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A *ARMY*
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REPORT OF THE ARMY SCIENCE BOARD
INDEPENDENT REVIEW
OF
THE US ARMY COMMUNICATIONS AND ELECTRONICS COMMAND
RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

NOVEMBER 1987

EXECUTIVE SUMMARY

The Army Science Board (ASB) peer group review of the Research, Development and Engineering (RD&E) Center of the U.S. Army Communications and Electronics Command (CECOM) was conducted during the spring and summer of 1987. The primary focus was placed on evaluation of the:

- o RD&E Center headquarters
- o Advanced Systems Concepts Office (ASCO)
- o Center for Command, Control & Communications (C³ Systems - formerly Comm/ADP)
- o Center for Life Cycle Software Engineering
- o Center for Night Vision and Electro Optics

Peer group reviews had been previously conducted by the ASB for the Signals Warfare Laboratory and the Electronic Warfare Laboratory.

The detailed findings and discussions of the peer group are contained in the body of the report. The most urgent actions as seen by the peer group, that should be considered to improve the RD&E Center performance are:

- a. Define the mission of the ASCO as the primary office for the development of the RD&E Center strategy for the allocation of resources, interfaces of the RD&E Center to TRADOC schools, other AMC major commands, operational commands, other services, DARPA and industry. Recruit a senior lead individual for the director consistent with the newly established requirements and build up the staff over the next three to five years to approximately 75 personnel.
- b. Establish a strong systems engineering function with responsibility to define interfaces; establish and enforce system hardware and software standards; and maintain system architecture and networks.
- c. Develop a comprehensive plan for the recruiting and retention of qualified staff that is based on an Organizational Effectiveness Staff Office (OESO) review of the RD&E Center. The objective should be to "send a message" to the staff that the management is committed to maintaining technical excellence of the RD&E Center.

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A. INTRODUCTION

1. Background --

Past studies of Federal laboratories have suggested the importance of independent effectiveness reviews as a means of assuring continued laboratory excellence. Consistent with the findings of these studies, at the request of the Commander of the U. S. Army Materiel Command (AMC), the Army Science Board (ASB) has initiated a series of reviews of the AMC laboratories and Research, Development and Engineering Centers. The first of these reviews was conducted during the summer of 1984. To date thirteen Laboratories/RD&E Centers have been reviewed (see Appendix E1 for reference to past and ongoing ASB reviews). This document reports ASB findings based on a review of the U.S. Army Communications and Electronics Command (CECOM), Research, Development and Engineering Center.

CECOM is responsible for providing top quality, reliable systems related to: communications; command control; signals intelligence; surveillance; night vision; electronic warfare; and automation. It is chartered to do the research, development, engineering, procurement, and quality assurance on those systems and to sustain that equipment in the field by acquiring and distributing maintenance and repair parts. To support that mission, the CECOM Research, Development and Engineering (RD&E) Center is chartered to be a full spectrum center of technical excellence for C³/IEW, night vision and electro-optics; to integrate communications-electronics technology into weapon systems; to provide life cycle software support for C³/IEW systems; and to provide life cycle engineering support. A summary of the RD&E Center mission and its organizational interfaces is contained in Appendix 2.

2. Panel Composition -- The review panel consisted of the following members:

Dr. Lawrence J. Delaney (Chairman)
Senior Vice President
Science Applications International Corporation

Dr. Andrew G. Favret
Dean, School of Engineering and Architecture
Catholic University of America

Dr. Philip H. Francis
Director, Advanced Manufacturing Technology
Motorola, Inc.

LTG Robert J. Lunn (USA Ret.)
Deputy Program Manager
Science Applications International Corporation

Mr. John R. Moore
Vice President & General Manager, Electromechanical Division
Northrop Corporation

Mr. Lawrence H. O'Neill
Chairman of the Board & President
Riverside Research Institute

LTG Marion C. Ross (USA Ret.)
Executive Vice-President
Sidwell-Ross and Associates, Inc.

Dr. Irene C. Peden
Professor of Electrical Engineering
University of Washington

3. Panel Activities --

The ASB panel was asked to provide independent observations on the potential and actual performance of the RD&E Center with specific emphasis on the following issues:

- a. Quality of staff, facilities and technical program;
- b. Productivity of the Center in accomplishing its mission;
- c. Relevancy of the Center's work to important Army problems.

During the course of the review, the panel conducted on-site visits at the CECOM RD&E Center to survey facilities and receive detailed organizational and program briefings. In the limited time for the conduct of this review, it was not possible for the panel to examine all technical programs in detail. Thus, three areas were reviewed in greater detail in order to gain insights into the quality and relevance of the Center technical program. Those were the Center for Night Vision and Electro Optics (CNVEO), the Center for Command, Control Communications Systems (C³) and the Center for Life Cycle Software Engineering. Results of these reviews are contained in Section D.

The panel also met with the primary users of the RD&E Center's products and services to assess the adequacy of their working relationship with the center. Included in these discussions were representatives from major Army program offices, TRADOC schools and industry. In addition, the panel chairman met with DA and AMC officials involved in laboratory/RD&E Center management. Organizations and individuals contacted are listed in Appendix E4. Note that since peer group reviews of the Center for Signal Warfare and the Center for Electronic Warfare have recently been conducted by the Army Science Board, this report will focus on the other organizational elements in the RD&E Center and management interfaces with those organizations already reviewed.

4. Acknowledgments -- The panel greatly appreciates the cooperative spirit of the CECOM RD&E Center management, technical personnel and support staff in assisting in the conduct of the review. In particular, they were frank and open in discussions and responded professionally and quickly to detailed questions and requests for support.

B. SUMMARY OF FINDINGS

The Army Science Board (ASB) was asked to provide independent observations on the potential and actual performance of the US Army Communications and Electronics Command (CECOM) Research, Development and Engineering Center (RD&E Center) with specific emphasis on the following issues:

- a. Quality of staff, facilities and technical program;
- b. Productivity of the Center in accomplishing its mission;
- c. Relevance of the Center's work to important Army problems.

The panel found an organization of highly motivated people with a proud heritage of key accomplishments including many original contributions to military communications and electronics. The overall quality of the staff is good, but the emergence of industry with major capabilities in military communications and electronics and the decreasing size of the staff places the center in a transition period where critical choices for the allocation of resources will have to be made.

The following paragraphs summarize the key findings of this review. These findings identify areas the panel feels need improvement. The RD&E Center is performing many needed services for the Army and is performing much high quality work. There are deficiencies. More detailed discussion of each of these findings is contained in Section C of the report.

1. Does the RD&E Center have a quality staff, facility, and technical program?

1.a. Staff quality is declining.

1.b. The RD&E Center needs a competitive program to recruit required talent at the entry levels.

1.c. Retention of technical staff is a very severe problem.

1.d. Current RD&E Center senior technical leadership is well qualified; however, expected retirements will leave a serious gap in capability.

1.e. Continued Army undervaluation of research and development is the source of most serious personnel problems.

1.f. The RD&E Center includes recognized centers of excellence. It also contains inadequate centers.

1.g. Facilities appeared to be generally adequate.

2. How productive is the RD&E Center in accomplishing its mission?

2.a. Current emphasis of the RD&E Center is materiel readiness at the expense of technology development.

2.b. The tech base program simply evolves without concerted direction from the RD&E Center management.

2.c. The Advanced Systems Concept Office, in its present state, is not effective.

2.d. There is no recognizable systems engineering function within the RD&E Center.

2.e. Without effective management attention, the matrix organizational concept will not succeed.

3. How relevant is the RD&E Center work to important Army programs?

3.a. RD&E Center knowledge of long term user needs is inadequate to assure relevance to such needs.

C. DISCUSSION OF FINDINGS

1. DOES THE RD&E CENTER HAVE A QUALITY STAFF, FACILITY AND TECHNICAL PROGRAM?

1.a. Staff Quality is Declining.

When compared to appropriate industrial organizations, overall staff quality at the RD&E Center is adequate, but declining. There are elements of the organization where staff quality is very strong. At the Center for Night Vision and Electro Optics and the Center for Signals Warfare, for example, technical quality is excellent where members of the staff are considered to be leaders in their field worldwide. The panel has a concern, however, that while the CNVEO and CSW enter the RD&E Center with outstanding reputations shifting of personnel in a zero sum game environment could reduce the quality in all centers to the lowest common denominator.

Interviews with industry indicated that the RD&E Center staff was responsive, but generally supported the panel's impressions that staff technical quality has been declining over the past ten years.

The panel did not hear any significant approach to solving this problem of declining quality and feels that the RD&E Center cannot sustain staff quality in the long run unless some action is taken.

1.b. The RD&E Center Needs a Competitive Program to Recruit Required Talent at the Entry Levels.

The current market for engineers and scientists is a tough one, approximating a "sellers" market. Entry terms of employment are not particularly attractive compared to those of competing private organizations. However, the RD&E Center seems to have been quite effective in recruiting outside of the "main stream" of colleges and universities. In particular, they have placed a lot of emphasis in Puerto Rican colleges and in other schools with significant numbers of minority students. The panel is concerned that apparently no strong alliances have been formed between the Center and the major academic institutions in the CECOM geographical area, e.g., Princeton, the University of Pennsylvania, Carnegie Mellon University, and the University of Maryland, which are known for the strength of their communications/computer related programs.

It was noted that even though the RD&E Center has the authority to make on-the-spot offers, approximately 30% of these opportunities never materialize due to delays in the administrative aspects of bringing the individual on board. The delays are attributable to: a) the time required to attain a security clearance and b) the CECOM command group implementation of the glide path restrictions on hiring imposed by higher headquarters.

It was also pointed out that the direct hire authority only applies to engineers in grade levels GS-9 and GS-11. In December 1986 the Office of Personnel Management removed the direct hire authority for engineers at grade levels GS-5, GS-9 and GS-12. This action has had a major

negative impact since the majority of the recruitment efforts are targeted at recent college graduates who are only eligible for hire at the GS-5 and GS-9 levels.

1.c. Retention of Technical Staff is a Very Severe Problem.

The retention of qualified scientists and engineers, particularly at the higher skill levels, at the RD&E Center is a problem. This situation is compounded by the fact that it has become increasingly difficult to promote people into the vacated positions due to inherent restrictions associated with average grade ceilings and glide path reductions. The retention problems place the RD&E Center in a vulnerable position and subject to problems which will become very severe in a few years.

An Organizational Effectiveness Office review of the RD&E Center should be conducted to identify the sources of the problems and actions for management to implement.

1.d. Current RD&E Center Senior Technical Leadership is Well Qualified; However, Expected Retirements Will Leave a Serious Gap in Capability.

The Directors of the RD&E technical centers are well qualified. However, future continuity in management is not apparent in several key positions. With the difficulty in retaining personnel and the pending retirement of many key senior technical managers, future technical management is in jeopardy. This is particularly acute at the CNVEO and CSW since there are no obvious center director replacements, and both directors are eligible for retirement, or soon will be. Recruitment into the center director and deputy director positions from the outside is severely constrained by existing restrictions in the number of senior executive positions. In order to provide the RD&E Center with additional leverage for recruiting and retention of technically superior candidates for these positions, consideration should be given to incentivizing deputy director positions at the centers at the SES level.

1.e. Continued Army Undervaluation of Research and Development is The Source of Most Personnel Problems.

A contributor to the personnel retention problem is the long term undervaluation of tech base work within AMC and the Army. This is manifested in a vulnerable RD&E budget and the fact that competing readiness activities hold a favored status. For example, while many of the CECOM readiness elements are overstrength, the RD&E Center is being held at less than authorized strength. This situation "sends a message" to the people engaged in technical work that what they do is not very important. This lack of support for technical work causes loss of engineering and science personnel to PMs or other organizations where it is perceived that the Army places a higher value on their work program.

1.f. The RD&E Center Includes Recognized Centers of Excellence. It Also Contains Inadequate Centers.

The Centers for Night Vision and Electro-Optics and Signals Warfare appear to have a healthy combination of applied research, product development and production and can currently be categorized as true centers of excellence in their respective areas of responsibility. The Electronic Warfare segment has in the past demonstrated this full spectrum capability, but the impact of the integration of Electronic Warfare and Reconnaissance, Surveillance and Target Acquisition will require special attention to ensure continued excellence. A particular concern to the panel is that the split of radar work between the RD&E Center and LABCOM/HDL causes problems. This split of capability does not lend itself to productive work in this area. There is no evidence of a overall coordinated radar/research program.

Although there was a time when the military services led or sponsored much of the pioneering research and development in communications and computers, today the reality is that most of this leadership and initiative occurs in industry. The dominant development over the past decade has been the commercial application of communications and ADP technology, so the contribution of the military R&D in those areas has declined significantly compared to the commercial sector. The panel observed that the vitality of the R&D effort by the Center for C³ systems has diminished accordingly, and that the smart buyer capability required with this center is drifting away.

1.g. Facilities Appeared to be Generally Adequate.

The panel believes that the facilities of the CECOM RD&E Center are generally adequate. It is recognized that problems and potential solutions exist, but these are not preventing the RD&E Center from accomplishing its mission. Specifically, the panel visited the facilities at the Hexagon, the Centers for EW/RSTA, NVEO and LCSE, and these facilities appear to be adequate for accomplishment of their mission. In presentations, it was noted that there has been a long standing request for additional facilities at the CNVEO and CSW. It must be noted that since CNVEO has been given the responsibility for testing all DoD tactical detectors as part of the DoD Product Engineering Services Office (DPESO) effort, their new facility planned for start in 1994 must be on a schedule consistent with that of the DPESO. In other cases, with the information presented, the panel was not in a position to judge the fundamental requirement for these additional facilities. The development of additional supporting rationale/documentation of requirements and the identification of current facility investments would appear to be an important step in ensuring the continued upgrade of the facilities to meet the staff requirements.

2. HOW PRODUCTIVE IS THE RD&E CENTER IN ACCOMPLISHING ITS MISSION?

2.a. Current Emphasis of the RD&E Center is Materiel Readiness at the Expense of Technology Development.

Interpretation of the CECOM mission tends to emphasize readiness aspects. This interpretation is reflected in all efforts and significantly influences staffing and operations, which are heavily readiness oriented. The disappearance of the In-House Laboratory Independent Research Program (ILIR) in FY88 is an indication of this deemphasis of in-house research.

Although the intent to divide the responsibility for tech base work between CECOM, LABCOM and others is appropriate, there is clearly a need to maintain a credible tech base capability at the RD&E Center. Thus, it is essential for the Army to make a clear decision on whether or not CECOM should include in its mission the work needed to sustain important parts of the base of science and technology on which future Army systems will rest. All indications to the panel are that tech base work at the RD&E Center is declining and may be in danger in becoming subcritical.

2.b. The Tech Base Program Simply Evolves Without Concerted Direction From RD&E Center Management.

The CECOM RD&E Center has a large and diverse mission area. The panel recognizes that with such a mission area there are many tasks to be performed; however, there is concern that the center has no mechanism for making the critical choices necessary in structuring program priorities. There is evidence that as more and more requirements come in to be worked the programs lose focus and the work force gets spread thinner and thinner. There is no evidence of a plan which addresses how best to deal with those unique military requirements that receive little or no emphasis from industry.

The panel believes that in the current environment in which constrained resources are coupled with a large, diverse and critically important mission area, the RD&E Center must manage project selection and prioritization.

2.c. The Advanced Systems Concept Office, in its Present State, is Not Effective.

The Advanced Systems Concepts Office (ASCO) is a vital element of an effective RD&E Center. It should play a major role in setting the direction and program strategy for the center. At CECOM, the ASCO is currently not filling this role and without significant action on the part of CECOM management will never attain that goal. The panel believes there are several factors contributing to this shortcoming in the role of the ASCO:

(1) The Army Materiel Command (AMC) has not really come to grips with its expectations of an ASCO, and as a result, such organizations are floundering. In the opinion of the panel, ASCOs should have significant degrees of commonality across the command. The ASCOs are so important that AMC should ensure they have a common mission within their field of specialization so that there is a positive synergism from their total effort.

(2) RD&E Center and CECOM management do not understand what an important strategic role an ASCO should play. The panel clearly got the impression that the ASCO has a lower stature than any other organization within the RD&E Center. During the discussions at the CNVEO, it was indicated that they made no use of the ASCO and have no confidence in the ASCO.

(3) The ASCO is inadequately staffed both in leadership and numbers to perform the role envisioned by the panel. To accomplish its mission at least 75 personnel with the right mix of military are required (the current strength of 26 is definitely inadequate). It is estimated that on the order of 3-5 years will be required for the ASCO organization to become mature.

2.d. There is No Recognizable Systems Engineering Function Within the RD&E Center.

The dissipation of the systems engineering function, while retaining responsibility for design integrity, is a major reduction in the RD&E Center capability. The providing of an effective systems engineering function is a major challenge, and its importance is increasing because of the integrated nature of today's military systems. Systems engineering is key in interface specification, standards and as the keeper of order, networks, software, etc. Long term productivity is bound to be adversely affected by the lack of a systems engineering unit in the Center.

2.e. Without Effective Management Attention, the Matrix Organizational Concept Will Not Succeed.

The matrix management support for Project Management Offices (PMO) is based on the premise that PMOs will be staffed with only the minimum "core" staff necessary to plan, direct and control the execution of the program. The remainder of the PM's support will come from personnel in functionally related assignments in the RD&E Center and other CECOM support activities. The specific type, number and skill mix of matrix personnel supporting the PM is to be negotiated between the PM and the functional directors and approved by the Commanding General, CECOM.

Discussions with PMs and RD&E Center personnel concerning the CECOM implementation of the matrix manning concept revealed skepticism about its effectiveness. There is a general feeling that up to the present time there have been no changes other than paper changes. Personnel who were previously in a PM shop, are still in that PM shop even though on paper they belong to

another organizational element. The perception is that in six months to a year when physical changes are required the whole concept will unravel.

Instances were also cited in which the matrix was unable to provide the support required by PMs. In these cases, PMs were forced to do their own recruiting, often having to settle for entry level personnel with little or no experience.

It is the panel's opinion that in areas where technology is changing rapidly, organizations cannot be rigid, and that the skill mix must change to satisfy the requirements associated with that changing technology. The existing personnel policy that gives tenure to individuals will make it difficult, if not impossible, to attain the balance in skill mix required to meet these changing requirements. The RD&E Center must be aggressive in establishing training programs, personnel rotation programs, and improved workload projection procedures to minimize the likelihood of ending up with a skill mix that is not matched with program requirements.

3. HOW RELEVANT IS THE RD&E CENTER WORK TO IMPORTANT ARMY PROBLEMS?

3.a. RD&E Center Knowledge of Long Term User Needs is Inadequate to Assure Relevance to Such Needs.

Discussions with several supported program managers, the Signal School, the Intelligence School and the Combined Arms Combat Development Agency disclosed that the RD&E Center was responsive to requests for assistance. All users expressed concern, however, that the center is not aggressive in trying to find out what the user's needs are and how they can best be met. In many cases TRADOC/RD&E Center interactions were initiated by TRADOC. There was little evidence of RD&E Center interaction with operational units in the field to ascertain operational type problems. A fully capable ASCO should be the focal point for strengthening the user interface.

The panel was particularly concerned about relevance to user needs in the case of the Center for C³ Systems. Examples of this concern are discussed in the special section on the Center for C³ Systems.

In the other major components of the RD&E Center it appears they are doing extremely relevant work with little or no guidance and assistance from higher management echelons. While this is expected to continue for the short term, known losses in leadership for which there appears no adequate replacements will force the RD&E Center HQ to pick up the slack in control and guidance of these divisions -- something it is not now doing.

D. CONSIDERATION OF SELECTED TOPICS

1. Center for Night Vision and Electro-optics

The Center for Night Vision and Electro-Optics (CNVEO) has the primary responsibility in the Army for the development, evaluation and application into sensor subsystems of the technologies of electro-optical imaging, infrared sensing/imaging, image enhancement, EO/IR countermeasures, low/medium power laser, laser countermeasures and sensor fusion. In addition, CNVEO plays the most dominant part in the (otherwise somewhat fragmented) development and application of automatic target cueing and recognition (although this activity is also carried out by other Army Centers, LABCOM laboratories, programs and other service organizations). CNVEO also appears to work effectively in support of Army end product programs, the various branches of TRADOC and the field operational commands as well as other parts of CECOM and LABCOM.

The CNVEO has an authorized staff of 458 civilian and 39 military personnel, against an actual staff of 445 civilians, 30 military, and 35 AMC interns and co-op students. There are 268 individuals in the Center who hold degrees of which 158 are at the BS level, 75 at the MS level and 35 at the PhD level. This mix of advanced degrees appears marginal for an organization with the advanced technological mission of CNVEO.

As a general observation, the CNVEO is well organized, well managed, staffed with competent engineers and scientists and operates with adequate equipment in adequate facilities. It must certainly be considered to be one of the very best high technology organizations within the DoD; representing as it does, an acceptable balance of in-house and contract activities in 6.1, 6.2 and 6.3a budget designations; plus support of activities in its fields of expertise in other Army technical, TRADOC and field operational organizations.

Since advanced technology microelectronics is essential for the computing power, size, reliability and cost demanded by CNVEO's advanced image enhancement, Automatic Target Recognition (ATR) and sensor fusion programs, CNVEO works closely with the Electronic Technology Device Lab (ETDL); and with contractors having capabilities to design and/or develop and produce VHSIC level technology, and application specific integrated circuits (ASICs).

The CNVEO's technical program concentrates its sensor fusion, automatic target cueing, automatic target recognition, and target/terrain laser illumination technologies on the UV through IR spectra. The Center possesses no radar, radiometer or Electronic Support Measures (ESM) capabilities. Thus, its sensor work precludes effective operations in

clouds, fog, heavy precipitation, and certain types of countermeasures which may be faced during Army missions. The CNVEO is a strong technical leader in low and midpower, near IR and visible lasers, and in laser applications, including laser countermeasures. The Center's research work is restricted to solid state lasers. These limitations in the scope of sensory, target recognition and laser programs need to be re-examined in light of the Army's strategic mission requirements.

The limitation of CNVEO to a single SES grade threatens the leadership capabilities of the CNVEO in the near future. Many of the top people are at a point in their careers where they are soon to be eligible for retirement, and it will be necessary to seek some replacements from industry. The single SES position will make it difficult to assure continued competent leadership.

The CNVEO makes no use of the RD&E Center Advanced Systems Concepts Office (ASCO). This is perhaps understandable as of this time, since the ASCO is so new and understaffed. However, CNVEO should coordinate with the ASCO and help shape its development, with the purpose of using it when it becomes adequate.

The complexity and contract cycle time of the procurement process for CNVEO/CECOM continues to be a significant problem. Such delays, exacerbated by standard DoD/Congressional program and funding strategies, are not compatible with advanced and accelerating technologies. Attention needs to be given to upgrading the procurement process, so that it can be made more responsive to technological needs for developing new systems.

2. Center for Command, Control and Communications Systems

The Center for Command, Control and Communications Systems (C³) is composed of elements formerly known as CENCOMS, CENTACS, CENSEI, plus an engineering directorate and a Technical Support Agency. These were combined in October 1985. The Center has a budget of over \$100 million per year of which slightly more than 50% is "mission" money.

The Center for C³ Systems has an authorized staff of 469 of which 15 are military. The Center has an actual strength of 449 civilians and 10 military. There are 264 personnel in the Center for C³ Systems who hold degrees of which 134 are at the BS level, 116 at the MS level and 14 at the PhD level. The balance of degrees held in electronics or electrical engineering appears adequate.

Some of the more noteworthy achievements and on-going work in the Center for C³ Systems are:

- a. The HF modem for use with frequency hopping HF radios.
- b. The antenna projects, including the "fly swatter" antenna which exploit a system originally used by the Soviets.
- c. Fibre optic cable assemblies for use with field units.
- d. An HF "umbrella" propagation system that can be used for relatively short range transmission.
- e. Day to day technical management of the DARPA Survivable Radio Network (SURAN) programs.
- f. The development of EHF on SINGARS along with other enhancements of the standard communication systems.

Approximately \$7 million per year is funded by CENTCOM, USAEUR, 9TH ID, and the XVIII Airborne Corps for test bed work supported by the Center for C³ Systems. This work involves collaborative efforts with field units such as the 9th Infantry Division (motorized) and the U.S. Central Command (USCENTCOM). The purpose of the test bed activity is to help provide some capability to field units, allowing them to work with and utilize C³ systems on an exploratory basis. This in turn will help these units develop and establish their own needs and requirements all of which should lead to evolutionary development of these systems. This approach is receiving enthusiastic support from the field units, and personnel from the Center are becoming more aware of the needs and problems within field units.

Most of the software activity in the Center for C³ Systems is performed in the Software Engineering Division of the Information Processing Technology Directorate. This group, which evolved from the old CENTACS, is heavily involved with the Ada language and the Ada language system development. It is anticipated that they will be more heavily involved in programming activity within the next year. Another directorate known as Advanced Information Processing Technology is involved in artificial intelligence work, in fibre optics work and in the Air-Land Battle Management (ALBM) project. The Computer Systems Applications Directorate is primarily involved in PM support. It is heavily involved in Computer Aided Logistics Systems (CALs), which is expected to evolve into a PM managed program.

Although there was a time when the military services led or sponsored much of the pioneering research and development in communications and computers, today the reality is that most of this leadership and initiative occurs in industry. There are some specialized areas or problems that are peculiar to military needs, but in general the focus of a Center such as C³ Systems must be on applications, advanced or specialized development, and keeping abreast of the state of the art. It is necessary, however, for the Center of C³ Systems to pursue a number of areas of advanced research in order for it to maintain quality and to be a "smart buyer." Most of the technology thrust areas do not represent new research but are applications of technology to obtain improved products. Many of the projects are aimed at improvements or enhancements to the emerging communication systems (SINGARS, MSE, PLRS). They are typically developed as enhancements/appliques to the systems presently under procurement.

In the communications area, the Army has committed itself to fielding three new major systems over the next decade or more. The basic characteristics of these equipments have been established, and it is very difficult to focus basic research on the follow-on systems. Accordingly, much of the communications activity is centered on possible adaptations and enhancements of the already planned equipment. Under the circumstances this seems to be a good investment strategy, but the nature of the work tends more toward advanced development rather than basic research.

Demonstration projects such as packet switching networks and distributed command and control test bed operations receive major emphasis at the Center for C³ Systems. While a certain amount of this type activity is necessary and desirable, the panel was concerned that this emphasis may be at the expense of other programs and that there was no provision for acceptance by the Program Management and/or user structure. Too many test beds without corresponding sponsor attention or resources lead to systems which are unsupportable and therefore unacceptable. There should be a clear delineation within the Army of the roles and responsibilities of the RD&E Center in technology demonstration projects.

The most interesting and highest quality work and the most technically qualified personnel seem to be concentrated in work related to areas of individual preference rather than high priority requirements. The tech base work in the Center for C³ Systems should focus in those areas which have a unique military need and which do not make an incremental contribution to areas that are heavily worked by the commercial sector. To assure user relevance and to focus resources on unique military needs requires close management attention and control.

3. Center for Life Cycle Software Engineering

The CECOM Center for Life Cycle Software Engineering (CLCSE) comprises seven directorates, whose missions are software development support, PM support, developing test procedures, maintaining computers, and computer security. Its activities span the range from mission analysis, through concept development, design, development, production, deployment and support. With operations at Forts Monmouth, Leavenworth, Sill and Huachuca, CLCSE supports some 60 distinct types of host computers and 100 distinct languages.

The Center has an authorized personnel strength of 258 civilian and 84 military. The Center is operating with an on-board strength of 229 civilians and 61 military. There are 101 personnel at the Center who hold degrees of which 57 are at the BS level, 42 are at the MS level, and 2 are at the PhD level. This balance of skill level appears to be appropriate for the CLCSE mission.

Within the RD&E Center, the CLCSE has the largest repository of software (S/W) expertise. The other software and computer engineering talent resides mainly in the Command, Control and Communications Systems, EW/RSTA and CSW centers, and in the Product Assurance & Test, and MIS areas. Conversations with both the CLCSE staff and "customers" (i.e., staff from PM shops) indicated the technical competency of CLCSE is good, though not excellent, and that the CLCSE staff generally is responsive, proactive and innovative. There appears to be little capability, or need in present PM support, for advanced S/W technologies, such as expert systems, self-diagnostics, natural language translation, etc. This is disturbing in light of CLCSE's wide mission and the pace with which such technology is becoming imbedded in advanced S/W systems.

A major issue to be faced is the establishment of the S/W Technology Center. This Center was requested by AMC in July 1986. The RD&E Center management must soon decide whether to create the center within CLCSE or the Center for Command, Control and Communications Systems. It is essential that CLCSE have some S/W and EE staff. Such staff is lacking now, which compromises the technical effectiveness of CLCSE and will make it increasingly difficult to support leading edge S/W technologies. Since an adequately funded S/W Technology center would provide this platform and since it naturally would fit into the CLCSE, this option should be given serious consideration.

Another concern evident to the panel which needs RD&E Center management attention is the overreliance of the CLCSE on contractor S/W support due to CLCSE staff shortages. General Telephone & Electronics (GTE) and other contractors supply "job shop" S/W development services to CLCSE, and a contract is renegotiated annually to supply resident S/W systems and programming people. Contract staff generally outnumber the CLCSE staff by more than 3:1. There are several problems perceived by the CLCSE management with this approach. First, contractors are more expensive. Second, third party contractors are not effective, indeed sometimes not even welcome, at contractor's plants for working, review and coordination sessions. Third, contractors cannot generally contribute as effectively as in-house staff in

the developmental phase of a new project, although they can be productive when the system is mature. This staffing issue needs to be addressed. The staffing concerns relate to both numbers of permanent technical staff and their technical quality.

APPENDIX E.1

REFERENCES TO PAST AND ONGOING ARMY SCIENCE
BOARD REVIEWS OF LABORATORIES AND RESEARCH,
DEVELOPMENT AND ENGINEERING OFFICE

APPENDIX E.1

REFERENCES TO PAST AND ONGOING ARMY SCIENCE
BOARD REVIEWS OF LABORATORIES AND RESEARCH,
DEVELOPMENT AND ENGINEERING CENTERS

1. Report of the Army Science Board Independent Review of the Army Avionics Research & Development Activity, September 1984.
2. Report of the Army Science Board Independent Review of the U.S. Tank-Automotive Command Research and Development Center, October 1984.
3. Report of Army Science Board Ad Hoc Subgroup on Atmospheric Sciences Laboratory Effectiveness Review, June 1985.
4. Army Science Board Panel Review of U.S. Army Signals Warfare Laboratory, June 1985.
5. Report of Army Science Board Ad Hoc Subgroup on Electronic Warfare Laboratory Effectiveness Review, June 1985.
6. Report of the Army Science Board Independent Review of the U.S. Army Research and Technology Laboratories, June 1985.
7. Report of the Army Science Board Independent Review of the U.S. Army Missile Command Research, Development and Engineering Center, September 1986.
8. Report of the Army Science Board Independent Review of the U.S. Army Ballistic Research Laboratories, August 1986.
9. Report of the Army Science Board Independent Review of the U.S. Army Armament Research, Development and Engineering Center, April 1987.
10. Report of the Army Science Board Independent Review of the U.S. Army Human Engineering Laboratory, April 1987.
11. Report of the Army Science Board Independent Review of the U.S. Army Engineering Topographic Laboratory, June 1987.
12. Report of the Army Science Board Independent Review of the Army Research Institute, projected completion Fall 1987.
13. Report of the Army Science Board Independent Review of the U.S. Army Communications and Electronics Command Research, Development and Engineering Center, projected completion Fall 1987.

APPENDIX E.2

CECOM RD&E CENTER
MISSION AND INTERFACES

CECOM RD&E CENTER MISSION

The communications-electronics equipment and systems for the U.S. Army of the future are taking shape today in the Research, Development and Engineering Center of the Army's Communications-Electronics command. The CECOM mission covers the full life cycle management of communications-electronics. The initial process of converting concepts into new equipment and systems is conducted in the RD&E Center. The Center is dedicated to the development and acquisition of Command, Control and Communications (C³), Intelligence and Electronic Warfare (IEW), and Night Vision and Electro-Optic (NVEO) systems and equipment that will enhance the ability of the battlefield commander to achieve assigned missions in any climate, terrain, environment or mode of operations, allocate and sustain forces, and successfully engage the enemy. To accomplish this mission, the areas of communications, electronics, software, data processing, test, measurement and diagnostic equipment, signals intelligence, electronic warfare, reconnaissance, surveillance and target acquisition equipment, night vision and electro-optical and radiological measurement devices must all be explored.

The RD&E Center serves as a link with other producers of state-of-the-art technology, including industry, academia, the foreign sector and other government agencies and services. The Center supports 13 Program/Project and Product Managers and other activities that acquire and field new equipment and systems, maintain and upgrade fielded equipment, and manage both the inventory and shipment of repair and replacement parts.

The Center is comprised of four technology centers, the Center for Electronic Warfare/Reconnaissance, Surveillance and Target Acquisition, the Center for Night Vision and Electro-Optics, the Center for Signals Warfare and Center for Command, Control and Communications Systems, and includes a Center for Life Cycle Software Engineering and the Airborne Electronics Research Activity located at Lakehurst, NJ.

APPENDIX E.3

TASKING LETTER



DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310-0103

12 MAR 1967

Dr. Irene C. Peden
Chair, Army Science Board
8752 Sand Point Way, NE
Seattle, Washington 98155

Dear Dr. Peden:

A number of recent studies of Federal Laboratories have pointed out the importance of external effectiveness reviews as a means of assuring their continuing excellence. Accordingly, I ask that you appoint an Army Science Board panel of four to eight members to conduct an effectiveness review of the U.S. Army CECOM Research, Development and Engineering Center, Fort Monmouth, N.J. The panel should provide independent observations on potential and actual performance of the laboratory, including professional judgment on the cause of deficiencies, if any. A proposed framework for the assessment is enclosed. Specifically, the panel should address the following five questions:

- a. What is the quality of staff, facility and technical program?
- b. How productive is the lab in accomplishing its mission?
- c. How relevant is the lab's work to important Army problems?
- d. How can we improve the assessment methodology and procedures?
- e. What are the lessons learned from conducting the review?

General Richard H. Thompson, Commander, U.S. Army Materiel Command is the sponsor. Dr. Philip C. Dickinson, Acting Deputy Assistant Secretary Army (Requirements & Programs) will serve as the OASA(RDA) Cognizant Deputy. Dr. Erwin M. Atzinger, U. S. Army Materiel Systems Analysis Activity will serve as the DA Staff Assistant.

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It is not anticipated that your inquiry will go into any "particular matters" within the meaning of Section 208 of Title 18, United States Code.

The panel should begin as soon as possible and complete its review by 30 September 1987.

Sincerely,



J. R. Sculley
Assistant Secretary of the Army
(Research, Development and Acquisition)

Enclosure



6 March 1987

Participants List

Army Science Board Ad Hoc Subgroup
on
U.S. ARMY COMMUNICATIONS-ELECTRONICS COMMAND LABORATORY
EFFECTIVENESS REVIEW

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PROPOSED FRAMEWORK FOR ASSESSMENT

QUESTION 1. What is the quality of the staff, facility and technical program of the lab?

1. Balance of background - i.e., adequacy of the distribution and mix of degrees based on relevance to the lab's mission.
2. Currency of degrees and/or other technical training of technical and management staff.
3. Quality, scope and innovativeness of training programs.
4. Peer recognition of technical personnel within government and private sectors.
5. Initiatives to maintain staff technical competence to contract heavy operations, i.e., the ability to retain smart buyer posture.
6. Staff stability and effectivity of recruiting initiatives.
7. Adequacy of physical plant and other physical resources - plans and initiatives for upgrade.
8. Degree to which automation and other leading edge tools and techniques have been introduced into the workplace.
9. Assess technical program balance within context of mission responsibilities.
10. Degree to which technology program is forward looking, i.e., demonstrates willingness to assume technological risk to attain marked advances.

11. Relevance of technology base efforts to mission responsibilities.
12. Reputation of lab within Army, DOD and industrial complex.
QUESTION 2. How productive is the lab in accomplishing its mission?

1. Relevant patents granted (not just applied for).
2. Outside awards and other significant recognition accorded labs and/or personnel.
3. Relevant technical papers/reports published (subjected to independent peer review).
4. Responsiveness of lab, i.e., providing solutions to unanticipated problems in developmental or fielded systems and/or newly identified threats.

5. New concepts successfully transitioned to significant materiel development/improvement programs.
6. Integration of external technology capability to address lab responsibilities.
7. Manpower utilization/cost per professional manyear.
8. Army's present materiel/system/component capability in the laboratory's area of responsibility versus that of our adversaries.

QUESTION 3. How relevant is the lab's work to important Army problems?

1. Relationship of technology programs to MAA deficiencies and those identified in other materiel needs and requirements documents (Army 21, C²SPR, AC²MP, etc.).
2. Degree of interface with the field user.
3. Components/subsystems/systems fielded and supported (past five years).
4. Army/DOD customer programs (lab services or hardware provided).
5. Importance of maintaining an in-house capability (versus existing industry/university sources).

APPENDIX E.4

ORGANIZATIONS/INDIVIDUALS CONTACTED
OUTSIDE CECOM RD&E CENTER

APPENDIX E.4
ORGANIZATIONS/INDIVIDUALS CONTACTED OUTSIDE CECOM RD&E CENTER

1. Project Managers:

Position Location Reporting System/Tactical information Reporting
System/Tactical Information Distribution System (PLRS/TIDS) --
COL Stanley M. Clough

Operations Tactical Data Systems (OPTADS) -- COL Philip S. Threefoot

Test, Measurement and Diagnostic Equipment (TMDE) -- COL Dan L. Bullock

2. Industry:

Martin-Marietta/Orlando Aerospace -- Dr. Robert Wiseman

ITT Defense Communications Division (Nutley, NJ) -- Mr. Thomas Meloro

Emerson Electric Co. (St. Louis, MO) -- Dr. Charles Comer

Motorola, Inc., Government Electronics Group (Scottsdale, AZ) --
Mr. Ray Waddoups

TRW Corporate Offices (Wash, DC) -- Mr. Barry DeRoze

3. TRADOC Schools:

Combined Arms Combat Developments Activity -- James Fox, Scientific
Advisor

Signal School -- Charles Swann, Deputy Assistant Commandant

Intelligence School -- Byron Dean, Scientific Advisor

4. AMC:

Commanding General -- GEN Richard H. Thompson

DCG for Research, Development and Acquisition -- LTG Jerry M. Bunyard

5. DA:

Assistant Secretary of the Army, RDA -- Dr. Jay Sculley

Director of Force Requirements -- BG Jerome Granrud

APPENDIX E.5

LIST OF ACRONYMS

LIST OF ACRONYMS

1. ALBM -- Air-Land Battle Management
2. AMC -- U.S. Army Materiel Command
3. ASB -- Army Science Board
4. ASCO -- Advanced Systems Concept Office
5. ASIC -- Application Specific Integrated Circuits
6. ATR -- Automatic Target Recognition
7. CALS -- Computer Aided Logistics Support
8. CECOM -- U.S. Army Communications & Electronics Command
9. CENCOMS -- Center for Communications Systems
10. CENSEI -- Center for Systems Engineering and Integration
11. CENTACS -- Center for Tactical Computer Systems
12. CLCSE -- Center for Life Cycle Software Engineering
13. CSW -- Center for Signals Warfare
14. DARPA -- Defense Advanced Research Projects Agency
15. DPESO -- DoD Product Engineering Services Office
16. DoD -- Department of Defense
17. EE -- Electrical Engineering
18. EO/IR -- Electrooptical/Infrared
19. ESM -- Electronic Support Measures
20. EW -- Electronic Warfare
21. ETDL -- Electronic Technology & Devices Laboratory
22. GTE -- General Telephone & Electronics
23. HDL -- Harry Diamond Laboratory

24. HF -- High Frequency
25. HQ -- Headquarters
26. IEW -- Intelligence & Electronic Warfare
27. ILIR -- In-house Laboratory Independent Research
28. IR -- Infrared
29. LABCOM -- U.S. Army Laboratory Command
30. MSE -- Mobile Subscriber Equipment
31. NVEO -- Night Vision and Electro-Optics
32. OESO -- Organizational Effectiveness Staff Office
33. PLRS -- Position Locating Reporting System
34. PM -- Project Manager
35. PMO -- Project Management Office
36. RD&EC -- Research, Development and Engineering Center
37. RSTA -- Reconnaissance, Surveillance and Target Acquisition
38. SES -- Senior Executive Service
39. SINGARS -- Single Channel Ground and Airborne Radio Systems
40. SURAN -- Survivable Radio Network
41. S/W -- Software
42. TRADOC -- U.S. Army Training & Doctrine Command
43. USCENTCOM -- U.S. Central Command
44. UV -- Ultraviolet
45. VHSIC -- Very High Speed Integrated Circuits