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Organizational Management of Army Research

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PREFACE

This documented briefing presents an historical overview of the organizational management of the Army's combat materiel research. It includes historically based insights on how the Army can address the reorganization of its research and development structure.

One reorganization concept currently under consideration is to place R&D under a new research development and engineering command. Elements of this concept resemble constructs that the Army employed from 1985 to 1990. This research was conducted to shed light on how the previous constructs originated, how they were implemented, and why they were abandoned. Insights from the Army's past experience might illuminate beneficial features that should be incorporated in the new reorganization structure as well as prevent a repeat of what has already been tried unsuccessfully. This research will interest those involved in the design and implementation of new Army R&D constructs.

This research was requested and sponsored by the Deputy Chief of Staff for Research, Development, and Acquisition (AMCRDA-T) at the Army Materiel Command. This study is an element of various aspects of reorganization being examined within the Army Materiel Command Changing Work Force project. Other aspects include organizational design methodologies, organizational structures, and the organizational management of Air Force research. The study was conducted in the Force Development and Technology Program of RAND Arroyo Center. The Arroyo Center is a federally funded research and development center sponsored by the United States Army.

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SUMMARY

The Army has employed several basic organizational management constructs to conduct its research and development (R&D). They are the independent operation of the laboratories under the Technical Services, the Army Materiel Command (AMC) corporate labs complemented with the commodity-oriented labs, the parallel R&D and Readiness commands under the Materiel Development and Readiness Command, the Laboratory Command (LABCOM) construct, and the Army Research Laboratory (ARL) construct. As such, organizational management of Army combat materiel research in areas such as physics, chemistry, and electronics has progressed from a loosely structured decentralized construct to today's consolidated and centralized control mechanism.

During the first 162 years, from 1800 to 1962, while the labs operated independently under no formal central structure, major world events included the conduct and end of the World Wars and the Korean War. In 1915, the U.S. government was very concerned about how its military might perform in the future should the nation be drawn into another war. Thomas Edison publicly opined that scientific research aimed at military applications and the technological superiority such efforts would bring was the answer to the government's concern. His remarks were an influential event in military research. In 1916, Congress established the Naval Research Laboratory and charged it with conducting research aimed at military applications in order to establish technological superiority for the U.S. military. Although the Army did not seek an analogous research center, it did support several centers of innovative research in key areas of Army interest.

In 1962, with the formation of the Army Materiel Command (AMC), the Army made its first major structural change in the organizational management of its R&D. Studies mandated by Secretary of Defense Robert S. McNamara led the Army to form AMC to consolidate a number of its procurement and logistics activities. This move gathered a number of research facilities, including the combat materiel laboratories, under the AMC umbrella. Although the Army acknowledged problems with the

control of R&D money, working relationships among its laboratories, long timelines for technology transition, duplicate research, and research relevance, the combat materiel laboratories were allowed to continue to operate independently under the AMC structure. AMC did make organizational changes to try to address these problems. In the 1960s, AMC designated several laboratories performing generic research as "corporate" labs and had them report to AMC Headquarters. Other labs that performed research more closely associated with the commodity commands were assigned to the appropriate commodity commands.

Further change came in 1969, when AMC established a Deputy Commanding General for Materiel Acquisitions and a Deputy Commanding General for Logistics Support. During the tenure of this construct, the United States fought and terminated participation in the Viet Nam War, triggering a drawdown at AMC. In 1973, the Army Materiel Acquisition Review Committee authorized by the Secretary of the Army performed a study on the Army acquisition process. That study recommended that logistics activities be separated from acquisition activities with two separate commands. In particular, the study asserted that the research, development, engineering, support, and project management components should be managed through development centers focused on missions. AMC carried out these recommendations by forming parallel R&D and readiness commands in place of the existing commodity commands. AMC itself changed its name to Materiel Development and Readiness Command. Under this construct, the "corporate" labs, such as the Ballistic Research Laboratory (BRL), were also placed in commodity areas. Meanwhile, R&D funds had decreased by one-third since the inception of AMC, and the R&D spectrum had grown with rapid advances in areas such as computers and information technology. With more technologies to research and less money to do it with, research took longer, thus lengthening technology-transition timelines. The same problems persisted, and by the early 1980s the Army was ready to try a different approach.

In 1985, the Army placed the laboratories under a new AMC Major Subordinate Command (MSC) called Laboratory Command (LABCOM) and, with this action, placed Army R&D under the military chain of command. The end of the Cold War initiated Base Realignment and Closure Commission (BRAC) actions and a Department of Defense (DoD)

drawdown from which AMC and the labs were not exempt. The Gulf War was fought during this period, and during this war, technological solutions were very quickly found to optimize systems and equipment. These rapidly accomplished successes set off thinking that if the Army R&D community could work together so well and so quickly during wartime, certainly the persistent R&D problems could be permanently solved.

In 1992, the Army sought that permanent solution through the Army Research Laboratory (ARL) construct. The ARL construct consolidated all of the Army's core materiel research into a single lab. Under the ARL construct, basic research funded by 6.1 money, as well as some applied research funded by 6.2 money and some advanced development funded by 6.3 money, were brought under one organization. The Research, Development, and Engineering Centers (RDECs) retained responsibility for the balance of the 6.2 and 6.3 efforts as well as research and development activities beyond 6.3.

A decade later, the Army is reorganizing its R&D structure again. The Program Managers (PMs) assigned within AMC have been moved back to the Program Executive Officer (PEO) structure at Department of the Army (DA). The Army has also begun to centralize various other elements such as its financial organizations and personnel organizations. In the last decade, the Army has seen its R&D investments dwarfed by commercial R&D investments. Once again, the Army is looking to solve the same R&D problems that have persisted through many decades and many different organizational management constructs. As the Army contemplates its next move, another major factor has emerged. While the recent terrorist events were not an impetus for the current reorganization moves, the Army must keep in mind that the R&D construct it chooses must be able to provide any R&D and technological support the Army will need to fulfill whatever role it might be called on to play in combating terrorism.

Four major R&D issues have emerged as key elements for the Army's next move toward a new R&D organizational management structure. These issues are centered on the first one, control of the R&D money. How the Army defines the money stream will influence the other issues. In particular, planners must ensure a single authority for the allocation of

R&D resources, personnel, and responsibilities. The second issue is working relationships. The new construct will have to facilitate cooperative and collaborative working relationships among Army scientists and engineers in ARL and the RDECs as well as with scientists and engineers working in other government agencies, industry, and academia. Third, Army systems have become more complex in that they now routinely involve combining multiple scientific and technological advancements in many areas. As such, the Army needs to create an R&D environment and processes that facilitate integrated research to smooth the progress of technology transition. One option is to extend Integrated Product Teams (IPTs) to involve multiple disciplines and all life-cycle stakeholders. Another option is to adopt a construct that better reflects the concept-formulation phase, where technological advances are joined with Army operations. Finally, improving R&D visibility both within the Army and to the research community outside of the Army will help enhance collaborative research, thus eliminating unnecessary duplication. These four issues are closely interrelated, and addressing one necessarily involves the others. Hence, any solution aimed at one issue must be thoroughly examined to identify its effects on the others. Only through such an integrated approach will the Army be able to balance the risks and benefits of any new construct for Army R&D.

While the Army's new R&D construct must clearly address the Army's key R&D issues, this historical review also shows that the Army needs an R&D construct that can quickly adapt to changes in research agendas, budget levels, response times, personnel levels, and stakeholders. In short, history directs the Army to design and implement a new R&D construct that addresses the Army's key R&D issues and is adaptive.

ACKNOWLEDGMENTS

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GLOSSARY

AIRMICS	Army Institute for Research in Management Information Communications and Computer Sciences
AMC	Army Materiel Command
AMCCOM	Army Armament, Munitions, and Chemical Command
AMMRC	Army Materiel and Mechanics Research Center
AMRA	Army Materials Research Agency
ARL	Army Research Laboratory
ARO	Army Research Office
ASAFM	Assistant Secretary of the Army for Financial Management
ASA (RDA)	Assistant Secretary of the Army for Research, Development and Acquisition
ASAP	AMC Streamlined Acquisition Process
ASL	Atmospheric Sciences Laboratory
AVSCOM	Army Aviation Systems Command
BRAC	Base Realignment and Closure Commission
BRDC	Belvoir Research and Development Center
BRL	Ballistic Research Laboratory
CECOM	Communications and Electronics Command
CG	Commanding General
COL	Colonel
CSTAL	Combat Surveillance and Target Acquisition Laboratory
CTA	Collaborative Technology Alliance
DA	Department of the Army
DARCOM	Materiel Development and Readiness Command

DCG	Deputy Commanding General
DoD	Department of Defense
DOFL	Diamond Ordnance Fuze Laboratory
ECL	Electronic Components Laboratory
ECOM	Electronics Command
ERADCOM	Electronics Research and Development Command
ETDL	Electronics Technology and Devices Laboratory
ETSSC	ERADCOM Tactical Software Center
EWL	Electronic Warfare Laboratory
FedLab	Federated Laboratory
GEN	General
GOCO	Government Owned, Contractor Operated
HDL	Harry Diamond Laboratories
HEL	Human Engineering Laboratory
HQ	Headquarters
IPT	Integrated Product Team
IR&D	Independent Research and Development
LABCOM	Laboratory Command
LEIP	Laboratory Effectiveness Improvement Program
MANPRINT	Manpower and Personnel Integration
MICNS	Modular Integrated Communication Navigation System
MICOM	Missile Command
MSC	Major Subordinate Command
MTL	Materials Technology Laboratory
NASA	National Aeronautics and Space Administration

NBC	Nuclear, Biological, and Chemical
NBS	National Bureau of Standards
NIST	National Institute of Standards and Technology
NRL	Naval Research Laboratory
NVEOL	Night Vision and Electro-Optics Laboratory
OC	Ordnance Corps
OMEW	Office of Missile Electronic Warfare
OMRO	Ordnance Materials Research Office
PEO	Program Executive Officer
PM	Program Manager
R&D	Research and Development
RDA	Research, Development, and Acquisition
RDE	Research, Development, and Engineering
RDEC	Research, Development, and Engineering Center
RTD&E	Research, Development, Test, and Evaluation
S&T	Science and Technology
SES	Senior Executive Service
SMSA	Signal Missile Support Agency
SWL	Signals Warfare Laboratory
TACOM	Tank-Automotive and Armaments Command
TROSCOM	Troop Support Command
VAL	Vulnerability Assessment Laboratory
WAL	Watertown Arsenal Laboratory

Organizational Management of Army Research

Dr. Carolyn Wong

INTRODUCTION

This briefing presents an historical overview of the organizational management of the Army's combat materiel research activities, in areas such as physics, chemistry, electronics, tank, aviation, munitions, mobility, quartermaster, and, later, space. The Army's combat materiel laboratories have traditionally been charged with performing basic research funded with 6.1 money, exploratory or applied research funded with 6.2 money, and some advanced development research funded with 6.3a (now known as 6.3) money in the combat materiel areas.[1] Reviewing how the Army has managed its combat materiel science and technology (S&T) efforts in the past can lend insight to how well various constructs have worked and

[1] "6.1, 6.2, and 6.3 money" refers to Research, Development, Test, and Evaluation appropriations for conducting Budget Activity 1, Basic Research; Budget Activity 2, Applied Research; and Budget Activity 3, Advanced Technology Development; respectively. Budget activities are defined in the Department of Defense 7000.14-R, Financial Management Regulation, Volume 2B, Chapter 5, page 5-2, June 2002. See the appendix for details.

what might be promising features for future Army S&T organizational management structures for combat materiel research. Equally important, an historical review can show future planners which aspects of past implementation strategies have not worked and why caution should be exercised when reconsidering similar constructs.

As the Army contemplates how to reorganize its research and development (R&D), it should be aware of the key issues that have emerged as persistent problems over the past decades. These key issues are control of money, working relationships, integrated research to facilitate transitions, and R&D visibility to avoid duplicative research. None of the previous Army R&D reorganizations have directly and successfully addressed these interrelated issues. In this briefing, we will begin by describing the issues and then show how the problems emerged and persisted through previous reorganizations. Our concluding remarks will offer recommendations on how the Army might directly address these issues in the next reorganization.

Control of money has several dimensions. This issue includes how much money an individual or organization is authorized to spend, what research is funded, the conditions under which the funds can be spent, and whether the funding decisions can be appealed to a higher authority. An example outside of the Army illustrates these points. The Air Force Office of Scientific Research (AFOSR) within the Air Force Research Laboratory (AFRL) administers the Air Force's Basic Research program and, as such, receives the entire Air Force 6.1 budget. AFOSR receives

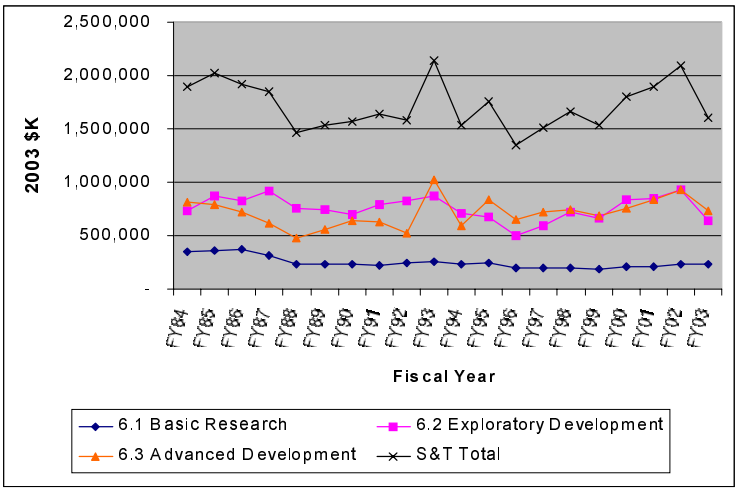
guidance on what topics should be funded for basic research. Guidance can filter down from the Department of Defense (DoD), the Secretary of the Air Force, the Assistant Secretary of the Air Force for Acquisition, Air Materiel Command, and AFRL. In addition, Air Force policy requires AFOSR to spend 30 percent of the research funds on projects proposed and performed by in-house AFRL scientists; the other 70 percent must be allocated to projects proposed and performed by organizations outside of the Air Force. AFOSR is the final authority on which basic research projects are funded. AFOSR establishes priorities based on the guidance it receives, and it coordinates the funding and searches its databases to prevent duplicative efforts. Although higher authorities, such as the AFRL director or the commander of the Air Force Materiel Command within which AFRL resides, participate in establishing the guidance, they are seldom if ever approached to override AFOSR basic research funding decisions.

Working relationships among scientists, engineers, and managers of different research laboratories can encompass many issues. In this document, the term refers to the existence and effectiveness of communications among the organizations and the willingness of the organizations to work together as a team rather than as competitors for funding and projects.

Integrated research to facilitate transition in this document means designing research environments and processes so that the combined advancements in multiple fields can be simultaneously inserted into new Army systems. Decades ago, a single major scientific or technological advancement in one area could lead to a new military system. Perceptions of long technology transition times arose through observation of when a single advancement was made and when it was fielded. Trends in more recent years indicate that new systems have been and are continuing to be more complex, often relying on multiple advancements in many technological areas. Technology transition times are now based on how quickly a number of advancements can be accomplished to realize a concept and develop it into a fielded system. Perceptions of long technology transition times still persist, but the causes may now be tied to the maturation of multiple technologies.

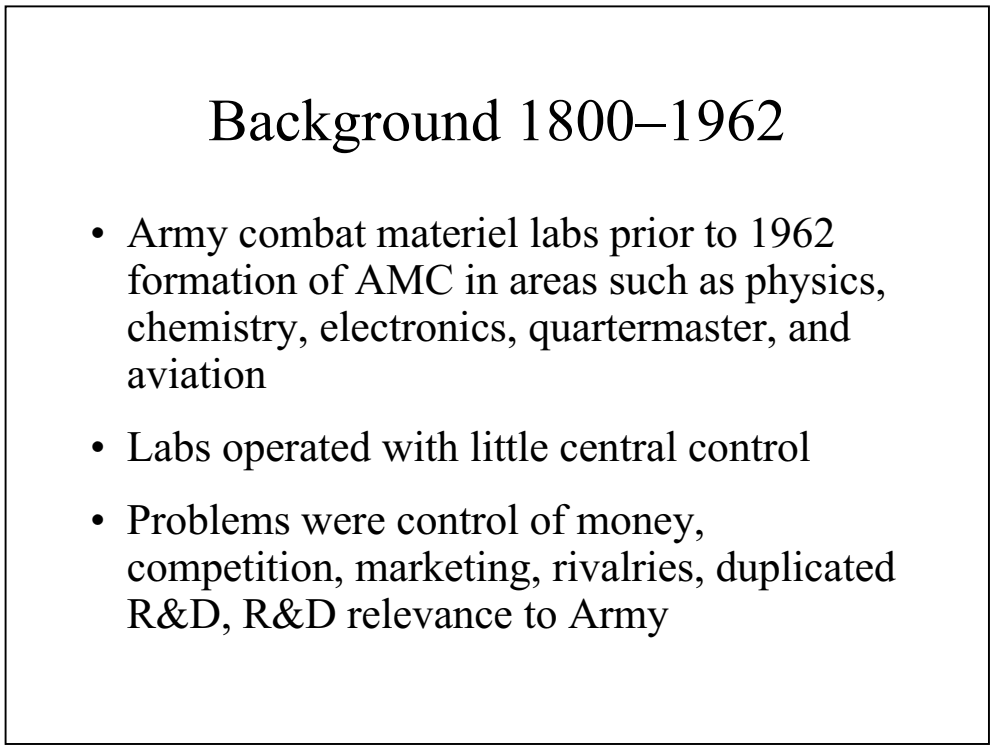
R&D visibility to avoid duplicative research means the sharing of research results and findings so that all Army labs can use the results to build research efforts in related fields, rather than unknowingly duplicate what has already been accomplished elsewhere. When labs operate in an insular fashion, the benefits of synergy cannot be realized.

FY84 – FY03 Army S&T Budget



SOURCE: Calculated from data provided by ASAFM; RDT&E Budgets for FY99, FY00/01, FY01, FY02, and FY03; and deflators in Table 5-6 of National Defense Budget for FY03. All figures are actuals except FY02 & FY03 are projected.

This briefing will show that control of money has been a central issue for the Army's labs for many decades. This chart shows the amounts of money the labs competed to control. The Army's S&T budgets for fiscal year 1984 (FY84) through fiscal year 2003 are shown in 2003 dollars. The actual budgets are shown for FY84 through FY01. The figures for FY02 and FY03 are projected.



THE ERA OF INDEPENDENT LABORATORIES

Military technological activities were performed as early as the Revolutionary War. By World War I, the Army had established research capabilities in the ordnance, signal, and chemical areas. For example, arsenals, such as Watertown established in 1800, provided the Army's first formal research facilities and contributed much to the nation's military research before and during World War I. In the interwar period, the civilian National Bureau of Standards (NBS) performed a substantial amount of research of interest to the Army. Not surprisingly, the Army began to contract ordnance-related research with the NBS during World War II. By 1960, the Army had established other research facilities, originating as the Ballistic Research Laboratory, the Ordnance Materials Research Office, the Human Engineering Laboratory, the Radio Laboratory/Signal Corps Electronics Laboratory, and as divisions of the National Bureau of Standards. As a group, these Army labs reflect increased capability in traditional ordnance and signal areas as well as expansion into quartermaster and human engineering research. In addition, some Army Engineer R&D organizations did materiel research.

Some of these, such as the Engineer Research and Development Laboratories, became part of the Army Materiel Command, while others migrated back to the Army Corps of Engineers.

As the Army facilities were established, they became loosely grouped into the "Ordnance Corps facilities" and "Signal Corps facilities." For example, the Signal Missile Support Agency, the Electronics Components Lab, and the Atmospheric Sciences Lab were associated with the Signal Corps, while the Ballistic Research Lab, the Ordnance Materials Research Office, and the Human Engineering Lab were associated with the Ordnance Corps.

From their inception through 1962, these facilities operated under the Technical Services. The Technical Services is the organizational construct the Army employed from 1777 to 1962. It was based on the concept of individual supply, and consequently the Army's research facilities operated in an independent fashion, with little control imposed by the Headquarters of the United States Army.

By 1962, there was general recognition by the Army that some R&D issues had arisen. These issues primarily related to the money stream—that is, who controlled the money, what the Army was getting for its R&D expenditures, and whether the R&D outputs helped solve Army issues. Since the facilities operated essentially as independent corporate labs, they competed with each other for money. This competitive spirit contributed to rivalries, and communications among the labs deteriorated. Furthermore, in the continual search for more research dollars, each facility conducted marketing efforts to do research for entities such as the Army Corps of Engineers. Protecting turf, carving a niche, and creating a client base to ensure a steady money stream and work took on importance. As such, research findings were not shared. With little cooperative spirit, research was duplicated because the labs were not focused on sharing research results or learning about the projects being performed at other labs. In addition, with limited central guidance and long technology transition times, some of the research was viewed as marginally relevant to Army missions.

Background 1962–1985

- Ordnance labs, Signal Corps labs, and some Engineer labs gathered under AMC in 1962
- Several R&D reorganizations within AMC
  - Former Ordnance Corps labs became AMC labs and former Signal Corps labs became ECOM labs in 1960s
  - Major Subordinate Commands split into R&D command and readiness commands under AMC, renamed DARCOM in 1976
- All labs continued to operate independently
  - Problems persisted – Control of money, working relationships, duplicated R&D, technology transition

In 1962, with the formation of the Army Materiel Command (AMC), the Army made the first major structural change in the organizational management of its R&D. Studies mandated by Secretary of Defense Robert S. McNamara led the Army to form AMC to consolidate a number of research facilities, including the combat materiel laboratories, under the AMC umbrella.

The five facilities associated with the Ordnance Corps were consolidated into four: the Ballistic Research Lab (BRL), the Human Engineering Lab (HEL), the Harry Diamond Lab (HDL), and the Army Materials Research Agency (AMRA). The Signal Corps Lab was split into three entities: the Atmospheric Sciences Lab, the Signal Missile Support Agency, and Electronic Components Laboratory (ECL). All seven research facilities were brought under AMC, under a Deputy for Laboratories, formally uniting the combat materials and electronic materials research under a single command.

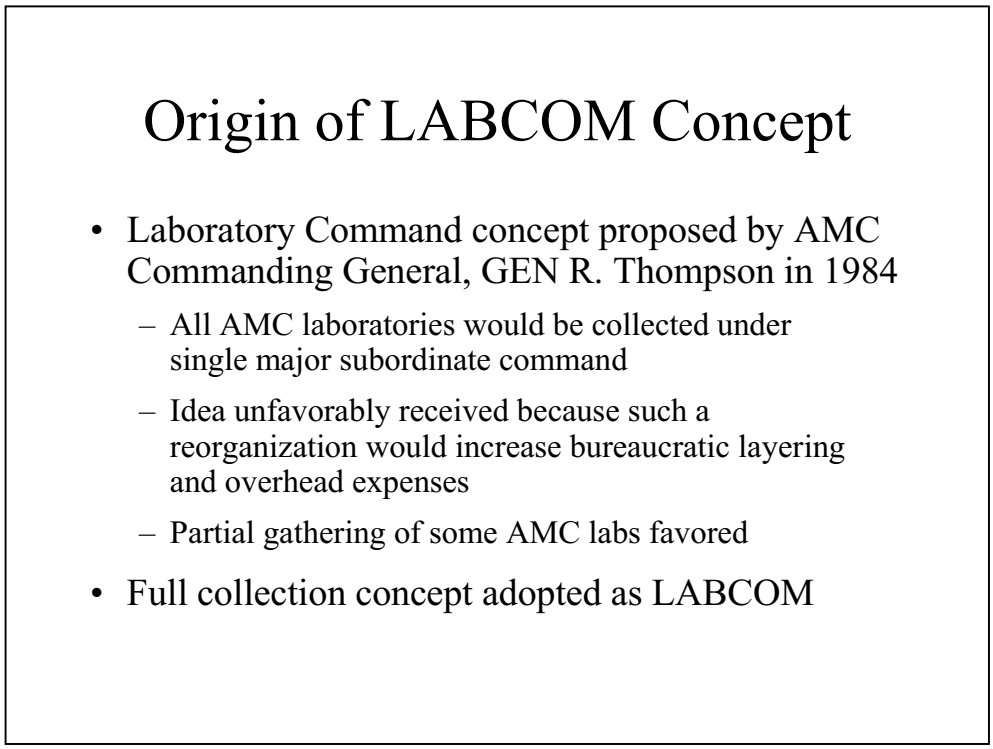
Although all the facilities were united under the AMC umbrella, they continued to operate in an independent fashion and the R&D problems remained unresolved. In the next two decades, AMC attempted several

R&D reorganizations to address the problems. In the 1960s, the former Ordnance Corps facilities were grouped together as the AMC labs and the former Signal Corps entities were grouped together under the AMC Major Subordinate Command (MSC) called Electronics Command (ECOM), thus loosely returning to the pre-AMC configuration but this time formally under AMC. The AMC labs were regarded as "corporate" labs engaged in more generic research, and they reported to AMC Headquarters. The ECOM labs performed research associated with electronics and reported to ECOM, the electronics MSC. The regroupings were intended to foster closer working relationships among the ordnance labs and among the electronics labs. The thinking behind the move was that if the related labs could work together more effectively by establishing better communications and working as joint teams, then the intense rivalries and competition for control of money might be lessened. In addition, improved communications would encourage sharing of research, which would decrease duplication. Furthermore, working together as teams created an environment more conducive to combining multiple advances in related areas to insert into a system, which might lead to shorter technology transition times.

The hoped-for improvements did not materialize, and AMC made further changes to its management of Army R&D. In 1969, AMC established a Deputy Commanding General for Materiel Acquisitions and a Deputy Commanding General for Logistics Support, providing formal separation of AMC's acquisition and logistics activities. In 1973, the Army Materiel Acquisition Review Committee, authorized by the Secretary of the Army, performed a study on the Army acquisition process. That study recommended that logistics activities be separated from acquisition activities, with two separate commands. In particular, the research, development, engineering, support, and project management components should be managed through development centers focused on missions.

AMC carried out these recommendations by forming parallel R&D and readiness commands in place of the existing commodity commands. In 1976, AMC itself changed its name to Materiel Development and Readiness Command. Under this construct, the AMC "corporate" labs were also placed in commodity areas. For example, in 1977, the Ballistic Research Laboratory was assigned to the Armament Research and Development Command, and in 1978, the Harry Diamond Laboratories

joined the former ECOM labs and all reported to the Electronics Research and Development Command (ERADCOM). Meanwhile, R&D funds had decreased by one-third since the inception of AMC, and the R&D spectrum had grown with rapid advances in areas such as computers and information technology. With more technologies to research and less money to do it with, research took longer, thus lengthening the technology-transition timeline. The same problems persisted, and by the early 1980s the Army was ready to try a different approach.



THE LABCOM ERA

By the early 1980s, it was evident that the persisting problems had to be directly addressed. In 1983, the AMC Deputy Commanding General for Research, Development and Acquisition, Lieutenant General Robert Moore, initiated the Laboratory Effectiveness Improvement Program (LEIP). The plans, studies, and proposals developed under this program were aimed at improving the effectiveness of the laboratories and reorganizing the research and development functions in the Army. In 1984, using the LEIP vehicle, the Commanding General of AMC, General Robert Thompson, proposed a concept whereby all of the AMC laboratories would be gathered under a single MSC focused on Army research. This notion was named Laboratory Command (LABCOM). Two separate reviews of the LABCOM concept returned generally negative assessments of the idea, citing increased bureaucratic layering and increased overhead expenses. A more limited association of BRL and the HEL with other related elements was favored. But despite the unfavorable reviews, the concept of collecting all the AMC labs under LABCOM was adopted.

LABCOM's Start

- LABCOM became official AMC position in October 1984
- LABCOM created to provide stronger centralized R&D management
  - Eliminate duplicate research and development efforts
  - Encourage sharing of research results among Army organizations
  - Minimize rivalry for research dollars
  - Shorten transition time from R&D to insertion

LABCOM became the official AMC position in a formal declaration in October 1984. LABCOM was to provide a stronger centralized management of Army materiel research. Specifically, this stronger centralized management was to eliminate duplicate research efforts; encourage the sharing of research results among various Army organizations, but especially among the labs themselves; and minimize rivalry for research dollars. This more effective and efficient management, along with the more collaborative and congenial spirit, also had the promise of shortening the transition time from R&D to technology insertion.

Creation of LABCOM

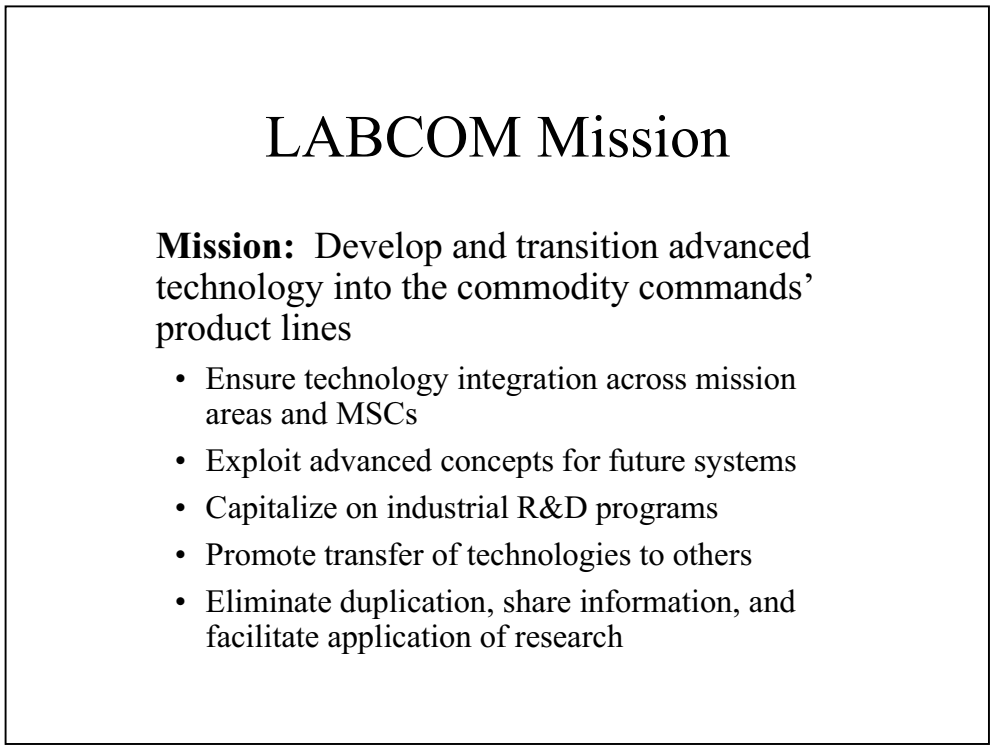
- U.S. Army Electronics Research and Development Command (ERADCOM) HQ in Adephi, MD provisionally redesignated LABCOM on 1 July 1985.
- Permanent redesignation and reorganization, and deactivation of ERADCOM 1 October 1985
  - Nonlegislative action
  - Permanent Order 51-1, 19 July 1985
  - LABCOM reorganization to be accomplished without any physical change of location

With this optimistic outlook, the Army quickly proceeded to implement the LABCOM concept. The U.S. Army Electronics Research and Development Command (ERADCOM) was provisionally redesignated LABCOM on 1 July 1985. Permanent redesignation and reorganization, and deactivation of ERADCOM, followed on 1 October 1985. Authority for these changes came from Permanent Order 51-1, dated 19 July 1985. Specifically included in the Permanent Order was a statement stipulating that LABCOM reorganization was to be accomplished without any physical changes of location. No legislative action was involved in accomplishing these changes. Major General James C. Cercy was installed as LABCOM's first Commanding General.

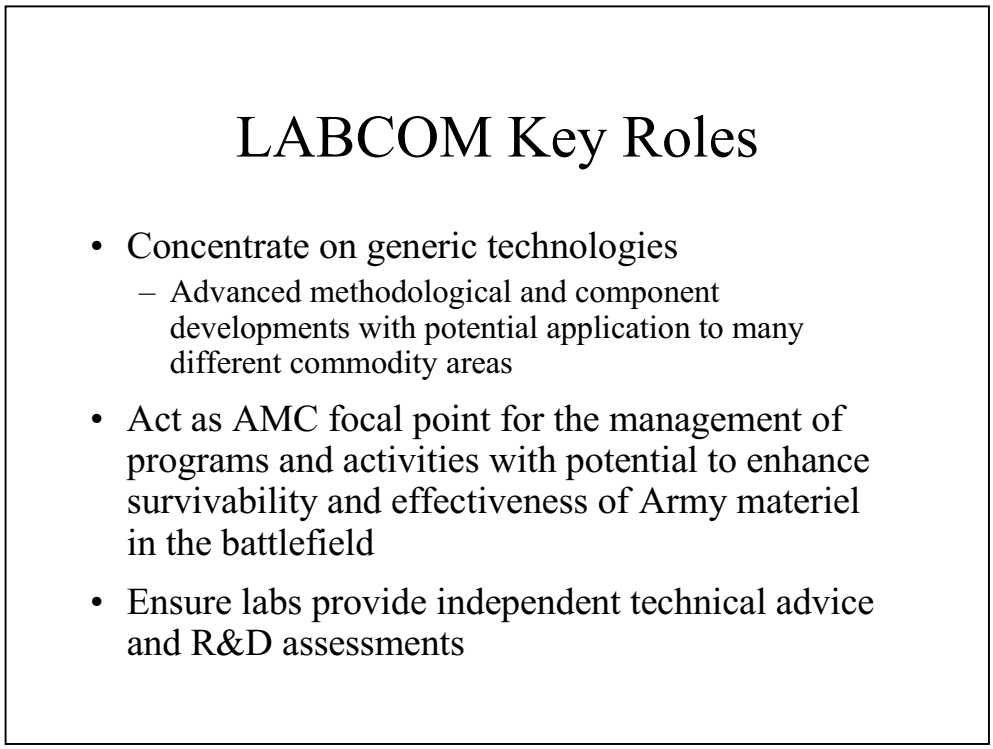
Overview of LABCOM

- LABCOM designated as new major subordinate command of Army Materiel Command
  - LABCOM formally established by AMC Permanent Orders 35-1, 26 August 1986
- Purpose: To integrate formerly independent labs and offices into a single cohesive command focused on the technology base

Although LABCOM was permanently established and activated in 1985, the orders for its existence as an MSC did not occur until the issue of Permanent Orders 35-1 on 26 August 1986. The purpose of establishing LABCOM was to integrate formerly independent labs and offices into a single cohesive command focused on the technology base. There was still a separation between technology base and advanced research and development—a separation that continued to cause duplication and competition among organizations.



LABCOM's mission was to develop and transition advanced technology into the commodity commands' product lines. This mission focused on the transition of technology from the research stage to equipment and systems in the field, thus emphasizing the goals of ensuring relevance of the R&D and shortening the time from R&D to fielded equipment and systems. In addition, LABCOM was to ensure that technology was integrated across mission areas and MSCs. LABCOM was also charged with exploiting advanced concepts for future systems and capitalizing on industrial R&D programs. In addition to exploiting technology advancements made by others, technology transfer was a major mission for LABCOM. LABCOM was to promote the transfer of its technologies to others, share information, and with this more open cooperative stance, eliminate duplication of research.

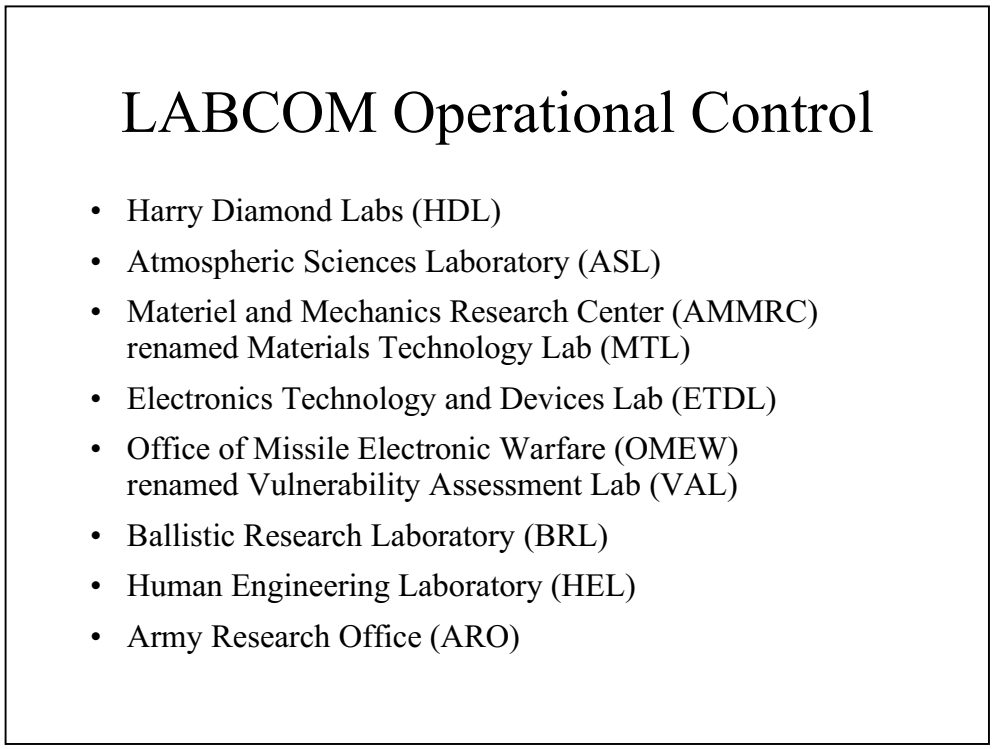


The research performed at LABCOM facilities was supposed to focus on areas that were generic in the sense that their application crossed commodity lines. Research in specific commodity areas was to be performed at facilities not included in LABCOM (see the RDECs on pages 21–23). The selection of the elements included in the LABCOM construct reflected this generic research mission. In establishing key roles for LABCOM, the Army's first formal recognition of the "smart buyer" function surfaced. The Army wanted LABCOM to ensure that the labs provided independent technical advice for R&D assessments. Today, the "smart buyer" role is still seen as a fundamental responsibility of the Army's in-house research entities.

Intended Consequences

- Reduce number of laboratories and offices reporting directly to HQ AMC
- Strengthen the day-to-day management of the laboratories and their programs
- Focus basic R&D activities
- Generate technology growth required to carry Army into 21st century

With seven laboratories reporting to LABCOM instead of HQ AMC, the number of entities reporting to HQ AMC was reduced, and hence it was hoped the effectiveness and efficiency of the headquarters outfit would also be increased. With a single command overseeing generic research, it was also hoped that the Army-relevance of all the research could be established by mapping the research efforts to Army missions. With this more focused research activity, the Army hoped that LABCOM would effect the technology growth required to carry the Army into the 21st century.



At its inception, eight major Army elements were placed under LABCOM operational control. Seven of these elements were laboratories: the Harry Diamond Labs (HDL); the Atmospheric Sciences Lab (ASL); the Materiel and Mechanics Research Center (AMMRC) that later became the Materials Technology Lab (MTL); the Electronics Technology and Devices Lab (ETDL); the Office of Missile Electronic Warfare (OMEW) that later became the Vulnerability Assessment Lab (VAL); the Ballistic Research Lab (BRL); and the Human Engineering Lab (HEL). The eighth element placed under LABCOM was the Army Research Office (ARO). Since the 1950s, ARO had promoted basic research of interest to the Army by managing grants and contracts with individual scientists and, later, with academia and nonprofit entities. Under LABCOM, ARO retained its traditional role and also provided independent assessments of research efforts to LABCOM HQ. In addition, although ARO was placed under LABCOM, ARO retained its original privileges to interact directly with AMC HQ and the ASA (RDA).

Expanded CECOM

CECOM gained operational control of seven former HQ ERADCOM entities:

- Night Vision and Electro-Optics Lab (NVEOL)
- Combat Surveillance and Target Acquisition Lab (CSTAL)
- Electronic Warfare Lab (EWL)
- ERADCOM Technical Support Activity
- ERADCOM Flight Test Activity
- ERADCOM Tactical Software Center (ETSSC)
- Office of the Product Manager for Modular Integrated Communication Navigation System (MICNS)

Several ERADCOM entities conducting work closely associated with the communications-electronics commodity line were realigned into the existing Communications-Electronics Command (CECOM). The new CECOM entities included the Night Vision and Electro-Optics Lab (NVEOL), the Combat Surveillance and Target Acquisition Lab (CSTAL), the Electronic Warfare Lab, the ERADCOM Technical Support Activity, the ERADCOM Flight Test Activity, the ERADCOM Tactical Software Center (ETSSC), and the Office of the Product Manager for Modular Integrated Communication Navigation System (MICNS). Hence, CECOM was significantly expanded as a direct result of LABCOM's formation.

Creation of RDECs

- Existing laboratories at commodity commands not transferred to LABCOM became Research, Development, and Engineering Centers (RDECs)
- Term "laboratory" now reserved for LABCOM research facilities

Existing research facilities that primarily did research in commodity command areas were redesignated as Research, Development, and Engineering Centers (RDECs). The term "laboratory" was now reserved for LABCOM research facilities.

RDEC Role Shifted Away from Basic Research

- Analyze threats
- Respond to user concerns
- Be aware of opportunities from other sectors
- Meet user needs
- Identify technologies for equipment development
- Provide IR&D guidance
- Manage essential technologies for emerging systems
- Prototype testing integration
- Plan concept phase of new systems
- Conduct feasibility demonstrations
- Serve as PM liaisons
- Develop first buy engineering
- Support block improvement
- Provide life-cycle support

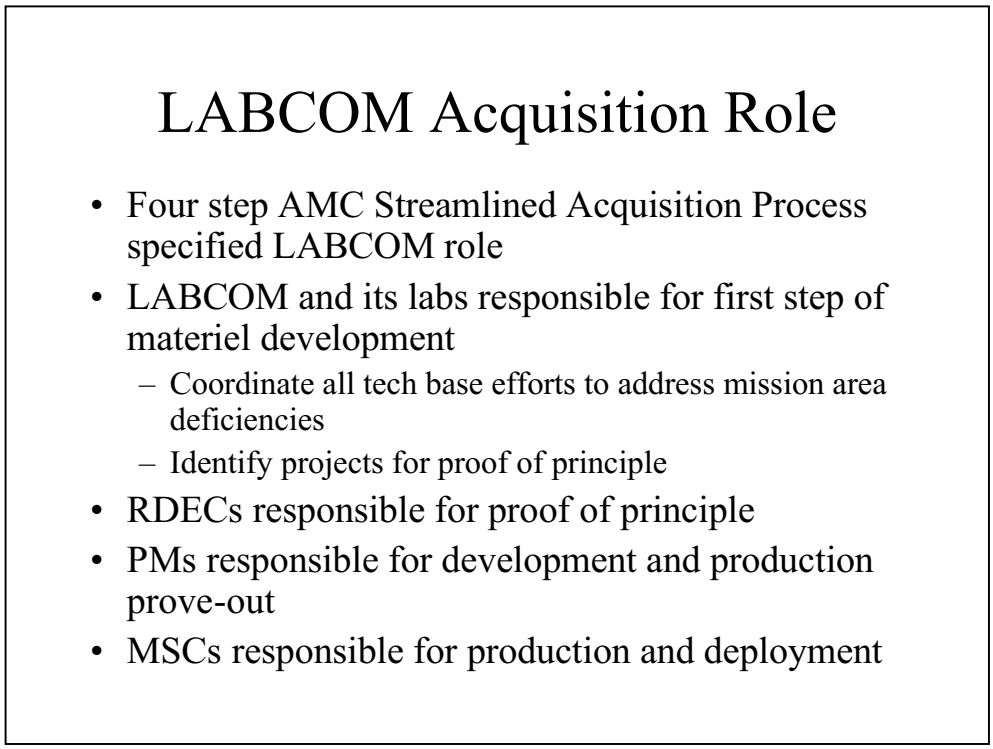
The RDEC roles became primarily engineering development. Until the formation of LABCOM, RDECs had performed basic research (research funded through 6.1 money) as well as exploratory or applied research (research funded by 6.2 money) and advanced development (research funded by what was then 6.3a money and is now known as 6.3 money). After the formation of LABCOM, basic research was no longer listed as an RDEC role, signaling the shift of basic research from the commodity command research centers to LABCOM lab facilities. As we will see later in this briefing, this distinction of the labs performing the bulk of the in-house basic research remains today, with LABCOM's present-day descendant, ARL, performing most of the in-house research funded by 6.1 money.

With the separation of basic research, the RDECs could now focus on their engineering development role, a responsibility the RDECs still carry today.

RDECs in Late 1980s

Command	RDEC
AMCCOM	Armament RDEC
AVSCOM	Aviation RDEC
CECOM	Communications-Electronics RDEC
MICOM	Missile RDEC
TACOM	Tank-Automotive RDEC
TROSCOM	Belvoir RDEC, Natick RDEC

Immediately after the inception of LABCOM, the Army reviewed operations at its commodity command research units. The Armament RDEC, Aviation RDEC, Communications-Electronics RDEC, Missile RDEC, Belvoir RDEC, and Natick RDEC all received generally positive reviews. The TACOM research units were criticized, with the recommendation that they be collected under a new Tank-Automotive RDEC. TARDEC was formed as a result of the study.



In an effort to address the technology-transition issue and shorten the length of time from R&D to fielded equipment and systems, AMC implemented a new acquisition process and defined specific roles for LABCOM, the RDECs, Program Managers (PMs), and MSCs. This four-step process was called the AMC Streamlined Acquisition Process or ASAP. LABCOM was charged with responsibility for the first step of materiel development. LABCOM was to coordinate all technology-base efforts to address mission-area deficiencies and identify projects for proof of principle. The RDECs were responsible for proof of principle. The RDECs then handed responsibility to the PMs, who were responsible for development and production prove-out. Finally, the PMs handed responsibility to the MSCs, who were to oversee carrying out production and deployment.

The separation of responsibilities was intended to improve the acquisition process, but it resulted in transfer problems when responsibility was handed over to the successor organization. For example, the RDECs, having performed basic research in the past, did not always agree with the proof-of-concept projects LABCOM identified for them to perform. Likewise, the PMs sought to provide production feasibility input early in

the process to ensure adequate consideration of such issues prior to assuming full responsibility for the acquisition.

That this process did not work out as advantageously as envisioned is evidenced by today's Integrated Product Teams (IPTs), where representatives of all four acquisition steps are included in the initial phase so that all life-cycle stakeholders have opportunities to contribute their expertise in the beginning of a program rather than during the transfer periods specified by ASAP. Today, most life-cycle stakeholders believe the IPT method helps to ensure smooth transitions from phase to phase and to avoid problems within phases.

LABCOM Commander Duties

- Responsible for managing labs
- Also served as AMC Deputy Chief of Staff for Technology Planning and Management
- Responsible for AMC-wide technology base program
  - Planning and allocating technology base funds (6.1 - 6.3a funds)
  - Review and analysis of technology base
  - Transition of advanced technology to operational use
- Mimic "private sector" structure

The LABCOM Commander was responsible for managing the labs but was also made AMC Deputy Chief of Staff for Technology Planning and Management. As such, the person would be responsible for the AMC-wide technology-base program. He was charged with planning and allocating technology-base funds (6.1–6.3a funds, now known as 6.1–6.3 funds), reviewing and analyzing the technology base, and overseeing the transition of advanced technology to operational use. This "dual-hatted" construct was adopted to mimic the "private-sector" structure in which a company's R&D leader was commonly charged with the three analogous responsibilities in nongovernment laboratories.

Although the "dual-hatted" construct appears to work in industry, it did not work as envisioned at AMC. The LABCOM Commander was physically located at Adelphi, Maryland and not at AMC Headquarters. Teleconferencing, e-mail, and video-teleconferencing were not commonly used in the 1980s, and the thirty-mile distance required advance planning for the LABCOM Commanding General (CG) to attend staff meetings at AMC. Hence, others were able to promote their causes, but the LABCOM CG often had to rely on his representatives to do so. This arrangement served to dilute the LABCOM CG's effectiveness. In addition, the CG's

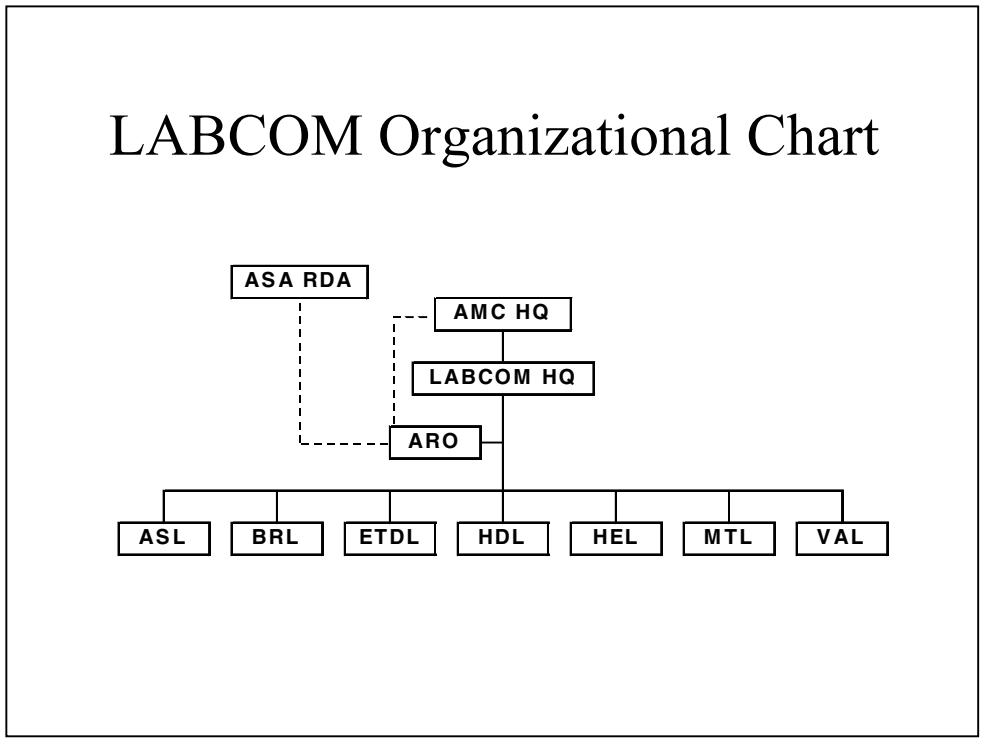
other "hat," AMC Deputy Chief of Staff for Technology Planning and Management, was responsible for allocating 6.1–6.3a funds. Because he was also the LABCOM CG, an RDEC perception surfaced that allocations favored the labs, and at the same time there was a lab perception that lab funds were being given to the RDECs. These perceptions of favoritism were sometimes strong enough to prompt "back door" approaches by the directors of the labs and RDECs. For example, when a decision was perceived to favor either a lab or an RDEC, the RDEC or lab director perceiving disadvantage went directly to the AMC Deputy Commander General for Research, Development, and Acquisition (DCG RDA), the AMC commander, or ASA (RDA) to get decisions changed. This experience demonstrates that private-sector structures might require adjustments before they can be successfully transferred to a government setting. Indeed, AMC terminated use of the "dual hat" construct in 1991.

The Army's current reorganization of its R&D suggests notions of locating the leader of this new construct away from AMC Headquarters. If this physical location plan is realized, the Army must ensure that the construct supports a unified view of the two locations. For example, regular use of e-mail, telephone, teleconferencing (even for routine meetings), network meetings, video-teleconferencing, cell phones, and fax between the two locations should all be encouraged. In addition, viewing the multiple physical locations as different buildings of the same campus (akin to a university, where leadership and staff freely and often walk the halls of the many campus buildings) might help avoid some of the problems that arose in the LABCOM case.

Planners should note that physical colocation is not necessarily the solution. The leader of the new construct will have to interact successfully with many entities, including labs, RDECs, and others in the Army and non-Army R&D community, in addition to AMC HQ. Few, if any, of these others will be colocated. To be effective, the new leader will have to use the communications tools to forge and maintain productive working relationships with all.

Moreover, the current reorganization eliminates the Deputy Chief of Staff (DCS) for RDA at AMC. It is anticipated that the responsibilities of the AMC DCS RDA will be given to the leadership of the new R&D construct. The LABCOM experience strongly suggests that the leader of the new

R&D construct should be AMC's sole authority for R&D resources, personnel, and responsibilities. That is, the new construct should be designed so that no "back doors," such as the AMC DCG RDA in LABCOM's case, exist for parties to seek an override of R&D decisions.

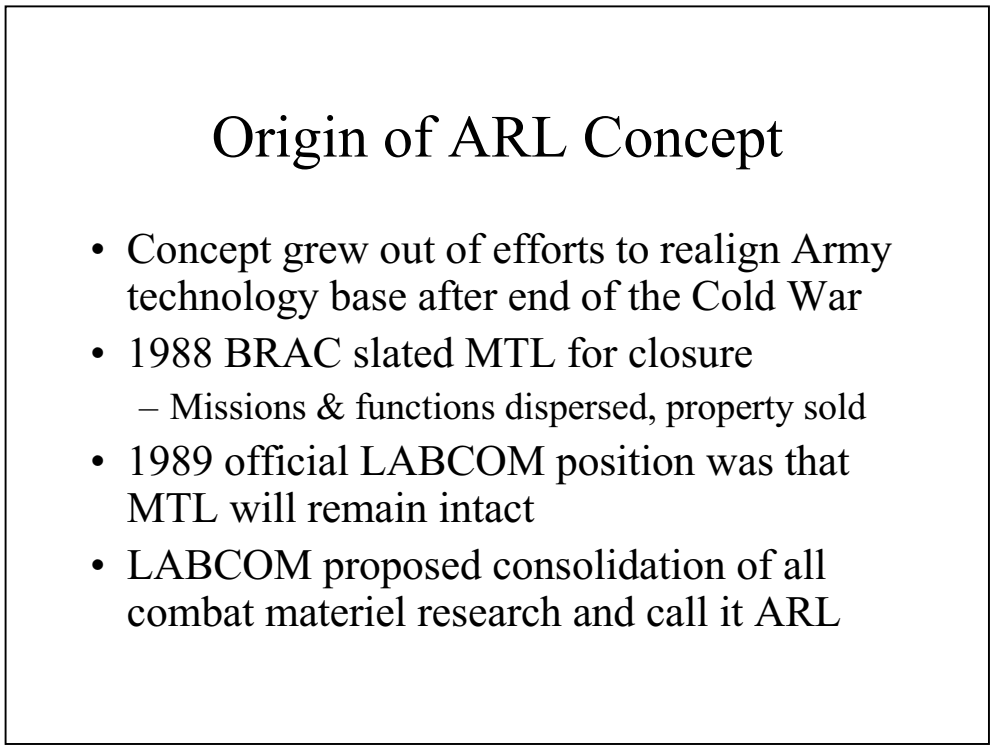


This slide shows the LABCOM organizational chart. Note that ARO is shown as an assisting organization to LABCOM HQ, while the individual labs are subordinate to LABCOM HQ. ARO was traditionally the organization in charge of Army-funded basic research at academic and nonprofit organizations (e.g., grants). ARO wanted to retain this role rather than give it up to LABCOM. When LABCOM was formed, ARO was assigned the position of a LABCOM assistant organization and retained its former role. ARO also retained all of its pre-LABCOM privileges of interacting directly with AMC HQ and the ASA (RDA).

LABCOM Shifts Control of Labs

- Creation of LABCOM moved operational control of labs out of headquarters where they were managed by a civilian staff, and put it in the field where they would be managed through the military chain of command
- Effect was forced review of headquarters organization and processes for managing and reviewing the technology base
- Problems persisted – Control of money, competition, marketing, rivalries, duplicated R&D, technology transition

Although not expounded as a primary impetus for reorganization, the creation of LABCOM transferred the control of Army laboratory operations from AMC HQ, where the research facilities were managed by civilians, to a construct where these facilities would be managed through the military chain of command. The Army believed that tighter military oversight would mitigate the problems associated with Army research. Unfortunately, the problems of control of money, competition among the labs, marketing, rivalries, duplicated R&D, and long transition times from the research stage to field equipment and systems persisted.



THE ARMY RESEARCH LABORATORY CONSTRUCT

By the late 1980s, world developments had occurred that would have a lasting impact on military research. The Cold War had ended and the Army, like the other military services, had to adjust its research agendas to match the new world situation. The end of the Cold War brought on defense downsizing moves, and AMC and its labs were not exempt from these actions. Hence, further complicating the Army's R&D problems was the 1988 Base Realignment and Closure Commission (BRAC) decision that slated the Army Materials Technology Laboratory (MTL) for closure. Under this BRAC action, the MTL missions and functions would be dispersed and the property would be sold. Shortly after this BRAC decision was made, the LABCOM director issued a statement declaring the official LABCOM position that MTL would remain intact. This standoff meant that the Army would have to devise a way to both obey the BRAC decision and stay true to its position of keeping MTL intact. The Army's solution was the Army Research Laboratory (ARL) concept, where all of the Army's combat materiel research, including MTL's, would be consolidated into a single lab. The ARL concept was consistent

with the intent of the BRAC decision as well as with LABCOM's position to keep MTL intact.

Start of ARL

- Consolidated ARL construct endorsed by various studies
  - Inclusion in DoD recommendations to BRAC 91 key
- 1991 BRAC allowed most of MTL to become part of ARL
- Implementation of ARL construct delayed to allow Federal Advisory Commission input
  - Conversion of some or all labs to GOCOs
  - Mission/function modification at some or all labs
  - Consolidation or closure of some or all labs

During the next few years, various studies endorsed the ARL concept. The Department of Defense helped the ARL concept become reality by including it in the DoD recommendations to BRAC 91. As a result of DoD's stance, the 1991 BRAC decision revised the BRAC 88 decision and allowed most of MTL to become part of ARL. Although the BRAC 91 decision was favorable, the Army had one more hurdle to clear before the ARL concept could be implemented. This hurdle was a congressionally mandated study by the Federal Advisory Commission. Included in this study was a task to examine the Army labs with respect to three points: (1) conversion of some or all of the labs to Government Owned, Contractor Operated (GOCO) operations; (2) mission and/or function modifications at some or all of the labs; and (3) consolidation or closure of some or all of the labs.

Creation of ARL

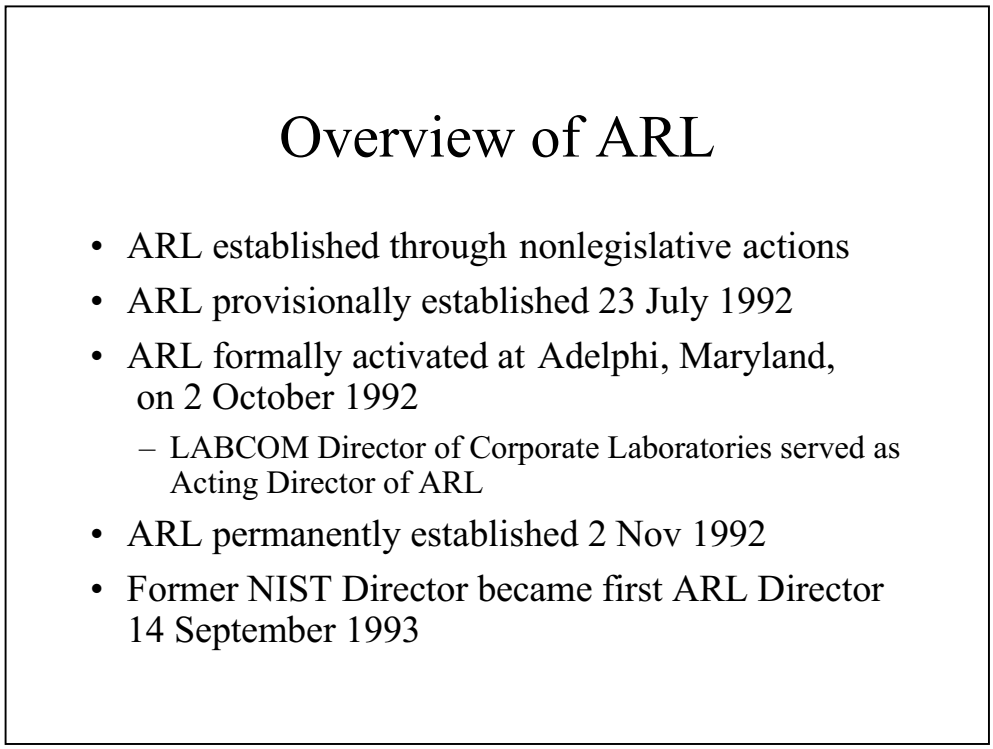
- Federal Advisory Commission accepted ARL construct
  - Fixing problems organizationally preferable to converting to GOCO
  - ARL should be a dedicated organization free from commercial pressure
- DA approved Implementation Plan in March 1992 with changes
- Most significant change was ARL would be headed by a civilian chief executive
  - General Officer as a Deputy

The Federal Advisory Commission study accepted the ARL construct, stating that fixing the Army's laboratory-related problems organizationally was preferable to the complicated and costly process of converting the labs to GOCOs. The commission went on to say that ARL should be a dedicated organization free from financial pressure. In other words, ARL should not have to market and compete for research funds, thus addressing the control-of-money and marketing issues. In March 1992, the Department of the Army (DA) approved the ARL Implementation Plan dated December 1991 with some significant policy changes. One important change was that ARL would be headed by a civilian chief executive. The civilian ARL leader would have a General Officer as a deputy. The original Implementation Plan had proposed a General Officer head of ARL who would report directly to the AMC Commander. This revision of the plan signaled a move back to civilian management of the Army's S&T.

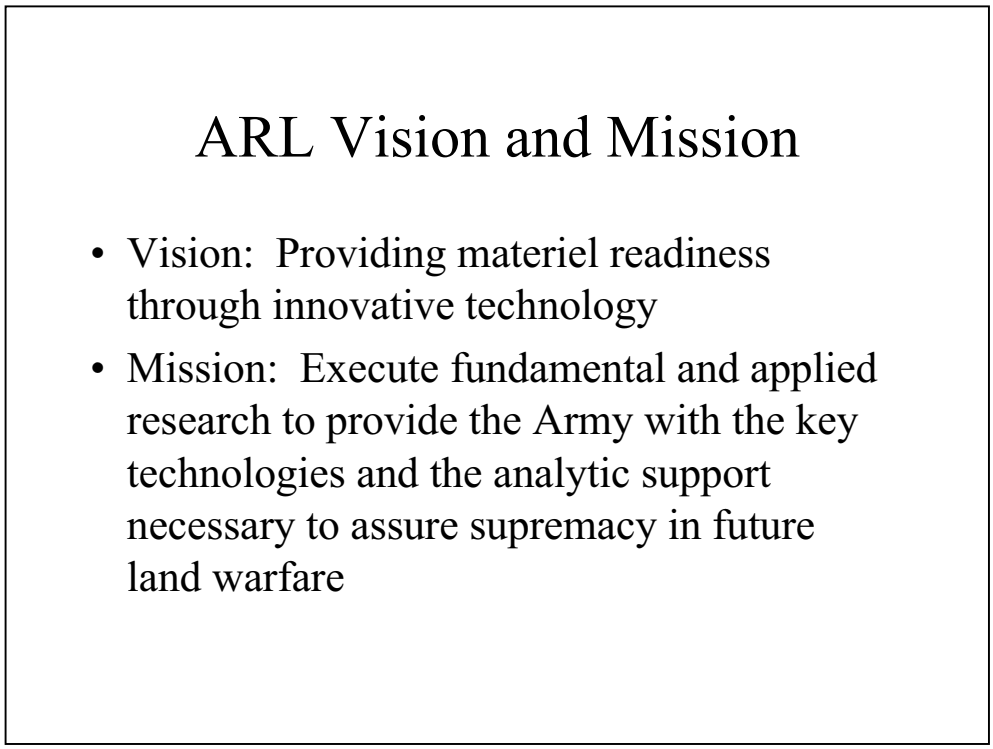
Though approved, the Implementation Plan was changed again as it was being carried out. One significant change was that the Deputy Director of ARL was never a General Officer. Instead, a colonel was placed in the Deputy Director slot. From September 1992 until July 1994, COL William

J. Miller served as the ARL Deputy Director, and from August 1994 until June 1996, the position was filled by COL Thomas A. Dunn.

The most significant recommendation not implemented was the suggestion that ARL be a dedicated organization free from financial pressure. To this day, neither AMC nor the Army has ever provided all of the funds for the labs. ARL component organizations still compete for research funds and market their services to outside organizations. As might be expected, ARL components still struggle for control of funds, and working relationships still have room for improvement. Being a single organization has helped eliminate duplicate research, but perceptions of long technology-transition times persist.



ARL was provisionally established 23 July 1992. Three months later, ARL was formally activated at Adelphi, Maryland on 2 October 1992. The civilian LABCOM Director of Corporate Laboratories, Richard Vitali, became the Acting Director of ARL. ARL was permanently established one month later on 2 November 1992. The Acting Director served for nearly a year before the former head of the National Institute of Standards and Technology (NIST), Dr. John W. Lyons, became the first ARL Director on 14 September 1993. All of these activities to establish ARL were nonlegislative actions.



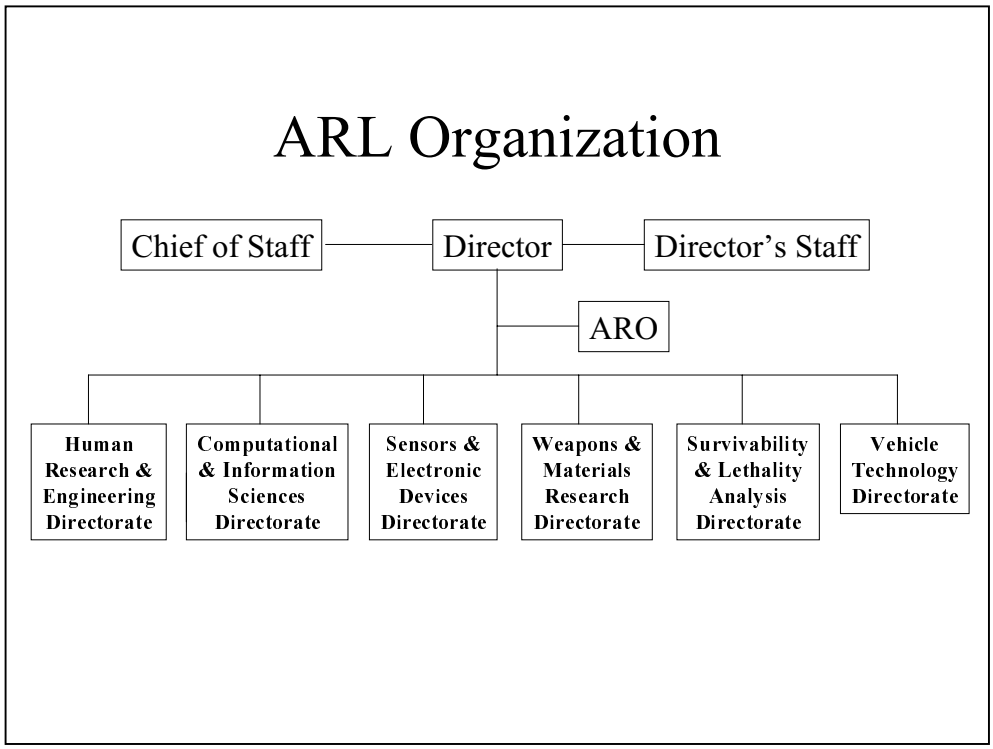
ARL's vision is to provide materiel readiness through innovative technology. Its mission is to execute fundamental and applied research to provide the Army with the key technologies and analytic support necessary to assure supremacy in future land warfare. Hence, we see in ARL's mission statement the emphasis on basic and applied (6.1 and 6.2 funded) research, signalling a more formal recognition that most of the Army's basic research, in particular, would be performed at ARL and not at the RDECs.

At its inception, ARL assumed operational control of LABCOM headquarters, the seven corporate labs (formerly under LABCOM direction), the LABCOM Installation Support Activity, and Special Technology Offices. Though ARL has gone through numerous reorganizations, to this day it still maintains management control over the descendants of these former LABCOM entities

1996 Reorganization

- ASA (RDA) approved plan to sharpen technology focus and reduce overhead
- Deputy CG position shifted to civilian SES deputy
- Military Chief of Staff
  - Filled by colonel

In 1996, the ASA (RDA) approved a plan to sharpen the technology focus of ARL's research and reduce its overhead. Significant changes included in this plan were that the Deputy Director was replaced with a civilian Senior Executive Service (SES) deputy. An Army colonel continued to serve as Chief of Staff. This reorganization moved the ARL research organization to today's management setup, where ARL senior leadership is made up of civilians with a military Chief of Staff. Vito J. DeMonte was the first civilian Deputy Director of ARL.



This slide shows ARL's current organization structure. Although ARO did not become a part of ARL at ARL's formation, ARO joined ARL in 1998 and now serves as an assisting organization that provides research assessments to the ARL director and maintains its role in overseeing Army-funded basic research performed by academic and nonprofit institutions. Six technical directorates replaced the former LABCOM lab structure. A Board of Directors, a Technical Assessment Board, and a Stakeholders Advisory Board representing funding, technical, customer, and peer interests are embedded in the current ARL organizational structure to facilitate and coordinate research activities at ARL, the RDECs, and the greater Army community.

The ARL Board of Directors, with members such as the technical directors of the AMC RDECs and the MSCs, review ARL's research agenda to make sure that at least half of the basic and applied research (work funded with 6.1 and 6.2 funds) supports Army customers. The Technical Assessment Board is a group of scientists who review ARL projects for technical excellence. This board is administered by the National Research Council to ensure independent technical assessments. The Stakeholders Advisory Board, whose members include lieutenant generals on the Army Staff, the

Deputy Commanding General of the Training and Doctrine Command, and others who represent Army customers, provide ARL with input to ensure that its research matches the Army's needs.

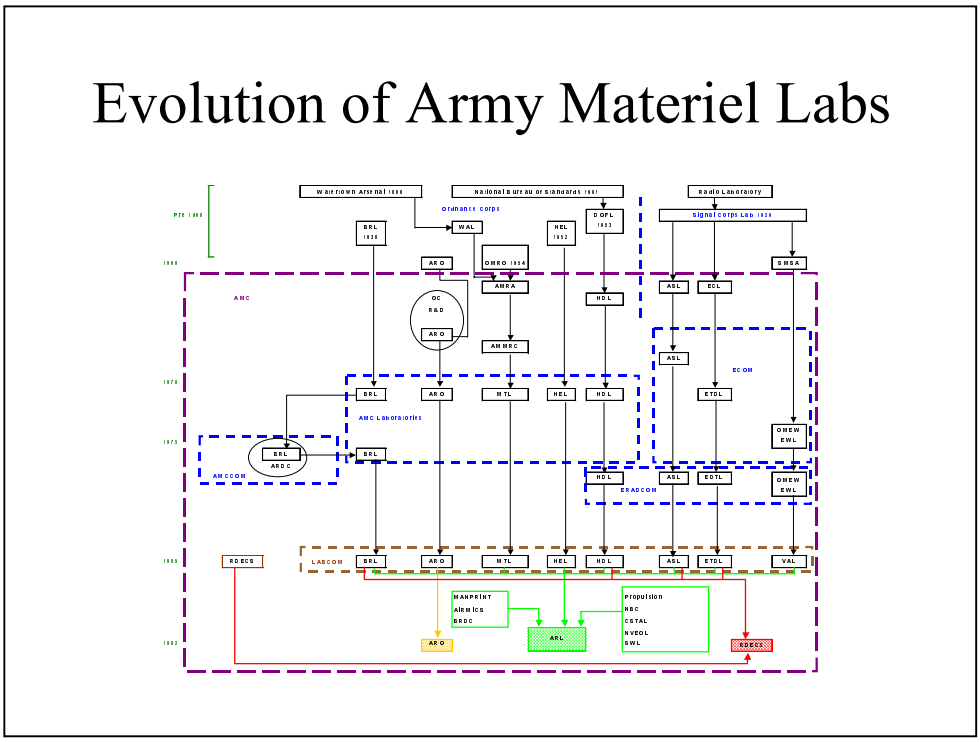
ARL's organizational structure is augmented with a program designed to help ARL take advantage of technical expertise outside of the Army. In 1996, ARL initiated a new Federated Laboratory (FedLab) concept to conduct basic research in areas where technological leadership resided in the private sector. To take advantage of the expertise in the private sector and to help expand the ARL knowledge base in fast-moving fields, ARL used Cooperative Agreements (under the authority of Title 10 Section 2358 of the United States Code) to partner with industry and academia. The three fields chosen for the FedLab concept were Advanced Sensors, Telecommunications/Information Distribution, and Advanced Displays and Interactive Displays. Each consortium consisted of a major private-sector partner who served as the consortium leader, a major university, and an Historically Black College/University or Minority Institution. To ensure that ARL gained expertise in these areas, the FedLab concept included the provision that at any given time, 20 percent of the partners' technical staffs in these areas would be in exchange status working at ARL and an equivalent number of ARL staff would be working in the partners' laboratories. The FedLab agreements were for a five-year term. The FedLab consortiums ended in 2001 and are generally regarded as successes.

The FedLab concept has now evolved into the Collaborative Technology Alliances (CTA) Program. CTA is governed by a Research Management Board, and participation in CTA has been expanded to include other Army organizations and other government agencies. In addition, the CTA structure is more flexible than the FedLab structure in that there is a new three-year option as well as the original five-year commitment. The CTA structure also incorporates a new provision whereby the up to 10 percent of each alliance's annual funding can be withheld to fund entities outside of the alliance for innovative research. This provision allows the alliances to quickly add new partners and take advantage of innovations made after the initial alliances have been formed. There are currently five alliances: Advanced Sensors, Power and Energy, Advanced Decision Architectures, Communications and Networks, and Robotics. Each alliance is managed by a Collaborative Alliance Manager who is a senior ARL representative.

ARL Facilities

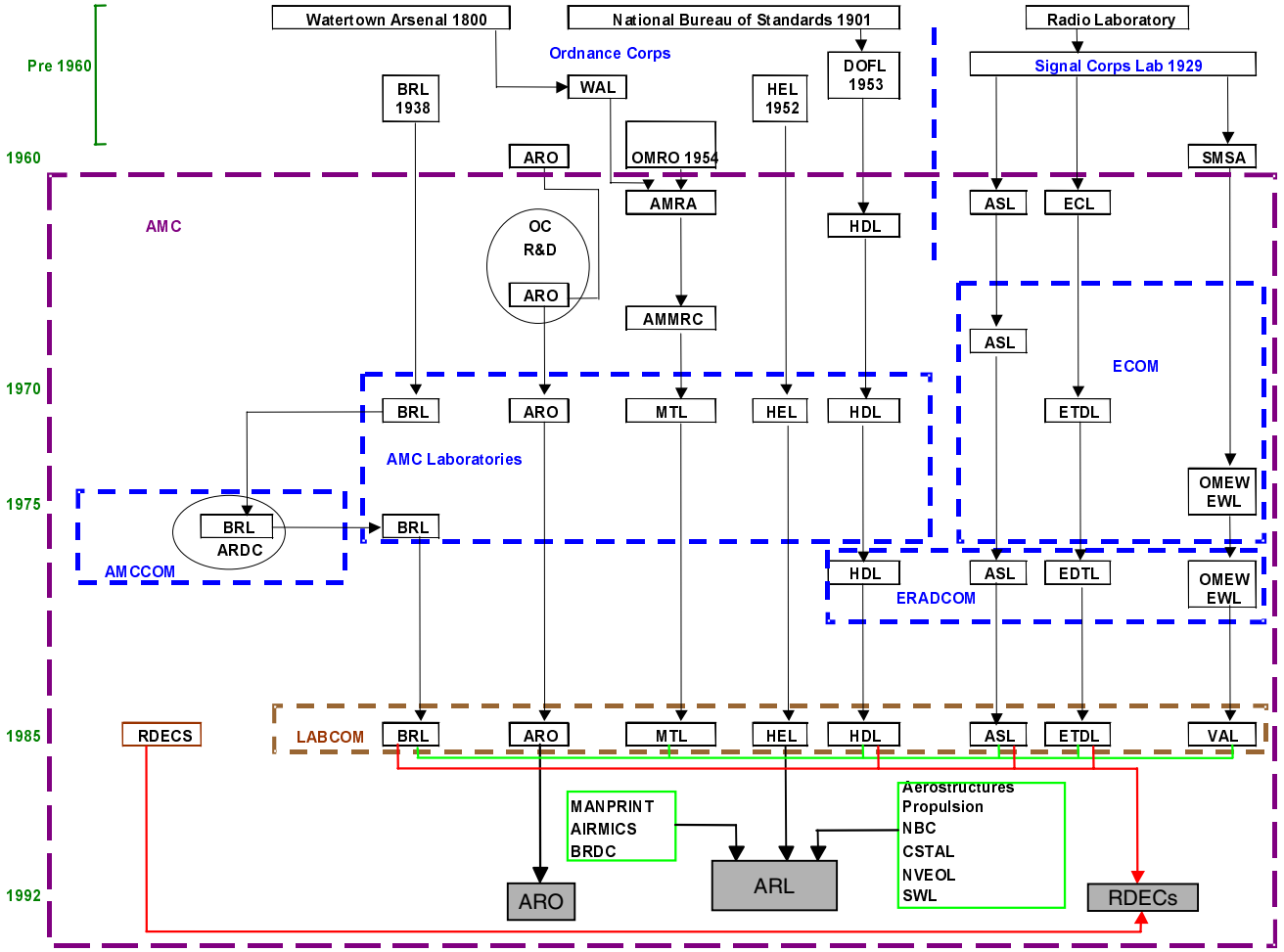
- Adelphi, Maryland
  - Information Science, Sensors, Electronics Devices
- Aberdeen Proving Ground, Maryland
  - Human Research, Survivability/Lethality, Weapons, Materials
- NASA Glenn Research Center, Ohio
  - Vehicle Research
- White Sands Missile Range, New Mexico
  - Survivability/Lethality
- NASA Langley Research Center, Virginia
  - Vehicle Research
- Army Research Office, North Carolina

ARL research is conducted in the six major research facilities shown on this chart. Research in information sciences, sensors, and electronic devices is performed in Adelphi, Maryland. Human engineering, survivability, lethality, weapons, and materials research is performed at Aberdeen Proving Ground in Maryland. Vehicle research is performed at the National Aeronautics and Space Administration (NASA) Glenn Research Center in Ohio. Additional survivability and lethality research is performed at White Sands Missile Range in New Mexico. Vehicle research is also performed at the NASA Langley Research Center in Virginia. Finally, the ARO is located in North Carolina.



CLOSING REMARKS

This slide shows the evolution of Army materiel laboratories and the major organizational constructs under which they have operated during the 202 years of their history. (See the next page for a larger version.) This summary of what's been presented so far in this briefing is instructive from a big-picture viewpoint, depicting the gradual shift from a loosely structured and semi-formal control mechanism to a fairly consolidated and centralized management approach. From the top, the chart shows the materiel labs as they were loosely grouped into Ordnance Corps labs and the Signal Corps labs before AMC was formed in 1962. During that period, the labs operated independently under the Technical Services. In an effort to correct control-of-money, competition, rivalry, marketing, duplicated R&D, technology transition, and R&D relevance problems that developed during this period of independent operation, the materiel labs were collected under the AMC umbrella in hopes that this more formal gathering under a single command would mitigate the problems. The 1960s showed no significant improvement, however, so


Pre 1960
1960
1970
1975
1985
1992
Watertown Arsenal 1800
National Bureau of Standards 1901
Radio Laboratory
Ordnance Corps
Signal Corps Lab 1929
BRL 1938
WAL
HEL 1952
DOFL 1953
ARO
OMRO 1954
SMSA
AMRA
ASL
ECL
AMC
OC R&D
HDL
ARO
AMMRC
ASL
ECOM
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EDTL
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ERADCOM
RDECS
LABCOM
BRL
ARO
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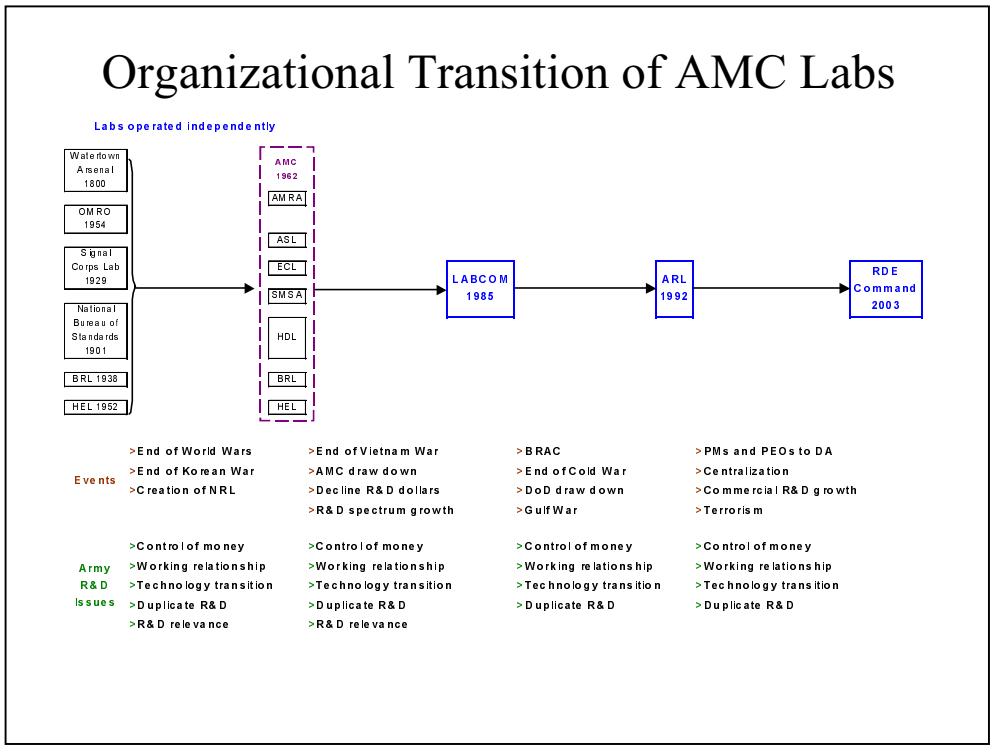
ASL
ETDL
VAL
MANPRINT
AIRMICS
BRDC
Aerostructures
Propulsion
NBC
CSTAL
NVEOL
SWL
ARO
ARL
RDECs

the Army tried to regroup the materiel labs as they were formerly gathered, with the former Ordnance Corps labs becoming AMC "corporate" labs and the former Signal Corps labs becoming Electronics Command (ECOM) labs. Hence the Army tried to reinstate the former lab construct within the AMC setting to solve its persistent R&D problems. Other adjustments were made to try to make this construct work. For example, in the 1970s, AMC formed parallel R&D and readiness commands in place of the existing commodity commands and assigned the labs to the appropriate commodity area. To reflect these changes, AMC itself changed its name to Materiel Development and Readiness Command in 1976. Even with these reorganizations, the problems persisted, and by the early 1980s the Army was ready to try another approach. Gathering all of the materiel labs performing generic research under the LABCOM MSC construct and thus placing them under the military chain of command was the Army's next organizational move in 1985. Also in 1985, materiel research facilities performing more specific research and not included in the LABCOM MSC took on the name Research, Development, and Engineering Centers (RDECs).

In less than a decade, evolving military needs coupled with the changing research environment rendered this construct ineffective against the Army's persistent R&D problems. In 1992, the Army tried formal consolidation of its combat materiel research into the ARL structure, complemented by the RDEC construct. This arrangement is the organizational structure under which Army materiel research is conducted today. However, the same persistent problems—which can be summed into control of money, working relationship, technology transition, and duplicate R&D issues—still exist today.



To be sure, Army research has not been conducted in a vacuum, and this historical overview of the Army's organizational management of its R&D would not be complete without pointing out some of the major world events that have influenced the organizational decisions.

The Army has employed several basic organizational management constructs to conduct its combat materiel R&D. They are the independent operation of the laboratories under the Technical Services, the Army Materiel Command (AMC) corporate labs complemented with the commodity-oriented labs, the parallel R&D and Readiness commands under the Materiel and Readiness Command, the Laboratory Command (LABCOM) construct, and the Army Research Laboratory (ARL) construct. As such, organizational management of Army combat materiel research in areas such as physics, chemistry, and electronics has progressed from a loosely structured decentralized construct to today's consolidated and centralized control mechanism.

During the first 162 years, while the combat materiel labs operated independently under no formal central structure, major world events included the conduct and end of the World Wars and the Korean War. In

1915, the U.S. government was very concerned about how its military might perform should the nation be drawn into World War I. One of the nation's leading scientists, Thomas Edison, publicly opined that the nation should look to science for the solution to this national issue. He stated that military advantages could be gained through technological superiority and that such advantages could not be achieved by adding more people to the armed forces. Furthermore, Edison suggested that the most cost-effective, efficient, and rapid way to achieve military technological superiority would be to establish a national laboratory where the nation's best scientists and engineers could perform basic fundamental research aimed toward military applications. Edison's statements were an influential factor in military research. In 1916, Congress passed legislation establishing the Naval Research Laboratory as a national resource. Although the Army did not seek an analogous centralized research center, it did support several centers of innovative research in key areas of Army interest, such as radio, radar, and ballistics.

In 1962, with the formation of the Army Materiel Command, the Army made its first major structural change in the organizational management of its R&D. Studies mandated by Secretary of Defense Robert S. McNamara led the Army to form AMC to consolidate a number of its procurement and logistics activities. This move gathered a number of research facilities, including the combat materiel laboratories, under the AMC umbrella. Although the Army acknowledged problems with control of R&D money, working relationships among its laboratories, long timelines for technology transition, duplicate research, and research relevance, the combat materiel laboratories were allowed to continue to operate independently under the AMC structure. AMC did make organizational changes to try to address these problems. In the 1960s, AMC designated several laboratories performing generic research as "corporate" labs and had them report to AMC Headquarters. Other labs that performed research more closely associated with the commodity commands were assigned to the appropriate commodity commands.

Further change came in 1969, when AMC established a Deputy Commanding General for Materiel Acquisitions and a Deputy Commanding General for Logistics Support. During the tenure of this construct, the United States fought and terminated participation in the Viet Nam War, triggering a drawdown at AMC. In 1973, the Army

Materiel Acquisition Review Committee authorized by the Secretary of the Army performed a study on the Army acquisition process. The resulting study recommended that logistics activities be separated from acquisition activities with two separate commands. In particular, the research, development, engineering, support, and project management components should be managed through development centers focused on missions. AMC carried out these recommendations by forming parallel R&D and readiness commands in place of the existing commodity commands. AMC itself changed its name to Materiel Development and Readiness Command. Under this construct, the AMC "corporate" labs, such as the Ballistic Research Laboratory (BRL), were also placed in commodity areas. Meanwhile, R&D funds had decreased by one-third since the inception of AMC and the R&D spectrum had grown with rapid advances in areas such as computers and information technology. With more technologies to research and less money to do it with, research took longer, thus lengthening the technology-transition timeline. The same problems persisted, and by the early 1980s the Army was ready to try a different approach.

In 1985, the Army placed the laboratories under a new AMC Major Subordinate Command called LABCOM and, with this action, placed Army R&D under the military chain of command. The end of the Cold War initiated BRAC actions and a DoD drawdown from which AMC and the labs were not exempt. The Gulf War was fought during this period, and during this war, technological solutions were very quickly found to optimize systems and equipment. These rapidly accomplished successes set off thinking that if the Army R&D community could work together so well and so quickly during wartime, certainly the persistent R&D problems could be permanently solved.

In 1992, the Army sought a permanent solution through the Army Research Laboratory construct. The ARL construct consolidated all of the Army's core materiel research into a single lab. Under the ARL construct, basic research funded by 6.1 money, as well as some applied research funded by 6.2 money and some advanced development funded by 6.3 money, were brought under one organization. The Research, Development, and Engineering Centers retained responsibility for the balance of the 6.2 and 6.3 efforts as well as research and development activities beyond 6.3.

A decade later, the Army is reorganizing its R&D structure again. The Program Managers assigned within AMC have been moved back to the Program Executive Officer (PEO) structure at Department of the Army. The Army has also begun to centralize various other elements such as its financial organizations and personnel organizations. In the last decade, the Army has seen its R&D investments dwarfed by commercial R&D investments. Once again, the Army is looking to solve the same R&D problems that have persisted through many decades and many different organizational management constructs. As the Army contemplates its next move, another major factor has emerged. While the recent terrorist events were not an impetus to the current reorganization moves, the Army must keep in mind that the R&D construct it chooses must be able to provide any R&D and technological support the Army will need to fulfill whatever role it might be called on to play in combating terrorism.

Key Issues for RDE Command

- Control of money
  - Definition of the money stream
- Working relationships
  - Among Army R&D entities (ARL, RDECs,etc)
  - With other government agencies, industry, & academia
- Integrated research to facilitate transition
  - Among disciplines
  - Among life-cycle stakeholders
- R&D visibility to avoid duplicate research
  - Share results with RDA community, industry, academia

Four major R&D issues have emerged as key elements for the Army's next move toward a new R&D organizational management structure. These issues are centered on the first one, control of the R&D money. How the Army defines the money stream will influence the other issues. It will be important for the Army to carefully consider who influences the control of the money, how much money each entity controls, and when the entity has control of the money. Furthermore, planners must ensure a single recognized structural process for R&D resources, personnel, and responsibilities by ensuring that the "back doors" that plagued the LABCOM construct are absent from the new structure. All stakeholders in the R&D process must agree and abide by the process and empower an authority that enforces the decisions.

The second issue is working relationships. The new construct will have to facilitate cooperative and collaborative working relationships among Army scientists and engineers at ARL and the RDECs as well as with scientists and engineers working in other government agencies, industry, and academia. With the amount and level of technological innovation occurring at the labs and outside the Army, the Army must, through this

new construct, recognize that exploiting non-Army R&D accomplishments is, in fact, effective and efficient Army research.

Third, Army systems have become more complex in that they now routinely involve combining multiple scientific and technological advancements in many areas. As such, the Army needs to create an R&D environment and processes that facilitate integrated research to smooth the progress of technology transition. One option is to extend Integrated Product Teams (IPTs) to involve multiple disciplines and all life-cycle stakeholders. Another option is to adopt a construct that better reflects the concept-formulation phase where technological advances are joined with Army operations. The current DoD-wide process is designed for single technological advances, where a technology progresses from basic research to applied research and then on to development. With modern systems incorporating multiple advances in many technologies, the R&D process is better described as progressing from basic research to technology maturation to concept formulation and then on to development activities, with some possible iteration with different technologies among these first three phases. Concept formulation is key to military innovation: it is the series of events that joins technological and scientific advances to military operations. Currently, there is no group within the Army charged with concept formulation, and there is no pot of money dedicated to concept formulation. With the Army's current R&D reorganization efforts, it has a chance to design a construct that retains innovation and maximizes concept-formulation activities to create an R&D environment more conducive to incorporating multiple advances in many technologies into a single Army system.

Finally, improving R&D visibility both within the Army and to the research community outside of the Army will help enhance collaborative research, thus eliminating unnecessary duplication. Again, a single authority that controls the Army's R&D resources, personnel, and responsibilities can also effect a single voice for Army R&D and thus improve visibility as well as management. Likewise, improving working relationships among members of the Army research community will help create environments amenable to Army researchers working together to enhance the Army's capabilities to accomplish its missions.

These four issues are closely interrelated, and addressing one necessarily involves the others. Hence any solution aimed at one issue must be thoroughly examined to identify its effects on the others. Only through such an integrated approach will the Army be able to balance the risks and benefits of designing a new construct for Army R&D.

History Points to an Adaptive Construct

- History shows that Army R&D needs a construct that is responsive to changing
  - Research agendas
  - Budget levels
  - Response time
  - Personnel levels
  - Stakeholders

While the Army's new R&D construct must clearly address the Army's key R&D issues, this historical review also shows that the Army needs an R&D construct that can quickly adapt to changes in research agendas, budget levels, response times, personnel levels, and stakeholders. For example, the rapid commercial development of computers and information technologies in the 1960s forced the Army to expand its research agenda to include emerging aspects of this technology. The Gulf War also forced a change in research priorities as technological solutions were sought to quickly optimize equipment for that war. The recent terrorist events may also impose changes on the Army's research agenda. The new Army R&D construct will be expected to successfully adapt to such agenda changes in the future.

In the decade between the early 1960s and early 1970s, the Army's R&D budget declined by one-third. Through it all, however, the Army research community was still expected to meet the technological needs of the Army. It is only realistic to believe that such substantial budget reductions might also occur in the future. The Army's new R&D construct must be adaptive to varying research budgets.

The Gulf War imposed extremely short timelines on finding and fielding technological solutions to the Army's battlefield problems. The LABCOM construct was able to meet that challenge. The new construct will also be expected to meet such challenges.

Congress, the DoD, and AMC have imposed several personnel drawdowns in recent decades. Research personnel were not exempt from any of them. However, even as research staff was being reduced to skeleton levels and below in some areas, all areas were expected to continue meeting the Army's technological needs. The new Army construct will have to be adaptive to changes in personnel levels as well.

Historically, there have always been many stakeholders in Army R&D. These have ranged from the series of life-cycle participant organizations to research organizations in many discipline areas, other services and government organizations, as well as political entities such as Congress. The Army can only expect more players. As all of the services move toward more joint research efforts, the Army's R&D organizations will be expected to establish good working relationships with R&D groups from the other services. These relationships may not yet exist. In addition, the Army's research community could be called upon to interact with new agencies such as the Department of Homeland Security. The Army's R&D community will be expected to establish such new relationships while maintaining the bulk of those that have already been established. The Army's new construct will have to support a changing group of stakeholders.

Hence, in addition to evaluating how well a construct might address the four key Army R&D issues, the new R&D constructs under consideration should also be evaluated with respect to flexibility in the dimensions identified above. Clearly, designing and implementing a structure that meets all these constraints is a challenging task. Additional, more focused studies on the individual dimensions might be required to identify a range of alternatives and desirable features. An implementation plan that includes phased transitions might be helpful in creating the time required to identify and pilot-test features to make the structure more flexible in the various dimensions.

As we have seen again and again, these issues reappear as the principal problems that motivate changes in organization, and although the task is

challenging, history directs the Army to design and implement a new R&D construct that addresses the Army's key R&D issues and is adaptive.

APPENDIX: R&D BUDGET CATEGORIES

The following definitions are quoted from Department of Defense 7000.14-R, *Financial Management Regulation,* Volume 2B, Chapter 5, p. 5-2, June 2002.

"Budget Activity 1, Basic Research. Basic research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind. It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to long-term national security needs. It is farsighted high payoff research that provides the basis for technological progress. Basic research may lead to: (a) subsequent applied research and advanced technology developments in Defense-related technologies, and (b) new and improved military functional capabilities in areas such as communications, detection, tracking, surveillance, propulsion, mobility, guidance and control, navigation, energy conversion, materials and structures, and personnel support. *Program elements in this category involve pre-Milestone A efforts.*"

"Budget Activity 2, Applied Research. Applied research is systematic study to understand the means to meet a recognized and specific national security requirement. It is a systematic application of knowledge to develop useful materials, devices, and systems or methods. It may include design, development, and improvement of prototypes and new processes to meet general mission area requirements. Applied research translates promising basic research into solutions for broadly defined military needs, short of system development. This type of effort may vary from systematic mission-directed research beyond that in Budget Activity 1 to sophisticated breadboard hardware, study, programming and planning efforts that establish the initial feasibility and practicality of proposed solutions to technological challenges. It includes studies, investigations, and non-system specific technology efforts. The dominant characteristic is

that applied research is directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters. Applied Research precedes system specific research. Program control of the Applied Research program element is normally exercised by general level of effort. *Program elements in this category involve pre-Milestone B efforts, also known as Concept and Technology Development phase tasks, such as concept exploration efforts and paper studies of alternative concepts for meeting a mission need.*"

"Budget Activity 3, Advanced Technology Development (ATD). *This budget activity includes development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment. ATD includes concept and technology demonstrations of components and subsystems or system models. The models may be form, fit and function prototypes or scaled models that serve the same demonstration purpose.* The results of this type of effort are proof of technological feasibility and assessment of subsystem and component operability and producibility rather than the development of hardware for service use. Projects in this category have a direct relevance to identified military needs. Advanced Technology Development demonstrates the general military utility or cost reduction potential of technology when applied to different types of military equipment or techniques. *Program elements in this category involve pre-Milestone B efforts, such as system concept demonstration, joint and Service-specific experiments or Technology Demonstrations*. Projects in this category do not necessarily lead to subsequent development or procurement phases."

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