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REPORT OF THE ARMY SCIENCE BOARD
INDEPENDENT REVIEW
OF
THE US ARMY ARMAMENT RESEARCH,
DEVELOPMENT AND ENGINEERING CENTER

SEPTEMBER 1987

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A. EXECUTIVE SUMMARY

We have conducted an effectiveness review of the Armament Research Development and Engineering Center (ARDEC).

The Center has a full-spectrum mission for armament materiel. This includes basic and applied research; advanced development; full-scale engineering development; product and process improvement; support to the government ammunition-related production plants and industrial producers of its materiel; and support to the forces in the field for problem resolution. It also provides an engineering base in the event of mobilization for scientific and engineering know-how required to assure support to our troops. More than 70 percent of the ARDEC yearly budget of \$460M is devoted to RDT&E, including support for a significant portion of the Army's GOCO facilities.

The products are diverse (e.g., weapons and munitions for artillery, armor, infantry, engineers, air defense, explosives and gun propellants). They are used in large numbers during peacetime training and extremely large numbers in war. The staff works with academic institutions and many industrial R&D and production organizations to accomplish its mission.

Armament materiel is associated with most systems in the field. As a result, the Center has many interfaces. It works for and with a large number of Project Managers (e.g., CAWS, TOW, Tanks, Bradley) and with most Army schools (e.g., Sill, Knox, Benning). The center is increasingly involved with foreign developers and producers who have and can make armaments to meet the user's requirements.

During the review, the panel conducted two visits to the Dover site and a visit to the Benet Laboratory. We interviewed a number of users. Of particular benefit were confidential discussions with a number of ARDEC staff members.

Panel members, who were familiar with ARDEC in the past, have noted a significant change in the Center for the better. The Center effectiveness, attitude and performance have greatly improved. This view has been confirmed by the recent selection of ARDEC by the Technical Directors of the labs and centers in AMC as one of the best performers of all the AMC full-spectrum mission centers. We attribute this to the new direction of BG Beltson, assisted by Mr. V. Lindner, until recently the Technical Director.

We have focused our review on the following questions:

1. What is the quality of the staff, facility and technical program?
2. How productive is the Center in accomplishing its mission?
3. How relevant is the Center's work to important Army problems?

A summary of the observations is as follows:

1. Technical Personnel

The technical leadership is qualified and competent, recognizing that ARDEC is primarily a Development Engineering and Production Support Center with a life cycle responsibility and with a limited amount of fundamental and applied research. Obtaining and keeping personnel with specific skills such as system engineering and program management will continue to be a challenge. The Center has had no difficulty in hiring new people as needed. However, new people from universities and colleges generally have been from the middle of the class. Although government salary constraints limit competition for top flight graduates, we think the Center could do better. Personnel turnover is small, running at about 2.5 percent per year. This indicates good management and morale, but does cause problems under the present circumstances of decreasing budget and total manpower. The problem is worsened by the absence of authority to lay off personnel with unneeded skills. Lack of such authority to the Center Director will cause erosion of quality.

There is a relatively flat age distribution, so that the Center is not facing a major loss of capability due to retirements. It is interesting that a number of personnel interviewed privately had opinions quite to the contrary, using complaints like "loss of corporate memory," "loss of experienced people," "leaving at mid-career," etc. The loss is actually less than normal by industry standards. This misunderstanding should be of some concern to management.

Many of the top level management positions are held by command select military officers. We perceive this to be necessary and desirable, but many of the people interviewed looked at it negatively. Management should make an effort to inform the staff of the benefits of such an arrangement.

Government bureaucratic red tape and regulations have a negative impact on the staff. Management should consider improving the attitudes and/or effectiveness of the support staff to ameliorate the effects of this burden.

The technical training and education program is excellent and was at the top of the list for interviewee's when asked, "What do you like about the Center?" Management is to be commended for establishing and maintaining this program.

Morale has been adversely affected by the necessary moving away from the traditional arsenal system, where a complete development and production capability was available. There has been a shift toward contract managing, rather than do it yourself. This change is intellectually understood, but in some cases, not emotionally accepted. Management must continue to strive to develop industrial partnerships and define policies and procedures to process "know-how" definition and transfer while making it clear to the staff that the character of the Center is necessarily changing.

2. Productivity of the Center

The Center has development or technology efforts in virtually every one of the Army prioritized MAA Deficiencies which fit within ARDEC's area of responsibility. The Center is carrying out relevant work and has fielded a large number of armament systems. Specific recent successes are Copperhead and SADARM. However, we believe that the Center has not been keeping up with the threat in some important areas and we would have to say that it has not been serving adequately the high technology needs of the Army. Recent major initiatives, such as the Armor-Antiarmor program, the Armament Enhancement Initiative* and, more recently the Mine program, which have been sponsored and funded independently of the Center, are a recognition of the fact that deficiencies exist in the technology programs. The Center Strategic Planning function does not appear to be functioning properly. Some of the reasons appear to be beyond Center control, such as rapidly changing user requirements, micro-management by AMC and others, and inadequate threat information. The Army's Concepts Based Requirements System seems to define the answer as well as the problem. There is a high probability of constraining innovation and alternatives. If the system requires a validated threat, identification in the Battlefield Development Plan, a tie to Army 21 and support of Air Land Battle, etc., there may be little opportunity to do more than simple evolution and little chance to pursue leap-ahead opportunities. We did not see a strategic planning activity tied to an investment strategy with adequate funding that would ensure pursuit of the high tech applications that are said to be our only hope of keeping up with the Soviets.

Contributing to the problem, as observed by a number of the users, is the lack of an adequate Systems Analysis, Systems Synthesis, Systems Engineering Group that ties user needs to new technology and vice versa. The suggestion was made that some kind of a technology promotion channel was needed. This would have to be supported by independent Center system analysis.

Some parts of the community would attribute at least part of the problem to a lack of competition. Stimulation of competition is one objective of the Armor-Antiarmor Initiative and we already see positive effects on Center attitudes due to this program.

The lack of a systems integrator for some of the missions was noted by some users. Increasingly this has become the responsibility of the PM's. The criteria that establishes a PM is not clear. Consequently, responsibilities and accountability may be diffuse. There is no PM Artillery, although the PM Cannon Artillery Weapon Systems plays a major, but not all embracing role in this arena. There is a PM Smoke and PM Fuze. These latter two appear to be more multidisciplinary technology groups than PM's. We find the system integration, PM system inadequate and in need of attention.

* The Center participated in the establishment and selling of this program.

3. Relevance of Center Work to Army Problems

The preceding discussion applies to the high tech part of the issue. The Center mission is so diverse that we can deal with issues only in a general way. The technology programs deal with a number of MAA deficiencies. The relationship with some of the users is not as good as it should be. One of the users stated that the relationship was clearly and definitely adversarial. Another said the Center was not responsive. The interaction needs to be improved. Efforts have been underway by the Commander to do so for some-time. We have been informed that the Center was cited by the user for excellence in outlining and informing the user of the Center programs. None of the Army Schools have liaison personnel at the Center, nor does the Center assign liaison personnel to the schools. Such assignments were made in the past, but were judged cost ineffective. We do not believe "cost effective" can be quantified in this type of endeavor. Such liaisons can be useful, if not essential, in many respects.

It was stated earlier that the Center will need to increasingly rely upon the R&D capability of Industry. This is happening now but there was a reluctance to admit it on the part of some of the Center briefers. The relationship must be one of true partnership with a sharing of the whole problem, rather than the farming out of piecemeal tasks. In those technology areas where there is a large industrial capability (i.e., sensors) the Center cannot justify a large in-house effort to maintain "knowledgeable buyers." The resources can be utilized in more productive ways.

We appreciate the personal effort of BG Beltson and his staff in assisting our study. They gave us complete cooperation and openly and favorably discussed any and all issues that were brought to the table. We were very impressed by their depth of knowledge of the Center activities and the new sense of direction and excellence they are imparting to the organization.

B. INTRODUCTION

1. Background

Past studies of Federal laboratories have supported 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, eight laboratories/RD&E Centers have been reviewed (see Appendix D1 for reference to past and ongoing ASB reviews).

On 31 July 1986, Dr. J. R. Sculley, Assistant Secretary of the Army, Research Development and Acquisition, requested the Army Science Board to conduct an effectiveness review of the Armament Research Development and Engineering Center (ARDEC), Dover, New Jersey (Appendix D2). As noted in the tasking letter, the ASB panel was asked to provide independent observations on the potential and actual performance of the RD&E Center with the special 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.

2. Panel Composition

The Army Science Board appointed Dr. Harry L. Reynolds, Director, Strategic Defense Center, Rockwell International Corporation, as Chairman of the review panel. Other members of the panel were:

Andrew A. Lieber
Department Manager, Survivability Systems Department
Sandia National Laboratories

Michael M. Mann
Private Consultant
Palos Verdes Estates, California

LTG Marion C. Ross (USA Ret.)
Private Consultant
Dunwoody, Georgia

William F. Scanlin, Jr.
Principal Deputy Associate Director, Defense Systems
Lawrence Livermore National Laboratory

Derald A. Stuart
Vice President
Lockheed Missiles & Space Co., Inc.

John J. Welch, Jr.
Senior Vice President
LTV Aerospace and Defense Company

The Department of the Army (DA) Staff Assistant was Benjamin F. King, Chief of the Support Warfare Analysis Branch, Ground Warfare Division, U.S. Army Materiel Systems Analysis Activity (USAMSAA), Aberdeen Proving Ground, Maryland. We were ably assisted by Mary Kowalewski of USAMSAA.

3. Approach

The ASB panel's approach to the review of ARDEC consisted of three meetings of two days each, one meeting for one day, and individual panel member's review of background material provided. The issues mentioned in paragraph 1 were expanded in the tasking letter by a series of framework questions which were sent to ARDEC for response. Information was also provided for review by panel members in the form of briefing charts and reports. A list of the material available for review by the panel is listed in Appendix D3.

Due to a delay in starting this review because of conflicts in schedules of the panel members, on 13 November 1986, the Executive Director of the Army Science Board, Ronald A. Mlinarchik, changed the completion date from 31 January 1987 to 30 April 1987 (Appendix D4).

The four panel meetings held were as follows. An agenda covering each meeting is in Appendix D5.

a. 30-31 October 1986 at ARDEC

The objective of the first meeting was to meet with the Commanding General at ARDEC, the technical directors, and Center and directorate chiefs to discuss the mission, management, and organization of ARDEC and to receive detailed program reviews by selected organizational elements.

Concerns expressed by the management of ARDEC at this meeting tended to be systemic rather than specific. These included the durability of decisions (e.g., 9mm pistol), the stability of funding, declining funds (e.g., Gramm-Rudman impact and personnel cuts), decision implementation restrictions (e.g., RIF authority versus attrition in workforce reductions) and the paradox faced by developers in the nondevelopmental item (NDI) procurement process. The latter paradox also manifests itself in procurement of foreign systems where the capability of the development community is questioned when an NDI or foreign system is procured or the developer is questioned when an NDI "not invented here" syndrome when an NDI or foreign system is not selected.

Throughout the two-day meeting, panel members focused on issues such as the cradle-to-grave mission of a center (research, development, support to production, and support to fielded systems), separating the ARDEC elements from other elements at the Dover site (PM's and AMCCOM elements), military versus civilian leadership, employee morale, distribution of funding by category and in-house versus contracted out, personnel development and advancement, the status of current and planned facilities, and the adequacy of the technical program.

b. 16-17 December 1986 in Alexandria, Virginia

The goal of the second meeting was to meet with outside agencies to determine the degree of satisfaction of "users" and recipients of the ARDEC products and the interface with outside organizations. Guests included representatives from the TRADOC community, PM offices, and the Department of Army Staff. In the interim between the first and second meetings, individual panel members contacted private contractors who worked with ARDEC to discuss the state of their working relationships.

During this meeting, the panel Chairman and the DA Staff Assistant met with LTG Skibbie, AMC Deputy Commanding General for Research, Development, and Acquisition, to get his views on Army problem areas which he felt ARDEC should be pursuing. LTG Skibbie noted two areas which currently are very important to the Army in the field. These areas are insensitive munitions to improve survivability of the force and efforts to lighten the force for increased capability of the light divisions through deployability, mobility, and supportability.

c. 13-14 January 1987 Meeting at ARDEC

The purpose of this meeting was to meet with resident PM's and AMCCOM elements at the Dover site to explore the quality and quantity of ARDEC support, review the Benet Laboratories element of ARDEC at Watervliet Arsenal, and explore further questions and tentative issues identified at previous meetings.

Issues explored included the breadth of the mission statement, Appendix D6, the impact of the loss of in-house production facilities, modernization of mortars relative to armor, ATGM's, and artillery, quantitative analysis of system design tradeoffs, passive attitude toward user-driven or concept-based requirements as opposed to pro-active technology solutions to deficiencies, and degree of strategic planning.

The meeting adjourned with specific assignments to individual panel members for preparation of a draft report.

d. 16 March 1987 Meeting in El Segundo, California

The entire meeting was devoted to reviewing, discussing and completing the final draft report. All aspects of the previous meetings were discussed with the panel members to insure that there were no conflicts regarding the report.

C. DISCUSSION OF OBSERVATIONS

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

1.a. The technical staff is qualified and competent.

ARDEC has many personnel who have received peer recognition, both internal and external to the government. The technical work is of high quality and generally relevant. In particular, the work in basic chemistry (in support of propellants and explosives), in structural mechanics (both theoretical and experimental) in support of composite materials, and in dynamic behavior of materials and structures (in support of tube development) appear to be as current as anything being done elsewhere in these fields.

1.b. The structure of the ARDEC technical staff appears appropriate for the work to be done with the exception of systems analysis, systems synthesis and systems engineering.

ARDEC has a most interesting structure due to its background and mission, as perceived by the Center. ARDEC is primarily an engineering center with a strong sense of life cycle responsibility - as opposed to a laboratory. This predominance of life cycle engineering is reflected in the structure of the technical workforce - a large majority of the E&S personnel are engineers who do not have advanced degrees. However, as mentioned above, ARDEC does do a significant amount of rather basic research. Buried within ARDEC are research organizations which are structured more as one would expect a laboratory to be structured - with a majority of the personnel having advanced degrees (generally in mathematics or the physical sciences - physics and chemistry).

In recent years, ARDEC has had a basic change in character (make or buy policy) which has, does, and will continue to impact the technical staff - changing the character of much of what they do and providing the potential for misunderstandings and morale problems. (A potential only partially recognized by ARDEC middle management - see Item 1.c. below.)

One would anticipate that such a basic change in character of working conditions and "shop support" would be reflected in serious morale problems in the technical staff - and to be further reflected in loss of personnel (increased turnover). Though the individual interviews with members of the ARDEC technical staff did reflect some "mourning" about loss of capability, there has not been a large turnover. Indeed, the ARDEC E&S retention record is remarkably good, with a voluntary quit rate of only about 2-1/2 percent per year.

Considering the difficulties and restrictions imposed in the government hiring process, ARDEC has done remarkably well in their hiring programs. They have no critical shortages, except for systems analysis, systems synthesis, and systems engineering as discussed in 2.0. Their acquisition rate is determined by need, funding, and ceiling and not by ability to hire. In addition, if it were possible to eliminate some positions occupied by personnel with unneeded skills, some augmentation of pertinent technical staff would be possible.

However, the hiring generally is not from first-class Universities, and not the top of the class. In 1984 and 1986, 40 percent of acquisitions had a grade point average of 2.9 or better/scale of 4.0). In 1985, standards were reduced (332 people were hired) and only 29 percent had a grade point average over 2.9. The government salary constraints limit competition for top flight people.

If ARDEC were to attempt to upgrade their technical staff by more selective hiring of people with higher grade point averages, it is probable that they would not be able to do so without special considerations - the 3.5+ grade point students will not wait for a firm offer from the system as it now operates. One must be able and prepared to make special offers and firm commitments at the time of the interview or shortly thereafter. ARDEC will have this ability soon in their recruitment effort for GS 5-11 engineers.

1.c. In general, ARDEC is NOT facing a major loss of capability due to a wave of retirements.

This is undoubtedly due to the fact that because of the relatively low turnover rate in past years ARDEC's technical age distribution is relatively flat. If they encounter such a problem in the future, it will be due to factors other than age distributions and age-related retirements.

On the other hand, with a relatively "flat" age distribution, ARDEC should not be plagued with an abnormally high number of "blockers" who "peaked" in positions of authority at an early age and now prevent the progress of others in the organization because of "ceiling limitations." (Of course, a flat distribution also requires special efforts to prevent "technical stagnation" - see 1.d. below.)

1.d. There are some potentially serious morale problems evidenced in the technical staff.

The Army has generally moved away from its traditional arsenal system and now contracts for development, as well as production hardware. This has been, and continues to be, a rather traumatic change for some of the technical personnel. Some years ago, the prototype, demonstration, development and pilot production hardware for many systems was produced in the government under the direct engineering supervision (and the direct involvement) of the ARDEC engineers. Now, with the exception of some laboratory work in propellants and explosives and the work at Benet laboratory in conjunction with Watervliet Arsenal, hardware and materials are purchased from private industry. This change in the character of the engineering task may be intellectually understood by the technical staff, but is not totally emotionally accepted - especially by some of the "old-timers."

The ARDEC technical culture has been one of independence and control through the knowledge of theory and industrial practice. Now ARDEC must depend upon industry and will no longer be the sole possessor of the knowledge or practice. Indeed, as time goes on, more and more of that knowledge resides exclusively in the private industrial support world. ARDEC is becoming more technically dependent upon private industry and is being forced to trust industry. Management has recognized this situation as impacting its external relations and has taken action accordingly -- setting up an Industry Advisory Board; setting up briefings for industry; holding Program Reviews and other meetings with Industry Executives; etc. They are to be congratulated for their initiative in those endeavors. However, internal changes are also required and are not apparent.

In briefings to the Panel, ARDEC reflected the attitude that "industry cannot be trusted!" This attitude has been "picked up" by the staff and influences their actions. (It was quite apparent in some briefings that the speakers were reluctant to state or admit that the particular ideas or R&D being described had originated and been carried out in industry - or that they were in any way dependent upon industrial initiative.)

The situation of being forced to depend upon organizations which are believed to be non-trustworthy is putting the technical staff in a frustrating position. (The dilemma is one that is felt, but not analyzed, and, hence, not articulated.) Unless action is taken by management, the perceived conflict between internal attitudes and required actions is almost certain to become more serious as ARDEC's technical preeminence in its field erodes, as it will do with the current policy and budgets.

Management must foster partnerships if they are to obtain the greater contributions by other Laboratories and Industry that are required to produce the technology, synergistic technical competition and innovation required to keep up with the Soviets. In the opinion of the panel, such partnerships require trust and trusting - and an internal ARDEC atmosphere which legitimizes such attitudes - as well as explicitly defined policies and procedures to process "know-how" definition and technical transfer by means other than "reverse engineering."

The committee interviewed several E&S employees in informal, not-for-attribution interviews. The interviewees included a long tenured employee; one who had interrupted service (worked at ARDEC for several years then left government service and consulted for a few years and has now been back with the government for a couple of years); one with less than five years work experience - all with ARDEC, etc. They had been selected with the intent of giving as complete a cross section of the technical staff as a dozen individuals could.

None of the people interviewed seemed to be dissatisfied with ARDEC, with the facilities or equipment provided, with their work, or with their continuing education opportunities. They were not so sanguine about their rate of pay or with the rate of advancement beyond salary grade 12. In general, their morale was high. A common complaint, however, was concerning the burdens of red tape, forms and the difficulties of obtaining simple services, such as secretarial, minor procurements, travel, etc. One comment was that employees were all assumed to be crooks. (It was explained to the employee that this Washington-generated cultural attitude did not affect ARDEC alone.)

An additional concern was that short-term military personnel occupied many of the top level positions which caused short-term goals, us vs. them attitudes and other problems. The committee agrees that military personnel in these positions are necessary and should provide user perspective and needed interaction with the customer. However, we believe that top management should make an effort to inform the staff of the necessity and benefits of the arrangement.

It should be noted that the E&S personnel interviewed displayed a very incorrect understanding of ARDEC's personnel picture. More than one of us heard "complaints" like: "loss of corporate memory;" "loss of experienced people;" "leaving the government at mid-career;" etc.

These misunderstandings should be of some concern to ARDEC management. The picture drawn of ARDEC by the interviewees was that of an organization with major loss of capabilities due to retirements (high seniority and high salary grades) and voluntary quits (by personnel in mid-career who can "do better in private industry") In actual fact, as indicated in 1.b. above, ARDEC's loss rate (due to all causes) is quite nominal - many industrial concerns would like to have a retention record as good.

Budget reductions are causing a reduction in the number of ARDEC personnel. At the same time, the workload is increasing and the skill mix is changing. Effective management of this problem is severely impacted by the prohibition of layoffs. There are some groups and skills that are no longer needed. Yet, there is no way to remove them from the payroll. This restriction should be removed.

1.e. The ARDEC continuing education program is comprehensive and effective.

All personnel interviewed placed the education program at or near the top of their "good things" about working at ARDEC.

1.f. The laboratories, equipment and facilities which we observed were up to date and well maintained. (Both at Picatinny and Benet.)

2. How productive is the lab in accomplishing its mission?

2.a. The Center is quite productive for most of its mission objectives.

The scope and breadth of responsibility encompassed by the ARDEC Mission statement necessitates a considered and difficult allocation of resources. While broad statements are obviously subject to exception, there appears to be a general consensus among the users as well as the panel members that the overall productivity was reasonable and that the organization reflected effective leadership. ARDEC production and support activities and product improvement programs have been effective. However, there appears to be insufficient capability and focus on the ARDEC role in armament system engineering and integration. There is also concern that the balance between "evolutionary" and "revolutionary" R&D activities is such that the tech base does not support future requirements and is inadequate to forestall technological surprise.

There are ARDEC developmental successes such as SADARM, Copperhead, and tank anti-helicopter round. However, major development activities such as the Armor-Antiarmor program, the Armament Enhancement Initiative, and more recently the Mine Program, have been initiated and sponsored independently of the Center. We are concerned that ARDEC is not in the vanguard addressing the needs of and benefits to the Army of new technology. As stated in the executive summary, this is not entirely the fault of the Center and also involves users, AMC, Army management and funding restraints.

There have been significant contributions in the Value Engineering and producibility areas. With regard to the latter areas, the future of programs such as Manufacturing Technology (MANTECH), Industrial Modernization (IMOD), and Industrial Modernization Incentives Program (IMIP) seems endangered. Less than 10 percent of the FY87 MM&T was for production base modernization, and this is proposed to decrease to less than 5 percent in FY88.

With regard to manufacturing process development, greater use of smaller scale pilot production facilities would provide more timely and cost effective alternatives for enhancing productivity.

2.b. Systems analysis, systems synthesis and systems engineering need to be strengthened.

The need for enhancing and expanding the ARDEC capability in systems synthesis and systems engineering and integration was a recurring theme in discussions with the user community. The ARDEC is viewed as having the responsibility for integration of total armament systems, but it is not evident that the necessary multi-disciplinary system engineering personnel to meet this demand are available or that there is an identified focus within the organization for this function. Related to this is the issue of inadequate liaison with the schools and other Army agencies.

2.c. ARDEC could make more effective use of base technology funding.

The ARDEC conducts a wide ranging R&D program in support of its responsibilities. The level of activity is reflected in the release for publication of approximately 200 journal articles and presentations and the issuance of approximately 30 patents (120 currently pending) during the past year. The scope of the ARDEC Mission, coupled with the fact that less than 10 percent of the budget can be allocated to research activities, makes it difficult to meet the objective of maintaining a Center of Excellence at the leading edge of all of the relevant disciplines. The result is that some research and development programs are excellent and highly productive while others are subcritical. Consideration should, therefore, be given to concentrating the effort in critical technologies where the ARDEC has established capabilities and expertise not readily available in other governmental or industrial organizations (e.g., explosives) and emphasize cooperative efforts in other areas, e.g., sensors and image processing, in which there exists a high level of activity and expertise elsewhere. Several contractors volunteered that while they viewed their relationship with the ARDEC as positive, they were concerned that the contracted activity was almost exclusively in support of ARDEC technology initiatives, and outside initiatives were not encouraged. In addition, it was stated that there did not appear to be an integrated goal-oriented program in place. As a result they have been reluctant to invest IR&D in support of ARDEC objectives. While the inputs from this very limited sample may not be truly representative, it appears to warrant consideration. This issue is likely to have increasing significance in the future as decreasing manpower ceilings for the ARDEC tend to magnify the problem.

The problem of maintaining an aggressive and productive R&D program is exacerbated by the Concepts Based Requirements System which frequently tends to define the answer as well as the problem. There is a very real prospect of overly constraining innovation and alternatives. If the system requires a "validated threat," identification in the Battlefield Development Plan, a tie to Army 21 and support of Air Land Battle, etc., there may be little opportunity to take advantage of more than simple evolution and no chance to capitalize on leap-ahead opportunities. This is an issue which deserves serious consideration in the planning and resource allocation processes.

3. How relevant is the RD&E Center's work to important Army Problems?

3 a. The Center is addressing technology programs related to MAA deficiencies.

Of the first 100 prioritized MAA deficiencies, about 15 fit within ARDEC's area of responsibility. The Center has developmental or technology efforts in virtually every one of these. This is a strong indication that the development center is carrying out relevant work.

Further evidence of the key nature of ARDEC's work is that it involves the payload or the lethality-producing element of all Army weapons systems with the exception of missiles. ARDEC also makes a contribution in the area of tactical nuclear munitions.

It is clear that the mission assignment for ARDEC is extremely broad. It is our view that support of such a broad mission requires a larger exploratory development effort than would appear to be in place at ARDEC and a more effective use of base technology funding as stated earlier. We did observe some very competent technology programs which were aimed at important Army problems, but it is our assessment that the developmental activity was highly directive, that is, solution-oriented rather than problem-oriented. We perceive this to be more of a problem of the management of the research Centers than a failing of the Center itself. With respect to the need for augmentation of exploratory development efforts, the Center should utilize more thoroughly the technology base provided by contractors and other Federal laboratories.

3.b. The interface with the User community is inadequate.

The panel perceives this to be an inadequacy with a probability of detrimental effects in terms of the Center's responsiveness to user problems and needs. In interviewing Program Managers and users, we learned of examples in which the interfacing and liaison were satisfactory. Most input we received indicated that the situation has been generally improving over the period of the last 18 months or so. There were instances, however, where the interfacing and liaison were not satisfactory and in at least one case, the relationship between the Center and user was stated as adversarial.

In addition to the UK, Canada and West Germany, the U.S. Marine Corps maintains a liaison office at the Center. It seems particularly noteworthy that no Army school has liaison personnel at the Center, nor does the Center assign liaison personnel to those schools. Apparently, such assignments were made in the past, but were judged cost-ineffective, because there were not sufficient programmatic matters of common concern. It is our belief that this is a short-sighted view. Liaison personnel, should not only resolve interface technical problems but in their "spare time" observe and work with the troops and equipment associated with their assignment. Rapport with the User would improve and the current dependence on military assignees in key positions to provide the military view would diminish.

3.c. Components/subsystems/systems fielded and supported (past five years).

The Center has fielded (or participated in the fielding of) a number of systems over the past five years. We were particularly impressed with Copperhead and SADARM. These systems represent the most significant advanced conventional munitions fielded by the U.S.

3.d. Army/DoD customer programs (lab services or hardware provided).

Although ARDEC does participate in several customer programs, the number of people involved in these activities, according to our briefings, is very small; in each of several activities, generally numbering less than 10 people. Such activities are relatively insignificant in the overall assessment of ARDEC.

3.e. Importance of maintaining an in-house capability (versus existing industry/university sources).

This question has no simple answer. Our interviews with some of the ARDEC staff members, some of whom have been at the Center for more than 20 years, provided comments that were critical of the loss of in-house production/prototype capability and the general drift towards the Center becoming an organization which performs mostly contract monitoring. It was our perception that this has had a deleterious effect on morale. There is the concern that engineers and scientists with too few opportunities for hands-on design and development experience may gradually lose technical competence and become ineffective contract monitors.

The Benet Laboratory, with its close association with Watervliet Arsenal, presented a sharp contrast. Morale was markedly higher. In view of the relative manning levels, the quality and variety of technology programs were much greater than at the Center at Picatinny. However, this situation is near-unique. The Arsenal is essentially Benet's customer and the arrangement is not available throughout the system.

For the Center to act as "smart buyers" for the Army, a sound background of hands-on experience in the pertinent field is necessary. However, continued hands-on participation is not required; otherwise the very concept of technical supervision and management is not workable. We note that progressive technical organizations take deliberate planned measures of various types to assure that both their management and their technical staff do not become obsolete in their field. The development of a competent staff would seem to properly include a period of relevant hands-on experience for all staff members with consideration for the possibilities of rotation back to hands-on programs on a periodic basis.

During our tours we visited a number of ARDEC laboratories. In some, the work was of major importance and fairly unique (e.g., high explosives). In others, the work obviously did not compete with extensive efforts and competence in industry. In response to this observation we were told that the effort was necessary to maintain smart buyers. We believe this luxury cannot generally be maintained in the face of decreasing manpower and increasing workload and suggest that some pruning is in order.

APPENDIX D.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 US Army 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 the US 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 US Army Research and Technology Laboratories, June 1985
7. Report of the Army Science Board Effectiveness Reivew of the US Army Ballistic Research Laboratories, August 1986
8. Report of the Army Science Board Effectiveness Review of the US Army Missile Command Research, Development and Engineering Center, September 1986
9. Report of the Army Science Board Effectiveness Review of the US Army Human Engineering Laboratory, projected completion April 1987

APPENDIX D.2

TASKING LETTER



DEPARTMENT OF THE ARMY
ARMY SCIENCE BOARD
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310-0103

31 JUL 1986

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 seven members to conduct an effectiveness review of the U.S. Army Armament Research and Development Center, Dover, New Jersey. 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 A. Thompson, CG, USA Materiel Command is the sponsor. Mr. Ronald A. Mlinarchik, Executive Director, Army Science Board will serve as the OASA(RDA) Cognizant Deputy. Mr. Ben King, Chief, Combined Arms Warfare Analysis Branch, USAMSAA will serve as the DA Staff Assistant.

It is not anticipated that your inquiry will go into any "particular matters" within the meaning of Section 201 of Title 18, United States Code.

The panel should begin immediately and complete its review by 31 January 1987.

Sincerely,



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

Enclosure

APPENDIX D.3

LIST OF MATERIAL FOR REVIEW FROM ARDEC

1. ARDEC Overview (Briefing Charts)
2. Advanced Systems Concept Overview (Briefing Charts)
3. Close Combat Armaments Overview (Briefing Charts)
4. Fire Support Armaments Center (Briefing Charts)
5. Nuclear Program (Briefing Charts)
6. Mine Program (Briefing Charts)
7. Product Assurance Directorate (Briefing Charts)
8. Production Base Modernization Agency (Briefing Charts)
9. Fuze Program (Briefing Charts)
10. Armament Technology Laboratory (Briefing Charts)
11. Technology to Fielding Briefings (Briefing Charts)
M833, Volcano, Explosive Formed Penetrator
12. Miscellaneous Personnel Data
13. Biographical Sketches of Key Management Personnel
14. ARDEC's Mission: "Definition and Detail"
15. ARDECR 10-1 (ARDEC's Mission, Functions and Assigned Material)
16. FY 86 Engineer and Scientist Recruitment Plan
17. Center for Defense Studies Course Schedule FY86 3rd & 4th Quarters
18. Center for Defense Studies Course Schedule FY87 1st & 2nd Quarters
19. SES and Recent Recruitment Data for ARDEC as of December 1986
20. Benet Weapons Laboratory Booklet dated January 1987

APPENDIX D.4
LETTER CHANGING COMPLETION DATE



DEPARTMENT OF THE ARMY
ARMY SCIENCE BOARD
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310

13 NOV 1986

Dr. Harry L. Reynolds
Corporate Director, Advanced Concepts
Advanced Systems Development
Rockwell International Corporation
2230 East Imperial Highway
El Segundo, CA 90245

Dear Dr. Reynolds: *Harry*

Due to administrative delay in starting this effort, the completion date stated in the Terms of Reference for the effectiveness review of the U.S. Army Armament Research and Development Center has been changed from 31 January 1987 to 30 April 1987.

The remainder of original Terms of Reference remain the same, but I have updated the participants list and enclose a copy for your files.

Sincerely,

R. A. Mlinarchik
Executive Director

Enclosure

Copy furnished:
Mr. Freedman
Mr. Lieber
Dr. Mann
LTG Ross (USA Ret.)
Mr. Scanlin
Dr. Stuart
Mr. Welch
GEN Thompson
Mr. King
Dr. Peden
Mr. Decker

APPENDIX D.5
MEETING AGENDUMS

AGENDA
ARMY SCIENCE BOARD REVIEW
30-31 October 1986

Thursday, 30 Oct:

0730-0800	Enroute from motel by Govt vehicle	ASB Members
0800-0830	ASB Executive Session/Security Processing Bldg. 1, Rm. 447	
0830-0835	Welcome - Bldg. 1, Rm. 460	BG R. Beltson
0835-1030	ARDEC Overview	Mr. V. Lindner
1130-1200	ASCO Overview New Concepts IR&D MAMP Process	COL A. Meier
1205-1500	Close Combat Armaments Center CCAC Overview JSSAP Armor/Antiarmor Program Armament Enhancement Initiative 120mm Lightweight System Bradley High Survivability	Mr. H. Krosser Mr. J. Ackley
	Room 460 (Working Lunch)	
1500-1730	Fire Support Armaments Center FSAC Overview Artillery Delivery Systems Adv Field Artillery System 155mm Lightweight Howitzer Smart Munitions	Mr. R. Davitt Mr. H. Opat Mr. T. Moore
1730-1815	Discussion of Issues Bldg. 1, Room 460	Mr. T. Davidson
1815	Depart for Motel	Ms. R. Price Mr. S. Floroff Mr. E. Zimpo
		ASB Members/ BG R. Beltson Mr. V. Lindner

Friday, 31 Oct:

0730-0800	Enroute from hotel by rental car.	
0800-0900	Individual Groups	
	a. Small Arms Demonstration, Bldg. 1, Rm 224	COL Manderville (lead) A. Lieber/W. Scanlin, Jr.
	b. Mission Discussion, Bldg. 1, Rm 443	Mr. V. Lindner (lead) J. Welch/M. Mann
	c. Personnel Issues, Bldg. 1, Rm 459	COL Bachelor (lead)/ Mr. Filippone LTG Ross (USA Ret)/ Dr. Derald Stuart
0900-1100	ARDEC Tour	
	a. Energetics Lab, Bldg. 3028	Mr. Bushey (lead)
	b. Sensor Evaluation Lab (Smart Munitions) Bldg. 353	Mr. Davidson (lead)
	c. Center for Defense Science Studies Bldg. 162S	Mr. Krones (lead)
1100-1200	AED Overview, Bldg. 1, Rm 460 Room 460 (Working Lunch)	Mr. Bushey
1200-1330	Personnel Interviews Bldg. 1, Rms 446, 447, 460, 454	ASB Members/ARDEC Employees
1330-1400	Executive Session Bldg. 1, Rm 460	ASB Members BG Beltson Mr. V. Linder
1400	Adjourn	

AGENDA

16-17 December 1986

ASB Review of ARDEC at LTV Aerospace & Defense Company

16 December 1986

- 0830-0900 Panel Executive Session
- 0900-0945 COL Heiberg, Ft. Sill DCD
- 0945-1030 PM TMAS Tom Mahler, Howard Bernstein
- 1030-1115 COL Raymond Ross & Irena Szkrybalo
- 1115-1245 L U N C H
- 1245-1330 MAJ Birdsong, Ft. Benning DCD
- 1330-1415 MG Woodmansee
- 1430-1515 PM BFVS, Mr. Gary Chamberlain, APM for Development
- 1515-1600 MG Crosby - ADCSPER
- 1600-1700 Panel Discussions

17 December 1986

- 0830-0930 Nuclear Projectile, Carmen Spinelli, AV 880-5516
- 0930-1030 Mine Program, Sid Glassman, AV 880-6195/6191
- 1030-1500 Adjournment - Panel Working Session



DEPARTMENT OF THE ARMY
ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
US ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND
DOVER, NEW JERSEY 07801

AGENDA
FOR VISIT OF
ARMY SCIENCE BOARD
13-14 JANUARY 1987

Tuesday, 13 Jan:

- 0730-0800 Enroute to Picatinny Arsenal by Govt vehicle.
- 0800-0815 Administrative Procedures
Bldg 1, Rm 460
- 0815-0830 Welcome Remarks by ARDEC Commander
Rm 460 BG Belton
- 0830 Army Science Board splits into two teams:
(Team A and Team B)

Team A - COL Manderville

- 0830-0945 Enroute to Benet Lab by helicopter.
Depart from National Guard helipad.
- 0945-1415 Tour Benet Laboratory
- 1415-1530 Enroute to Picatinny Arsenal
- 1545 Rejoin Team B
Bldg 1, Rm 460

Team B

- 0830-0915 Army Science Board discussions of private plans
Bldg 1, Rm 460
- 0915-1000 Product Assurance Directorate
- 1000-1045 Production Base Modernization Agency
- Mr. Lazar
COL Mulcahey,
Mr. Kolis

SMCAR-GSP/12 JAN 87 (2)

1045-1130	Product Manager - Fuzes Bldg 1, Rm 460 (Each session should have ASB, and agency only)	LTC Sinclair Mr. Spaulding
1130-1230	Working Lunch Private Discussions	ASB only
1245-1345	Electromagnetic Gun Tour/SDI Bldg 329	Dr. Gora
1400-1530	Munitions Demonstration Bldg 616 Test Area	Mr. Rosamilia
1545	Rejoin Team A Bldg 1, Rm 460	
1600-1630	Discussions with ARDEC Commander and Technical Director	BG Beltson, Mr. Krosser
1630-1650	Enroute to hotel by Govt vehicle	
1700	RON Sheraton Mt. Arlington	

Wednesday, 14 Jan:

0730-0800	Enroute to Picatinny Arsenal by rental cars.	
0800-0830	Armament Technology Laboratory Bldg 1, Rm 460	Mr. Gehbauer
0830-0930	GEN(Ret) Ross and Mr. Stuart meet with CPO, DRM and DC Bldg 1, Dep Cdr's Ofc	
0830-0930	Technology to Fielding Briefings M833 Volcano Explosive Formed Penetrator Bldg 1, Rm 460. (Div Head, Dep, and Briefer only)	Mr. Konrad Mr. Glassman Mr. Fong
0930-0945	Mobilization Plan	Mr. Decker, COL Palmieri

SMCAR-GSP/12 JAN 87



DEPARTMENT OF THE ARMY
 Armament Research and Development Center
 Hq. US Army, Armament, Munitions and Chemical Command
 Watervliet, N.Y. 12187

12 January 1987

SMCAR-CCB

AGENDA
 ARMY SCIENCE BOARD

13 January 1987

- | | | |
|-----------|--|-------------------|
| 0945 | Arrive Watervliet Arsenal (via helicopter) | |
| 0945-1000 | Introduction to Benet/WVA (B115 Conf Rm) | Mr. Johnson |
| 1000-1130 | Research Overview (B115 Conf Rm) | Dr. D'Andrea |
| | Composite Material Technology | Mr. R. Soanes |
| | Coatings Technology | Mr. G. Friar |
| | Dynamic Testing | Dr. J. Vasilakis |
| | Advanced Technology Alloys | Dr. P. Cote |
| | Non Destructive Testing & Evaluation | Mr. G. Capsimalis |
| | Robotics | Dr. R. Racicot |
| | Non Living Intelligence | Mr. M. Johnson |
| 1130-1250 | Gun Dynamics (B115 Conf Rm) | Mr. R. Hasenbein |
| | Gun Thermal Shrouds | Mr. R. Gast |
| | Ammunition Autoloader Systems | Mr. D. Jones |
| | 120mm Lightweight Gun | Dr. J. Zweig |
| 1250-1350 | Tour of Selected Areas of Mfg/Shops
w/Benet Involvement | Dr. F. Heiser |
| | Swage Autofrettage | Mr. R. Farrara |
| | Forge | Mr. R. Meinhart |
| | Heattreat | Mr. P. Thornton |
| | Guided Bore | Mr. W. Sullivan |
| | FMS | Mr. B. Rose |
| 1350-1410 | CAD/CAM | |
| 1415 | Depart Watervliet Arsenal (via helicopter) | Mr. V. Montouri |

AGENDA

March 16, 1987

Rockwell International Corporation
El Segundo, California

0830 - 1500 Hours

1. Administrative Announcements.
2. Discussion of Executive Summary.
3. Discussion of Framework Question No. 1:
Does the R&D Center have a quality staff, facility, and technical program?
4. Discussion of Framework Question No. 2:
How productive is the lab in accomplishing its mission?
5. Discussion of Framework Question No. 3:
How relevant is the RD&E Center's work to important Army problems?
6. Discussion on suggested changes/improvements to the evaluation process.
7. Discussion of appendices.

APPENDIX D.6

01.04 ARDEC MISSION STATEMENT

To conduct research, development and life-cycle engineering, to include program management of initial procurement packages, for assigned armament and munitions systems and materiel. Execute assigned missions in support of other US Army Materiel Command (AMC) or Department of Defense (DoD) elements and other Federal Organizations as appropriate, having centralized management responsibility for specific weapon systems, items, or technologies. Maintain, and life-cycle support of assigned materiel or transitioned technologies.