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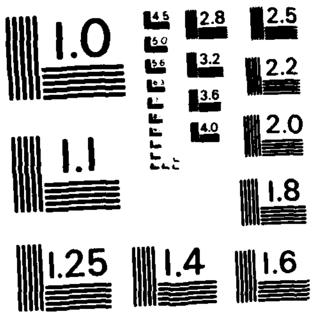

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USAWC MILITARY STUDIES PROGRAM

R&D INVESTMENTS TOWARD THE 21ST CENTURY

INDIVIDUAL ESSAY

by

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US Army War College
Carlisle Barracks, Pennsylvania 17013
28 March 1983

ABSTRACT

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The military investment balance since 1970 has significantly shifted toward the Soviet Union. This trend and a growing reliance on high technology portends an erosion of the US qualitative advantage in weaponry. This paper addresses the Army R&D process and the technological requirements implied by the AirLand Battle 2000 concept. A strategy is offered to provide a program balanced between near-term modernization and the generation of an array of technology options for achieving battlefield superioty in the 21st Century.

Three critical factors currently impacting the defense scene suggest the need to reassess our approach to investment in the Army Research and Development (R&D) Program. First, in the last decade, the imbalance in military investment between the Soviet Union and the United States has continually widened in favor of the Soviets. Their net resource advantage is likely to increase in the next few years giving rise to further erosion of our qualitative advantage in weaponry. The Reagan administration's defense program addresses this issue, but it focuses on expanding near-term modernization. Secondly, there is the rapidly growing trend toward reliance on high technology in our emerging force structure and doctrine. Technological advances in some fields are doubling every ten years. The AirLand Battle 2000 concept projects a battlefield and structure which will demand significant materiel improvements through the application of emerging technologies. Finally there is the widely recognized need for improvement in our material acquisition process which Time Magazine recently described as "The Winds of Reform" in a cover story.[1] The process problems were largely addressed by the Defense Acquisition Improvement Program in 1981. To the extent to which it is effectively implemented, that program will make major improvements in the full-scale development, procurement and production aspects of materiel acquisition. These factors lead to the need for a coherent strategy for Research and Development which balances near term modernization with the long-term need for a variety of advanced concepts addressing the Army in the 21st Century. This paper addresses the environment, resources, requirements and players involved in Army Research and Development. A strategy for investment is offerred which can improve management and provide a balanced program which is future oriented and flexible enough to meet the challenges of AirLand Battle 2000. The approach taken involves increasing R&D resources, strengthening technology and expanding use of experimental prototypes.

THE ENVIRONMENT

It is generally recognized that in the last decade the Soviet Union has invested resources in a peacetime military build-up of unprecedented proportions. During this period, US expenditures in military investment accounts (i.e. Procurement, R&D and Military Construction) first declined and then in 1976 began to increase; nonetheless total Soviet investment each year since 1976 has been about twice the US investment. The gap in constant FY 1983 dollars was estimated at $440 billion by the end of 1982.[2] The Reagan Administration is committed to reversing this trend, and it significantly increased the defense budget beginning in FY 1981. Most of the increases in the investment accounts have gone into procurement to support force modernization and readiness. In the case of investment in military Research and Development, the Soviet lead is estimated at $120 billion, and in 1981 Soviet R&D investment was still twice that of the US.[3] While there is considerable debate about the technological capability of the Soviet Union vis-a-vis the United States, it is clear that the combination of greater investment and aggressive technology transfer from the West has significantly improved the technological quality of fielded Soviet equipment.

The Under Secretary of Defense, Research and Engineering, Dr. Richard D. DeLauer, has provided a most revealing assessment of relative US/USSR technology levels in deployed military systems. In the category of tactical land forces, Dr. DeLauer does not assess the US as superior in any deployed system. He gives the Soviets the advantage in infantry combat vehicles and chemical warfare and he counts all other areas as even between the US and the USSR. Dr. DeLauer also examined the basic technologies which he feels hold the greatest potential for changing military capabilities in the next two decades. His assessment placed twenty basic technologies into the following judgmental categories:[4]

- USSR Superior
  - Conventional warheads
  - Mobile power sources
- US Superior
  - Automated control
  - Computers
  - Microelectronic materials and integrated circuit manufacture
  - Production/manufacturing
  - Software
  - Stealth (signature reduction)
  - Telecommunications
- US-USSR Equal
  - Aerodynamics/fluid dynamics
  - Directed energy
  - Nuclear warheads
  - Structural materials (moving toward US superior)
- US Superior But Changing Toward USSR Superior
  - Electro optical sensors (including IR)
  - Guidance and navigation
  - Optics
  - Aerospace propulsion
  - Radar sensors

- Signal processing
- Submarine detection

The implications of this assessment are clear--while the US has maintained its lead in most areas, the Soviets are gaining significantly. The two technologies in which the Soviets have the lead are critical to ground force operations. Certainly we can not allow our position to continue eroding without risking eventual Soviet superiority in all categories of deployed systems. The current US technological advantage is not necessarily reflected in the weapons systems balance which the Army faces. We apparently have not succeeded in translating technology into fielded systems as rapidly as has been the case in the USSR. This is a reflection of the extremely long development cycles which have characterized the acquisition process.

The genesis of this situation is deeper than just a question of resource allocation in the Army or Defense budgets. While US national R&D funding over the period 1971-1981 did increase in real terms, the rate of growth declined. Research and Development expenditures as a percentage of the Gross National Product (GNP) over that period fell from about 2.5 to 2.3 percent, while the Soviet Union was investing about 3.4 percent of GNP in R&D. Importantly the US expenditures for basic and applied research, measured in constant dollars, remained level; thus the growth in investment has gone into development activities.[5]

The trends in education and employment of scientists and engineers have also been unfavorable. The proportion of scientists and engineers engaged in R&D in the labor force has declined in the US while it has increased in the USSR.[6] Moreover, the Soviet Union is producing about 250,000 engineering graduates per year compared with about 50,000 per year in the United States.[7] Of particular concern to defense is the fact that the US generation of doctorate degree recipients in engineering, physical science, mathematics and computer science fell twenty-six percent from 1972 to 1979. That situation is made worse by the fact that the proportion of foreign graduate students in US universities is growing in those fields which are critical to defense (e.g. in 1979 forty-one percent of all engineering graduate students were non-citizens).[8] The shortage of scientists and engineers is reflected in a seventeen percent vacancy rate for positions in the defense laboratories.

While one can question the absolute values assigned to Soviet investments, technological capabilities, and generation and employment of scientists and engineers, it is apparent that the long-term trends are not favorable to the United States. If this situation is not reversed, we face the prospect of not only being outnumbered on the future battlefield but also facing decidedly superior weapon systems.

An additional second important element in the current environment is the vocal criticism of the material acquisition process. The real and perceived shortcomings are being widely articulated by the various elements of the military reform movement which importantly includes a caucus of some fifty members of Congress. The key issues raised such as cost growth/program slippages, inadequate competition and affordability have been addressed in the Defense Acquisition Improvement Program, and progress is being made. Other allegations such as failure of the Administration and Congress to set priorities among weapons systems and infatuation with advanced technology rather than real needs cannot be addressed by simply writing a new policy statement. We are accused of developing systems which we don't need and can't afford to field. The importance of this is in the perceptions of the public and the Congress that defense resources are being wasted. The result is that the difficulty of presenting and successfully defending our budget is compounded.

The Defense Acquisition Improvement Program points out the need for program stability and reduction of technological risk in development programs. Going beyond the initiatives of that program, we need to address the earlier phases of the acquisition cycle. We need to ensure that the technology is demonstrated as being within the state of the art and to thereby reduce the risk of cost growth and schedule slippage during development. Thoroughly wringing out the technology and achieving a firm agreement on the required performance prior to entering full-scale development would help defuse the perception that advanced technology inevitably leads to overruns and waste. Establishing the doctrinal concept for the future battlefield is key to providing a firm basis for materiel requirements which will focus R&D effort. In other words, the doctrine should drive the technology rather than the reverse.

RESOURCES

Department of Defense policy on material acquisition gives the services the responsibility and authority to manage their own programs subject to detailed review by the Office of the Secretary of Defense (OSD). Resource allocations are made through the Planning, Programming and Budgeting System (PPBS). The milestone decisions involving acquisition of major systems are a driving factor in formulating the Research, Development, Test and Evaluation (RDTE) program. Within the Army Staff, the Deputy Chief of Staff for Research, Development and Acquisition is charged with formulation of the RDTE and procurement programs and budgets in response to OSD and Army guidance and approved materiel requirements. The Assistant Secretary of the Army (Research, Development and Acquisition) provides policy guidance and oversight. The Army's resource allocation decisions are subjected to critical review within OSD and by the Office of Management and Budget. Finally the President's budget must be presented and defended before the defense oversight committees of the Congress where substantial changes are frequently made.

As a result of the Reagan Administration's defense build-up, the Army's Total Obligational Authority (TOA) has increased significantly even though the Army's share of the Defense budget has remained constant at about twenty-four percent since 1980. Most of the Army budget growth has gone into the investment accounts so that this portion of the budget has increased from about twenty-nine percent of TOA in FY 1980 to about forty percent of the FY 1984 budget request. The resource priority has gone to the support of near-term modernization and readiness with the procurement accounts dramatically increasing. Although the dollar amounts invested in RDTE have also increased, the overall portion of Army TOA devoted to Research and Development has remained at about seven percent. However, R&D costs have risen about 111 percent since 1972 and are projected to increase 4.5 percent in 1983.[9]

The Army budget achieved a real growth in the eleven to twelve percent range in FY 1981 and FY 1982. However, while the FY 1983 budget request provided for ten percent real growth, Congressional appropriations provide an actual real growth of less than ten percent. The political realities today reflect great concern over the domestic economy, and a vocal reform movement challenges the need for rapid growth in defense expenditures. Thus there is considerable doubt as to whether the ten percent real growth requested for FY 1984 will survive in Congress this year. It appears that we are unlikely to have the resources in the next few years to continue the pace in modernization and at the same time increase our investment in the future through an expanding RDTE program.[10,11]

In the face of reduced resources, the question of allocation within the investment programs will require some difficult choices. The trade-offs will revolve around readiness in the near term and future advanced weapons options. In the past the tendency when faced with this dilemma has been to maintain the long range programs at a constant level and to emphasize the near term hardware programs. Weapons systems, once they move into engineering development, seem to acquire a life of their own, and an outright termination is a wrenching decision for the institution. The practical result is that as programmed resources are reduced during the budget formulation process, frequently most programs have been reduced proportionately rather than canceling the lowest priority projects. This so-called "salami-slicing" of projects keeps programs alive but stretches out schedules and increases costs. The Defense Acquisition Improvement Programs addressed this problem by dictating full-funding of on-going development programs and presumably forcing the cancellation of those with lesser priority. The jury is still out on how forcefully that dictum will be implemented. Furthermore there is always the question of whether the Congress will endorse a termination decision or, as has happened, appropriate funds for a "pet project" anyway. Suffice it to say that there are no easy answers for the decisionmakers. A clear result of the policy of full-funding of systems to include allocations for technological risk will be to reduce the overall flexibility of the RDTE program (about two-thirds of the funds are already fenced). The outlook, therefore, is for less total resources to address the long-range R&D requirements.

THE PROCESS AND THE PLAYERS

The Research, Development, Test and Evaluation (RDTE) Program is resourced as a separate congressional appropriation and is structured for resource control purposes into six categories:

- o Research (6.1)--scientific study and experimentation seeking fundamental knowledge.
- o Exploratory Development (6.2)--studies and investigations ranging from applied research through production of experimental prototypes.
- o Advanced Development (6.3)--advanced technology development through experimental prototypes addressing technology options or risks (6.3A) and design and development of system peculiar hardware to satisfy an approved need (6.3B).
- o Engineering Development (6.4)--full-scale development projects being engineered for military use.
- o Management and Support (6.5)--R&D overhead functions such as general, administrative and facility support cost.
- o Operational System Development (6.7)--RDTE costs associated with systems already in the field.

For ease of discussion the RDTE program is usually considered in terms of two components. The Science and Technology (S&T) Program addresses the technical options for solution to mid-to long-range problems. It is made up of the categories of research (6.1) exploratory development (6.2) and advanced technology development (6.3A) and accounts for about twenty-two to twenty-four percent of the Army RDTE appropriation. The tasks in this program range from very fundamental basic research through the demonstration of technology in the form of experimental prototypes. Program control is essentially based on general level of effort. The RDTE "hardware program" on the other hand is addressing specifically defined system needs. This is made up of systems advanced development (6.3B), engineering development (6.4) and operational systems development (6.7). Program control is maintained by individual line item projects.[12] Figure 1 provides the relationship among the phases of the system acquisition cycle and the program categories, players, hardware configuration and requirement documents.

Within the Army, there are a variety of key players involved in the execution of the RDTE program. The appropriation supports about nineteen thousand full-time Army employees. The larger weapon systems (above $200 million in RDTE cost) in the hardware programs are managed by designated project managers and are generally developed by commercial contractors. The project managers receive technical support from the various Army laboratories and the development commands. Development of non-major systems is generally managed by the Research and Development elements of the commodity commands. Again most development work is done on contract with support/management provided by the Army laboratories.

The players involved in the Science and Technology Program are somewhat more diverse. First there are three Defense agencies under the auspice of the Under Secretary of Defense Research and Engineering, which sponsor investigations: the Uniformed Services University of Health Science; the Defense Nuclear Agency which is concerned with nuclear effects; and the Defense Advanced Research Projects Agency (DARPA). The DARPA is the largest of these receiving some fifteen to twenty percent of total Defense S&T Program resources (a level about equal to the entire Army S&T Program). DARPA's projects cover a broad spectrum of technologies. Although feasibility demonstrations are being conducted in cooperation with the Services, there has been criticism that DARPA's programs are not well tied-in with Service needs. In any event from an Army perspective, the DARPA programs appear to emphasize naval and aerospace projects and are not entirely relevant to land combat needs.[13]

The Army Science and Technology Program is executed by three performers: the in-house laboratories of DARCOM, the Medical R&D Command, and the Chief of Engineers; the universities and Federal Contract Research Centers (academia); and private industry. Each of these performers have strengths and weaknesses but they tend to complement each other in a well-balanced program.

The Army laboratories generally provide the management for the S&T Program and are major performers of the work through their in-house scientists and engineers. In fact the research and exploratory development funds are usually the major source of payroll for the laboratories. This fact tends to inhibit change in resource allocation since that would force changes in permanent employment. This leads to a frequent criticism of the laboratories--that they tend to continue pursuit of the same technology area regardless of the changing priority of military needs. The flexibility of the labs has been hurt by repeated reductions in force, grade freezes and consequent inability to attract and retain younger scientists and engineers. In short there is a perception of an aging work force and somewhat stale technical skills. The need to meet payroll costs from the S&T Program also tends to dampen the use of contractors for the conduct of research. The laboratories are, however, vital to our R&D program because they provide the reservoir of institutional knowledge in military technology, and they give us the capability to be "smart buyers" in a very complex marketplace. Because of the continuity of laboratory personnel, they have a thorough understanding of Army needs and the know-how to translate needs into technological terms. They provide the means to assess foreign developments and to stay abreast of developments in academia and industry. Finally the labs give us a quick reaction capability and the means to undertake unusually high risk projects.

The role played by academia is largely in the conduct of basic research. The American tradition of combining research and graduate education has been actively supported by Defense for many years. The Army supported research is concentrated in physical science and engineering, although life science and social science are also funded. Most of the work is performed through contractual/grant arrangements between the universities and the Army Research Office. The Army laboratories assist in reviewing proposals and results, and they provide for further application of technical advances. Army resources devoted to educational institutions in FY 1981 totaled about $81 million.[14] These funds are spread across a very wide spectrum of projects in a large number of institutions. These dollars are leveraged in the sense that research can be performed less expensively in graduate school laboratories than is possible in either industry or in-house laboratories. The pay-off from this investment is, of course, very long-term and difficult to quantify. OSD has emphasized expanding the support to universities, and more than half of the Army research program is executed in educational institutions. While this research is defense related, it is necessarily fundamental, and it is published in open literature. This leads to concern about technology transfer which could damage US security interests. OSD supported a study on that issue and recently reported that "very little technology leakage of military value could be attributed to the universities."[15] On the other side of the coin, there are critics who argue that our universities are being militarized by participating in defense sponsored projects. The Quaker Peace Group, American Friends Service Committee, has challenged the growing defense support of university research as "alarming, growing militarization."[16] Aside from the research efforts, the Army depends upon academia as a source of expert consultants who can provide independent advice. Furthermore, the universities are a source of scientific and engineering manpower to staff our in-house laboratories, and the Army plans to increase sponsorship of graduate fellowships. OSD is also encouraging defense industry to increase ties with the universities by sponsoring research using Independent Research and Development funds which are generated as overhead costs on Defense contracts.[17]

About forty percent of the total Army RDTE program is performed by industrial (profit making) contractors. This work covers the spectrum from research through full-scale development. The science and technology effort is concentrated in exploratory development and non-system advanced development and is generally sponsored by the laboratories or development commands. Contractors have the freedom to select the areas of concentration for their Independent Research and Development projects. This source is relatively expensive and naturally tends to be application-oriented with a view toward early payoff in transition to full-scale development. The level of innovation tends to be higher in industry since they are not necessarily tied to "traditional solutions" and the technical staffs are well up with their fields.

REQUIREMENTS

The Army's Research and Development Program is driven by material requirements generated by the user community and validated by the Army

Staff (DCSOPS). A variety of documents usually written by the combat development departments of the service schools in conjunction with the material developer and logistician form the basis for the hardware programs. A Justification for Major Systems New Starts (JMSNS) support program initiation for projects exceeding $200 million in RDTE or $1 billion in procurement. A Preliminary Letter of Agreement (PLOA) initiates concept exploration for a minor new system and the Letter of Agreement supports entry into demonstration and validation. The Required Operational Capability (ROC) document supports transition into full-scale development for major systems, and the Letter Requiremen supports minor systems. This process is well structured and subject to intensive review. These documents define the performance parameters which together with cost and schedule form the development objectives. The principal problem in the implementation of this process has been the tendency to change the specified requirements during the course of the development. This occurs due to changing views on doctrine, advances in relevant technology, new threat information and sometimes simply the changing players in the user community. In any event, the results of such changes are likely to be adverse in terms of development and end item costs and in slipped development schedules. This is a major underlying factor in our inability to meet projected budgets and schedules for new systems and is the subject of great criticism of the acquisition process.

The requirements for the Science and Technology Program are necessarily less well structured. Broader statements in the form of Science and Technology Objectives (STOs) describe desired operational capabilities ten or more years in the future. These objectives are approved, prioritized and published. In March 1982, DARCOM published a science and technology volume of the Long Range Research, Development and Acquisition Plan, FY83-98.

These documents provide prioritized statements of future requirements organized into mission areas such as close combat, fire support, etc., and all S&T Program work is to be tied to these objectives. The scope of the objectives is broad enough so that virtually any defense oriented investigation could be related. Indeed it would not necessarily be desirable to restrict investigations too greatly since that might stifle innovation. The challenge is to focus the majority of the program on priority material goals so that we achieve a "critical mass" of resources to solve real problems. In practice the focus narrows sharply as we proceed from pursuit of fundamental knowledge in research to design of technology demostrations in exploratory or advanced technology development.

The suggestions for S&T areas to investigate arise from a number of sources. Review of foreign science and technology indicators provides a means of overwatching friendly and hostile nation technology. The Defense and Army Science Boards are frequently tasked to provide both broad-based and topical reviews. These reviews have often provided our new technology thrusts. Finally there are unsolicited proposals from industry which respond to general statements of needs published by the Services. While these proposals may be very innovative, they are difficult to support because they represent unprogrammed resource requirements. Further there may be a problem of a "Not Invented Here" (NIH) attitude in the Army laboratory where the proposal must ultimately be evaluated. Real or not, the perception of a NIH factor can inhibit good ideas which are generated in the private sector. Several years ago an Advanced Concept Team was established by DCSRDA to evaluate and fund promising proposals at the departmental level.

The Army is now in a transition as it implements the AirLand Battle concept and the force modernization program. The concept provides a framework for integrating technology into force structure with current emphasis on locating and attacking deep targets and providing responsive command and control which can anticipate and react rapidly to the flow of battle. Looking toward the next century, this concept has been projected in the expanded AirLand Battle 2000 which provides guidance for force development doctrine and material. It envisions a battlefield characterized by independently operating small units, large numbers of sophisticated weapons, difficult command and control, and expansion into aerospace and enemy depth. Intensive combat at decisive points would require employment of integrated weapon systems under fluid conditions. The trends in international politics, worla economies, new materials and demographics suggest that the Army will have to be prepared to fight anywhere even when outnumbered and win. The concept demands continuous maneuver style warfare involving small self-sufficient units, great mobility, highly effective firepower and a blend of real time intelligence and positive command and control. The projection suggests an Army which is less manpower intensive and more system oriented.[18]

The evolving AirLand Battle 2000 concept should provide the thrust for our S&T Program for the remainder of this century. The supporting systems should be characterized by such things as:

- o High mobility and agility
- o Increased strategic deployability
- o Operation in severe environments (NBC and EW)
- o Less reliance on manpower
- o Real time theater intelligence (fusion and distribution)
- o Reliable command and control of dispersed units (jam resistant, mobile communications)

- o Intensive and effective firepower
- o Built-in survivability
- o High reliability and availability (operator reparable)
- o Reduced consumption (fuel, ammunition, spares)
- o Deep target acquisition (stand-off imaging in all weather)
- o Deep target attack (over-the-horizon precision weapons)
- o Intense electronic warfare operations

From these characteristics the following appear to be key technologies and commodities:

- o Advanced ballistic and guided missile weapons
- o Directed energy weapons
- o Advanced armor materials
- o Combat and tactical vehicle propulsion
- o Signature reduction (stealth-passive sensors)
- o Chemical defense/offense
- o Remotely piloted vehicles
- o Countermine/counterobstacle systems
- o Advanced, automated fire control
- o Rotary wing aircraft
- o Microelectronics/supercomputers
- o Artificial intelligence and robotics
- o Night vision devices
- o Mobile power sources
- o Energetic materials (warheads, propulsion and demolitions)
- o Medical prophlaxis/casualty treatment

It must be recognized that the AirLand Battle 2000 concept is evolving--it is not a final roadmap which clearly lays out our future course. It does represent, however, a framework upon which we can build.

A STRATEGY

In the face of the unfavorable trends currently working in the external environment, the constrained resources and probability of reduced growth, and the demands for advanced systems to meet the needs of AirLand Battle 2000, it appears that a revised Research and Development strategy is in order. It is, after all, the RDTE program which must satisfy the Army's Future Development Goal, since R&D is the element of the investment programs which looks out decades into the future. My approach would be three-fold: a modest increase in the portion of Army TOA devoted to RDTE; a strengthening of the Science and Technology Program; and an emphasis on generating an array of future technology options.

Given rising R&D costs, declining budgetary growth and an RDTE program which is two thirds fixed, our flexibility to respond to the future challenges is severly limited. Recent history tells us that the Army's share of the Defense budget is not likely to change--so simply requesting additional funds in RDTE is an exercise in futility. If any resources must come from the "Army's hide," then I would suggest that we look first to those programmed for modernization. It appears that the plate may already be too full in the sense of our ability to field and support everything currently programmed for deployment in the next few years. The curtailment of Roland and Copperhead last year are examples of affordability already driving such decisions. Specifically, I am suggesting that the seven percent of Army TOA now devoted to RDTE be increased to eight percent of TOA over a two year period. In the FY 1984 request, this would have amounted to a shift of approximately $430 million. This committment should be viewed as an investment in the Army's future which is to accomplish two important things--provide an array of advanced technological options for the 21st

Century Army and preclude technological surprise by any potential adversary. It is a conscious trade-off between near-term modernization and readiness and future opportunities. It is worth noting that this level of RDTE investment would still be below that of the Navy and the Air Force.

The key to a future-oriented strategy is in the Science and Technology Program. It appears that the real contribution of these vital efforts could be improved in several ways. First our investments should be made based upon an analysis of the likely return and not simply reflect a historical level of effort in a particular technology area. Our focus should be on those technologies which are either peculiar to land combat or for which the Army has been designated the lead Service. This would include, for example, such areas as ballistics and guided missiles, conventional warheads and propellants, chemical offense and defense, medical defense and casualty treatment, night vision, rotary wing aeronautics. To avoid unwarranted duplication we should de-emphasize those technologies which are heavily invested in by the other Services and DARPA (e.g. advanced electronics, microprocessors).

Recognizing the contributions of the academic research community to national well being as well as to defense, the current research category funding levels directed to academia should be maintained. Any growth in this category should be devoted to in-house research expansion. Increased opportunities for Army scientists to conduct fundamental work is a means of strengthening the laboratories. The OSD pressure to expand support to university programs should be resisted, and the emphasis should be put on improving the scientific prowess of our laboratories.

The bulk of the increased resources in RDTE should go into the exploratory development and advanced technology development programs. This will ensure continuation of the funding increase achieved in these programs recently. The emphasis should be on innovation, and the focus should be on the priority user needs evolving from the AirLand Battle 2000 concept. This would require some redirection to reduce or eliminate work in areas with which laboratory personnel may now be most comfortable and to substitute areas of greater potential payoff. To stimulate and nuture good ideas from the private sector, significant funds should be earmarked specifically to support promising unsolicited proposals. This dedicated funding would eliminate the competition between the laboratories and private industry for the same dollars.

Additional resources and strenthening of the Science and Technology Program leads to the objective element of this strategy, which is the creation of an array of future technology options. Dr James R. Schlesinger, writing in 1968, suggested that under conditions of rising costs, relatively stable budgets and increasing threat level one should stress a R&D program which provides a number of advanced optons:

> "The force of the program is shifted away from the full systems development to exploratory and advanced development stages. The goal is to create, in effect, a shelf of advanced weapon hedges."[19]

That prescription, it seems to me, fits the Army's current situation. Obviously such an approach could be carried to the extreme so that possible options derived are endless, but nothing is ever fielded; however, if properly managed it does offer hedges against future uncertainty without comitting to full-scale development systems which we later cannot afford to field.

Specifically we would fund the most promising approaches through study, analysis and design and produce technology demonstrations/experimental prototypes. The objective would be to accurately assess and reduce technological risk and cost, to demonstrate the potential payoff in military capability, and to thereby reduce cost and schedule variations in those few systems committed to full-scale development. This type of prototyping effort would allow for extensive "test marketing" with the user community so as to better refine and fix the requirement parameters prior to a development decision. The High Technology Test Bed is an example of how that "test marketing" might be done. Implementation of this approach would require some changes in our philosophical outlook. Perhaps the most difficult problem to overcome is the natural desire to see every successfully prototyped system move immediately into development. The management decisions will be difficult in the face of system proponents in and out of the Army. For those systems moving into development, near rigid discipline will be required to fix performance requirements and to freeze the design leaving all incremental improvements for pre-planned product improvement. Hopefully, this would eliminate the phenomenon of systems remaining in engineering development for five to ten years. Affordability considerations will demand that we transition to develop only the highest priority needs, but this approach should at least give us an array of proven concepts from which to choose as the threat and doctrine evolves. That array could also enhance our mobilization posture in that proven concepts would be available for exploitation even though production was not affordable in peacetime.

CONCLUSION

In an unsettled world facing an expanding Soviet threat, the Army cannot afford to mortgage the future by failing to aggressively pursue rapidly expanding technologies. A growing chorus of critics coupled with domestic economic problems do not bode well for funding the Army's total needs. The R&D strategy outlined here is an approach to the problem which may make the available dollars go further and provide better defined options to meet the weapons systems need in the next century. It seems clear that business as usual will not get the job done, but I also recognize that the changes proposed here would be very difficult to implement and would certainly take time. To be effective this strategy should be announced as a Secretary of the Army policy decision and must be actively sold both in OSD and in the oversight committees of the Congress.

SYSTEM ACQUISITION CYCLE

	Phases				
	Continuing Analysis of Mission Areas	Concept Exploration	Demonstration & Validation	Full Scale Development	Production & Deployment
Program Category	6.1, 6.2, 6.3A → "S&T Program"	6.3B →	"Hardware Program"	6.4 →	Procurement →
Major Players	Commodity Comds Army Labs DoD Agencies Academia Industry	Proj Mgr, Commodity Comd, Army Labs, Industry →			
Supporting Requirement Documents	STO Long Range RDA Plan	JMSNS PLOA	LOA	ROC LR	
Hardware Configuration	Experimental Prototypes (Tech Demo)	Experimental Prototypes	Adv Development Prototypes	Engineering Development Prototypes	

Figure 1

ENDNOTES

1. Walter Isaacson, "The Winds of Reform," Time Magazine, 7 March 1983, pp. 12-30.

2. Casper W. Weinberger, Annual Report to the Congress FY 1983, p. III-134.

3. Casper W. Weinberger, Annual Report to the Congress FY 1984, p. 21.

4. Richard D. DeLauer, Statement by the Under Secretary of Defense, Research and Engineering to the 97th Congress Second Session 1982, pp. II-20 thru II-24.

5. National Science Foundation, National Patterns of Science and Technology Resources, 1981, pp. 1-14.

6. Ibid, p. 30.

7. Organization of the Joint Chiefs of Staff, United States Military Posture for FY 1983, p. 63.

8. National Science Foundation, Academic Science 1972-81, pp. 27, 47.

9. Army R,D&A, January-February 1983, p. 22.

10. Comptroller of the Army, The Army Budget FY 1983, pp. 9-14.

11. E. C. Meyer and John O. Marsh, Jr., The Posture of the Army and Department of the Army Budget Estimates for FY 1984, pp. 46-47.

12. US Department of the Army, Final Draft Army Regulation 70-1, 18 February 1983, pp. 2-40 thru 2-42.

13. Weinberger, pp. III-131 to III-133.

14. US Department of the Army, Justification of Estimates for FY 1983 Submitted to Congress February 1982, p. 24.

15. Leo Young, "The University Link," Defense 83, February 1983, p. 6.

16. Harrisburg Evening News, 14 October 1982, p. B3

17. Young, pp. 5-6.

18. Eric C. Ludvigsen, "Rebuilding for 1980s with an Eye on 2000," Army, October 1982, pp. 248-256.

19. James R. Schlesinger, "The Changing Environment for Systems Analysis" in Systems Analysis and Policy Planning, ed by E. S. Quale and W. I. Boucher, p. 371-372.

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