REPORT

of the

DEFENSE SCIENCE BOARD

1985 SUMMER STUDY

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

MARCH 1986
Office of the Under Secretary of Defense for
Research and Engineering

Washington, D.C. 20301

Final Report

of the

1985 Defense Science Board

Summer Study on

Practical Functional Performance Requirements

This Document Has Been

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WASHINGTON, D.C. 20301-3140

DEFENSE SCIENCE BOARD

27 March 1986

MEMORANDUM FOR THE SECRETARY OF DEFENSE

THROUGH: Under Secretary of Defense for Research and Engineering

SUBJECT: Report on the Defense Science Board 1985 Summer Study on "Practical Functional Performance Requirements" - ACTION MEMORANDUM

I am pleased to submit this final report on the 1985 Defense Science Board Summer Study on Practical Functional Performance Requirements chaired by Mr. Robert A. Fuhrman.

I believe the study provides important new insights into some key aspects of the acquisition process and contains sound implementable recommendations which can significantly improve that process.

As you know, this Study was briefed to the Presidents' Blue Ribbon Commission on Defense Management, at their request. Additionally, at the request of the Under Secretary of Defense for Research and Engineering, we have initiated a Task Force on the LHX program with the specific goal of applying these recommendations to the LHX requirements process. It is my current assessment that this effort will prove to be highly beneficial to the Army and the DoD.

I recommend you read Mr. Fuhrman's forwarding letter and the Executive Summary which includes the Implementation Plan, and sign the attached memorandum.

Charles A. Fowler

Charles A. Fowler

Attachment
a/s

1 March 1986

Mr. Charles Fowler
Chairman
Defense Science Board
The Pentagon, Room 3D1034
Washington, D.C. 20301

Dear Mr. Chairman:

Enclosed with this letter is the final report of the Defense Science Board Summer Study on Practical Functional Performance Requirements. It expands on the information presented in August, provides additional background data, and, as appropriate, incorporates the suggestions made by the many reviewers from within and outside government.

The panel noted significant differences in the development process between commercial programs and military problem programs. Although there is no single action that can be successfully implemented to solve all problems, there are some major lessons that can be judiciously applied to military programs. Operational requirements generation should be iterative, with cost/capability trades continued during development. The CINCs, in their role as users, should become more involved in the requirements process. Schedule should be considered a dominant program driver after commencement of full scale development. The program manager must be given sufficient authority to truly manage his program; he must have direct access to a person with major authority and resource control so he can seek help when it is needed.

Our recommendations aim at strengthening the process by which requirements are generated, iterated and implemented. With effective monitoring and follow-up attention, we believe they hold the promise of significantly improving the procurement process.

I want to make special mention of the outstanding contributions of each member of the Summer Study panel, its working group and special consultants, and the very fine assistance provided by the military services and various elements of the Office of the Secretary of Defense during our investigation. Your assistance and encouragement are especially appreciated.

While the entire panel has participated in the generation of this report, the Summer Study Chairman bears principal responsibility for its content.

Sincerely,

R. A. Fuhrman
Summer Study Chairman

Enclosure

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EXECUTIVE SUMMARY

Background

This DSB summer study panel was asked by the Under Secretary of Defense for Research and Engineering to examine what role the performance requirements for military systems plays in the problems associated with the current systems acquisition process. He also asked it to recommend improvements in the manner in which the Department of Defense determines, prioritizes, and satisfies its official requirements. Specifically, the Panel was asked to suggest ways by which the systems acquisition process could be improved by changing the way requirements are generated, documented, and implemented.

To satisfy this request, the Panel was first broken into three subpanels for preliminary data-gathering and analysis. One of these subpanels performed a broad analysis of twenty-six DOD programs. Another studied, in depth, five comparable non-DOD (mostly commercial) development programs. And the third, throught direct contact with all the top-level U.S. operational comanders (the CINCs), obtained a user's perception of the desired degree and manner of user involvement in the requirements process and suggestions for improvement in this process.

The Panel also received in-depth briefings on each Service's requirements and acquisition processes, as well as being provided by them with eleven special development case studies. Third, pertinent briefings by OSD and OJCS were provided, in addition to a CIA briefing on the Soviet acquisition process. Finally, the Panel received personal testimony from two active CINCs and the Under Secretary of the Army on the topic and received a briefing on the so-called "streamlined acquisition process" that is used in some limited access programs.

Findings and Recommendations

From this background and its own experience, the Panel concluded overall that, although promising efforts are currently underway in all of the Services to improve their requirements processes, deficiencies in this process are still likely to be significant contributors to continuing increases in both the cost and length of time required to field new defense systems. In particular, it believes that even the improved processes will continue to suffer from: (a) a failure to sufficiently involve operational users in a direct and continuing way in determining and prioritizing military needs, (b) the rigidity with which requirements statements are still expected to be observed, and (c) the lack of adequate iteration of official requirements, before they are formalized, with those who must satisfy them (acquirers and suppliers). As a consequence, the Panel anticipates that in too many cases system program costs will still be driven up to the point that fielded systems will be procured in insufficient quantity to be effective. Alternatively, it believes they might take so long in development that when fielded will not be able to meet the present threat. In some cases, in fact, system programs could still become so troubled that the systems involved would never be deployed.

The Panel therefore developed two generalized models that demonstrate the differences it found in the way requirements are determined and implemented in the acquisition cycle of DOD's problem programs and the way they are dealt with the the successful non-DOD and the streamlined DOD programs studied. Key advantages of the non-DOD/commercial model over the problem DOD model include:

* a powerful executive, who has authority to make unchallengeable decisions, settle disputes and allocate additional resources; sometimes the Chief Executive Officer (CEO). He can directly support and insulate from external pressures the Program manager as critical needs arise;

* a Program Manager who has continuity, authority, flexibility, accountability for decisions and direct access to the key decision maker (CEO);

* iterative performance requirements analyses, with cost/user utility as an important factor;

* user involvement throughout the requirements process;

* emphasis on holding schedule after beginning full scale development, with use of block upgrades or field modifications to implement increased capability.

These advantages lead to the Panel's principal recommendation: the characteristics of the acquisition process which were found in the successful commercial and streamlined DOD cases studied would be applied more universally and consistently in the DOD whenever feasible.

Thus, the Panel concluded that the military porgram manager's role must be strengthened to give him additional authority and flexibility to make trade-off decisions on his program and direct access to a significant authority figure to whom he can go if he needs high level support. It further concludes that program risks must be identified and dealt with early in the development process; requirements must remain flexible and be iterated as long as possible; and users (CINCs) must participate in program dicisions and trade-offs that can affect their planned missions or operational effectiveness as acquisitions proceed, not simply at the beginning and at the end of the process. Finally, schedule (and its concomitant, cost) should be considered the dominant program driver, at least after commencement of full-scale development.

In sum, the way to avoid the inflexible contracts with inadequate resources, overstated performance goals, and concealed risks found in the DOD problem programs studied is to establish surrogate CEOs with the authority and responsibility for playing the role of their commercial counterparts, reduce the number of people in the program decision chain by eliminating the layers of review and control between program managers and these surrogate CEOs, control staffs such as those responsible for the "ilities" by allowing the PMs greater authority to make dicisions and ultimately, to appeal all staff requirements to the CEO, give PMs more flexibility to adjust performance to hold to schedules, and find ways to involve users more throughout the acquisition process. Above all, providing for the flexibility in the process that is needed to deal with troubles and uncertainties, and basing pesonnel performance measurement and rewards on clear-cut personal accountability for results, rather than on obeisance to the letter of procedures, would go along way towards moving the problem model towards the more successful commercial model.

Implementation Plan

1. Recommendation: Require the Military Departments to incorporate the following principles into their respective requirements and acquisition processes:

    a. The development of an operational requirement should be an iterative process during which potential solutions to the operational need are evaluated and traded off with respect to affordability, schedule, performance and risk prior to commitment to the program.

    b. After program initiation and prior to the commencement of FSED, technical risk reduction and cost/capability tradeoff efforts, with industry participation, should be conducted. Results of these efforts should be used to fully understand risks, ensure clear definition of program objectives, produce schedule realism and apply appropriate incentives.

    c. Upon commencement of FSED, schedule should be considered as the dominant program driver and the program contracted and funded accordingly.

    d. In the event that technological opportunities or operational requirements warrant change, block upgrades should be the primary solution to avoid schedule delays.

    Action: SEC DEF direct the Defense Acquisition Executive to revise DoD Directive 5000.1 as appropriate and require the Military Departments to incorporate the principles enunciated above into their respective requirements and acquisition processes.

2. Recommendation: Require the Military Departments to ensure clear lines of accountability and authority between a surrogate CEO (Chief Executive Officer) and the developing activity for progam management and execution.

    a. Reduce the number of people allowed to participate in the decision process and reduce the number of layers through which the program manager reports.

    b. Reaffirm developing activity and program manager responsibility for all aspects of program execution.

    c. Provide program managers direct access to a surrogate CEO who has the authority and control of resources to make and enforce decisions regarding trade-offs between performance, schedule and cost.

    Action: SEC DEF direct the Services to identify their top ten programs and for them designate a single surrogate CEO (of four star rank or equivalent) with the authority to make unilateral decisions regarding tradeoffs of performance, costs and schedules. Program budgets should include reserves for technological risk, to be held by the surrogate CEO, and used to preserve schedule to the maximum extent possible.

SEC DEF direct the Defense Acquisition Executive to update DoD Directive 5000.1 to include this recommendation.

3. Recommendation: The Secretary of Defense take corresponding action to reduce OSD monitoring staffs and excessive program review.

   Action: SEC DEF direct the Defense Acquisition Executive, as DSARC Chairman, to ensure that the milestone review process for major system acquisitions is streamlined and that excessive program review is avoided.

4. Recommendation: The Secretary of Defense and the Joint Chiefs of Staff expand the role of the CINCs in the overall DoD guidance and requirements process.

   a. Require long term (10 years) force development planning.

   b. Staff and fund CINCs (commensurate with mission and areas) to maintain cognizance of programs and budget priorities and tradeoffs.

   c. Authorize a scientific/technical advisor reporting directly to the CINC.

   Action: SEC DEF direct the ASD(C) and D, PA&E to expand the role of the CINCs in the PPBS process.

   SEC DEF direct the Chairman, Joint Chiefs of Staff to examine how best to enable CINCs to carry out this expanded role and adjust CINC staffing levels in Joint Manpower Programs to meet this goal. Include authorization for a scientific/technical advisor for each CINC.

5. Recommendation: The Secretary of Defense direct Departments and Agencies to obtain CINC review and comment on requirements and programs affecting their commands.

   a. In timing (IOC and FOC) -technology -totals (quantity).

   b. In priorities and tradeoffs.

   c. Interoperability validations.

   Action: SEC DEF direct the Defense Acquisition Executive to revise DoD directive 5000.1 to require the Military Departments and Defense Agencies to obtain CINC comments and reviews on requirements and programs affecting their commands. Revise 5000.1 to ensure DSARC I and II review the trade-offs between the relaxation of the principle technical cost drivers and changes in procurable quantities.

   SEC DEF direct the DSARC I, and II to include a Chairman, Joint Chiefs of Staff report on cost, performance, schedule and quantity trade-offs and their impact on mission area capability.

DEFENSE SCIENCE BOARD

DSB

PRACTICAL FUNCTIONAL

PERFORMANCE REQUIREMENTS

Responding to a request from Dr. James Wade, then Acting USDRE, the Defense Science Board accepted as one of its three summer study topics the review of how the Department of Defense generates, iterates and implements PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS in the process of developing/procuring large hardware and software systems. It was decided by the panel that they would limit the topic to focus on requirements generation and implementation and exclude a review of the ongoing Pentagon process of streamlining documentation requirements. The panel, after its membership was established, chose to focus its attention primarily on four specific areas:

sample DOD Program histories,

sample non-DOD program histories,

service procurement process and detailed program examples,

CINC's role in requirements.

Based upon the broad experience base of the DSB panel membership and significant data gathering at two preliminary meetings, the first four days in San Diego and the output of three subcommittees, the panel presented their general findings and recommendations.

OUTLINE

I. OPENING

II. TERMS OF REFERENCE/DEFINITIONS

III. MEMBERSHIP

IV. METHODOLOGY

V. DOD PROGRAMS SURVEYED

VI. THE NON-DOD CASE STUDIES

VII. CINC ROLE IN REQUIREMENTS

VIII. GENERAL FINDINGS

IX. RECOMMENDATIONS

Excessive cost, unforseen technical problems and the extended length of time required to field new defense systems have been recognized as serious problems in the acquisition process by the Department of Defense. Examples are readily available where systems either never reached the field in sufficient quantity to become effective, have taken so long in development that when fielded could not meet the present threat, or in many cases became so troubled they were never deployed. The panel was tasked to examine what factor requirements play in the problems associated with the present acquisition process, whether the users' role needs strengthening and what actions the DSB recommends to improve the overall process by improving the way requirements are generated, documented and implemented.

The panel established five questions as its original terms of reference.

DSB

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

TERMS OF REFERENCE

- IMPACT OF REQUIREMENTS PROCESS ON PROGRAM REQUIREMENTS, COST AND SCHEDULE?
- HOW TO INSURE PROPER TRADE-OFFS AMONG PERFORMANCE/COST/ SCHEDULE ARE MADE IN ESTABLISHING REQUIREMENTS?
- WHEN SHOULD REQUIREMENTS BECOME FIRM?
- IMPACT OF OPERATIONAL USER ON REQUIREMENTS - HOW TO IMPROVE?
- SIMILARITIES AND DIFFERENCES BETWEEN DOD AND COMMERCIAL INDUSTRY? LESSONS LEARNED FROM INDUSTRY?

To aid the panel in its focus on the role of requirements in the acquisition process, it was felt that a specific definition of the term PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS was required.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

DEFINITIONS

<u>PRACTICAL</u> — REASONABLY ATTAINABLE WITHIN AVAILABLE TIME AND RESOURCES

<u>FUNCTIONAL</u> — DEFINES THE TASK OR MISSION OF THE SYSTEM WITH A MINIMUM OF SPECIFIC CHARACTERISTICS

<u>PERFORMANCE</u> — OPERATING CHARACTERISTICS AS OPPOSED TO MIL-SPECS

<u>REQUIREMENTS</u> — ESSENTIAL MINIMUMS OF CAPABILITY AS DISTINGUISHED FROM DESIRED ATTRIBUTES

ESSENTIAL, MINIMUM OPERATIONAL CHARACTERISTICS WHICH DEFINE THE MISSION OR TASKS TO BE ACCOMPLISHED THAT ARE REASONABLY ATTAINABLE WITHIN AVAILABLE TIME AND RESOURCES.

The panel membership was composed of an experienced group of civilian and military management. Each individual had specialized expertise in at least one phase of the overall panel's task. In addition to a key representative from each of the services, the panel had an active CINC and several retired general officers. It had civilians who have formerly served as Undersecretaries or Assistant Secretaries of the Services. It contained a key representative of the CIA to gain perspective on the Soviet requirement's process. It has several key executives from leading defense contractors, executives from major non-profit research institutes and an executive from a commercial product company to represent commercial product development. Appendix 1 contains the affiliation of each of the participants.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

PANEL MEMBERSHIP

ROBERT A. FUHRMAN, CHAIRMAN

NORMAN R. AUGUSTINE, VICE CHAIRMAN

JOHN E. SMITH, EXEC. SECRETARY

LTC HERBERT R. VADNEY, DSB STAFF

<u>DSB MEMBERS</u>

WILLIAM A. ANDERS

VINCENT N. COOK

MALCOLM R. CURRIE

GEN RUSSELL E. DOUGHERTY, USAF(RET)

DANIEL J. FINK

ALEXANDER H. FLAX

ROBERT J. HERMANN

ADM ISAAC C. KIDD, JR., USN (RET.)

WILLIAM J. PERRY

<u>ASSOCIATE DSB MEMBERS</u>

ROW BROWN

ROBERT R. EVERETT

LTG PHILIP D. SHUTLER, USMC (RET.)

<u>MILITARY SERVICE MEMBERS</u>

ADM WESLEY MCDONALD, USN

VADM ALBERT J. BACIOCCO, JR., USN

MGEN RAY M. FRANKLIN, USMC

MGEN ROBERT D. HAMMOND, USA

MGEN HAROLD J. M. WILLIAMS, USAF

<u>WORKING GROUP MEMBERS</u>

AL BABBITT

ALLEN CARLEY, CIA

COL FRANCIS X. CHAMBERS, JR., USMC

WILLARD H. MITCHELL

CDR DAVID L. NORDEAN, USN

JAMES O'BRIEN, USA (AMC)

COL WINSLOW E. REITHER, USAF

DANIEL A. RUSKIN

RICHARD SCHWARTZ (IDA SUPPORT)

COL STAN SHELDON, USAF (OJCS)

NORMAN WAKS

The Practical Functional Performance Requirements panel was divided into three sub-panels for preliminary data gathering.

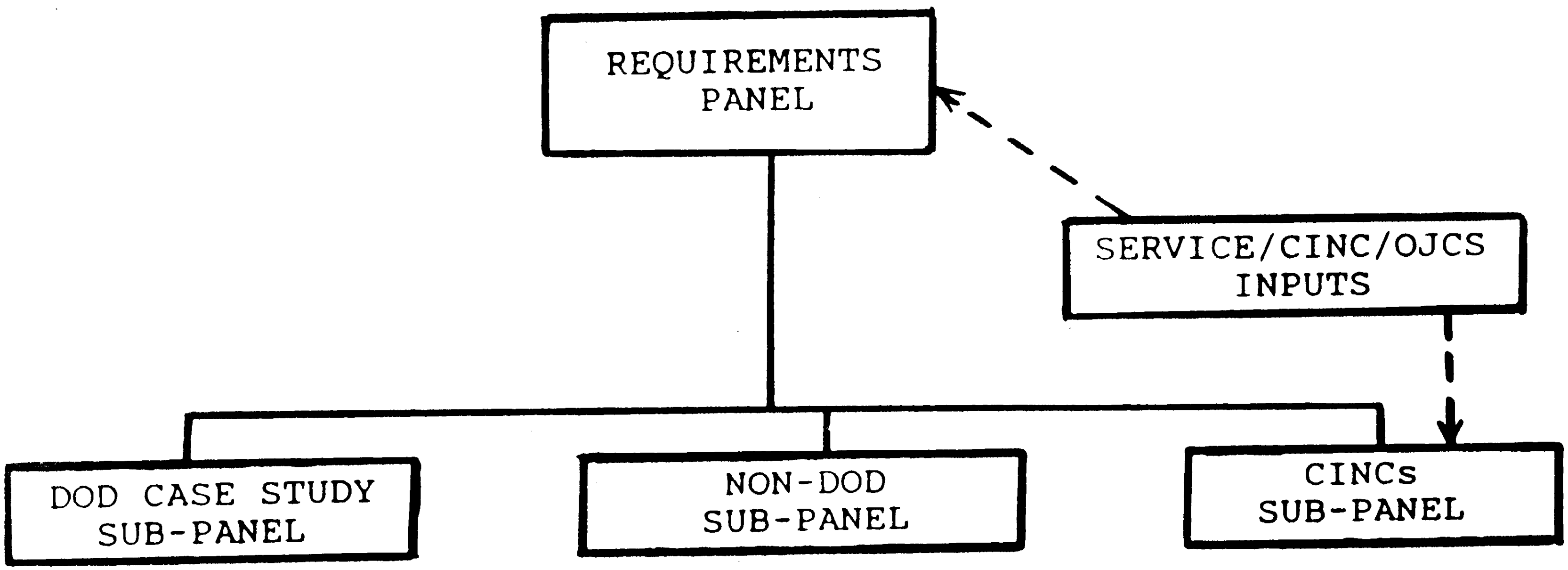
The DOD Case Study sub-panel, supported by IDA, examined and analyzed twenty six major DOD program histories. They developed a set of lessons learned based on characteristics noted from the histories.

The Non-DOD Case Study sub-panel examined and analyzed five major non-DOD development programs. They received detailed support from AT&T, SBS, IBM, MITRE and Boeing. They developed a set of lessons learned based on the common characteristics noted from the four commercial and one FAA case.

The CINC'S Role sub-panel established direct contact with all the CINCs to seek their assessment of their present role in the requirements process and their suggestions for improvement. The sub-panel produced a set of findings based on the combined inputs received from the CINCs.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

METHODOLOGY



DOD CASE STUDY SUB-PANEL

NORM AUGUSTINE (CHMN)

IDA (SUPPORT)

NON-DOD SUB-PANEL

VINCE COOK (CHMN)

BILL ANDERS

AL BABBITT

ROW BROWN

BOB EVERETT

NORM WAKS

CINCs SUB-PANEL

GEN. RUSS DOUGHERTY (CHMN)

ADM. IKE KIDD

LTGEN. PHIL SHUTLER

BOB HERMANN

The full panel received in-depth briefings from the Acting Undersecretary of Defense for R&D, James Wade, the Director of PA&E, David Chu, and other representatives of OSD. A briefing by each service of its present requirements and acquisition process, ten Service development case histories of both successful and unsuccessful programs, one DARPA development case and a briefing on the Soviet acquisition process were also received. The group heard directly from two active CINCs, Adm. Wes McDonald, CINCLANT, and Gen. Robert Herres, CINCNORAD, the Undersecretary of the Army, the Honorable James Ambrose, and representatives from the JCS. A sub-group of the panel also received a briefing on the streamlined acquisition process used in limited access programs. The five non-DOD cases and the twenty six DOD cases were presented in detail by their respective sub-panels.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

GOVERNMENT AND COMMERCIAL INPUTS

OSD

- OVERALL - DON HICKS - USDRE
- DSARC - JIM WADE - A&L
- PPBS - DAVID CHU - PA&E

SERVICE SECRETARIES

- JAMES AMBROSE - U/S ARMY

CINCs

- ALL UNIFIED AND SPECIFIED COMMANDS - LETTER INPUTS
- BRIEFINGS - ADM. W. MCDONALD
  GEN. R. HERRES

JCS

- JCS ROLE
- JRMB

CIA

- SOVIET ACQUISITION SYSTEM

SERVICES

- REQUIREMENTS PROCESSES
- ACQUISITION PROCESSES
- PROGRAM EXAMPLES
  - T-45TS TRAINER (NAVY)
  - C-12 TRANSPORT (NAVY)
  - MK-50 TORPEDO (NAVY)
  - C-17 TRANSPORT (USAF)
  - ADVANCED TAC FIGHTER (USAF)
  - WASP ANTI-TANK MUNITION (USAF)
  - HARD TARGET MUNITION (USAF)
  - SGT. YORK DIVAD (ARMY)
  - SHORAD C2 (ARMY)
  - ADVANCED ANTI-ARMOR WEAPON (ARMY)
  - SATELLITE LASER COMM. (DARPA)

COMMERCIAL FIRMS

- IBM
- SATELLITE BUSINESS SYSTEMS
- MITRE
- BOEING
- AT&T

With support from IDA, Norm Augustine surveyed the development history of twenty six programs. These programs represent the broad spectrum of large DOD procurements except major shipbuilding, which was excluded because its problems are generically different than other weapon systems. Clearly the individual reviews could not be accomplished in great depth, but many on the panel had intimate knowledge of the programs' histories. Some of the programs are from the past and do not reflect the recent improvements introduced by the Services. There were some successes and some failures. Fifteen of these systems have been deployed, some with much trial and tribulation. As of the time of the study two cases, the B-1B and the AMRAAM, were considered still in the TBD category.

The variety of systems comprising the sample includes fixed and rotary wing aircraft, ground vehicles, ships, missiles, and electronic warfare pods. Examples from all three military departments have been included. Most of the programs were conducted by a single Service; however, a few examples each of joint and international programs have been included. The examples include both strategic and tactical systems and product improvements as well as totally new developments.

This chart shows deployment outcomes for 24 cases. (The IOCs for AMRAAM and B-1B are scheduled for the outyears.) If the definition of a "successful outcome" is simply that the program led to the placement of equipment in the hands of the operating forces in sufficient quantities to assist in deterring and fighting a war, then 15 programs qualify as successes and 9 programs do not.

The foregoing definition does not consider the time the equipment is available to the operating forces nor its cost and performance. Many of the 15 systems could be judged generally successful in terms of these additional criteria. Even if the program did not meet projected schedule, costs, or performance, it might be presumed that the equipment would not have been deployed if it had not still been viewed as valuable to the operating forces.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

DOD PROGRAMS SURVEYED

FIXED WING AIRCRAFT

SR-71, C-5A, F-14, B-1A,
F-16, KC-10, B-1B

ROTARY WING AIRCRAFT

AH-56, AH-1, UH-60,
HEAVY LIFT HELO

SHIPS

HYDROFOIL PATROL, TRIDENT

TANKS

MBT-70, M-60A1E2, M-1

MISSILES

MMIII, CONDOR, LASER GUIDED BOMB,
ROLAND, HARM, AMRAAM, TRIDENT

TARGET ACQUISITION/ELECTRONIC WARFARE

SOTAS, ALQ-126, ALQ-131

WARFARE CATEGORY

19 TACTICAL
7 STRATEGIC

EVOLUTION

20 NEW DEVELOPMENTS
6 PRODUCT IMPROVEMENTS

SERVICE

9 ARMY
7 NAVY
10 AIR FORCE

STRUCTURE

2 JOINT
3 INTERNATIONAL

OUTCOME

15 DEPLOYED
9 PROGRAM TERMINATED
2 TBD

It was recognized that there were common factors that could negatively affect programs. Examples are listed to illustrate each lesson.

Unproven Technology. The foremost factor associated with unsatisfactory program outcomes was that the technology, usually after the fact, was assessed as being unready for entry into engineering development. Programs which began with key components already developed or at least with the technology well in hand were most likely to be successful. Occasionally, of course, threat considerations necessitate violating this concept--but in this case it is particularly important that adequate schedule and financial resources be provided to advance the technology to the needed level. It is likely that in almost every case of failure the project's initiators believed at the time of initiation of engineering development that the technology was, in fact, mature. Unfortunately these assessments frequently proved to be incorrect. This calls attention to the need for objective measures of maturity. Examples: AH-56, SOTAS

Underemphasis of Cost. The coupling between the process of fixing specific requirements and of determining the cost of those requirements has been too weak. The users who specify requirements sometimes have little basis for appreciating the cost implications of their desires. Even when cost was coupled to the requirements process, the poor quality of cost estimating often led to programmatic difficulties as the development evolved. The most successful programs, from a requirements sense, seem to be those that couple accurate cost analysis to the requirements specification activity. Examples: M-60 A1E2 tank, SOTAS, Heavy Lift Helo

Isolation of Requirements Generation. It is particularly important that there be a close coupling of the user, the technologist, the analyst and the coster in the specification of requirements. This appears to be best accomplished by a continuing interchange in the form of conducting trade-offs. Attempts to coordinate this effort by formal correspondence or periodic meetings have not been particularly successful. Continued face-to-face communications seems to be necessary. Example: Hydrofoil

Inadequate Parametric Designs and Trade-Off Analyses. Informed and sound requirements selection depends on examination of a broad spectrum of potential designs and associated trade-off analysis among performance features. These analyses should emphasize both cost and the military value of different levels of performance. When this process is skipped or abbreviated, requirements tend to be too demanding and there is a lack of consensus on the essential features and value of the system. Example: C-5A

Overly Rigid Requirements. As programs evolve, additional understanding of the cost of achieving any given requirement is gained. In some cases that cost continues to appear worthwhile and therefore must be borne. In other instances, however, major costs may occur simply to meet a goal that is no longer worth the price. This suggests that requirements should be made prudently flexible and reassessed throughout the progress of the development program. Achieving the needed degree of latitude can be hampered by the existence of inappropriate relationships between the contractor and the government. Inappropriate types of contracts for development work, usually in the form of a fixed price contract, make a particularly onerous contribution to this type of situation. Examples: C-5A, F-14, AMRAAM

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

DOD PROGRAMS SURVEYED

LESSONS LEARNED (NEGATIVES)

PROGRAMS WITH TROUBLES WERE CHARACTERIZED BY ONE OR MORE OF THESE LESSONS:

- WHEN ENGINEERING DEVELOPMENT BEGAN BEFORE THE BASIC TECHNOLOGY WAS AVAILABLE, THE HIGHER RISKS WERE NEITHER RECOGNIZED NOR WERE THE PROPER RESOURCES ALLOCATED.
- THERE WAS LITTLE OR NO EMPHASIS ON THE COST OF EACH REQUIREMENT DURING THE REQUIREMENTS DEFINITION PROCESS.
- THERE WAS NO CLOSE, CONTINUOUS ASSOCIATION OF USERS, DEVELOPERS, R&D COMMUNITY AND MANUFACTURERS.
- NON-ESSENTIAL REQUIREMENTS WERE INFLEXIBLY IMPOSED WITHOUT ANY DUE CONSIDERATION OF COST AND SCHEDULE IMPACT. THERE WERE UNSUCCESSFUL ATTEMPTS TO IMPOSE COST, SCHEDULE AND PERFORMANCE SIMULTANEOUSLY.
- PROGRAM REQUIREMENTS WERE NOT CONTINUALLY EXAMINED AS NEW INFORMATION BECAME AVAILABLE ON INCREASING SCHEDULE OR COST. THE CONTRACTOR OR CONTRACT TYPE TENDED TO BECOME THE ENEMY.

Lack of Attention to Reliability. A difficulty encountered in some programs in the sample was that although the end item performed very well when it was working, it too frequently did not work--or else demanded too extensive a maintenance effort in order to keep it working. Although a system's reliability is virtually always specified in its requirement, seldom has this factor received the attention that "performance" has enjoyed. Clearly, the priority of reliability (and ultimately maintainability) needs to be placed at least on a par with performance factors (such as speed, range, payload, etc.). However, the mere existence of demanding reliability and maintainability requirements do little to improve reliability. Reliability must be designed and built into the product, tested extensively and realistically, and afforded the management attention it deserves. Examples: M-1

Production Quantity Reductions. When quantities produced are greatly reduced from original planned quantities, the large development cost may not be justifiable by the small actual increase in force capability. Examples: Hydrofoil, Roland, C-5A

Munitions. Many munition programs are begun without the full review of munition types already available or under development from other sources. Example: DSB Munitions Study, L. Sullivan

Joint/International Development Programs. Development programs conducted either by more than one nation or by more than one service have tended to run into difficulties. There were three international cases. None resulted in substantial deployment. International programs often have requirements that tend to represent the sum of the requirements of each individual participant--thereby increasing the demands of those requirements. It should be noted that international coproduction programs appear to be more successful than codevelopment programs. In the case of joint programs both additional requirements burden and lack of common priority status among multiple services cause disruption. The Joint Requirements and Management Board was created to deal with joint program problems. Examples: Roland, MTB-70

Changing Requirements. As expected, when requirements increased during the development program a pattern of cost and schedule growth emerges that exceeds such growth in other programs enjoying more stable requirements. In some cases it is appropriate to increase program requirements during the development process. However, it should be realized that doing so will generally require additional time and money and will certainly increase the risk, both the technical risk and the risk of losing vital support. When the problem is severe, it is probably better to terminate the procurement and begin again. Similarly, significant reduction of stated requirements risks losing user support. Examples: SOTAS, HARM

Prolonged Schedules. Programs with prolonged development periods are prone to failure. Although cause and effect are clearly intertwined in this instance, a few cases have been observed wherein the capabilities offered by a specific development item have been overtaken by changes in threat or by the emergence of new technological alternatives. Example: Condor

External Influences on Strategic Systems. Some strategic systems are particularly subject to external influences, which may affect schedules, requirements, and deployment. Sometimes these influences favor the programs; sometimes they create onerous burdens. Examples: B-1B, MX

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

DOD PROGRAMS SURVEYED

LESSONS LEARNED (NEGATIVES) (CONT'D)

- THE REQUIREMENTS PROCESS DID NOT PUT AS MUCH EMPHASIS ON RELIABILITY AND MAINTAINABILITY AS IT DID ON OTHER PERFORMANCE PARAMETERS.
- FEWER THAN PLANNED NUMBERS OF ITEMS WERE PROCURED AFTER UNDERGOING VERY COSTLY R&D PROJECTS. REQUIREMENTS WERE NOT REALISTIC ON QUANTITY/COST TRADEOFF.
- MUNITIONS PROGRAMS HAVE HAD INORDINATE PROBLEMS, PARTIALLY DUE TO LACK OF TOP MANAGEMENT CONSENSUS ON REQUIREMENTS.
- JOINT OR INTERNATIONAL DEVELOPMENT (NOT PRODUCTION) PROGRAMS HAVE HAD A DISPROPORTIONATE AMOUNT OF TROUBLE.
- REQUIREMENTS WERE MADE MORE DEMANDING AFTER PROGRAMS WERE STARTED WITHOUT FULL ASSESSMENT OF IMPACT.
- PROGRAMS WHOSE DEVELOPMENT DRAGGED ON TOO LONG HAVE BEEN OVERTAKEN BY CHANGES IN THE THREAT OR WERE SUPPLANTED BY TECHNOLOGICAL ALTERNATIVES.
- IT WAS RECOGNIZED THAT OUTSIDE INFLUENCES HAVE A TENDENCY TO DISRUPT THE REQUIREMENTS PROCESS OF STRATEGIC SYSTEMS.

Successful programs also produced lessons that could be applied. Sample programs to illustrate each of these lessons are included.

Strong Institutional Support. Very few systems are acquired through smooth, trouble-free programs. A number of acquisition programs that were ultimately very successful experienced severe difficulties--in some cases severe enough to jeopardize program continuation. Programs with weak support succumb to these difficulties. The requirements process provides a means for both assessing and consolidating institutional support. This support should permeate the user community as well as the developer community. Examples: Trident, MM III, F-14

Verify Technology Prior to Initiating Engineering Development. Overestimating the readiness of a given technology to support a major development program often leads to difficulty that could have been avoided by having independent teams, not involved in either supporting or opposing the initiation of a development program, conduct technology validating assessments. Correspondingly, the provision of funds to support strong advanced development efforts, particularly at the component level, appears to be a very sound investment. Examples: B-1B, MM III, UH-60

Streamlined Acquisition System. The successful programs were characterized by strong institutional support, funding stability, risk reduction programs and increased attention by high level management; all of which were factors in the success of these programs. Special access programs have a tendency to have short management chains, user involvement in requirements iteration and schedule priority. Examples: SR-71, Special Programs

Built In Growth Potential. Even in well managed programs, changes in requirements are introduced during the long development cycle. Those programs that have planned growth potential can better absorb the changes without excessive program turbulence. Programs with planned block changes and P^3I are easier to field and easier to keep upgraded. Examples: F-14, AH-1, F-16

Risk Reduction/Cost - Capability Tradeoff. Early risk assessment, coupled with risk reduction efforts, greatly enhance the probability of maintaining development schedule and therefore maintaining cost control. Users and developers, supported by industry can together control costs without reducing operational utility by understanding and taking advantage of the cost/capability trade-off. Examples: F-16, MM III, Trident

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

DOD PROGRAMS SURVEYED

LESSONS LEARNED (POSITIVE)

- THOSE PROGRAMS HAVING STRONG INSTITUTIONAL SUPPORT AND STABLE FUNDING HAD A HIGHER PROBABILITY OF SUCCESSFUL DEVELOPMENT.
- DEVELOPMENT PROGRAMS WHOSE SCHEDULE WAS TAILORED TO THE LEVEL OF RISK HAD LESS DEVELOPMENT TURBULENCE.
- THOSE PROGRAMS THAT WERE DEVELOPED WITH A STREAMLINED ACQUISITION SYSTEM TENDED TO BE MORE SUCCESSFUL, EVEN WHEN THEY HAD SIGNIFICANT TECHNICAL RISKS.
- SYSTEMS WITH BUILT-IN GROWTH POTENTIAL RESPONDED MORE EFFICIENTLY TO CHANGING THREATS AND DOCTRINES.
- DEVELOPMENT PROGRAMS WHICH EMBODIED EARLY TECHNICAL RISK REDUCTION AND COST/CAPABILITY TRADEOFF EFFORTS TENDED TO BE MORE SUCCESSFUL.

NON-DOD CASE STUDIES

NON-DOD SYSTEMS CASE STUDIES

The non-DOD sub-panel, supported by senior representatives from the five listed companies, was asked to examine the commercial world's experience in the development of large, technically complex systems. The sub-panel responded with an investigation of five non-DOD case studies:

- ESS-4 Toll Switch (Bell Labs)
- 767 Aircraft (Boeing)
- Communications Satellite (SBS)
- System/360 Computer Family (IBM)
- FAA National Airspace System (MITRE)

These case studies were supplemented with a literature search and interviews to reduce the chance of drawing invalid conclusions from a small sample. In addition, the case studies were conducted on products which have a counterpart in DOD to improve the chance of deducing relevant object lessons from the investigation. Nevertheless, there are inherent and basic differences between the DOD and non-DOD processes which certainly inhibit and may even prevent the direct mapping of lessons learned into the DOD requirements process. For example, there is no counterpart to the role of Congress in industry, nor are there any unifying quantitative measures of success in DOD corresponding to profit or ROI. Furthermore, some personnel constraints in DOD have no counterpart in industry. Finally, DOD does not operate in a free market as buyer or seller, and can only imperfectly approximate free market competitive conditions.

NON DOD CASE STUDIES

PROBLEM STATEMENT: ARE THERE LESSONS TO BE LEARNED FROM HOW THE "NON"-DOD SECTOR HANDLES REQUIREMENTS WHICH COULD BE APPLIED TO THE DOD?

METHODOLOGY:

- 5 CASE STUDIES
  - MAJOR TELEPHONE SWITCH
  - 767 AIRCRAFT
  - COMMUNICATIONS SATELLITE
  - COMPUTER SYSTEM-360
  - FAA AIR TRAFFIC CONTROL SYSTEM
- LITERATURE SEARCH
- INTERVIEWS
- EXTRACTION OF PERTINENT LESSONS LEARNED

CASE STUDY #1

While the ESS-4 Toll Switch developed by Bell Labs was conceived and deployed in a regulated environment, the product development cycle displayed characteristics found in the successful case studies in the unregulated market. The switch was conceived and proposed to Bell management by the organization responsible for this product line. The requirements statement was broad and stemmed from the projected traffic growth which would have required many more of the existing smaller capacity switches in major cities and costly interconnections among them. New functional capability was envisioned, but this was secondary to the need for more capacity.

The development was a significant undertaking even for Bell Labs, employing new digital switching technology and over 2.5M lines of source code. However, the requirements statement was deliberately broad and permitted the product organization flexibility in implementation. Indeed, the most significant technical decision, digital vs. analog switching, was not made at the time Bell management gave program go-ahead. Nevertheless, the technical foundations and requirements understanding were solid, following two years of trade-offs and technology development. Because of this extensive preparatory effort and the corporate memory from many previous switch developments, the schedule was well suited to the complexity of the development which lasted eight years. Once committed, schedule became a driver and the product was delivered only six months late.

The program enjoyed high priority and received the funding requested. The requirements were relatively stable and changes were postponed to planned upgrades to the extent feasible. Characteristically, the program owed its success in large part to the continuity and capability of an established organization who knew its products, its technology, and its users well.

NON-DOD CASE STUDIES

SYNOPSIS

CASE #1 ESS-4 TOLL SWITCH (AT&T BELL LABS)

- MAJOR CITY DIGITAL COMPUTER SWITCHING
- ADVANCED NETWORK REQUIRED TO HANDLE PROJECTED GROWTH
- BROAD REQUIREMENTS STATEMENTS DID ALLOW TECHNICAL TRADES/BREAKTHROUGHS
- SCHEDULE HI-PRIORITY FOR MANDATORY FEATURES WITH INCREMENTAL ADD-ON'S

CASE STUDY #2

The 767 is an all new, 200 passenger, transcontinental, twin-jet airplane powered by "third generation" P&W or GE engines that matured during the past 15 years on the 747 and the DC-10. The airplane was committed to production in mid-1978 for initial delivery in mid-1982. The production phase was preceded by an intense two-year program and cost definition phase that paralleled a period of increased airline earnings that allowed three major U.S. airlines to provide an adequate number of orders to launch the program.

Aerodynamic, structural, and avionic development programs were continuously iterated with airline performance requirements. The technology level was selected to meet these requirements and to allow a "freeze" of the airplane's capability at go-ahead. After go-ahead, the schedule was dominant to ensure delivery of an FAA certified product to each airline in accordance with the contract. Major changes in the airline's stated requirements, such as the change from a three-person to a two-person flight crew, were accommodated only a few months prior to roll-out with no schedule impact.

The initial design was optimized to satisfy the somewhat diverse needs of the first set of customers. However, in order to capture follow-on orders, it was necessary to adapt later airplanes to additional, individual airline requirements. This was done by taking advantage of the latent capabilities that emerged after the initial design and testing were completed. In the case of the 767, an extended range model and a model with an increase from 200 to 250 passengers were committed within the first 200 deliveries.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

NON-DOD CASE STUDIES

CASE #2 767 AIRCRAFT (BOEING)

- ALL NEW DESIGN, BUT THIRD GENERATION ENGINE AND CONSERVATIVE USE OF ADVANCED TECHNOLOGY
- REQUIREMENTS ITERATED DURING DEVELOPMENT
- GREAT EMPHASIS ON PRODUCTION SCHEDULE FOR FINANCIAL AND COMPETITIVE REASONS
- PLANNED EARLY FOR FUTURE INCREMENTAL GROWTH

CASE STUDY #3

When Satellite Business Systems (SBS) began acquisition of four K-band communications satellites, the first commercial application of this technology, the company recognized that its continuing existence depended on the successful deployment of this critical system component on a demanding schedule driven by financial and market imperatives. This schedule allowed four years from initiation of requirements collection and analysis to the first launch. The SBS assessment of the market segment to be addressed was that customer data requirements would grow rapidly, and, hence, a system optimized for data, not voice, was appropriate. This assessment was the basis for the system requirements, an assessment not substantially changed prior to deployment. The short schedule, dictated by a specified launch window and financial needs, forced an early freeze of the space segment, so that the ground segment absorbed the subsequent functional and performance changes in requirements.

SBS solicited proposals from two communications satellite producers they felt could perform, given the short development schedule. The statement of requirements was broad, encouraging design innovation. The two solicited companies responded with substantially different specifications, but committed to deliver to their own specification under a fixed price contract. Without doubt, the acquisition of a technically superior space segment on schedule can be attributed to this acquisition strategy. Conversely, the as yet not fully successful total program is probably attributable to the market projections on data transmission demand that, thus far, has not materialized.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

NON-DOD CASE STUDIES

CASE #3 COMMUNICATIONS SATELLITE (SBS)

- COMMUNICATION SYSTEM OPTIMIZED FOR DATA TRANSMISSION, NOT VOICE
- SATELLITE FIXED EARLY; GROUND SEGMENT ABSORBED CHANGES
- REQUIREMENT STATEMENT BROAD...ALLOWING FP CONTRACT AND COMPETITIVE DESIGN INNOVATION
- SPACE SEGMENT SUCCESSFUL, BUT OVERALL PROGRAM NOT "YET" SUCCESSFUL

CASE STUDY #4

Though, perhaps, less obvious than in the case of SBS, IBM also "bet the company" on a sweeping new approach to their computer product line. The System/360 family of computers replaced seven incompatible IBM computers and permitted users to consolidate separate business and scientific computer installations into a single, more economical installation. By employing a common architecture, technology, and software, IBM was able to focus both its resources and people which were overburdened by the need to support and upgrade seven incompatible products.

As was the case with ESS-4 and the 767, the new product family was proposed and initiated on the basis of broad direction from upper management and assigned to a fully accountable product organization and management team with product experience, continuity, and deep understanding of user requirements. This permitted a three-year QRC development approach to meet the competitive pressures of the marketplace. Though the hardware and software design and the technology were new, the product was announced and shipped on schedule, except for the full-function operating system which was a year late.

The commitment of top management, who provided needed resources and people, was critical, especially in view of the continuing concerns and dissent. The concerns came from customers who were justifiably nervous and uncertain about what was coming, while dissenting opinions were raised by internal detractors who thought the System/360 concept ill-conceived or too risky. In the end, the CEO's commitment to the System/360 program and to sound management practices mattered more than the process itself. Along with the key people, this commitment is credited with the program's success.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

NON-DOD CASE STUDIES

CASE #4 SYSTEM 360 COMPUTER FAMILY (IBM)

- REVOLUTIONARY 1 SYSTEM REPLACES 7 INCOMPATIBLE COMPUTERS
- REQUIREMENTS, ARCHITECTURE TRADE-OFFS FOR ALL NEW TECHNOLOGY AND SOFTWARE
- SCHEDULE DOMINANT IN FACE OF COMPETITIVE PRESSURES
- SIGNIFICANT DISSENT, BUT TOP MANAGEMENT REMAINED COMMITTED

CASE STUDY #5

The National Airspace System (NAS) provides the technical means by which the FAA controls air traffic within the United States and in adjacent oceanic air space. The present system employs old hardware and has limited capability to handle projected traffic growth and new functions. Potentially there could be system saturation, resulting in constraints and delays, and increased concern about safety.

To manage the massive upgrade envisioned for NAS, MITRE assisted the FAA in developing a high level NAS Plan for a total system approach to the evolution of the facilities and equipment, along with the associated development needed to implement the NAS Plan. The NAS Plan encompasses some 90 individual projects, an $11B acquisition which not only will provide the requisite increased capability, but will also provide an internal control mechanism. Thus, the top-level operational requirements document for the planned NAS contains no requirement that is not implied by a capability specified in the NAS Plan. In turn, the proposed functional design is derivable from the NAS Plan and the requirements document. Thus, the NAS Plan ensures a top-down design that reflects the program priorities of top FAA management.

The NAS Plan has also served as a very useful means of interacting with the users of the system, because it keeps the dialogue at the level of functional capabilities, away from the details of implementation. Since the NAS Plan adds capability incrementally, it will provide a continuing and evolving mechanism for what must be a highly interactive process of requirements trade-offs and development.

Given the high priority of many of the planned capabilities and consequent demanding schedule, the overall number of projects, and the intricate interactions among them, the systems engineering effort is extraordinary. Thus far, the methodology employed is working and is exemplary of a top-down approach to install discipline in the acquisition process and enforce priorities.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

NON-DOD CASE STUDIES

CASE #5 FAA NATIONAL AIRSPACE SYSTEM (MITRE)

- $11B ACQUISITION MASTER PLAN TO AVERT POTENTIAL SATURATION AND SAFETY PROBLEMS
- EXTRAORDINARY SYSTEMS ENGINEERING EFFORT TO UPGRADE CURRENT OPERATIONS AND EVOLVE NEW TECHNOLOGY
- INCREMENTALLY ADD NEW CAPABILITIES (P3I)
- SCHEDULE HIGH PRIORITY

LESSONS LEARNED

The sub-panel on non-DOD case studies derived eleven "lessons learned." Of these, the seven grouped here relate to the quality of the trade-offs of requirements against cost, schedule, and risk.

Market understanding, closeness to customers, and a deep, continuing concern for user satisfaction have long been attributes of successful companies. Conversely, misassessment of requirements or the market is one of the most common causes of product failure. The case studies confirmed this and revealed that extensive trade-offs of function and performance against schedule, cost, and technology risk generally precede commitment to field a product and may even continue through the development of a manufacturing prototype. The availability of quantitative criteria such as profit and ROI ensure a relevance and immediacy for these trade-offs and a sharp focus on product viability, permitting crisp "go/no-go" decisions. In short, good requirements analysis is vital.

The product case studies generally represented major financial commitments for the companies involved. Moreover, a single pattern emerged. After various periods of study, technology development, requirements analysis, and other product assessment activities, the company made an unequivocal commitment to develop and market the product. This commitment included providing the full funding believed needed to see the entire product program through.

Product experience and continuity of program management contributed to an ability to match the project schedule and funding to the degree of challenge inherent in the requirements. Generally, additional resources and people were applied to solve problems while holding the committed schedule.

The continuing iteration of design trade-offs concurrently with requirements analysis during development more sharply focused the projected costs, perceived risks and reduced the schedule uncertainties. During this entire process, the successful programs were marked by the continuing concern for the user and his evolving requirements.

The program manager was given the authority to trade-off all parameters, including requirements, as long as he could demonstrate his product would be successful at the bottom line. The program manager also was not constrained by technical solutions mandated from above.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

LESSONS LEARNED

FINDINGS FROM CASE STUDIES

- IDENTIFICATION AND REASSESSMENT OF REQUIREMENTS WAS VITAL
- FULLY FUNDED AT GO-AHEAD
- DETAILED TRADE-OFFS OF PROGRAM REQUIREMENTS, TECHNOLOGY, COST AND SCHEDULE DONE WELL
- PROGRAM REQUIREMENTS, TECHNOLOGY & DESIGN ITERATION IS A CONTINUOUS PROCESS DURING DEVELOPMENT
- USER SURROGATE HAS STRONG, CONTINUING ROLE
- PROGRAM MANAGER CONTROLS ALL PARAMETERS, INCLUDING PROGRAM REQUIREMENTS; FULLY ACCOUNTABLE
- TECHNICAL SOLUTIONS NOT MANDATED BY UPPER MANAGEMENT

POTENTIAL APPLICATION TO DOD

ENSURE THAT ADEQUATE TRADE-OFFS FOR PROGRAM REQUIREMENTS AND COST/PERFORMANCE IMPACTS ARE CONDUCTED

...CONTINUE TRADE(S) UNTIL LATE IN DEVELOPMENT

...MATCH SCHEDULE AND FUNDING WITH DEGREE OF REQUIREMENTS CHALLENGE

LESSONS LEARNED

While it is recognized that holding to a product schedule is a commercial product imperative for financial, competitive, and market considerations, the benefits that accrue to giving top priority to schedule may be equally desirable in DOD. Given the caveat that some DOD programs have too many uncertainties or technical challenges to be managed like a commercial product, there are many DOD programs in which the schedule should be held sacrosanct (at least after Milestone II) to prevent drawn out developments and the fielding of systems no longer responsive to the threat. This can mean accepting some back-off requirements, deferring new requirements introduced during development to block upgrades, building in P^3I at the start of the program for lower priority or riskier requirements, and employing proven technology when schedule is paramount. Giving high priority to schedule can control changes, and hence costs, and reduce the chance of drawn out, overrun developments.

There are important military programs in which significant changes will be required during development due to new information about the threat, unforeseen development difficulties, funding changes, etc. The need for being flexible and adapting quickly to such mandatory changes is self-evident, but the mapping of the organizational and management approach of industry to DOD is made difficult and problematical by the institution and the environment in which it currently functions.

LESSONS LEARNED

FINDINGS FROM CASE STUDIES

- FINANCIAL AND MARKET CONSIDERATIONS MADE SCHEDULE TOP PRIORITY
- PERFORMANCE REQUIREMENTS ARE TRADED TO HOLD SCHEDULE; BLOCK UPGRADES, P3I FOR NEW REQUIREMENTS
- TENDENCY TOWARD PROVEN TECHNOLOGY AS SCHEDULE IS PARAMOUNT
- QUICK REACTION TO MANDATORY CHANGES

POTENTIAL APPLICATION TO DOD

SCHEDULE PRIORITY USED
...TO CONTROL CHANGES (THEREFORE COSTS)
...TO FIELD SYSTEMS EARLY AND PROVIDE FOR P3I
...APPLY THIS SCHEDULE CONTROL FOR SELECTED ACQUISITIONS

CINC ROLE IN REQUIREMENTS

Our combatant CINCs are the men responsible for this country's capability to fight. To maintain that capability, four types of requirements must be properly implemented. Force levels must be adequate, combat supplies must be available, command authority must be maintained so that the available forces can work together effectively, and reliable weapons with advanced technology must be in the field in sufficient quantity to provide force superiority.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

CINC ROLE IN REQUIREMENTS

CLASSES OF CINC REQUIREMENTS

- <u>FORCE LEVELS:</u> AGGREGATED FORCES CAPABLE OF ACCOMPLISHING ASSIGNED MISSIONS

  -- PEACETIME AND WARTIME

- <u>SUPPLIES:</u> ADEQUATE MATERIEL SUCH AS AMMUNITION, POL AND SPARE PARTS NECESSARY TO SUSTAIN COMBAT TO A SUCCESSFUL CONCLUSION

  -- ESTIMATED IN DAYS OF WARFIGHTING

- <u>MEANS OF COMMAND (C3):</u> COMMUNICATIONS, COMMAND CENTERS, AND CONTROL FACILITIES

  -- INTEROPERABILITY BETWEEN SERVICES AND COUNTRIES

- <u>WEAPON SYSTEM CHARACTERISTICS:</u> TECHNOLOGICALLY SUPERIOR TO POTENTIAL ENEMY

  -- ACHIEVABLE, TIMELY AND RELIABLE

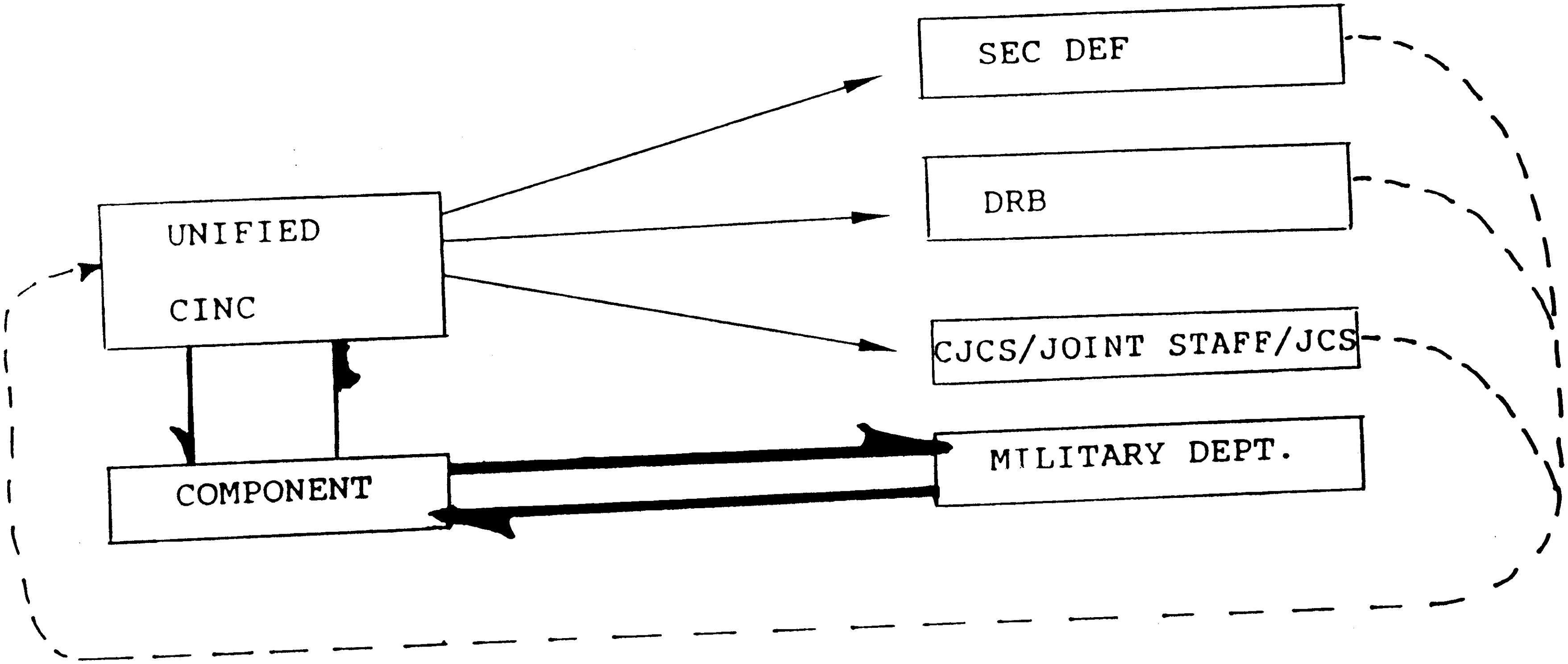
The Unified CINCs presently have an input through several routes into the requirements process. At this time, however, they have no formal or precise feedback or interaction with the military departments that have responsibility for the requirements, except through personal contact and persuasion.

EXCERPTS FROM ADMIRAL W. J. CROWE, JR., USCINCPAC:

"Another area requiring strong improvement is feedback. Currently there is no formal process for providing frequent feedback on how my requirements are being handled internally by OSD, OJCS, the Services and other DOD agencies. I believe our involvement in the determination of specific characteristics of required systems is adequate up to a point where the system enters development. From that point, however, I have little influence over the process because feedback on affordability, priorities and any trade-offs made by the developing Service is almost non-existent. I do not want the capability to design or build systems, but I do need sufficient involvement in the development process to be able to point out major design changes of omission or commission which would affect my capabilities and/or strategy. A mechanism to permit CINC interface with the developers is necessary to ensure that trade-offs do not result in end items which do not satisfy CINC requirements."

"The key words in the feedback process are visibility and communication. I need to know what weapons system requirements the Services generate and be allowed to provide my views on how these affect my ability to perform joint missions. There exists the possibility that a Service will submit a requirement, without CINC consultation, which does not contribute to the completion of assigned missions. Also, once requirements are identified and submitted by the Services, there are changes to the original submission which are not identified to the CINCs. This can result in a similar disparity between mission and requirement. However, if there is frequent feedback all along the development process, this should not happen."

CURRENT PROCESS



- STRONG FORWARD COMMUNICATION
- FEEDBACK IMPROVING BUT STILL OFTEN "FORMAL" ONLY AND NOT ROBUST ENOUGH TO ALLOW CINC TO INFLUENCE PROGRAM AND BUDGET DECISIONS

The mission of each CINC is different. They are not homogeneous; they are unique. Each has different command relationships, different force objectives and different relationships with the services. Their requirements are different and the way their requirements are handled is different.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

CINC ROLE IN REQUIREMENTS

- THE CINCs ARE AT THE USING END OF THE "REQUIREMENTS PROCESS" -- THUS:
  - COMBAT CAPABILITY IS ULTIMATE INTEREST
  - VITALLY CONCERNED THAT REQUIREMENTS BE "PRACTICAL" AND "FUNCTIONAL"
  - PRINCIPAL CONCERNS: MEET THE THREATS -- RELIABLE INTEROPERABLE -- FASTER RESPONSE TO PERCEIVED NEEDS
- CINCs RESPONSIBILITIES/MISSIONS/STAFFING VARIES WIDELY -- NOT HOMOGENEOUS
  - COMMAND RELATIONSHIPS AND OBJECTIVES DISSIMILAR
  - FORCES AND OBJECTIVES UNIQUE WITH EACH CINC
  - STAFF CAPABILITIES AND SERVICE RELATIONSHIPS DIFFER
- SERVICE PROCESSES/PROCEDURES FOR HANDLING CINC REQUIREMENTS NOT FORMALLY STRUCTURED
  - CINC REQUESTS AND INPUTS MAY OR MAY NOT HAVE IMPACT
  - FEEDBACK TO CINCs SPOTTY -- INCONSISTENT
  - UNIFIED CINCs NOT BROUGHT INTO PRIORITIES/TRADEOFFS

Many improvements have been added to the system recently that help the individual CINCs make inputs into the requirements process. In addition to being able to submit ROCs and prioritize R&D objectives for the JCS, there is a new JCS agency, the Strategic Plans and Resource Analysis Agency, charged with tracking and pursuing CINC priorities in the PPBS and requirements process. Each CINC also is asked to make a presentation of his requirements and prioritize them each year to the Defense Resources Board. They appreciate the new improvements, but feel that they can be of more help if their part of the process can be made more formal early in the requirements generation cycle and if they can get feedback on a continuing basis.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

CINC ROLE IN REQUIREMENTS

- SECDEF/JCS ACTIONS TO ENHANCE TIMELY CINC INPUT INTO REQUIREMENTS PROCESS
  - CINC CAN SUBMIT REQUIRED OPERATIONAL CAPABILITY STATEMENTS (ROCs) INTO PPBS PROCESS
  - THEY PRIORITIZE CRITICAL R&D OBJECTIVES ANNUALLY (ANNEX D, JSPD) {JSPD IS JCS INPUT INTO DEFENSE RESOURCE PLANNING GUIDANCE/SERVICE POMS}
  - HAVE FOCAL POINTS AND SPECIAL STAFFS FOR PROCESSING CINC INPUTS (C3S AND SPRAA)
  - QUARTERLY LETTER REPORTS TO SECDEF -- R&D OBJECTIVES/ LETTERS
  - PERSONAL PRESENTATION TO THE DEFENSE RESOURCES BOARD

The CINCs report that their inputs are received, but they get very little feedback on what happens as a result of their inputs. They do not participate with the services in making requirements trade-offs even though they may be the most qualified to judge the true operational value of a particular requirement. Some CINCs feel that there is a lack of service interest in some instances into the unique responsibilities that a particular CINC exercises.

EXCERPTS FROM GENERAL BERNIE ROGERS, CINCEUR:

"For downward-directed, single-service programs, we are usually not brought into the planning process early enough and in enough depth to identify and avoid interoperability problems or identify duplication of effort."

EXCERPTS FROM GENERAL ROBERT KINGSTON, CINCCENTCOM:

"At present, there is not one standard method for a joint command to enter requirements into the system. Our ability to influence the system is often dependent upon action officer abilities, experience, and familiarity with the acquisition process. Our experience, to date, at influencing the various Services with respect to requirements as we perceive them has met with mixed success."

CINC ROLE IN REQUIREMENTS

- CINCs GENERALLY PLEASED WITH ENHANCED FORMALITY AND STRUCTURE OF "FRONT-END" INPUT, BUT....THIS DESIRABLE MOMENTUM SHOULD BE CONTINUED
  - NOT IN THE PRIORITIES/TRADE-OFF PROCESS (UNIFIED CINCs)
  - GET LITTLE OR NO "FEEDBACK" (UNIFIED CINCs) FROM SERVICES
  - CONSIDER ROC PROCESS TOO SLOW
  - PPBS TOO COMPLICATED TO RESPOND TO THREATS
  - LACK OF SERVICE INTEREST IN UNIQUE RESPONSIBILITIES
  - INCAPABLE OF PARTICIPATING IN PPBS/POM PROCESS
    - LACK TECHNICAL STAFF/PROGRAM STAFF/BUDGET AUTHORITY

Admiral Ike Kidd has illustrated the warfighting requirements of the CINCs as a three-legged stool. The forces must have functional technology, in time and in adequate totals. These three factors must be balanced or the requirements process will fail its ultimate test.

DSB

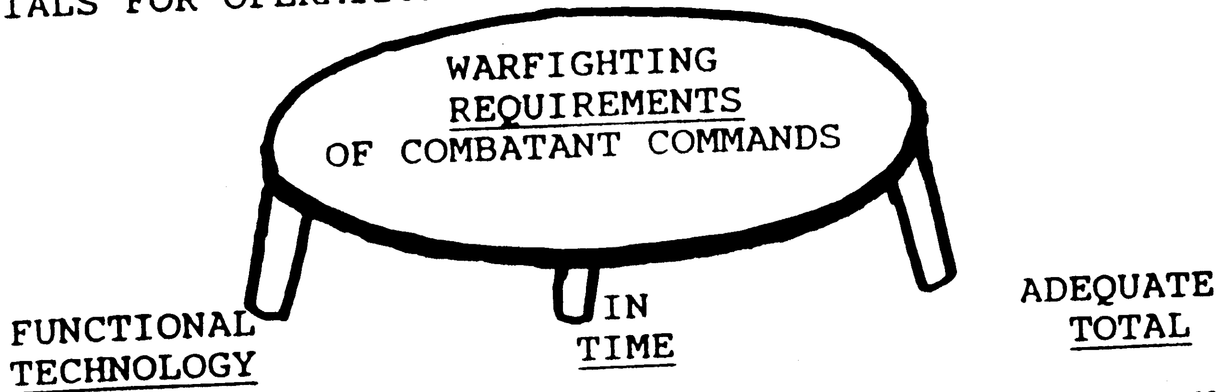
PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

CINC ROLE IN REQUIREMENTS

- CONSEQUENTIAL PROGRESS MADE IN INCORPORATING CINCs INPUT INTO REQUIREMENTS PROCESS...

  -- BUT MORE NEEDS TO BE DONE! (AND MORE CAN BE DONE)

- CINCs APPROACH TO REQUIREMENTS KEYED TO BALANCE OF THREE ESSENTIALS FOR OPERATIONAL EMPLOYMENT:



-- IF THE TECHNOLOGY IS LACKING, UNRELIABLE, OR NOT SUSTAINABLE IN THE FIELD

-- IF THE REQUIREMENT IS NOT FILLED IN A TIMELY MANNER TO MEET HIS OPERATIONAL REQUIREMENTS...

-- OR...IF THE TOTAL QUANTITIES DEPLOYED/DEPLOYABLE ARE INADEQUATE...THEN...

THE REQUIREMENTS PROCESS WILL HAVE FAILED ITS ULTIMATE TEST!

In particular, the unified CINCs are not responded to consistently. They are not presently staffed to produce quality inputs. They can't track progress to identify what is going on with their requirements.

EXCERPTS FROM GENERAL BERNIE ROGERS, CINCEUR:

"Currently, the CINCs have a limited impact upon the requirements process -- limited in both scope and effectiveness. A mechanism needs to be developed that will permit CINC interface with the services, OSD and the system developers to ensure that trade-offs do not produce end items that fail to satisfy our requirements. The services and OSD are the DOD "experts" in Research and Development (R&D) matters. They have the staffs and expertise to work in these areas. The CINCs do not. Yet, while I do not desire that we be given the broad capability to design and build systems, I do, however, need sufficient involvement in the development process to be aware of major design changes which could affect our capabilities."

"A "Scientific Adviser" would enhance our ability to more accurately state our needs to the scientific/R&D community, evaluate ongoing R&D efforts, and also meet SECDEF's desires for a more active involvement in cooperative joint research, development, production, and acquisition programs with our allies. I find it very useful to have a scientific adviser in my SACEUR role, especially with the increased NATO planning and requirements generation at shape."

EXCERPTS FROM ADMIRAL W. J. CROWE, JR., USCINCPAC:

"Specifically the institutional procedures available for voicing CINC requirements need to be strengthened and streamlined. I would like to see continued progress toward increased CINC participation in the POM/DRB process, more Service attention to non-institutionalized inputs such as the USPACOM Master Requirements List, and a "fenced" pot of money for CINC requirements."

"The basic problem with the ROC process is that it is extremely slow, and thus, frequently unresponsive to our needs. The OJCS will not validate a ROC without prior Service approval. This places me in the untenable position of not being able to improve my operational capability except through a "persuasion process" with the Services. Furthermore, "validation" does not ensure funding."

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

CINC ROLE IN REQUIREMENTS

- UNIFIED CINCS ARE "LISTENED TO" BUT...
  - -- NOT "CONSULTED WITH" OR "RESPOND TO" CONSISTENTLY
  - -- NOT STAFFED TO MAKE QUALITY INPUTS AT ALL DECISION POINTS
  - -- NOT ABLE TO TRACK AND RESPOND TO DEVELOPMENTS AND PROCUREMENT PROGRAM TRADEOFFS
- CINCS INPUT NOT YET WIDELY RECOGNIZED AS ESSENTIAL TO A RESPONSIBLE, CONTINUING REQUIREMENTS PROCESS AFFECTING COMBATANT FORCES
  - -- HE IS IN BEST POSITION--WITH ULTIMATE RESPONSIBILITY--FOR BALANCING THE THREE ESSENTIALS OF COMBAT REQUIREMENTS:

TIME - TECHNOLOGY - TOTALS

The CINCs need to do long range force requirements planning so that they can be a participant at the front end of the weapons system requirements process. They must participate more fully in the generation of defense guidance and the establishment of relative priorities. The CINCs should have a structured place in the service requirements; not to inhibit, but to help mold and guide.

EXCERPT FROM ADMIRAL W. J. CROWE, JR., USCINCPAC:

"To sum up, military requirements which were or are being developed and provided in a timely manner are more the result of diligent ad hoc efforts than institutionalized processes. The CINCs are the ultimate users of the end items being developed and need to be more involved in the requirements process. The keys to CINC participation and influence are the visibility of Service requirements as they are generated/modified, and feedback on the process of the actual and associated systems developments."

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

CINC ROLE IN REQUIREMENTS

FINDINGS

- CINCs ROLES AND RESPONSIBILITIES ARE VITAL TO THE DEVELOPMENT AND PRIORITIZING OF PRACTICAL PERFORMANCE REQUIREMENTS FOR OPERATIONAL FORCES
  - -- TOO IMPORTANT TO LEAVE TO CHANCE, PERSONALITIES OR INDIVIDUAL PERSUASION
- CINCs STAFF MANNING SHOULD BE ENHANCED IDENTIFYING FUNCTIONAL REQUIREMENTS AFFECTING HIS MISSION/AREA
  - -- CINCs SHOULD BE TASKED (e.g., TEN YEAR FORCE DEVELOPMENT PLAN) FOR THEIR MISSION/AREA IN ORDER TO ACHIEVE TIMELY INPUT TO LONG-RANGE THINKING OF SERVICES, JCS, OSD.
- CINCs SHOULD PARTICIPATE MORE FULLY IN THE FORMATION OF DEFENSE GUIDANCE AND ESTABLISHING RELATIVE PRIORITIES FOR PPBS.
- CINCs SHOULD HAVE STRUCTURED REVIEW IN SERVICE AND AGENCY REQUIREMENTS IMPACTING THEIR COMMANDS.

FINDINGS AND RECOMMENDATIONS

SYSTEM MODELS

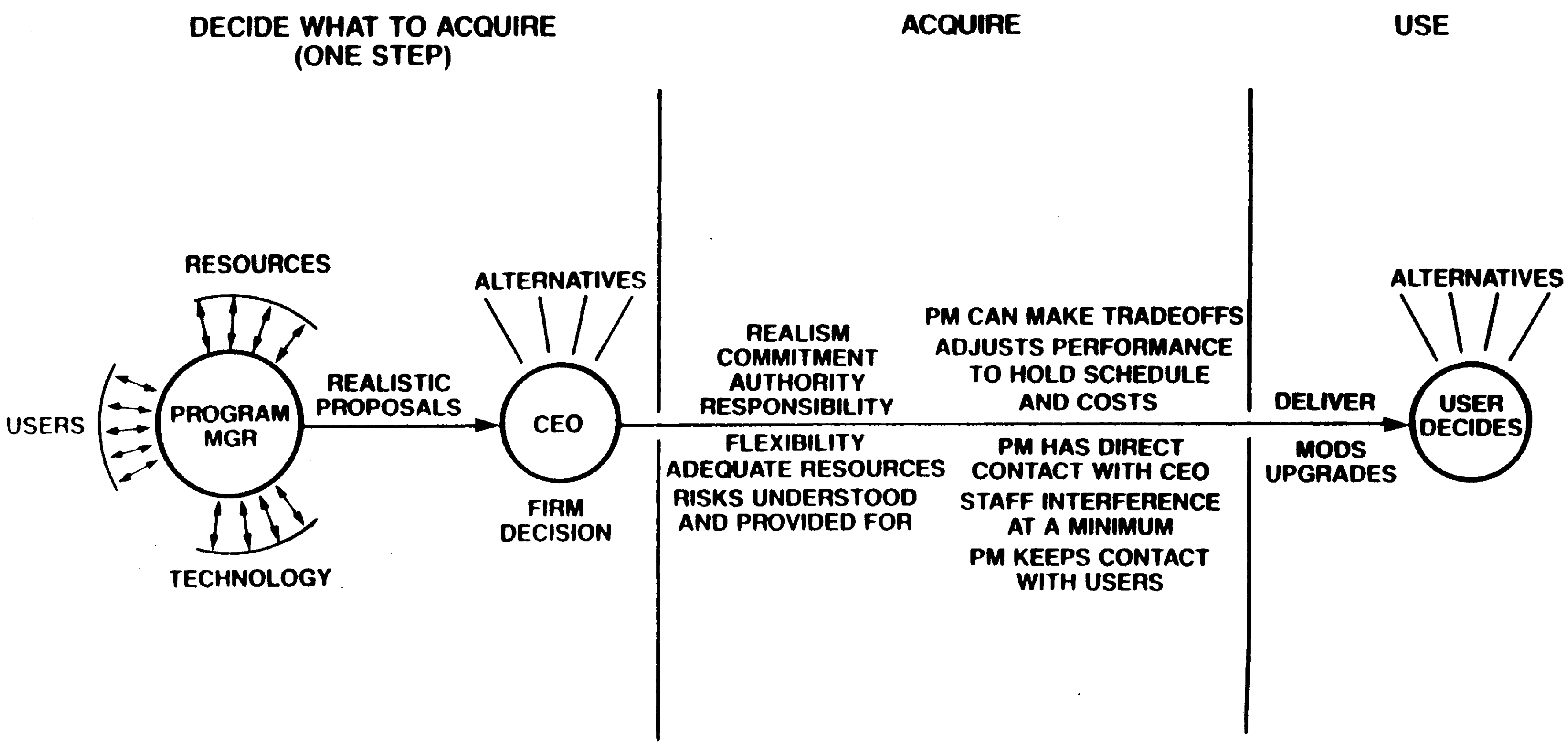
A review of the cases studied by the panel indicates that two distinctly different models of the acquisition process can be distinguished, one of which characterizes the commercial process (at least for the successful programs studied) and the other of which characterizes the DOD process (at least for the unsuccessful programs studied). While not intending to imply that all commercial programs are alike or are successful, the correlation between the fundamental differences in the two general models of the process and program success leads the panel to believe that the closer a program follows the "Commercial Model" the more likely it is to succeed; and the closer it is to what might be termed the "Problem Program Model", the more likely it is to fail.

The "Commercial Model" (or the streamlined process used for special programs in the DOD) is characterized by a relatively few major players, a continuing and highly iterative relationship among these players, constant interface with the market (users) and advancing technology, realistic measurement and matching of program risks with the resources needed to hedge these risks, a reward system tied to results achieved, and a highly flexible attitude regarding needed program changes and desirable trade-offs. Too, the model embraces a clear-cut, focused decision-maker -- a so-called "CEO" -- and a Program Manager (PM) who has the continuity, authority, and decision-maker access needed to carry out his responsibilities. Finally, the commercial process is dominated by the knowledge that users have a very real choice of whether and from whom they will obtain the final product of such processes. Hence there is a tendency to hold to program schedules and to relax performance if required to meet these schedules, both because timing is important in a competitive market and because holding to schedule tends to hold down costs and hence prices.

It is important to note that in the "Commercial Model" the decisions of what to acquire and whether to go ahead, though often involving a lengthy and expensive process with much iteration, are nevertheless essentially a one-step activity from the identification of user requirements and their matching by a program manager with needed resources and technology to the firm choice by the CEO of one of the alternatives available to him or the decision not to go ahead at all.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

Commercial Model



In contrast, in the Problem Program Model there are many more people involved, they have far less continuity of position, and they have different and sometimes conflicting degrees of authority, responsibility, and interest. Too, in this second model there is no equivalent to the commercial CEO, with his ability to make firm decisions and to hold to them. Finally, in the DOD the user has little choice of whether he will accept the results of a program. He either accepts it or goes without the needed capability. Hence he can influence the process little after he has stated his need.

In this model the decision on what to acquire is basically a two-step process. This process begins with a competition for funds in a highly political environment, an environment in which proposal realism is not the first goal. Rather, there is great pressure to overpromise in order to survive this budget competition. The result of this step is often a firm, over-stated requirement which too frequently can neither be met nor changed.

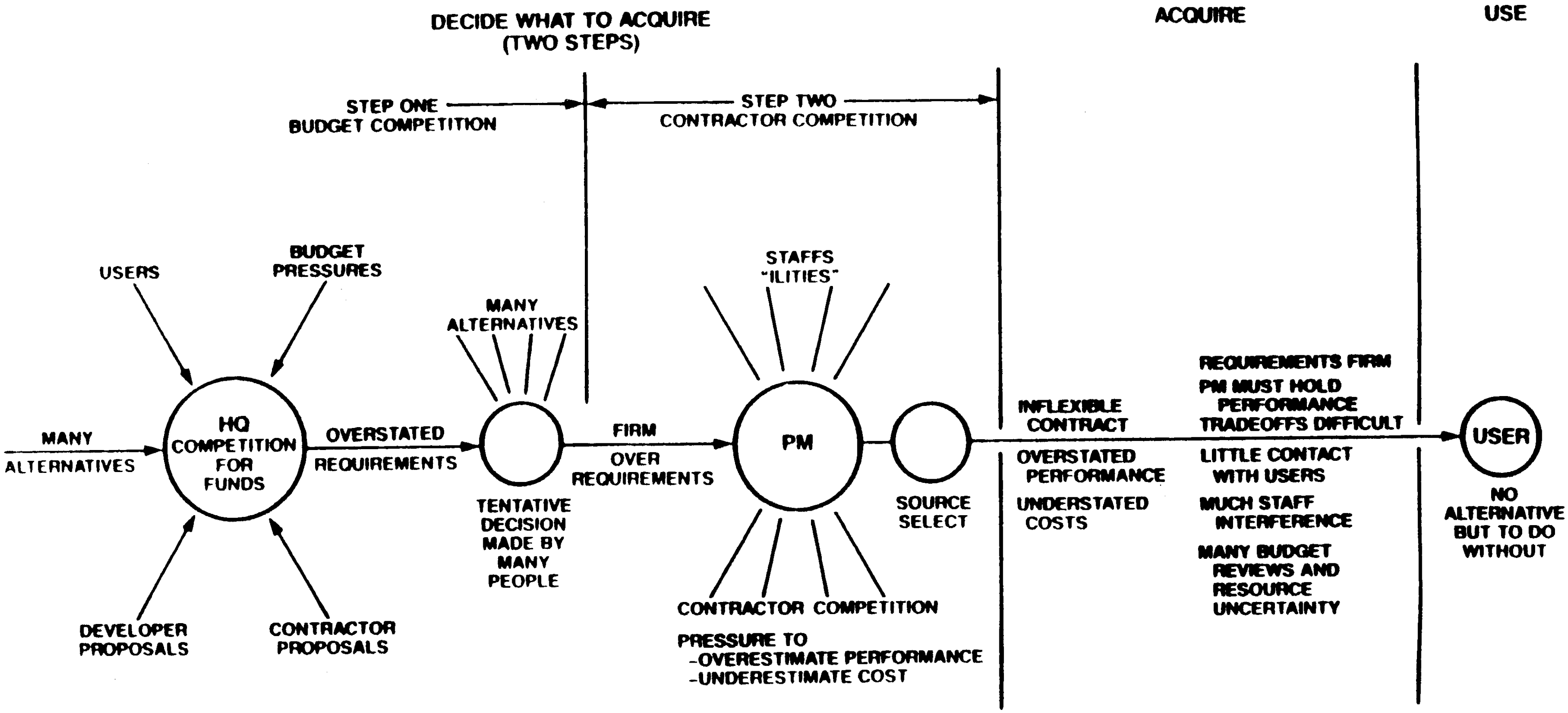
The second step is a competition among potential suppliers in which these suppliers are under great pressure to overestimate what they can do and to underestimate what it will cost to do it.

The result of both of these steps can be an inflexible contract with inadequate resources, overstated performance goals, and concealed risks.

The solution to the problems caused by the second model lies in the direction of reducing the number of people in the decision chain, establishing surrogate CEOs with the authority and responsibility for playing the role of their commercial counterparts, giving the PMs more flexibility to adjust performance to hold to schedules and costs, and finding ways to involve users more throughout the acquisition process. Above all, providing for the flexibility in the process needed to deal with troubles and uncertainties and basing personnel performance measurements on clear-cut personal accountability for results, rather than on obedience to the letter of procedures, would go a long way towards moving the problem model towards the more successful commercial model.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

PROBLEM PROGRAM MODEL



Based both upon the extensive data received and evaluated by the panel and taking advantage of the broad experience base of the participants, eleven general findings were generated to summarize the findings of the study:

All new programs have, in varying degrees, technical risks associated with their development. These risks should be recognized and properly dealt with. After program initiation and prior to the start of full scale engineering development, the program must include efforts to identify program risk and reduce it. Reducing system performance capabilities is one approach to be considered. Industry should participate in these efforts to achieve a clear understanding of program risk and produce realism in the development effort. It is important to provide adequate schedule margin and funds to realistically overcome the unexpected difficulties. Risk reduction, however achieved, can greatly stabilize the development process.

Association of the developer and the user, aided by the R&D community and the contractor, is key to making intelligent trade-off decisions. The process for obtaining equipment that has meaningful operational utility for an affordable price can be aided by being flexible and providing the user an input into the requirements trade-off process. Strong institutional support is key to protecting new programs.

Until you reward realism rather than overoptimism, the system will produce overoptimism. Pressure is applied by the normal procurement system to predict a "success oriented" technology development program and a failure free test program. When problems occur, costs inflate above prediction and schedules are not met.

Requirements should be as flexible as you can make them. The system should require only those things that must be required. Particular care must be taken when there is a tough contract type, because no one can do the sensible thing when the contract won't allow it.

DSB

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

GENERAL FINDINGS

1. SUCCESSFUL PROGRAMS EITHER HAVE THE REQUIRED TECHNOLOGIES IN HAND BEFORE DEVELOPMENT IS INITIATED, OR THE TECHNOLOGICAL RISKS ARE IDENTIFIED AND RECOGNIZED IN SCHEDULE AND RESOURCES.

2. DURING THE REQUIREMENTS PROCESS, THERE SHOULD BE CLOSE ASSOCIATION BETWEEN USERS, THE R&D COMMUNITY, DEVELOPERS AND INDUSTRY. THE RESULT IS STRONG INSTITUTIONAL SUPPORT AND AN ITERATIVE "ONE-STEP" PROCESS RATHER THAN "HANDOVER" AND RE-INVENTION BY EACH NEW ELEMENT.

3. PROGRAMS WHICH DO NOT ALLOW FOR EARLY TRADES BETWEEN PERFORMANCE AND COST USUALLY RESULT IN OVERSTATED PERFORMANCE REQUIREMENTS AND UNDERESTIMATED COST. IT IS IMPERATIVE THAT THE REWARDS ARE FOR REALISM AND NOT OVER-OPTIMISM.

4. PROGRAM REQUIREMENTS SHOULD BE PRUDENTLY FLEXIBLE, AND REASSESSED THROUGHOUT THE PROGRESS OF THE DEVELOPMENT PROGRAM. NON-ESSENTIAL "REQUIREMENTS," IMPOSED INFLEXIBLY, WITHOUT PROPER CONSIDERATION FOR COST AND SCHEDULE IMPACT CAN DO GREAT HARM, PARTICULARLY WHEN AN INAPPROPRIATE CONTRACT TYPE IS USED.

There should be more use of block upgrades rather than major schedule delays if full requirements can not be met when fielding a first block. Serious consideration should be given to the operational value of having equipment in the field quickly when it meets a majority of the final requirements rather than waiting until all requirements are fully met. If there is a major change in requirements that can not be handled by block upgrades, consideration should be given to termination and starting the process over.

One of the most significant differences noted between our two procurement models is the role of the (surrogate) CEO. The ability of the Program Manager to receive high level support from someone with significant authority can make a great deal of difference in his effectiveness if the CEO is willing to intercede when it is necessary.

Part of the process of giving the Program Manager more authority is the potential of reducing specialized staff reviews. Again the role of the CEO is one of keeping the review process to the required minimum and allowing the Program Manager to more truly manage his program.

The full effect of the newly formed office of the Director, Operational Test and Evaluation was not evaluated, but the panel urges caution, and recommends that steps be taken to ensure that new requirements are not imposed on programs late in their development cycle.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

GENERAL FINDINGS

5. MORE EXTENSIVE USE OF BLOCK UPGRADE (P3I) PLANNING DURING DEVELOPMENT CAN PERMIT ACHIEVEMENT OF DEFERRABLE REQUIREMENTS WITHOUT SCHEDULE COMPROMISE.

6. POSITIVE RESULTS WERE GENERALLY PRODUCED WHEN THERE WAS A SHORT CHAIN OF COMMAND BETWEEN A SINGLE DECISION MAKER WITH CLEAR AUTHORITY (CEO) AND A PROGRAM MANAGER WITH FLEXIBILITY TO MAKE TRADES WITHIN DEFINED LIMITS. THE PM NEEDS DIRECT ACCESS TO THE CEO, AND THE CEO KEEPS OTHER STAFFS FROM ADVERSELY IMPACTING THE PROGRAM.

7. THE NEED FOR SPECIALIZED EXTERNAL REVIEW STAFFS CAN BE REDUCED BY ASSIGNING THE PROGRAM MANAGER RESPONSIBILITY FOR THE "ILITIES" IN THE REQUIREMENTS DOCUMENT AND PASSING THAT BURDEN TO THE CONTRACTOR THRU THE RFP AND CONTRACT INCENTIVES.

8. CONSISTENCY BETWEEN VALIDATED REQUIREMENTS, INCLUDING T&E CRITERIA, AND THE DEVELOPMENT EFFORT IS CRITICAL TO PROGRAM SUCCESS.

Forces external to the DOD permeate the entire acquisition cycle with their influence. The panel suggests that the Packard Commission, appointed by the President, might be the proper forum for suggesting ways to channel those forces into better aiding the acquisition process.

There is a lack of general agreement on how effectively the Soviet Union produce quality military equipment. Their system is characterized by producing large amounts of equipment and the stability of their funding.

The panel thinks that the DOD Program Survey produced some historically meaningful lessons. The survey was done on a relatively small sample, and the short time period did not allow an in-depth review. Tasking an organization like the Defense Systems Management School to expand the study might shed further light on the whole subject.

GENERAL FINDINGS

9. EXTERNAL FORCES (I.E., POLITICAL PRESSURES, BUDGET CYCLE, AND CONGRESSIONAL INFLUENCES) CAN STRONGLY IMPACT AN ORDERLY REQUIREMENTS AND ACQUISITION PROCESS. FURTHER, DOD STAFF REDUCTIONS CAN BE NEGATED BY THE PROLIFERATION OF EXTERNAL STAFF REVIEWS (I.E., OMB, CONGRESSIONAL). THIS ISSUE COULD BE AN APPROPRIATE SUBJECT FOR PACKARD COMMISSION.

10. THE USSR DEVELOPMENT PROCESS APPEARS TO HAVE CERTAIN ATTRIBUTES SIMILAR TO THE NON-DOD MODEL: STRONG USER INVOLVEMENT, BLOCK UPGRADES AND P3I, SCHEDULE A HIGH PRIORITY AND THE ADVANTAGE OF FUNDING STABILITY.

11. THE DOD PROGRAM SURVEY DONE IN SUPPORT OF THIS PANEL PRODUCED USEFUL "LESSONS LEARNED". EXPANDING THE NUMBER OF CASE STUDIES AND REVIEWING THE TWENTY SIX CASES IN MORE DEPTH WOULD PRODUCE ADDITIONAL VALUABLE DATA.

<u>OBSERVATION:</u> ALTHOUGH MUCH NEEDS TO BE ACCOMPLISHED, ALL THE MILITARY DEPARTMENTS ARE NOW TAKING STEPS TO STREAMLINE THEIR REQUIREMENTS AND ACQUISITION PROCESS, GENERALLY IN THE DIRECTION OF OUR FINDINGS.

Based upon the general findings of the study, recommendations on improving the present system are submitting in three general categories:

The development of operational requirements should be an iterative process during which potential solutions of the operational need are evaluated and traded off with respect to affordability, performance and risk prior to commitment to the program.

After program initiation, and prior to the commencement of FSED, technical risk reduction and cost/capability trade-offs should be conducted. If at all possible, industry participation should be encouraged. These results should be used to understand the risks to program success, produce schedule realism and apply appropriate incentives in the program. Understanding the results of these trade-off studies should be a primary concern at Milestone II.

Following Milestone II, adherence to established schedule is an important means of preserving program stability and constraining cost growth. Schedule dominance during FSED implies an understanding of program risk, the existence of validated requirements, and a commitment for full funding of the program during development. The use of a pre-planned product improvement (P^3I) approach in lieu of continual requirements creep can allow attainment of validated requirements without schedule compromise.

At the FSED stage of a program operational requirements are not expected to change. In cases when they do, block changes should be the first option considered. If the changes have major impact and a block change option is not acceptable, its probably better to terminate the program and begin the process over again.

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

RECOMMENDATIONS

- REQUIRE THE MILITARY DEPARTMENTS TO INCORPORATE THE FOLLOWING PRINCIPLES INTO THEIR RESPECTIVE REQUIREMENTS/ ACQUISITION PROCESSES:

  - THE DEVELOPMENT OF AN OPERATIONAL REQUIREMENT SHOULD BE AN ITERATIVE PROCESS DURING WHICH POTENTIAL SOLUTIONS TO THE OPERATIONAL NEED ARE EVALUATED AND TRADED OFF WITH RESPECT TO AFFORDABILITY, PERFORMANCE AND RISK PRIOR TO COMMITMENT TO THE PROGRAM. (PRIMARY CONSIDERATION AT MILESTONE I)

  - AFTER PROGRAM INITIATION AND PRIOR TO THE COMMENCEMENT OF FSED, TECHNICAL RISK REDUCTION AND COST/CAPABILITY TRADEOFF EFFORTS, WITH INDUSTRY PARTICIPATION, SHOULD BE CONDUCTED. RESULTS OF THESE EFFORTS SHOULD BE USED TO FULLY UNDERSTAND RISKS, ENSURE CLEAR DEFINITION OF PROGRAM OBJECTIVES, PRODUCE SCHEDULE REALISM AND APPLY APPROPRIATE INCENTIVES. (PRIMARY CONSIDERATION AT MILESTONE II)

  - UPON COMMENCEMENT OF FSED, SCHEDULE SHOULD BE CONSIDERED AS THE DOMINANT PROGRAM DRIVER AND THE PROGRAM FUNDED ACCORDINGLY (MILESTONE II)

  - IN THE EVENT THAT OPERATIONAL REQUIREMENTS WARRANT CHANGE, BLOCK CHANGES SHOULD BE PRIMARY SOLUTION.

Military departments should be required to establish and maintain a clear line of authority and accountability between the program manager and a major authority figure, who the panel has labeled the "surrogate CEO". The surrogate CEO should be in a position that has control of resources and has the authority to protect the program manager from many outside staff pressures. Different programs would have the surrogate CEO at different levels. It may be as high as the Chief or the Secretariat level. The panel recommends trying this out on a few new programs. Similiar programs should be assigned to the same CEO sponsor. The system will certainly need the blessing of the Secretary of Defense if it is going to be effective.

For effective program management and execution, the panel feels that the number of people now allowed to participate in the decision process must be reduced. This can be partially accomplished by reducing the number of layers that the program manager now reports through before he can reach the surrogate CEO. To strengthen a program manager's position, a contract should be agreed upon between the program manager and the surrogate CEO reaffirming the PM's responsibility for all aspects of program execution. Anyone who challenges the program manager's decisions must deal with the CEO.

RECOMMENDATIONS

- REQUIRE THE MILITARY DEPARTMENTS TO ENSURE CLEAR LINES OF ACCOUNTABILITY AND AUTHORITY BETWEEN A SURROGATE CEO AND THE DEVELOPING ACTIVITY FOR PROGRAM MANAGEMENT AND EXECUTION
  - REDUCE THE NUMBER OF PEOPLE ALLOWED TO PARTICIPATE IN THE DECISION PROCESS AND REDUCE THE NUMBER OF LAYERS THROUGH WHICH THE PM REPORTS.
  - REAFFIRM DEVELOPING ACTIVITY/PM RESPONSIBILITY FOR ALL ASPECTS OF PROGRAM EXECUTION
  - PROVIDE PM'S DIRECT ACCESS TO A SURROGATE CEO WHO HAS REQUISITE DECISION AUTHORITY AND CONTROL OF RESOURCES.
- SECDEF TAKE CORRESPONDING ACTION TO HELP MILITARY DEPARTMENTS REDUCE EXCESSIVE PROGRAM REVIEW.

The CINCs represent the most knowledgeable user community. OSD and the services must strive to bring the CINC's inputs into their decisions on long range development needs and into the operational capability/cost/risk trades being performed during the development process. The CINCs in turn must be required to engage in longer range force development planning to make their inputs to the resource allocation and systems acquisition processes more useful. They must remain in the loop as cost/capability trades are made during development.

DSB

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS

RECOMMENDATIONS

- SECDEF/JCS EXPAND THE ROLE OF THE CINCs IN THE OVERALL DOD GUIDANCE AND REQUIREMENTS PROCESS
  - REQUIRE LONG TERM (10 YRS) FORCE DEVELOPMENT PLANNING.
  - STAFF AND FUND CINCs (COMMENSURATE WITH MISSION/AREAS) TO MAINTAIN COGNIZANCE OF PROGRAMS AND BUDGET PRIORITIES AND TRADEOFFS
  - AUTHORIZE A TECHNICAL ADVISOR
- SECDEF DIRECT DEPARTMENTS AND AGENCIES TO OBTAIN CINC REVIEW AND COMMENT ON REQUIREMENTS AND PROGRAMS AFFECTING THEIR COMMANDS
  - IN TIMING - TECHNOLOGY - TOTALS
  - IN PRIORITIES AND TRADEOFFS
  - INTEROPERABILITY VALIDATIONS

CLOSING COMMENTS

This summer study focused on five commercial case studies, twenty-six military cases, testimony from the CINCs, the services and OSD. Supplemented by the program experiences of the panel members, it was recognized that some key symptoms were prevalent in the procurement cases that continued to experience problems. Overstated requirements were frozen early in the program, the users were not active in the requirements' iteration process, there was no early involvement of the Program Manager in the requirements process, and there is no clear, short communication lines between the Program Manager and superiors with financial and key decision making authority.

The Board's recommendations will not be easy to implement in the real world of the present procurement environment. Congress has some of the authority held by the commercial CEO. No service or OSD official has sufficient authority to fully mirror a CEO's role. Oversight staff is growing instead of being reduced and controlled. Program managers are brought in late in the requirements generation process, are sometimes buried deep in the organizations, aren't encouraged to trade performance requirements against schedule slippage or cost growth, and do not stay long enough to see the development to its completion. There are so many organizations involved with accountability its hard to think that anyone can be truly held accountable.

The Board understands that fully implementing our recommendations will be difficult, but the obstacles are not insurmountable. The climate within Congress and DOD is ameniable to change. All the involved parties are striving to make the system more effective. As steps are taken to implement the positive lessons learned from this study, improvements can be expected. With continuing effort the system can be improved.

THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301-3010

RESEARCH AND ENGINEERING

22 MAY 1985

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Defense Science Board Summer Study on Practical Functional Performance Requirements

You are requested to convene a Defense Science Board Summer Study on weapon systems functional performance requirements.

Inherent program costs are driven by technical functional performance requirements, e.g., maximum speed, accuracy, etc. System technical performance requirements are often fixed before cost and schedule implications are well understood. Although the Services are responsible for establishing overall military requirements needed to meet the threat , these requirements may be met by various combinations of the technical performance parameters, which will result in different program costs, schedules and risks.

This Summer Study should address, but not be limited to, the following questions:

1. What is the impact of the process for establishing military system functional performance requirements on program cost and schedule, and what improvements can be made to ensure stated technical performance requirements are based on trade-offs to better optimize system performance, operability, supportability, cost, and schedule? In particular, what should be done to ensure sensitivity studies and "marginal returns" evaluations are integrated into the process for establishing system technical functional performance requirements?

2. Is it feasible to establish initial program technical performance "requirements" as goals or "quasi-requirements" during the concept and early development phases of programs, and establish firm performance requirements only after advanced development has provided the information needed to establish cost, schedule and technical risks with high confidence? If so, what changes need to be made to make this happen?

3. What is the impact of the operational user (e.g., the CINCs), in establishing weapon system performance "requirements" and what can be done to improve user impact?

The process for establishing subsystem and component technical performance requirements should also be addressed. The study should consider the implications of the Pre-Planned Product Improvement (P^3/I) initiative on the process for establishing performance requirements. Specific comparisons of the system performance requirements and definition processes used in several large commercial aerospace and electronics programs with those used in similar military programs should be made to reveal good approaches from the commercial sector.

This Summer Study is sponsored by the USDRE. Mr. Robert A. Fuhrman has agreed to serve as Chairman of the Task Force and Mr. John E. Smith, Director, Major Systems Acquisition, OUSDRE, will be the Executive Secretary. Lt. Colonel Herbert R. Vadney, USAF will be the DSB Secretariat Representative. It is not anticipated that your inquiry will need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. Code.

Jim Wade

James P. Wade, Jr.
Acting

PRACTICAL FUNCTIONAL PERFORMANCE REQUIREMENTS
PANEL MEMBERSHIP

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Group President
Lockheed Missiles, Space and
Electronics Systems Group

Norman R. Augustine, Vice Chairman
Senior Vice President
Martin-Marietta Corporation

LtCol Herbert R. Vadney
Defense Science Board Representative

John E. Smith, Executive Secretary
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James O'Brien, USA

Daniel A. Ruskin
Vice President-Government Requirements
Lockheed Missiles, Space and
Electronics Systems Group

Col Stan Sheldon, USAF (OJCS)

SUMMER STUDY PRESENTATION AGENDAS

June 19, 1985 - Pentagon

Navy Requirements Process	R/Adm. John T. Parker Dep. Director, RDT&E (OP98) Staff, Chief Naval Ops
Air Force Requirements Process	M/Gen.H.J.M.(Mac) Williams Director, Operational Rqmts Air Force DCS/RDA
Army Requirements Process	Jack Harris Headquarters, TRADOC Systems Mgt. Director Army DCS/Combat Development
Marine Corps Requirements Process	L/C E.C. Brown DCS/Research, Dev.& Studies Headquarters, Marine Corps.
Policy-Front End Acqusition Process	John E. Smith Director, Major Systems Acquisition, USDRE
Joint Requirements and Management Board	M/Gen. H.L. Olson Director, Strategic Plans & Resource Analy., JCS
USDRE and DSARC Process	Dr. James Wade USDRE (Acting)
DRB/PBRS and OSD Role	Dr. David Chu DRB Executive Secretary

July 16, 1985 - Sunnyvale, California

Satellite Laser Communications Program Requirements-An Example	Cmdr. Ralph Chatham Laser Satellite Comm. Program PM, DARPA
Commercial Case Review	Peter Bohacet, AT&T Frank Willingham, MITRE Kenneth Homon, SBS Row Brown, Boeing Al Babbitt, IBM
Army Accelerated Procurement	M/Gen. R. Hammond Headquarters, Army Material Command

July 29, 1985 - San Diego

Army Procurement	James Ambrose Undersecretary of Army

July 30, 1985 - San Diego

Air Force Requirements Examples	Col. Winslow E. Reither Headquarters, USAF/RDQ
Twenty Six Military Cases	Richard Schwartz IDA
USSR Requirements Process	Allen Carley CIA

July 31, 1985 - San Diego

Air Force Procurement	B/Gen. Gerry Schwankl Headquarters, USAF/RDA
Navy Procurement	R/Adm. J.B. Wilkinson Vice Commander, Naval Air Systems Command
Navy Requirements Examples	Capt. Bruce C. Marshall Capt. Ern Lewis Naval Air Systems Command
CINC Perspective	Gen. R. Herres CINC NORAD/Space

August 1, 1985 - San Diego

Army Requirements Examples	M/Gen. R. Hammond Headquarters, Army Material Command
Navy Requirements Examples	Capt. R. Welborn Program Manager PMS406 - SYSCOM

SYSTEM MODELS

A review of the case studies indicates that there are two general models of the acquisition process, one of which characterizes the commercial process (at least for the successful programs studied) and one which characterizes the DoD process (at least for the unsuccessful programs studied). We do not want to imply that all commercial programs are alike or are successful, nor do we imply that all DoD programs are alike or unsuccessful. We do see certain fundamental differences and believe that the closer a program is to the "Commercial Model" the more likely it is to succeed and the closer it is to the "Government Model" the more likely it is to fail.

The Commercial Model is shown in Figure 1. There are three major players, a Program Manager or PM who does the work, a Chief Executive Officer or CEO who makes the major decisions and a user or group of users who decide the ultimate success or failure of the program. There are many minor players, of course, including inside staffs, government regulators, consumerists, etc., but one of the major advantages of the Commercial Model is that the minor players play a minor role.

The first step in the model is for the PM to put together a realistic proposal for the CEO to consider. The PM knows what resources and what technologies are available, backed where

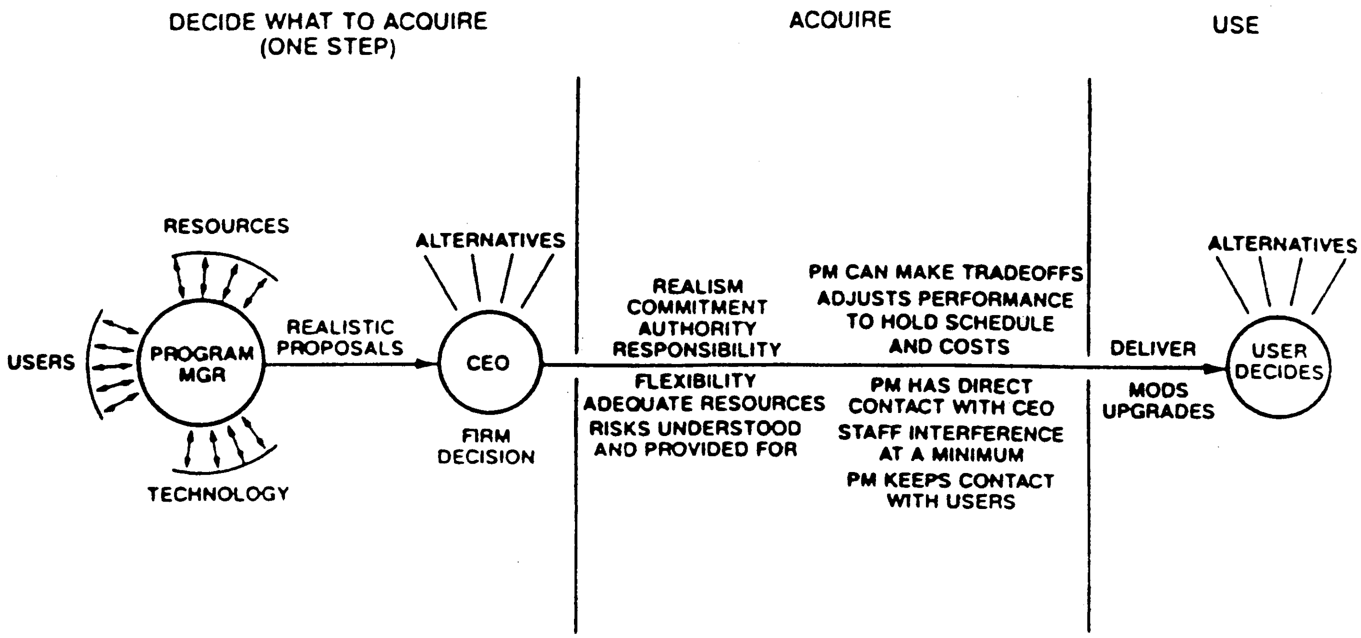

Figure 1. COMMERCIAL MODEL

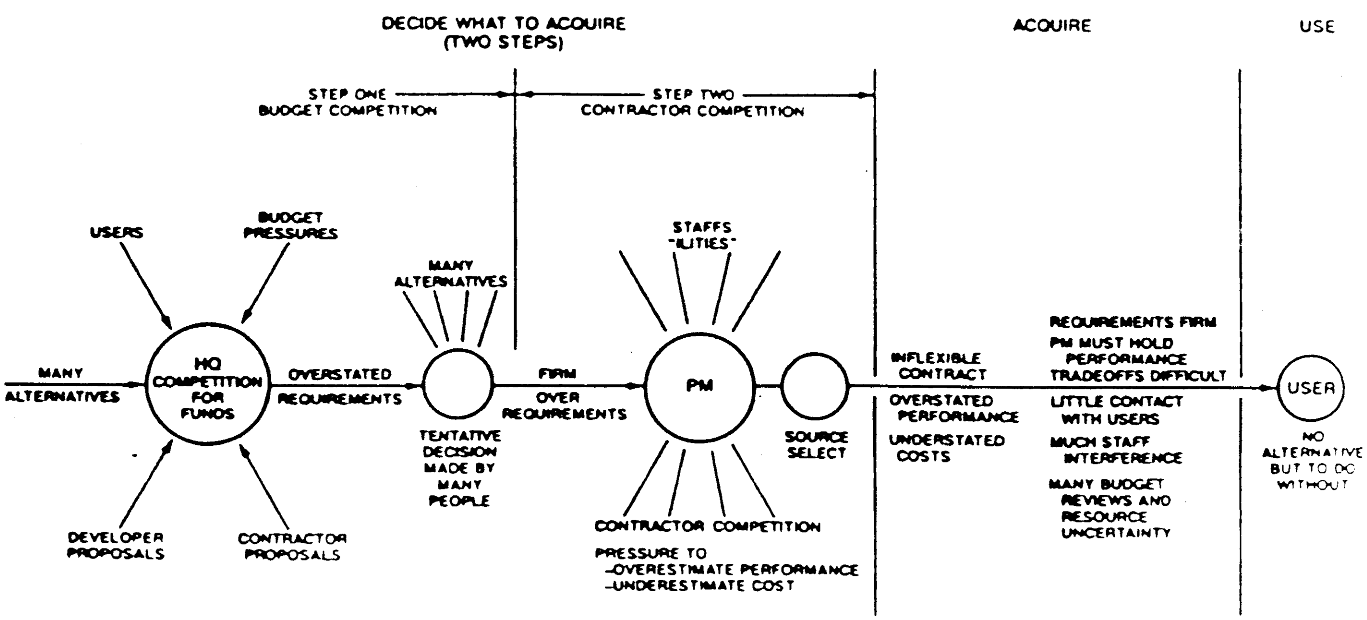

Figure 2. DOD MODEL

necessary with company R&D funds. The PM pays a lot of attention to the users wants and needs because he knows that they will eventually decide whether or not to buy. How he involves the users is up to him but involve them he must if he is to succeed. The PM is motivated to be realistic about performance, cost and schedule, both because he will have to carry out the program if it is approved and because his job is dependent on the merits of his proposal and not simply on whether it is accepted.

The CEO has clear cut decision authority. He may have to deal with Boards of Directors, bankers, etc., but they are just elements of his problem. He must decide whether or not to proceed and his decision must stick. The CEO has alternatives to proceeding; he can send the proposal back for redo or he can cancel the program and put his resources somewhere else. His future depends on whether programs he approves are ultimately successful, not on whether or not he goes ahead with them.

The CEO and the PM must have a close working relationship, direct access to each other, and mutual trust. The CEO can have, and probably will have, advice from many others which he can take into account or not, as he wishes.

A decision to proceed is a firm decision based on a realistic commitment on the part of both the CEO and PM. This commitment involves a clear agreement on authority, responsibility and flexibilty, an understanding of the risks involved and an agreement on the resources to be made available, including adequate resources to cope with contingencies. In turn the PM commits himself to performance, cost and schedule. Note that the process of reaching this decision is really a single step although it may be lengthy and expensive and go through many iterations.

The acquisition of a complex system involves many uncertainties. The PM copes with these in two ways. First, he has some flexibility in performance goals and second, he has some resources to reduce these uncertainties and to cover contingencies. In general he holds schedules and relaxes performance if he must, both because timing is important in a competitive market and because holding schedule tends to hold cost. If he gets in trouble he goes back to the CEO who can grant additional resources of time or money or can adjust performance goals. If things get too far out of line and the CEO decides the program no longer makes sense, he can cancel.

Once again the CEO and the PM must have a close working relationship. The CEO must be kept informed and the PM must be able to get help rapidly and reliably if he needs it. The principle is one of a joint activity toward a common goal. A program failure is a failure of both CEO and PM.

The staffs and inspectors, test groups and ilities groups exist, but are insulated from the PM by the CEO. The staffs can talk to the PM and comment and advise but cannot direct the PM without going through the CEO. Only the PM and the CEO can make decisions; they have the responsibility and therefore the authority.

When the development is complete, the product is produced and delivered to the users. It is fundamental to the model that the users have alternatives to buying the product. They can buy from a different source or spend their money in some entirely different way. This user choice, or competitive market, is what really makes the system work. The CEO/PM combination must seriously consider the users wants and needs, must make realistic plans and commitments, must hold to costs and schedules, must fend off the nit-pickers and keep the program under control or they cannot hope to sell it in the end.

The DoD Model is shown in Figure 2. There are many more people involved, they have far less continuity of position, and they have different and sometimes conflicting degrees of authority, responsibility, and interests.

The DoD process for reaching agreement on what is to be acquired really involves two steps. It begins with a competition for funds, carried out in a highly political environment involving the services, OSD, OMB, and the Congress. There are many alternative uses for the funds proposed by both government and industry for similar and different products. There are great pressures to overpromise in order to survive the competition. Since the decisions are made by political processes among a large and diverse group of people, there is little presssure to discipline the process and to enforce realism. Clear-cut designs to meet the requirements are not allowed because they would interfere with the next step -- competitive source selection. The result is a firm over-stated requirement which too frequently can neither be met nor changed.

Note that in this second model there is no equivalent to the commercial CEO. Although the DoD is nominally a hierarchical authoritative organization, it is very difficult in a democracy for anyone to make a controversial decision stick. The successful commercial programs we looked at were of great importance to the companies involved and therefore to the CEO. There is hardly any single program in DoD of equivalent importance to Service Secretaries, let alone to the Secretary of Defense. DoD has too many important programs for such officials to keep track of them in detail.

The second step is to hold a competition among potential suppliers. The requirement is firm and difficult or impossible to meet, and the contractors are under great pressure to overestimate what they can do and to underestimate what it will cost. Although the requirement is firm, the decision to proceed with the program is not. The losing players in the first step are still around and hoping for another chance. It is difficult for the PM to be realistic and he has no CEO to help him.

The result is an inflexible contract with inadequate resources, overstated performance goals, and concealed risks. The PM has little ability to cope with the inevitable troubles. He tends to keep these to himself because reporting them gets him much attention and little help. When the trouble gets so bad that it can no longer be kept quiet, it is extremely expensive to fix.

Staffs and ilities groups are numerous and continually harass the PM who has little protection from them. Many of them were established in the hope of preventing past troubles and have authority to interfere but no responsibility for getting out a product. Although the PM's commitments up are firm, commitments down are not, and changes in funding are common. The PM is usually forced to hold performance constant so trouble results in slipping schedules and rising costs.

Eventually, after much difficulty, the product reaches the user. The situation is now reversed; the PM has the advantage because the user has no alternative but to accept it or do without. The more fuss the user makes about the product, the longer it will take to fix it, the more it will cost and the fewer he will get. The user's ability to influence the design is limited throughout the process. It is probably greatest in the fist stage, depending on how much political influence the user has and is willing to expend. His influence gets less as time goes on.

We would hardly claim that all DoD programs go according to this model. We all know of successful high priority programs that have avoided many of these difficulties. Yet it is obvious that successful programs tend to be like the Commercial Model which is driven by market forces, rather than like the Government Model which is not. To improve the DoD process, we should move it toward the Commercial Model insofar as that is possible.

Unfortunately, normal human reactions are in the opposite direction. Bad prior decisions lead to adding more people to the decision process, which is exactly the wrong thing to do. As a general rule, the more people involved, the worse the decision. Any person or group added to the current process, no matter how able and motivated, will make things worse. We need fewer people in the decision process, not more.

Inefficiencies and high costs lead to demands for more competition, but competitions in promises do not help. The two-step process creates a separation between the funding decision and the source-selection or design decision makes it extremely difficult to get a realistic match between requirements, costs, and schedules. In many cases, less formal, but no less real competitions earlier in the process would help.

Missed goals lead to demands for firmer contracts within DoD, and between DoD and industry, but there is now inadequate flexibility to cope with troubles, and still less flexibility will only make matters worse.

Unsatisfactory performance in the field leads to demands for more operational test and evaluation, but OT&E will not help the user if he has no alternatives. The lack of user alternatives leads to lack of user influence, which leads to lack of realism throughout the process.

What should we do? We could start by not making things worse. We could review the current process and make it more like the Commercial Model where we can. In particular, we could provide for clear-cut personal accountability for results and less obeisance to the letter of procedures. In addition, we could reduce the number of people in the decision chain by establishing Surrogate CEOs with the authority and responsibility to play the role of their commercial counterparts. We could give the PM more flexibility to adjust performance to hold to schedules and costs. We could find ways to involve users more throughout the acquisition process and to give them alternatives and the chance to say that they will not accept a product. None of these are easy; but they would at least be in the right direction.

Surrogate CEOs

As discussed above, one of the striking differences between the Commercial and the Government Models is the role of the CEO. There is no equivalent to the CEO in the DoD. There are many important programs in DoD and many important people. No one person has the authority to make firm decisions. Decisions are made by a large, diffuse group that acts something like an extended committee and that lacks clear-cut responsiblity and accountability. The DoD itself exists in a political environment that further smears out the decision making process. As a result, decision-making is lengthy and uncertain. The players change and the decisions tend to change with them. The Program Manager is separated from the top level of the DoD by many intermediate layers, all of whom must be dealt with, none of whom can say yes, but most of whom can say no. Decisions are late, inconsistent, and untrustworthy.

The Commercial Model demonstrates that both an accountable PM and a CEO who can make firm decisions are needed. Increasing the authority of the PM alone will not solve the problem. Attempts to streamline the process and to connect the PM more directly to the top of the DoD have not been successful except in extraordinary cases. There are too many programs for the top level to understand in detail. They must rely on their staffs and authority rediffuses in the bureaucracy.

The Task Force suggests establishing what we have called Surrogate CEOs. These are individuals who have been delegated authority and responsiblity to act as decision-makers for one or a few programs. The PMs should report directly to them on program matters. The Surrogate CEO should make decisions on matters for which he has authority, insulate his PMs from the staffs, and deal with upper echelons as necessary. His success will depend on how much authority he really has, to adjust performance and schedule, provide additional resources if needed, make or approve tradeoffs. If he is responsible for only a single program or for a group of separate programs, his ability to provide resources will be limited. If he has responsibility for a group of related programs he could tradeoff among them and could be more effective. Too often today, what we call systems do not provide any military capability in themselves. They are only components of larger systems which are often left undefined. A Surrogate CEO with a group of related programs might be able to help develop real military capability in his assigned area.

It is not of first importance where the Surrogate CEO sits in the hierarchy. The important things are that the Surrogate CEO should have appropriate background and the confidence of the community so that he can, in fact, be delegated adequate authority, and that he have few enough programs under him so that he can understand and keep adequate track of each in addition to his other respoonsibilities (in general, Surrogate CEO is not his full time job).

A supervisor or commander in the current DoD structure is not equivalent to a Surrogate CEO because he does not have the necessary delegated authority. In general, the commander of a development organization is a kind of super PM whose superior rank and experience can be used to assist the PMs under his direction, and who can assign and organize the people resources available to him. He does not have any more authority over performance, cost, and schedule of his programs than his PMs do. He cannot transfer funds among programs and he has almost no discretionary money under his control. His control of staff and monitoring groups is minimal. He is overcommitted and has almost no flexibility.

If, in spite of these drawbacks, commanders of development agencies were asked to act as Surrogate CEOs, it probably would avoid confusion about who the PM reports to. However, a commander of a large organization cannot act as Surrogate CEO for more than a few programs, and he would have to recognize that he would have subordinates who are Surrogate CEOs for other programs over which the he has no program authority. This points out the essence of the Surrogate CEO idea, which is not that PM reports to him, but that he has been delegated the authority to make decisions about the program. The law of conservation of authority says that this delegated authority must come from somewhere and it must come, in fact, from the Surrogate CEO's superiors and from the staffs and regulatory bodies in the government. These people, in the manner of all human beings, will resist giving up authority even when they understand that their previous activities have been harmful rather than helpful. Delegation must begin at the top. If the most senior people will really delegate their authority and insist that it be further delegated to Surrogate CEOs, there is a chance the idea will succeed. There will still be plenty of other things for the senior people to do.

A COMPARISON OF THE U.S. AND SOVIET MAJOR MILITARY SYSTEMS ACQUISITION PROCESSES

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There is a logical sequence of research, requirement, design engineering, development and test phases that is followed by the U.S. and the USSR in the acquisition of a major military system. It follows that there are similarities in the processes each country uses to acquire its new and modernized systems. On the other hand, there are differing economic, industrial, management, and incentive systems in the U.S. and the USSR that have resulted in different approaches in National management and budgeting, and system design, management and style. The following sections highlight the major similarities and differences found during this study.

SIMILARITIES

Both the U.S. and the USSR have standardized systematic military system acquisition processes, and although the structures or phases of the processes may differ, they are functionally very similar. Features that are similar in each process are:

- A research base of developing technologies to be used in weapon system development.
- Top management review and decision concerning a major military system development phase before proceeding to the next phase.
- Formal documentation for each major phase and written top level approval to proceed to invest resources for the next phase.
- Rigorous testing during all phases of development.
- Full Scale Development (FSD) time for major weapon systems is similar in the U.S. and USSR.

DIFFERENCES

The principal differences between the U.S. and USSR acquisition processes in the major areas noted previously.

- National Management and Budgeting

  - The Soviets have an established top level national weapons oversight organization, the Military Industrial Commission (VPK), that combines certain functions performed in the U.S. by the Department of Defense (DOD) and the Congress, as well as some functions of the private industrial sector. Each major program phase decision is staffed through the VPK which reports to the Council of Ministers, and is documented in Joint Decrees of the Council of Ministers which have the authority of law.

  - The major development decision made to approve the resources required to proceed with Full Scale Development is the Defense Systems Acquisition Review Council Milestone II (DSARC II) in the U.S., and in the Soviet Union it is the Joint Decree of the Central Committee of the Communist Party and the Council of Ministers. This is the first, and possibly only, major approval of the Soviet Union whereas it is the second of three major approvals in the U.S.

  - U.S. resource commitments for defense programs are revisited on a yearly basis because of Congressional approval requirements, while Soviet resources are committed for the full program once directed by the issuance of a Joint Decree.

  - A major segment of Soviet industry is dedicated to defense work, maintains full employment, and has top national priority on national resources; whereas U.S. defense contractors must compete for business in market conditions that have wide variations.

  - The top level people involved in major weapon acquisition decision-making remain in their positions much longer in the USSR than in the U.S.

  - As a result, Soviet major military development programs tend to be much more stable than U.S. development programs.

- System Design Management and Style

  - Higher Soviet program security makes it more difficult for both other Soviet organizations and the U.S. to take advantage of Soviet knowledge and developments.

  - The USSR has separate design and production organizations; in the U.S. the functions are generally integral to single contractors.

- The top priority of Soviet programs is to meet a preset program schedules; while the top priority of U.S. programs is technical performance in order to win contracts.

- The U.S. tends to use new technology for each new system to provide maximum technical performance; the Soviets emphasize extensive use of technology transfer to keep pace with the technology in threat systems, and use off-the-shelf components for producibility considerations to help meet the program schedule.

- Technology freeze occurs in the USSR programs about the time the Experimental Design Work (OKR) Development Phase (Full Scale Development) begins; while it is years later in the middle of Full-Scale Development in U.S. programs, as a result of the above priorities.

- There is greater use of product improvements in the USSR, proceeding in parallel with new developments. This reduces the need for the Soviets to push technology in each development program since if the next program doesn't achieve desired performance, the one starting a few years later will come closer. In addition, the phasing of product improvements and new system developments allows full employment to be maintained and effectively used at the major design bureaus.