can do so by

- **Being recognized as the Army's technology and engineering center of mass**
- **Providing the Army a system of systems orientation and capability**
- **Proving adaptable to changes in technology and Army requirements**

RAND

The various laboratories and centers that were consolidated into RDECOM already helped shape America's Army as the most technologically advanced army in the world. For RDECOM to be successful as an organization it will have to provide the Army even greater real and perceived value. It will do so if it can achieve a better R&D focus and if it helps impose a greater system of systems orientation on the Army's technology and materiel acquisition and sustainment efforts. Additional value will also be realized if consolidation of the laboratories and R&D centers under one command can make them more adaptable to changing technology trends and Army needs.

Concluding Remarks (cont)

A matrixed RDECOM can provide the RD&E integration, flexibility, and responsiveness vital to our engaged and transforming Army, but realigning the current components of RDECOM into a matrix organization will be difficult

- **Current culture and relationships have formed over several decades**
- **Control of resources must shift toward RDECOM HQs**
- **A capability to manage a system of systems approach must be developed, and the approach must be rigorously enforced**

RAND

The matrix organizational construct is the ideal paradigm for RDECOM, and remains so under all four organizational models proposed in this report. As discussed, it is a flexible, mission-focused organizational plan that will make the Army's R&D efforts even more responsive for our engaged and transforming Army.

We recognize that getting to a matrixed RDECOM will be very difficult, however. The organizations that make up RDECOM in its current form have developed over half a century or more. This means that each organization has developed a unique culture and a set of relationships that have proved valuable over time. The challenge will be to retain those aspects of organizational culture and the productive organizational relationships, while enforcing the matrix paradigm that cuts across stovepipes and pushes organizational adaptability.

Perhaps one of the most important and difficult changes will be the move to "quasi-market" mechanisms to allocate budgets. Shifting budgetary control more toward the DCGs, who have an RDECOM-level mission focus, is likely to prove very contentious. For example, coordination of "customer"-provided funding through the DCGs, rather than directly with the suborganizations of RDECOM, will be difficult for those suborganizations to accept. Likewise, the process of allocating RDECOM's core budgets will require significant

adjustment, not only in RDECOM itself but in the process that occurs between RDECOM and the Army Staff.

Finally, the Army generally and RDECOM specifically are just now beginning to develop a significant capability for system of systems engineering and integration. Such a capability is essential if RDECOM is to provide value as an organization. Developing such a capability will require resources and very significant leadership emphasis. Since a system of systems approach is new and substantially different from the approach RDECOM and its suborganizations currently apply, developing the capability and enforcing the approach will be a substantial challenge for several years.

Concluding Remarks (cont)

The commander of RDECOM can make very effective use of deputy commanders in a matrixed RDECOM

- **Three DCGs and a Deputy for Engineering and Technology provides the best solution**
- **Two DCGs and a Deputy for Engineering and Technology is an acceptable alternative**

RAND

The four organizational models provided address the two- and three-DCG possibilities that we were asked to consider, both with and without a separate deputy for Engineering and Technology. All of these are aligned to our analysis of the RDECOM mission statement and flow from the “strategies-to-tasks” paradigm that we applied to insure that this will happen. Considering workload, we believe that the three-DCG model with a Deputy for Engineering and Technology would work best, but all should work, and the choice of model may—in the end—be determined by budgetary concerns, officer availability, or other considerations.

APPENDIX

**SYSTEM OF SYSTEMS INTEGRATION DIRECTORATE
(SOSI)**

MISSION AND ORGANIZATION

Bruce Held, Elliot Axelband, Jeff Drezner

Published as a RAND draft report in September 2003. The following pages retain their original pagination.

PREFACE

This annotated briefing presents the results of a study undertaken to recommend an organization for the U.S. Army Research, Development and Engineering Command's System of Systems Integration Directorate. It begins by identifying a mission and strategy set for the directorate and then organizing to accomplish those missions and strategies. This research will be useful to those responsible for setting up and managing the Army's science and technology efforts in particular, but also to those charged with organizing any new research group.

The Commanding General of the U.S. Army Research, Development and Engineering Command sponsored this study and it was conducted in the Force Development and Technology Program of the RAND Arroyo Center. The Arroyo Center is an Army-sponsored federally funded research and development center.

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SUMMARY

In recognition of the system of systems engineering and integration challenges that future Army acquisition programs represent, particularly the Future Combat Systems (FCS), a System of Systems Integration Directorate (SOSI) has been established as a part of the Army's Research, Development and Engineering Command (RDECOM). The importance of this new directorate was emphasized when MG John Doesburg, the first RDECOM Commanding General, directed that SOSI would be led by the only other general officer in RDECOM and that the SOSI director would also be appointed as the RDECOM Deputy Commanding General.

After SOSI's establishment, its management asked RAND to help it plan and develop the new organization. To accomplish this assignment RAND used a strategy-to-tasks framework that was modified to make organizational decisions. This approach identified the broad mission of SOSI, identified strategies and tasks to accomplish the mission, and then created an organizational structure to manage the strategies and tasks.

Our proposed SOSI mission statement is "Enable a system of systems research, development and engineering perspective throughout technology development, acquisition, testing, sustainment and related business processes." It has two bases. First, RDECOM is the Army's technologist and SOSI must be able to support this fundamental requirement. Program managers rely on RDECOM for technically oriented matrix support and expert advice when developing materiel, TRADOC relies on RDECOM for the "crystal ball" view of the technical future, and combat formations rely on RDECOM for technology applications to support current operations. This broad responsibility means that RDECOM must be capable of providing technology support throughout the life cycle of Army systems: from concept, development and fielding to long-term sustainment and disposal.

Second, as technologies grow increasingly complex and as the Army grows more and more reliant on advanced technologies, the system of systems perspective becomes progressively more important. The growing complexity implies greater connectedness across the battlespace and an ever-increasing number of interfaces between systems, as well as between humans and systems. While this trend implies an ever-increasing potential for breakdowns, system conflicts, and

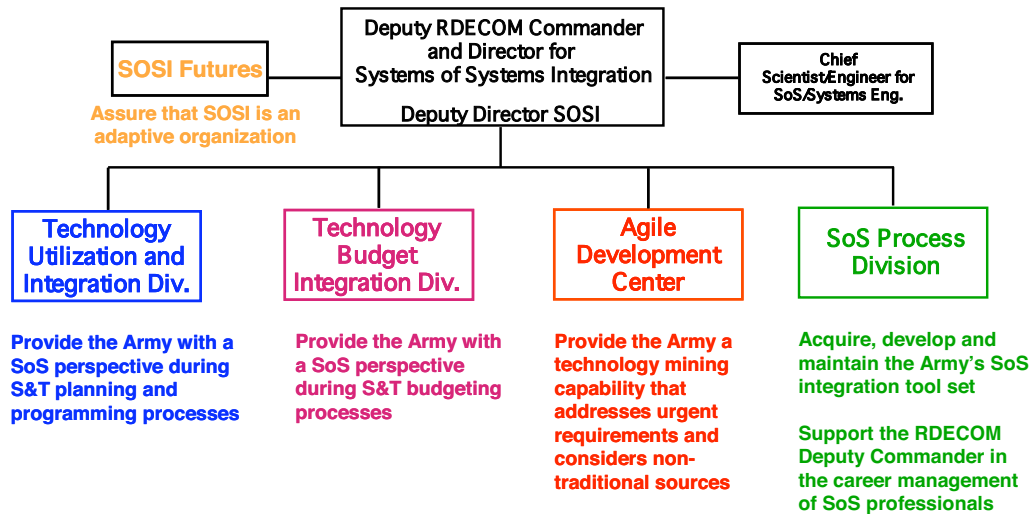
unintended events, the Army's growing reliance on advanced technology requires improving reliability and predictability from the systems it uses. The only way to manage this daunting contradiction is to understand and aggressively manage Army materiel, doctrine, and people from a system of systems perspective.

This perspective means trading off technology capabilities against requirements, cost, and schedule. It means iteratively experimenting across a broad range of environments and operational contingencies. It requires the development and use of modeling and simulation to an extent well beyond previous practice. Most importantly, it demands an ability to manage very high levels of complexity quickly, efficiently, and flexibly.

From the fundamental SOSI Mission Statement we extract six strategies which are required to accomplish the fundamental mission:

1. Provide the Army with a SoS perspective during S&T planning, programming, and budgeting processes.
2. Provide the Army a technology mining capability that addresses urgent requirements and considers nontraditional sources.
3. Acquire, develop, and maintain the Army's SoS integration tool set.
4. Facilitate a capable cadre of SoS talent that is available for critical Army R&D, acquisition, operational, and sustainment functions.
5. Support the RDECOM Deputy Commander in the career management of SoS professionals.
6. Assure that SOSI is an adaptive organization.

The proposed organization illustrated on this chart to the right has been designed to carry out the six strategies and achieve the SOSI mission. It is headed by a brigadier general who has the dual responsibilities of Deputy RDECOM commander and Director for System of Systems Integration. SOSI is organized into four divisions: the Technology Utilization and Integration Division, the Technology Budget Integration Division, the Agile Development Center, and the SoS Process Division. The SOSI Futures Office is a separate office reporting directly to the director.



The core technical expertise of SOSI centers around the Army Chief Systems Engineer. He/she will act as the director's principal advisor concerning technical matters and the Army's technical leader for systems and SoS engineering and integration.

The Technology Utilization and Integration Division's primary function is to insure that the S&T program, from planning to implementation, is overlaid with a SoS perspective. The division has two offices: the S&T Planning and Coordination Office and the Joint Technology Integration Office. The S&T Planning and Coordination Office will assure that the right foundation is in place for Army SoS through participation in the S&T planning process. In the end, SoS must achieve certain capabilities that are realized by individual technologies or groupings of technologies as synchronized across the DOTMLPF spectrum. The Joint Technology Integration Office will facilitate cross-cutting integrated product/process teams (IPT) that address groupings of technologies that require systems and SoS approaches if they are to be most successful. The Joint Technology Integration Office will also identify, propose, and oversee multi-functional ATDs and ACTDs.

The Technology Budget Integration Division will perform the financial function of assuring that the result of the S&T planning process is an executable budget. To make this happen, it will integrate the S&T budget inputs to the RDECOM budget. It will also work closely with the S&T Planning and Coordination Office

and the Assistant Secretary of the Army (Acquisition, Logistics, and Technology), or ASA(ALT), to develop future S&T funding requirements.

The Agile Development Center will address near-term field problems, find and examine technologies being developed by nontraditional sources, and manage the Army Venture Capital Fund.

The SoS Process Division provides the tools and training in the use of those tools to enable Army SoS engineers to make the DOTMLPF tradeoffs necessary to develop Army SoS. It also is the keeper of best SoS processes and a primary facilitator of training and certification programs for Army SoS engineers.

The SOSI Futures Office continually assesses the SOSI mission and its attainment, and proposes modifications to keep SOSI on a constant improvement path as an instrument of Army transformation. This office is also responsible for monitoring the status of the Army's cadre of systems and SoS professionals, providing advice and taking actions, in concert with other responsible Army organizations, to insure the continued vitality of this group.

ACKNOWLEDGMENTS

The authors wish to thank and acknowledge a number of people who made the work outlined in this briefing possible. Our sponsors, MG John Doesburg and BG Charles Cartwright, the Commanding General of the U.S. Army Research, Development and Engineering Command and the Director of the System of Systems Integration Directorate (SOSI) respectively, provided the support, advice, and vision that made the research possible. Several members of SOSI were instrumental in making the day-to-day arrangements for us and providing the information on which the research is founded. Our thanks therefore go to Mr. Roger Harold, Mr. Scott Tucker, and Dr. Paul Ehle.

Mr. Craig Barela and Ms. Karin Suede, both of RAND, provided us with support that made it possible for us to focus on the research.

Finally, we owe a debt of gratitude to the people in the organizations listed on Slide Two who endured our intrusions on their time and who were gracious and forthcoming in response to our questions.

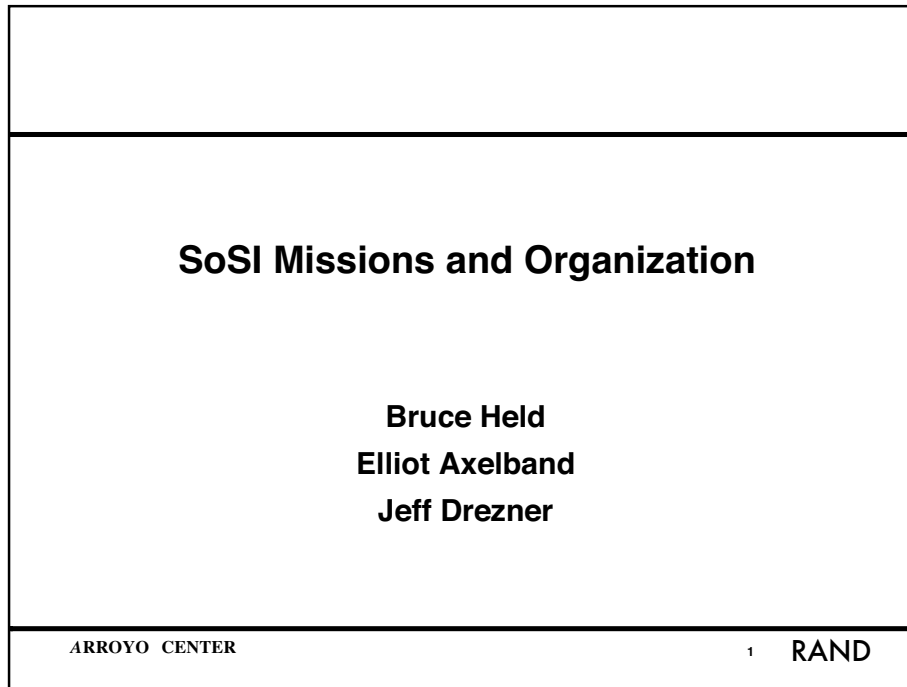
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ACRONYMS

ACTD	Advanced Concept Technology Demonstration
ADC	Agile Development Center
AF ISE	Air Force Institute for Systems Engineering
AMC	Army Materiel Command
Army CIO	Army Chief Information Officer
ASA(ALT)	Assistant Secretary of the Army (Acquisition, Logistics and Technology)
ATD	Advanced Technology Demonstration
ATEC	Army Test and Evaluation Command
DARPA	Defense Advanced Research Projects Agency
DASA (R&D)	Deputy Assistant Secretary of the Army (Research & Development)
DCSRDA	Deputy Chief of Staff for Research, Development and Acquisition
DoD CIO	Department of Defense Chief Information Officer
DOTMLPF	Doctrine, Organization, Training, Materiel, Logistics, Personnel, Facilities
FCS	Future Combat Systems
IPT	Integrated Product/Process Team
JFCOM	Joint Forces Command
LSI	Lead Systems Integrator
M&S	Modeling and Simulation
Navy CHENG	Navy Chief Engineer
PEO	Program Executive Officer
PM	Program Manager
RDECOM	[U.S. Army] Research, Development and Engineering Command
SBIR	Small Business Innovation Research
SOSI	System of Systems Integration Directorate

SoS	System of Systems
S&T	Science & Technology
TRADOC	Training and Doctrine Command

1. SOSI MISSION AND ORGANIZATION



In the Fall of 2001 the Army Materiel Command (AMC) Commanding General, GEN Paul Kern, directed his Deputy Chief of Staff for Research, Development and Acquisition (DCSRDA) to convene a workshop for AMC's research, development and engineering leadership. GEN Kern's motivation for the workshop was a desire to insure that AMC's technology generating organizations remained relevant and could effectively support the Army as plans for Army Transformation were developed and implemented. The AMC commander directed the workshop participants to examine the processes by which their organizations developed and transitioned technology to the Army. This examination was to lead to the identification of processes that could be improved and to implement improvements that would make the Army's technology generation and utilization more efficient and effective.

Over the course of the workshop the participants came to the conclusion that process improvement, by itself, was insufficient. Instead, they determined that a comprehensive reorganization of the Army's organic science and technology

organizations in AMC was called for, in addition to reengineering the processes of Army technology generation. As a result, a reorganization effort was initiated that resulted in the establishment of the Army Research, Development and Engineering Command (RDECOM) as a major subordinate command of AMC.

In recognition of the system of systems engineering and integration challenges that future Army acquisition programs represented, particularly the Future Combat Systems (FCS), a System of Systems Integration Directorate (SOSI) was established as a part of RDECOM. The importance of this new directorate was emphasized when MG John Doesburg, the first RDECOM Commanding General, directed that SOSI would be led by the only other general officer in RDECOM and that the SOSI director would also be appointed as the RDECOM Deputy Commander.

Organizations Interviewed	
RDECOM and SOSI Army Precision Strike Directorate TRADOC ATEC Army CIO DASA (R&D) DARPA DoD CIO LSI (Boeing and SAIC) Navy CHENG AF Center for System Engineering	
ARROYO CENTER	² RAND

After SOSI's establishment, its management asked RAND to help it plan and develop the new organization. To accomplish this assignment we used a modified strategy-to-tasks framework. (Glenn A. Kent, *A Framework for Defense Planning*, Santa Monica, CA: RAND Corporation, R-3721-AF/OSD, 1989.) The framework was modified in the sense that rather than using it to make resource and task planning decisions, we used it to make organizational decisions. We started by asking the leadership of RDECOM and SOSI what the broad mission of the organization should be. It is worth stressing that, while we made sure to understand what the organization was currently doing, we conducted our interviews with the purpose of learning the leadership "vision" for SOSI.

In addition, we also interviewed other Army organizations whose missions intersect with RDECOM and SOSI. We felt it important to understand what systems and system of systems engineering assets other Army organizations thought should reside internally in the Army. These included: The Army Precision Strike Directorate, an organization charged with M&S work directed by SOSI; the Training and Doctrine Command, the Army Test and Evaluation Command, the Army's Chief Information Officer, and the Deputy Assistant Secretary of the Army for Research and Development. We also interviewed the

FCS project manager at the Defense Advanced Research Projects Agency and the DoD CIO because of their obvious systems tie-in requirements with the Army.

Finally, we interviewed organizations outside the Army, including the lead systems integrator for FCS, the Navy, and the Air Force to learn what they are doing to manage their systems and system of systems engineering requirements. These organizations are important because they seem to either be planning to do, or are doing, the sorts of activities that are talked about for SOSI. Partly because the capability for system of systems engineering was insufficient inside the Army, a lead systems integrator was entrusted with most of that activity on the FCS program. The Boeing/SAIC team has been busy for a couple of years now, trying to manage this aspect of the FCS program. The Navy recognized the need for a SOSI-like organization a number of years ago because of difficulties with its Cooperative Engagement Capability system. As a result, it set up its Office of the Chief Engineer, now SPAWAR 05. That organization appears to have been successful in that carrier battle groups now sail with functioning battle systems. Finally, last year, Secretary of the Air Force James Roche (currently nominated to be the Secretary of the Army) directed the establishment of an AF Center for System Engineering because he felt that the Air Force had neglected systems engineering and integration for too long.

The Army Needs the System of Systems Integration Directorate		
• The future is transformation, transformation is network centric, and network centric is systems of systems • No system of systems focus in RDECOM except for SoSI • A specific action imposed by the DoD at the FCS milestone B review was to identify a focus for systems engineering in the Army. SoSI should be that focus. • Program offices cannot maintain an Army SoS Engineering focus; They only operate at the program level • Enables collaboration with parallel actions being undertaken by the DoD, Air Force and Navy		
ARROYO CENTER	5	RAND

Although establishing or defending the need for SOSI was not an original part of this study, we did a quick assessment anyway. Our conclusion is that the Army needs a SOSI organization. Future Army operations will depend on complex, networked SoS. As there is currently no focus within the Army for SoS expertise, establishing SOSI as that focus is important if the Army is to be a smart buyer of the systems and system of systems it will need. This requirement was even recognized at the DoD level, which made the identification of a systems engineering focus one of the conditions for continuing the FCS program at its milestone B review.

One suggestion has been that program offices can be the focus of the Army's organic systems engineering and integration capability. While program offices for SoS programs will develop or buy a SoS capability, they are temporary entities and cannot provide the long-term institutional SoS focus RDECOM and the Army require.

As we've seen in recent operations and as the DoD leadership insists, the concept of jointness is vital to the future of the American military. True jointness, however, is necessarily a function of collaboration between the services as they develop doctrine and materiel for future security environments. That

collaboration requires that the system of systems engineering and integration practices of the services be compatible. As noted earlier, the Air Force and Navy are well along in their efforts to have focused systems and system of systems engineering and integration organizations and programs. In particular, the Navy's Office of the Chief Engineer is a successful implementation of a system of systems focus. In discussions with RAND, Navy and Air Force personnel expressed enthusiasm about the Army initiating similar efforts and the prospect of collaborative future programs. Furthermore, they assured RAND that they will share their SoS knowledge base with SOSI.

Having validated the need for it, we proceed with the assumption that SOSI will endure and provide our views as to how to make it effective.

SOSI Mission Statement		
Enable a system of systems research, development and engineering perspective throughout technology development, acquisition, testing, sustainment and related business processes.		
ARROYO CENTER	7	RAND

Our proposed SOSI mission statement is “Enable a system of systems research, development and engineering perspective throughout technology development, acquisition, testing, sustainment, and related business processes.” It has two bases. First, RDECOM is the Army’s technologist and SOSI must be able to support this fundamental requirement. Program managers rely on RDECOM for technically oriented matrix support and expert advice when developing materiel, TRADOC relies on RDECOM for the “crystal ball” view of the technical future, and combat formations rely on RDECOM for technology applications to support current operations. This broad responsibility means that RDECOM must be capable of providing technology support throughout the life cycle of Army systems, from concept, development, and fielding to long-term sustainment and disposal.

Second, as technologies grow increasingly complex and as the Army grows more and more reliant on advanced technologies, the system of systems perspective becomes progressively more important. The growing complexity implies greater connectedness across the battlespace and an ever-increasing number of interfaces between systems, as well as between humans and systems. While this trend implies an ever-increasing potential for breakdowns, conflicts, and unintended

events, the Army's growing reliance on advanced technology requires improving reliability and predictability from the systems it uses.

The only way to manage this daunting contradiction is to understand and aggressively manage Army materiel, doctrine, and people from a system of systems perspective.

This perspective means trading off technology capabilities against requirements, cost, and schedule. It means iteratively experimenting across a broad range of environments and operational contingencies. It requires the development and use of modeling and simulation to an extent well beyond previous practice. Most importantly, it demands an ability to manage very high levels of complexity quickly, efficiently, and flexibly.

SOSI Strategies	
1.	Provide the Army with a SoS perspective during S&T planning, programming and budgeting processes
2.	Provide the Army a technology mining capability that addresses urgent requirements and considers non-traditional sources
3.	Acquire, develop and maintain the Army's SoS integration tool set
4.	Facilitate a capable cadre of SoS talent that is available for critical Army R&D, acquisition, operational and sustainment functions
5.	Support the RDECOM Deputy Commander in the career management of SoS professionals
6.	Assure that SOSI is an adaptive organization
ARROYO CENTER 5 RAND	

From the fundamental SOSI Mission Statement we extract six strategies which are required to accomplish the fundamental mission:

- 1. Provide the Army with a SoS perspective during S&T planning, programming, and budgeting processes.** Adopting a SoS perspective at the onset of the S&T planning process allows for the development, fielding, and sustainment of system of systems. Absent this early, internal perspective, the Army is likely to lose control of its own development.
- 2. Provide the Army a technology mining capability that addresses urgent requirements and considers non-traditional sources.** The Army's internal S&T capability must be capable of finding and exploiting technologies, whatever their source. More importantly, outside technology sources may suggest unique solutions to the Army's requirements. Exploiting such sources is often problematic, though, due to the "stovepiped" nature of current Army research and development activities. Placing a technology mining capability in SOSI allows a much broader perspective and greater opportunities for the exploitation of unique capabilities. It also facilitates more optimal inclusion of new capabilities into SoS that are being, or will be, developed.

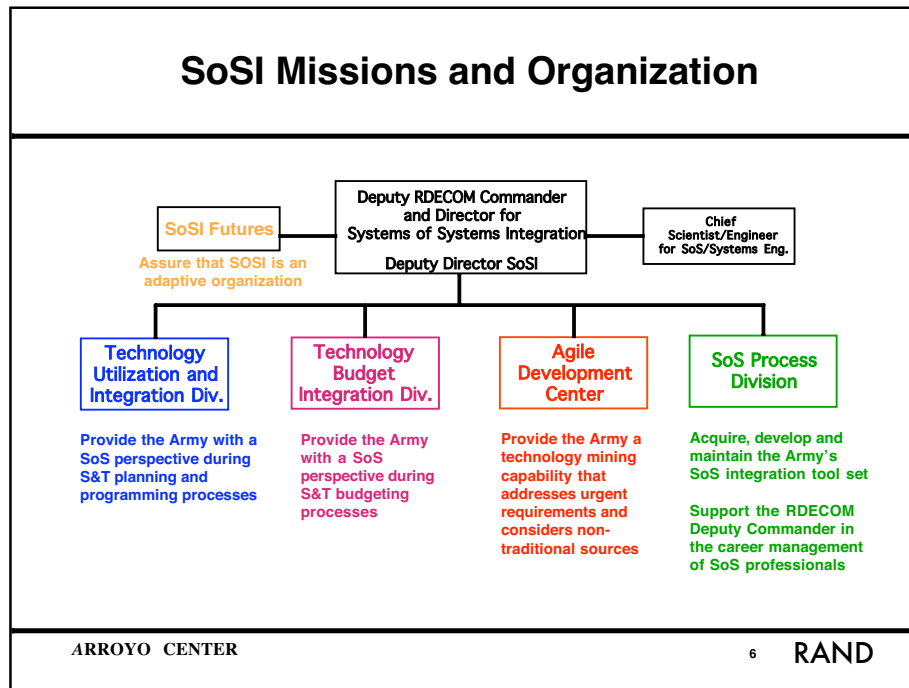
3. Acquire, develop, and maintain the Army's SoS integration tool set.

Without an Army-wide focus, the acquisition, development, and maintenance of Army SoS integration tools will either not happen or will happen in a haphazard and inconsistent manner, thus impairing or precluding effective management of the SoS trade-space. On the other hand, as the connectedness and complexity of the Army increases, central management of the Army's SoS integration tool set will enhance the Army's ability to manage its own transformation by providing consistent, validated tools for developing, experimenting, integrating, and evaluating new system of systems and the pieces that make them up.

4. Facilitate a capable cadre of SoS talent that is available for critical Army R&D, acquisition, operational, and sustainment functions. As the focus of systems and SoS in the Army, SOSI must be the source that the rest of the Army turns to when it needs that kind of help. This means identifying systems and SoS professionals throughout RDECOM, ensuring that these professionals are trained and capable at the state of the art, and helping to recruit talented professionals when needed.

5. Support the RDECOM Deputy Commander in the career management of SoS professionals. SOSI must work with the responsible Army personnel agencies to insure that systems and SoS professionals are encouraged and professionally rewarded for their contributions.

6. Assure that SOSI is an adaptive organization. All organizations must be adaptable to some degree or they will eventually fail. This maxim applies especially to SOSI. Systems and SoS engineering and integration is a relatively young and rapidly changing field. As a result, SOSI must routinely and effectively assess and evaluate its current utility and future role and adapt as necessary to maintain success.



The proposed organization illustrated on this chart has been designed to carry out the six strategies and achieve the SOSI mission. It is headed by a brigadier general who has the dual responsibilities of Deputy RDECOM Commander and Director for System of Systems Integration. The double title recognizes both the disciplinary nature of systems and SoS engineering and integration, as well as the overarching perspective that SOSI must maintain across the RDECOM.

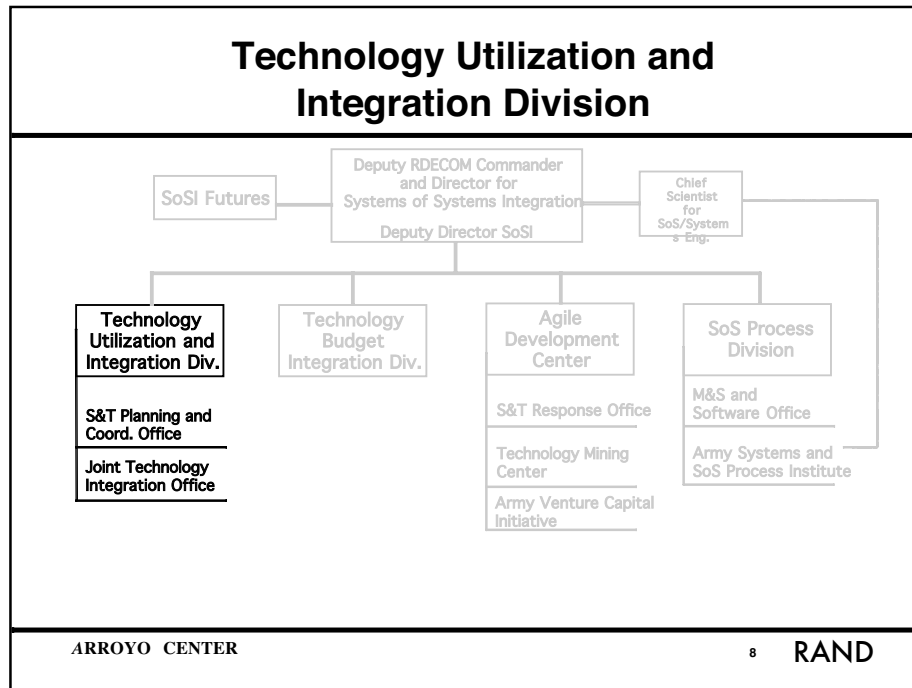
We suggest that SOSI be organized into four divisions: the Technology Utilization and Integration Division, the Technology Budget Integration Division, the Agile Development Center, and the SoS Process Division. Further, the SOSI Futures Office should be a separate office reporting directly to the director. We have organized these components of SOSI around the strategies discussed earlier, and we now turn to a discussion of each.

Director's Staff	
Deputy Director of SoSI • Assist the director	
Army Chief Scientist for SoSI/Systems Engineering and Integration • Provide technical SoS/systems advice to the Director • Provide technical mentorship to the SoSI Directorate • Act as RDECOM's internal and external first point of contact for SoS integration and engineering • Serve as the lead Army POC for SOS engineering as required by the FCS Milestone B decision	
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SOSI's mission is very important for the success of RDECOM and Army Transformation, and yet much of what it has to do will be accomplished through coordination with many affiliated organizations, to include: RDECOM, the Army Staff, PMs, PEOs, ATEC, TRADOC, DARPA, the Army CIO, the Navy CHENG, and the AF ISE, to name just a few. As such, the leadership of SOSI must be reasonably allocated. Our assessment is that this necessitates a deputy director for SOSI. The deputy director is an Army civilian employee. His/her responsibilities are defined by the incumbent director, though we envision the deputy director as providing leadership continuity in SOSI that the military commander cannot provide due to general officer rotation policies.

SOSI needs to be viewed as the center of SoS expertise within the Army. To be credible, this view must derive from professional recognition, not bureaucratic assignment. As such, SOSI must contain a small staff dedicated to expertise in system and SoS engineering—the core expertise of SOSI, headed by a Chief System Engineer, who by reputation, skill, and management capability is recognized as the Army Chief Systems Engineer. He/she will act as the director's principal advisor concerning technical matters and the Army's technical leader for systems and SoS engineering and integration. The Chief

Systems Engineer acts as the Army's "conscience" regarding systems and SoS engineering and integration, imbuing the SoS perspective throughout the Army, and especially across RDECOM. She/he must be the source of guidance for plans, evaluation, and support in this area.



The Technology Utilization and Integration Division's primary function is to insure that the S&T program, from planning to implementation, is overlaid with a SoS perspective. The division has two offices: the S&T Planning and Coordination Office and the Joint Technology Integration Office.

S&T Planning and Coordination Office	
Coordinate RDECOM's participation in the Army's S&T planning processes	
• Coordinate RDECOM input to and participation in the development of the Army S&T Master Plan • Coordinate RDECOM input to and participation in the development of the Army S&T Objectives (STO) • Support RDECOM in the Warfighter's Tech Council • Provide the RDECOM commander with staff support for the Army Science and Technology Working Group	
Oversee the Army SBIR program from a SoS Perspective	
Assess RDECOM S&T performance	
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The S&T Planning and Coordination Office will assure that the right foundation is in place for Army SoS through participation in the S&T planning process. For the most part, this involves managing RDECOM's input into the development of the Army's primary S&T planning processes and resource allocation estimates. While the Army's S&T planning process involves other Army agencies and organizations, RDECOM plays a very influential role as the Army's technologist. To fully utilize this influence, SOSI must provide RDECOM a focus and coordinating capability for S&T planning that prevents budgetary "pie-cutting" by the various R&D suborganizations in RDECOM and substitutes a SoS perspective that better optimizes the allocation of S&T efforts toward the vision for the future Army espoused by its leadership.

The Small Business Innovation Research (SBIR) program represents a significant portion of the Army's S&T budget. As such, planning the SBIR research agenda and insuring that the program develops from a SoS perspective is an important factor in effectively using SBIR funds. The S&T Planning and Coordination Office's process will manage this aspect of the program. In addition, the office will monitor research conducted in the SBIR program to assist in moving

relevant technology from the SBIR program into the Army's broader S&T agenda.

Technology planning is a periodic process. Therefore, planning conducted in any one year will be influenced by the success of prior planning. To be most effective, therefore, RDECOM's performance must be continually assessed. This function will be managed by the S&T Planning and Coordination Office. In addition to informing the S&T planning process, these assessments will also help the RDECOM commander manage the organization and will assist the Futures Office in charting the future course of RDECOM.

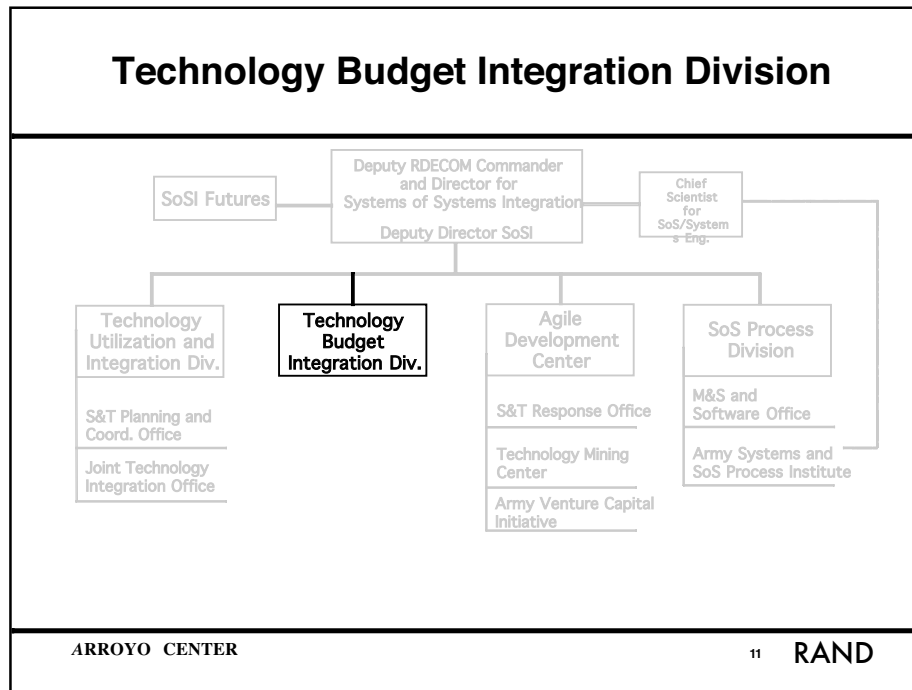
Joint Technology Integration Office	
Manage Integrated Product/Process Teams (IPT) chartered to harmonize horizontal technology integration across RDE Command and other Army and joint organizations	
Suggest and implement new IPTs when appropriate	
Coordinate activities with acquisition program IPTs	
Propose, plan and oversee multi-functional ATDs and ACTDs	
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In the end, SoS must achieve certain capabilities that are realized by individual technologies or groupings of technologies as synchronized across the DOTMLPF spectrum. The Joint Technology Integration Office will function by facilitating cross-cutting IPTs that address groupings of technologies. SOSI will manage these IPTs but will draw the expertise for them from across RDECOM (and other organizations when necessary). The purpose of the IPTs is to build and continually adapt S&T roadmaps to guide the development of broad capabilities for the Army. The capability areas embraced by the Joint Technology Integration Office are those that require systems and SoS approaches if they are to be most successful. For example, the broad capability of “survivability” has many facets, and the work to develop survivability crosses many S&T organizations. As the desirability of new capabilities is recognized, new IPTs will be formed to assure their inclusion in the Joint Technology Integration Office process.

While the IPTs that function under the Joint Technology Integration Office umbrella have little direct resource control, their output and recommendations will be provided to the SOSI director and RDECOM commander. The IPTs will also act as formal advisors to the S&T Planning and Coordination Office, thus influencing S&T planning and resource allocation.

The Joint Technology Integration Office will also have the vital function of supporting ongoing acquisition activities. Program offices typically form their own IPTs to address issues of importance and difficulty during the materiel acquisition process. We expect that many program IPTs will overlap the domains of established IPTs in the Joint Technology Integration Office. Since the expertise of the Joint Technology Integration Office IPTs will generally represent the Army's source expertise in a given capability area, very significant collaboration between them and program office IPTs will naturally occur.

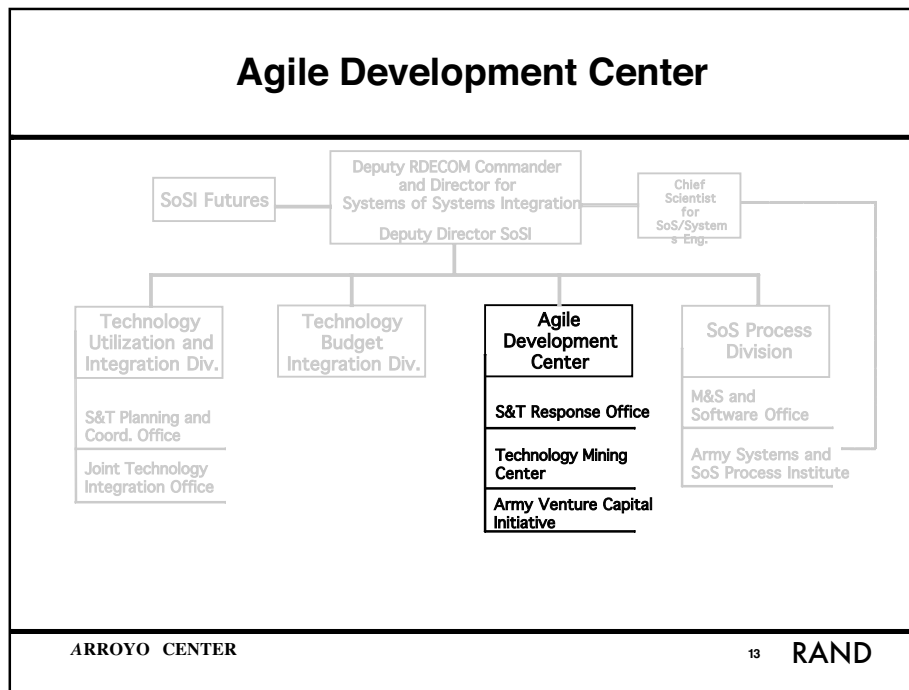
We also anticipate that as a natural part of this process, the Joint Technology Integration Office will identify, propose, and oversee multi-functional ATDs and ACTDs, in order to fully realize research in their capability areas.



The Technology Budget Integration Division, highlighted above, is discussed in the next viewgraph.

Technology Budget Integration Division	
Integrate the RDECOM RDE budget (6.1,6.2,6.3 & 6.7) Maintain close coordination between RDE budget development and S&T planning processes	
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The Technology Budget Integration Division will perform the financial function of assuring that the result of the S&T planning process is an executable budget. To make this happen it will integrate the S&T budget inputs to the RDECOM budget. It will also work closely with the S&T Planning and Coordination Office and the ASA(ALT) to develop future S&T funding requirements.



The Agile Development Center will address near-term field problems, find and examine technologies being developed by nontraditional sources, and manage the Army Venture Capital Fund.

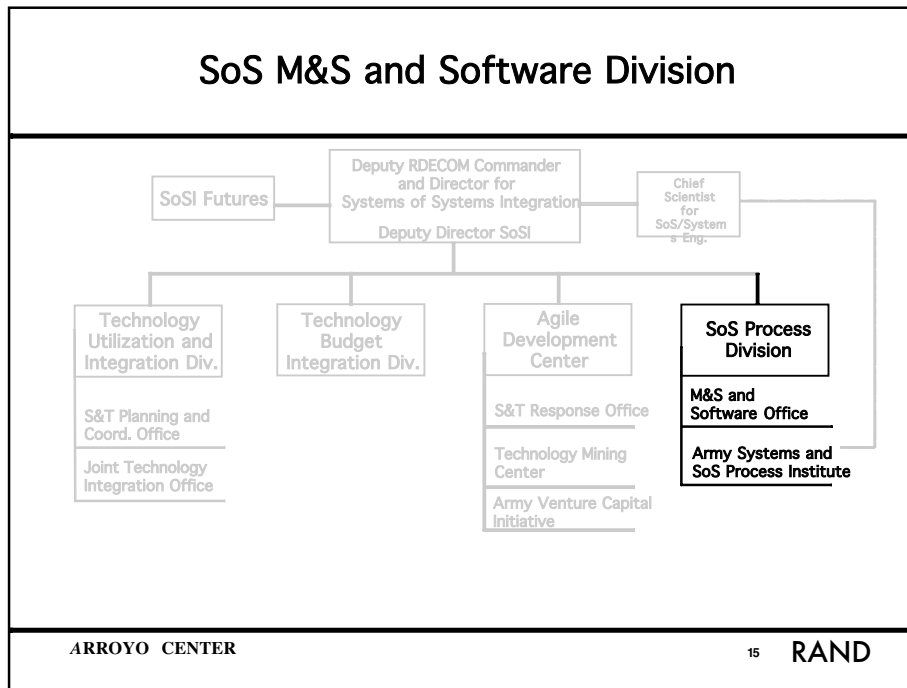
Agile Development Center	
S&T Response Office • Provide science and technology guidance, advice and support to senior Army and joint commanders • Address requests for rapid identification and/or development of solutions to urgent warfighter requirements – Actively solicit & anticipate warfighter requirements – Manage efforts to address urgent warfighter requirements	
Technology Mining Center • Identify and promote promising technologies and potential technology development partners: internationally, in commercial industry, and in other government organizations	
Army Venture Capital Initiatives Office • Manage the current and future Army Venture Capital Initiatives	
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The first function of the Agile Development Center (ADC) is to provide a rapid response to field problems. It does this by maintaining active contact and presence through ADC representatives who are stationed with field units. In addition to looking for current technology solutions and opportunities, these representatives serve as science and technology advisors to senior Army and joint commanders.

Since initially delivering this briefing, Mr. Bolton, the Army's senior acquisition officer, has approved a plan to form a cadre of highly qualified Army officers with advanced science and engineering degrees to serve in the field. One of their roles is to provide high-tech fixes for field problems. This program—the Uniformed Army Scientist and Engineer Program—plans to fill about 100 new 51S slots in the Army Acquisition Corps. This program closely aligns with the first function of the Agile Development Center, and clearly coordination must be achieved between the two. Also envisioned under the Uniformed Army Scientist and Engineer Program are a companion educational program and a career enhancement program. This relates closely to recommendations we will make in a later viewgraph for such programs directed at the careers of Army Systems Engineers.

The second function, technology mining, locates and assesses technology available outside of RDECOM that may be used to realize SoS capabilities. In particular, the Technology Mining Center looks for technology development outside the Army's normal sources. Finding these sources of technology can sometimes relieve the S&T budget, and can provide innovative new ideas and approaches that would otherwise go unnoticed.

The third function, the Army Venture Capital Initiatives Office, would begin with RDECOM assuming responsibility for oversight of the Army Venture Capital Initiative. Established by Congress in FY03 using \$25M seed funding, the Army Venture Capital Initiative is currently investing in power and energy technologies for the individual soldier. If the model is successful, however, additional venture capital programs could be established using returns generated by the first program, or additional funds that may be provided by the Congress in future years.



The SoS Process Division provides the tools and training in the use of those tools to enable Army SoS engineers to make the DOTMLPF tradeoffs necessary to develop Army SoS. It also is the keeper of best SoS processes and a primary facilitator of training and certification programs for Army SoS engineers.

M&S and Software Office	
Provide tools for DOTMLPF (SoS) trade-off analysis capability • Develop, maintain, and upgrade the Army's family of SoS M&S tools • Coordinate with SoS tool users to insure appropriate tool set • Propose policy and standards • Control tool configuration and interfaces (including protocols) • Maintain adequate security measures • Develop and maintain a program of tool validation • Develop and maintain training programs Maintain an awareness of developments in the SoS M&S tool market Collaborate with PEO Enterprise Information Systems to insure SoSI M&S tools are compatible with ACE and efficient in the ACE environment	
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The field of Modeling and Simulation (M&S) provides the primary SoS tools to manage the SoS trade space. Various government organizations and companies are developing and using such tools. The M&S and Software Office reviews the tools that are available and in development for Army use. It sponsors the development of unique tools the Army needs. It maintains/updates those tools as required and maintains a tool library including essential inter-tool interfaces. It develops programs to validate the tools and training programs to provide Army SoS engineers the knowledge necessary to use the tools.

This office also has two important liaison functions. The first is to maintain an awareness of the emerging SoS M&S tool market in order to anticipate the emergence of applicable tools. Second, it must maintain a close liaison with PEO Enterprise Information Systems to insure compatibility with its products and environments.

Army Systems and SoS Process Institute	
Insure the use of best SoS architecture and engineering practices	
Coordinate uniform/consistent use of software development tools and compatible software development throughout Army RDT&E	
Provide the Army's SoS Technical Knowledge Base	
• Maintain a library/database of systems/SoS eng. and int. resources • Develop and maintain a database of SoS lessons learned during Army (and other) SoS R&D and acquisition programs • Disseminate SoS lessons throughout the Army	
Support an SoS engineering and integration training program managed by the RDECOM Deputy Commander	
• Recommend requirements for a SoS Eng. training and certification program • Collaborate with Army educational/training organizations to provide training materials/classes/events to Army SoS eng. professionals • Recommend an exchange program for SoS professionals throughout the government and with industry and academia • Support professional affiliation with other SoS professionals in government, industry, academia and professional societies	
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The Army Systems and SoS Process Institute gathers, sorts, evaluates, and maintains a library of best system and SoS practices and tools, working in the latter case closely with its sister organization, The M&S and Software Office. It coordinates system and SoS practice and tool use throughout RDECOM, and more generally across the Army, to insure consistent use and compatible applications. It also disseminates applicable lessons learned.

The institute will also support the RDECOM deputy commander in his role of establishing training and certification programs for Army SoS professionals. This will require collaborating with Army education and training organizations to provide training materials (courseware) and qualified instructors in this area. It will include an exchange program for Army SoS professionals with the other services, departments of the government, industry, and academia. Finally, the institute will encourage and enable the affiliation and participation of RDECOM system and SoS engineers and scientists with the professional societies that represent those disciplines.

SoSI Futures	
Support the RDECOM Deputy Commander in his/her role as the Career Program Manager for SoS scientists and engineers • Identify the cadre of SoS personnel distributed across RDECOM • Recommend a systems/SoS career path in the Army • Provide career advice and counseling for Army SoS personnel • Recognize and reward SoS science and engineering performance Identify and recommend to the RDECOM Deputy Commander SoS expertise for: • Temporary, short, and long-term assignments to PEOs and PMs • Source selections, design reviews, milestone reviews and other critical Army acquisition events • Managing ATDs and ACTDs • Partnerships with TRADOC, JFCOM and other Army and DoD organizations developing future warfighting concepts	
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The future of SOSI requires the identification and nurturing of a cadre of Army SoS professionals. This will be a primary responsibility of the SOSI Futures Office. We anticipate that the bulk of this cadre will be found in the suborganizations of RDECOM and the Army acquisition program offices.

The SOSI Futures Office will also work with the responsible Army personnel agencies to assure that a career path for system and SoS engineers and scientists exists and that it can provide professionally rewarding careers. While this level of career management focus by an RDECOM agency may be somewhat anomalous, we feel it is appropriate to insure that systems and SoS professionals and organizations are established and built into a credible and effective force quickly. As the focus of Army systems and SoS engineering, SOSI, through the Futures Office, must help insure that SoS cadre members receive career path advice and are professionally encouraged and rewarded for their contributions. The Futures Office will help assure that there are available mechanisms to advance the educational and professional interests of the cadre, including participation in professional courses offered by educational institutions and through symposium attendance. It will consider and apply as appropriate cadre personnel assignment rotation programs both inside and outside the Army.

Such programs, in addition to professionally broadening cadre member experience, will provide expertise to PMs, PEOs, and other Army offices requiring SoS skills.

SoSI Futures (cont)		
Assure that SOSI is an adaptive organization • Monitor, assess and update SOSI mission accomplishments and requirements to support Army transformation • Investigate & explore external environment and state of the art in system of systems engineering • Plan and propose SOSI organizational, resource and personnel changes and implementing plans		
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SOSI Futures also continually assesses the SOSI mission and its attainment, and proposes modifications to keep SOSI on a constant improvement path as an instrument of Army transformation. It undertakes this by maintaining a current awareness of the state of the art in all components of SOSI's mission, including SoS engineering, and uses this latter as one component of its evaluation. By reviewing these factors, and related factors, using metrics and studies as required, SOSI Futures will propose modifications in mission, personnel, skill sets, and organization to enforce SOSI forward momentum.

SOSI Evolution Phases and Plan	
1. Get Agreement on SOSI Missions – June 03 2. Map SoSI missions to a revised organizational structure and develop implementation plan - Sep 03 3. Implement the organizational plan - FY'04 ➡ • Reorganize SoSI for mission accomplishment – Establish new offices and branches if needed – Right-size SoSI offices and branches – Move non-core functions • Staff • Train • Develop metrics • Implement, enable and publicize	
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Our impression is that we have reasonable support for our findings and have completed task 1 and much of task 2 above. The remainder of task 2 awaits a formal response from RDECOM that we are in agreement. Following that we are prepared to finalize the organizational plan and proceed with supporting implementation in FY04.

Implementation of an organizational plan is a living art. How it is done is as important as what is intended to be done. Anticipating that some changes will occur as part of the process of implementation, we look forward to organizing this effort with RDECOM and getting it underway.