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DEFENSE SCIENCE
BOARD

MEMORANDUM FOR THE SECRETARY OF DEFENSE
DEPUTY SECRETARY OF DEFENSE
UNDER SECRETARY OF DEFENSE (ACQUISITION)

SUBJECT: Executive Summary of Defense Science Board 1990 Summer Study on "Research & Development Strategy for the 1990's"

We are pleased to submit the Executive Summary of the Defense Science Board 1990 Summer Study which we briefed to you on August 8, 1990. The Study was conducted to assist the Department of Defense in defining an RDT&E Strategy responsive to future DoD objectives. We appreciate the confidence you displayed in the Board by charging us with this important and challenging task and we believe our product is responsive to your tasking. In order to assist DoD planning to cope with future uncertainties in a changing World, the report recommends new regional planning scenarios, suggests changes in our intelligence capabilities, emphasizes high leverage strategic and tactical capabilities that should be acquired, identifies high leverage technologies, and emphasizes the need for a new manufacturing strategy and the importance of the associated processes. Needed changes to technology transfer policies are recommended. The Board found that DoD efforts to attract and retain the high quality human resources, especially the civilians and Presidential Appointees to whom we entrust our R&D program, need a higher level of management attention, equal to the emphasis we now place on managing our fiscal resources.

It is likely that the hardest part of the Study lies ahead... selecting those recommendations or variations which are viable and critical to achieving your goals and then developing the implementation plan. That is now under way and we'll continue to help.

If you desire further dialogue, we are available to assist as necessary.

John S. Foster, Jr.
Chairman

RDT&E Strategy Integration	Norman R. Augustine	
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Strategic & C^3	James R. Burnett	Stephen J. Lukasik
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Technology & Technology Transfer Policy	George H. Heilmeier	Jacques S. Gansler

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PREFACE

The Defense Science Board 1990 Summer Study met in response to a charge from the Secretary of Defense to consider "what should be the DoD's technology strategy and thrust in the 1990s to meet the challenges of the next two decades." The study was organized into five task forces:

- Scenarios and Intelligence
- Strategic Forces and Supporting C^3
- Tactical Forces and Supporting C^3
- Technology and Technology Transfer
- Steering and Integration.

The study methodology deliberately built in a degree of overlap in the scope of each task force, so as to ensure that important issues were considered from several points of view. The steering and integration group ensured that these perspectives were shared among all the participants.

This executive summary presents the major findings and recommendations of the summer study, and is organized as follows:

- Principal Recommendations of the Summer Study;
- Key Findings is a summary of the major issues developed by the Task Forces in light of the future world environment;
- Task Force findings are an executive level summary of the individual Task Force reports. These reports will be separately issued in their entirety and should be consulted for detailed findings and recommendations;
  - Task Force recommendations have been organized in priority order by Task Force.

PRINCIPAL RECOMMENDATIONS

1. Establish a "CEO" for technology, with the responsibility to develop and implement an R&D strategy that responds to a future characterized by lower budgets, fewer opportunities for new starts, and more uncertainty about future adversaries.

   a. Establish a fast-track initiative with the intent of: 1) making many more fieldable component and system prototypes available quickly to stimulate real world use and feedback, and 2) retaining critical design teams that would otherwise be lost with fewer new starts:

      - Identify a few candidate systems and assign a single individual to establish the fast-track process.

   b. Place special emphasis on technology insertion to upgrade performance and keep old platforms current:

      - Ensure that acquisition regulations give preference to upgrades of existing platforms/major systems.

      - Require demonstration of breakthrough/leap-frog capability (primarily from prior fieldable prototypes) before approving major system new starts.

   c. Maintain our ability to generate new technology:

      - Implement a scenario based methodology to objectively allocate funds to core and critical technologies;

      - Assure needed S&T funding, including IR&D.

   d. Exploit civil technology for defense purposes:

      - Remove barriers to the DoD use of off-the-shelf civilian technology and advocate its use;

      - Establish criteria for identification of critical defense industry technologies and develop strategies to preserve access to them.

   e. Develop the means to produce small quantities of hardware efficiently, while preserving surge potential:

      - Identify several prototype initiatives, and assign responsibility;

      - Increase the resources and management attention devoted to manufacturing technology, and encourage the use of IR&D resources in this area.

2. Recognize the significance of stealth/counterstealth technology as one of the major breakthroughs of this quarter century:

- Take full advantage of low observable technology and make modifications where possible to give our forces both offensive and defensive edges;

- Give high priority to counterstealth in view of the proliferation of low observable technology.

3. Ease of deployability should be a major criterion for all tactical systems:

- Demonstration of system/lift compatibility should be mandatory, and highly capable light forces should be developed to complement heavy forces.

4. Re-orient strategic programs and continue force modernization to meet the challenge of the restructured world—numerically reduced US/Soviet forces, increasing Third World nuclear threat:

- Create more flexibility in planning the use of strategic forces;

- Maintain the triad for the foreseeable future but with a single RV silo-based replacement for Minuteman II (preserve R&D options for a mobile ICBM);

- Develop a strategic defenses option effective against small attacks (tens of warheads), and seek allied participation;

- Develop new nuclear weapons that are safe and reliable in a low or no-test environment.

5. Reprioritize intelligence needs and resources guided by the following principles: strengthening the ability to provide worldwide intelligence; and, seeking more efficiency and productivity in the worldwide intelligence workforce.

- Use of an integrated military-civilian intelligence "reserve force."

6. **The Department of Defense should initiate policies to attract and retain the most capable people available to provide the underpinnings for the above recommendations.**

I. Key Findings

• **New World Emerging**. The changes now occurring in the world are the most fundamental to occur since the end of World War II. Planning for the next several decades must proceed on the basis of "new thinking" reflecting these global trends:

- The collapse of communism and turning inward of the Soviet Union;
- An increasingly multipolar security environment;
- Economic/industrial reordering, leading to shifting allegiances;
- The perception of a declining threat driving declining defense budgets; yet -
- Persisting regional conflicts more lethal than in the past.

Alternative futures should drive defense planning -- not a single "likely" scenario.

• **Historic Opportunity to Plan for Most Likely Cases**. This "new world" represents a major challenge: dealing with greater uncertainty with fewer resources. But it also represents an historic opportunity: to shape our future capabilities to deal with the most likely future situations - regional conflicts - and to deal with the possible future re-emergence of a Soviet threat by establishing the potential for reconstitution of capability.

• **Intelligence Community Must Change**. The new world presents a major challenge to the intelligence community. There is clearly a need to reprioritize our collection capability and analysis to reflect changed global trends. This in turn presents the opportunity to restructure the community to make it more effective and efficient. The changes needed are so fundamental that an extraordinary structural change and management effort will be required.

• **Slow/Refocus Nuclear Modernization**. Strategic force levels will decline sharply in the next two decades (perhaps to 3 - 4000 U.S./ Soviet warheads by the year 2010). The Triad and a highly robust strategic C^3 system will be needed for the indefinite future, but the pace of modernization can be slowed substantially. The reduced warhead levels makes silo basing more viable, and will allow land-based mobility concepts to be kept as R&D options. Future nuclear warhead designs should emphasize greatly enhanced safety and reliability - looking towards a potential no-test environment. A critical problem will be the preservation of the R&D base and key nuclear design teams. Even here, there is an historic opportunity to restructure the DoE nuclear weapons complex to reflect reduced future needs, but this will require continuing high level DoD involvement.

• **Need for Light Strategic Defense**. The prospect of growth in third world nuclear weapons (10's of weapons possessed by up to ten countries) and delivery systems calls for a new concept of "defensive deterrence." Reduced offensive forces should be balanced with an effective defense against light attack. A multinational approach with U.S. space-based sensors providing targeting data for allied ground-based interceptors is a concept that makes sense in the new world.

• **Third World Threats Should Drive Tactical Forces R&D**. Tactical Forces development must now focus on Third World trends, which reflect increasing proliferation of high technology capabilities such as: low observables, IR SAM's, advanced armor, and even sophisticated C^3I. Because proliferation is occurring widely, the specific theater of likely tactical force employment is growing more ambiguous and future forces must be highly flexible and adaptable. Among the most important tactical capability enhancements needed are:

- Surveillance (regional, to local commanders, continuous, real time);
- Capabilities to conduct precision strikes at long range with no collateral damage and no losses;
- Greatly improved force defenses (especially for ships against IR threats);
- Rapidly deployable forces that are also highly capable on arrival against sophisticated threats;
- ASW to deal with Third World submarines;
- Less manpower intensive, more reliable and less logistically demanding systems;
- Anti-tactical ballistic missile capability.

• **Stealth /Counterstealth Critical**. Low observable technology is the major development of this quarter century. The spectrum of stealth technology can and should be widely applied, through retrofit as well as new systems. Counterstealth (against proliferating low observable air vehicles) is an urgent requirement in the coming decade.

• **Different Technology Investment Strategy Needed**. An investment methodology can and should be developed that systematically ties military needs to capabilities, and capability inventories to resources. The methodology must balance investments in critical technologies that offer breakthrough potentials, core technologies which underpin our existing capabilities and manufacturing/process technologies. Implementation will require major management changes in the OSD, services, and JCS.

• **Revamp Technology Transfer**. Major changes are needed in technology transfer policies and its management with the objective of providing stronger controls over a much smaller list and incorporating third world proliferation concerns. Changes in global economic interdependence call for a new approach to assuring access to critical technology, with increased focus on the uncertain future as the Soviet Union and Warsaw Pact threat recedes.

• **DoD Must Act to Assure Technological Edge**. An uncertain future implies the need for an even larger menu of R&D options, which calls for protecting science and technology base funding, including IR&D, even as budgets decline. In addition to streamlining the current acquisition process (which is focused on major systems), DoD also needs new approaches to get technology into the field and preserve key design teams in the face of fewer new starts and an aging inventory. The commercial sector must be increasingly relied upon as a source of technology which can be aided by specific actions to remove barriers to civil/ military integration, and as the primary base for manufacturing surge. A new R&D investment strategy is needed.

II. Scenarios and Intelligence Task Force

1. Global Trends

All of the Task Forces, either independently or through interaction with the scenario task force, used the following as their main premises to develop and expand their task force findings and recommendations:

- The shrinkage of the external empire of the Soviet Union, especially in Eastern Europe, has profoundly eased world tensions and changed the nature of European security problems. The implosion of the internal empire of the Soviet Union promises to keep Soviet leaders preoccupied for some time to come, but also holds the seeds of other futures that would have negative security consequences for the West.

- Partly related to the collapse of communism is the shift from a bi-polar to a multi-polar security environment in which the relative influence of the United States is decreased, U.S. allies increasingly are pursuing policies independent of those of the United States, and economic concerns are receiving higher priority relative to military concerns. A major attribute of the greatly increased salience of economics is the reordering of trade and industrial shares among nations and the strong degree of global economic interdependence. At the same time, economic relationships are likely to become an increasing source of political tension and perhaps even conflict among nations.

- As a result of reduced tensions and greater demands of nonmilitary problems, many of the world's major powers, including the United States and the Soviet Union, are reducing their military forces. The East and West are continuing to pursue arms control agreements to codify these reductions and to make the evolution of the traditional security threats more predictable and safe.

- At the same time, a growing number of small and medium powers is acquiring highly capable weapon systems. Many of these lesser powers have leaders and political systems that are unstable, with less reluctance to use CW/BW and perhaps even nuclear weapons. Consequently, the likelihood of challenges to Western security interests from these well-armed lesser powers may increase.

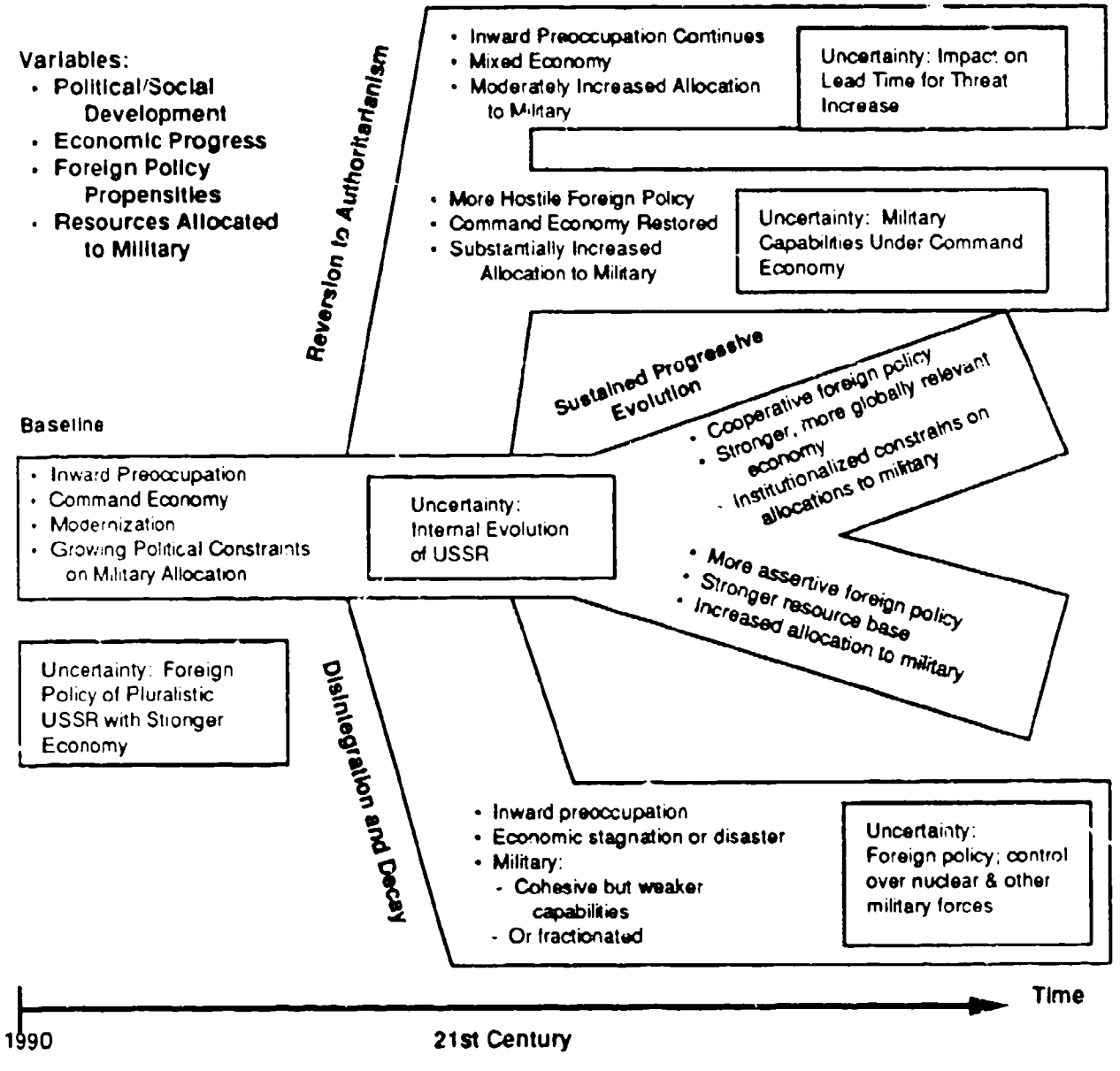
- Many nations are increasing the priority they accord to improving the global environment. This trend may reduce the resources available for defense in the Western nations and could also be a source of discord among nations.

- Finally, the implosion of the Soviet Union may actually release age-old ethnic, religious, and nationalistic tensions. Regional conflicts are **certain** to persist, potentially at an increasing level of lethality.

2. Principal Judgments Regarding Scenarios

The scenario task force developed a methodology for characterizing future alternative worlds by attempting to portray most likely events and then worst and best case scenarios from the most likely. The methodology diagrams have been included to give the reader a flavor for the work that went into developing them. The following paragraphs talk to the major judgments made by the scenario task force.

Figure 1: Excursions -- USSR



The baseline scenario for the Soviet Union projects Soviet and Warsaw Pact capabilities for large scale conventional aggression in Europe that are structurally weakened beyond near-term repair (see figure 1). This judgment results from (a) completed and pending Soviet conventional force reductions; (b) the collapse of the Warsaw Pact as a coherent military organization; (c) the eroding cohesiveness of Soviet society, a cohesiveness that would be necessary to support major and sustained belligerent action; and (d) the poor prospects for the Soviet economy, and the resulting pressure on Soviet defense expenditures and defense industrial base.

In the baseline scenario for Soviet evolution, the USSR develops over time into a pluralistic state with a strong, modern economy. The major uncertainty in this scenario is the foreign policy tendencies of this reconstituted future superpower—cooperative with U.S. interests or newly assertive. In one excursion from the baseline scenario, the Soviet Union reverts to authoritarianism. The principal uncertainties in this scenario are the foreign policy propensities of the regime (inwardly preoccupied and adverse to foreign adventures, or newly assertive and hostile) and the economic prospects of an entirely or largely command economy. In a second excursion from the baseline scenario, the USSR disintegrates internally into a number of necessarily weaker states.

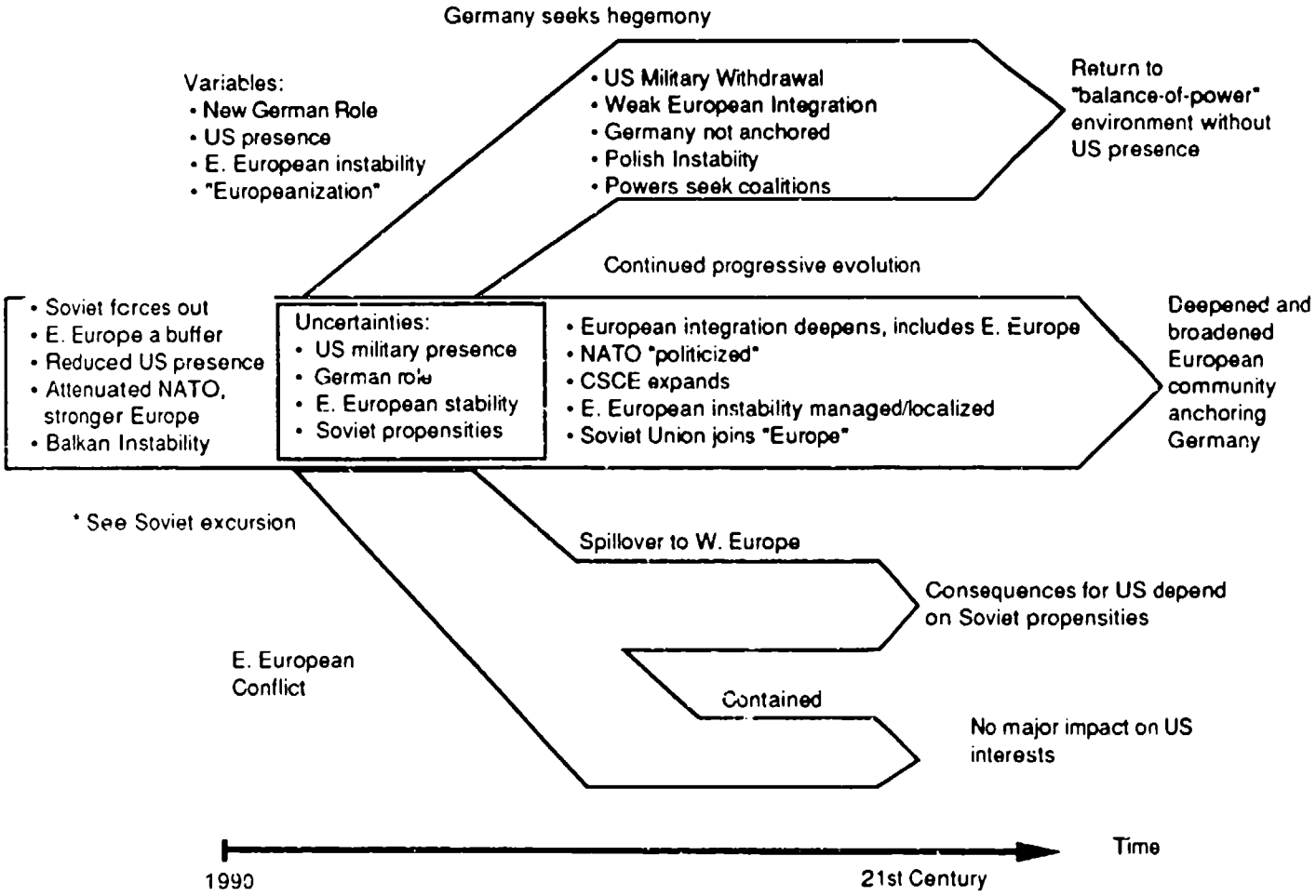
All three scenarios of Soviet evolution project a period of decreased Soviet conventional capabilities. In all three scenarios, reconstitution of the cold war level of the Soviet conventional threat could not occur soon, and all three would present comparable levels of warning and reaction time to the United States.

In the area of nuclear forces, Soviet capabilities are largely unchanged. In fact, Soviet strategic forces are undergoing modernization and, in land based missiles, a shift to mobile basing. Soviet forces will be reduced by START and, further in the future, by a possible START II agreement, but their strategic capabilities will not be qualitatively altered. The likelihood of nuclear war, on the other hand, has decreased for two reasons. First, the Soviet Union appears to have moderated its aggressive intentions, to have set in motion an internal process of demilitarization, and to be showing a greater awareness of its stake in the international status quo. Second, the diminished prospects for large scale conventional war in Europe eliminate the most likely path to U.S.-Soviet nuclear war.

There is a growing likelihood that the United States and the Soviet Union will find their interests converging in scenarios of interest, e.g., in relation to the proliferation of sophisticated weapons around the world. This evolution opens up a new domain of opportunity for U.S.-Soviet security cooperation.

A number of non-Soviet superpower threats involving Western Europe, Japan, China, or India can be imagined for the far-term future, but in each case a lengthy evolution would be required for the threat to emerge, during which the United States could reconstitute a large standing conventional force. For Europe, the necessary evolution would be largely political; for Japan, political and military; and for China and India, economic and military (see Figures 2 and 3).

Figure 2: Excursions - Europe



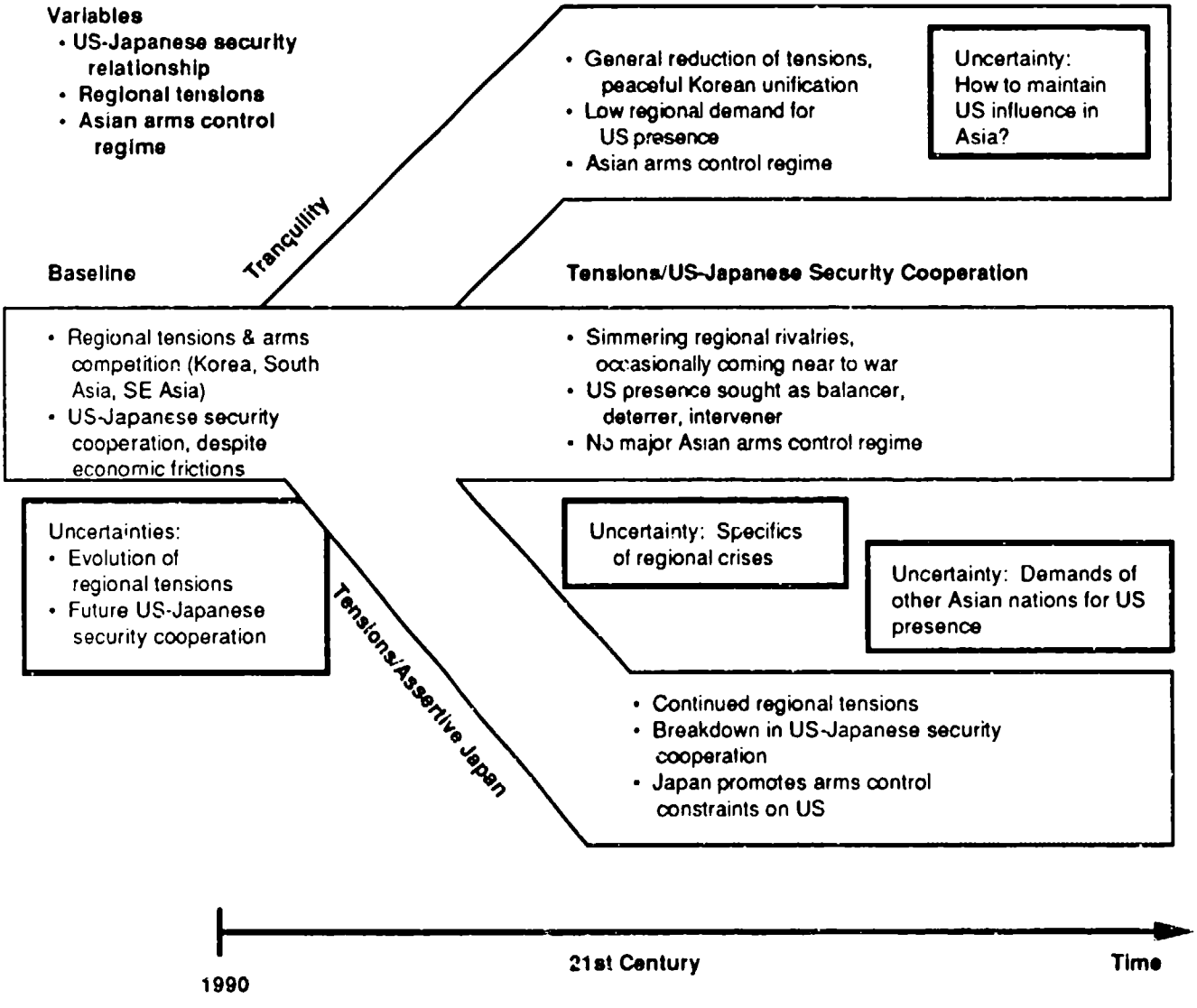
In virtually every region of the globe, contingencies can be identified that might call for U.S. military action in the near term, though on a scale much smaller than the cold war Soviet threat. These contingencies include fairly large interventions on behalf of important American interests or allies (e.g., countering an Iraqi invasion of Saudi Arabia or a North Korean attack on South Korea), regional wars that do not involve American interests directly but that would command American attention because of the possible use of nuclear weapons or other weapons of mass destruction (e.g., an India-Pakistan war), limited "police actions," special operations, and operations related to drugs, terrorism, or the taking of American hostages.

None of these near term, lesser contingencies are as demanding of U.S. military capabilities as the cold war Soviet threat to Europe. And though none are demonstrably

more likely than the others, collectively they amount to a near certainty of U.S. military action in coming years.

If such conflicts occur, however, they are less likely to draw in the superpowers and thereby to escalate.

Figure 3: Excursions -- Asia-Pacific Region



The near term scenarios cannot be treated as "lesser included cases" for two reasons: first, the United States will not be maintaining the level of defense spending or the large forces-in-being that have characterized the cold war; second, contingencies of this sort will increasingly exhibit new features that place new demands and constraints on the application of U.S. military power, among them:

- proliferation of high-technology weapons, including nuclear, chemical, and biological weapons, ballistic missiles, diesel submarines, and modern anti-air and anti-ship weapons;
- absent or uncertain regional alliance structures;
- reduced U.S. overseas basing structure;
- stringent limitations on the amount of force considered morally and politically acceptable.

3. Qualitative Changes to Military Forces

From the organization of scenarios into two rather distinct categories emerge three implications for defense planning. These implications in turn affect all four parts of the defense establishment: strategic forces, tactical forces, the intelligence system, and the technology/industrial base. The following sections apply these observations to the national intelligence system and to the technology/industrial base.

First, active U.S. forces will be significantly reduced in size. This is required by the decreases in the DoD budget that already are underway and is permitted by the decline in the Soviet and Warsaw Pact threats.

Second, DoD needs to build more flexibility into those forces that remain because of the diverse nature of the growing threat associated with small and medium powers. Thus a qualitative restructuring will need to accompany a reduction in size of U.S. forces. Some crises and wars may occur in areas remote from U.S. bases, so our forces must be able to operate at greater distances from those bases and to sustain such operations. Regional crises and wars can erupt with little warning, so our forces must be flexible enough to move quickly to geographically diverse areas. We must be able to operate effectively against lesser powers armed with modern tactical weapons, air defenses, submarines, and cruise missiles. Some of these potential adversaries now have chemical weapons, some are acquiring ballistic missiles, and some will have nuclear weapons in the future. An alert intelligence system with global reach and technological superiority for U.S. forces everywhere will be needed. This is particularly important with regard to battlefield surveillance capability.

The third important implication of the changing security environment is that the United States must build a strong reserve in its military forces, its technology base, and its production base. This reserve is needed to allow us to field a larger active military force within a period of time that is consistent with the lead times from the first clear indication that a substantially increased threat to U.S. interests is emerging until that threat reaches fruition. The reserve must hedge against several kinds of future threat increases: a reconstitution of a Soviet capability for large-scale conventional aggression (probably not before the turn of the century); the emergence of another superpower threat to U.S. interests (Japan and Germany are the only possibilities before the turn of the century); and regional powers (e.g., China) or coalitions of regional powers that in time could develop into a major military threat to U.S. interests.

4. Principal Judgments Regarding National Intelligence Needs in the New World Environment

The following are the principal judgments developed by the intelligence working group and are the cornerstone for the intelligence recommendations made by the task force.

A. The breadth of intelligence coverage and the quality of intelligence products must rise to meet the needs of U.S. policymakers in an uncertain world.

B. It is not clear that there will be an intelligence "peace dividend" resulting in a reduction in requirements for intelligence products related to the Soviet Union. It is clear that the need has decreased for products related to Soviet and Warsaw Pact conventional forces. But three countervailing tendencies offset this potential intelligence peace dividend:

- The volatile political and economic situation in the Soviet Union is leading to increasing demands by national security policymakers for current intelligence and projections for this area of the world.
- Future arms control agreements, if carried to completion, will likely place stringent new demands on the intelligence community for monitoring.
- There are standing national intelligence requirements to attempt to hold Soviet nuclear forces at risk. Monitoring mobile missile forces places a heavy load on the intelligence system.

C. At the same time, intelligence needs for the rest of the world will continue to increase significantly. These increasing needs include:

- Information about acquisition of advanced weapons by third countries, and indications and warning about their possible use;
- Support for counter-terrorism, counter-narcotics, counter-intelligence, and special military operations;
- Political, economic, and military information about an increasing number of nations;
- Continued intelligence support to the DoD acquisition process and to ongoing military operations.

D. It is also clear that new budgetary and human resources will not be available to satisfy these new requirements.

E. There are four ways to close the gap between intelligence requirements and available resources:

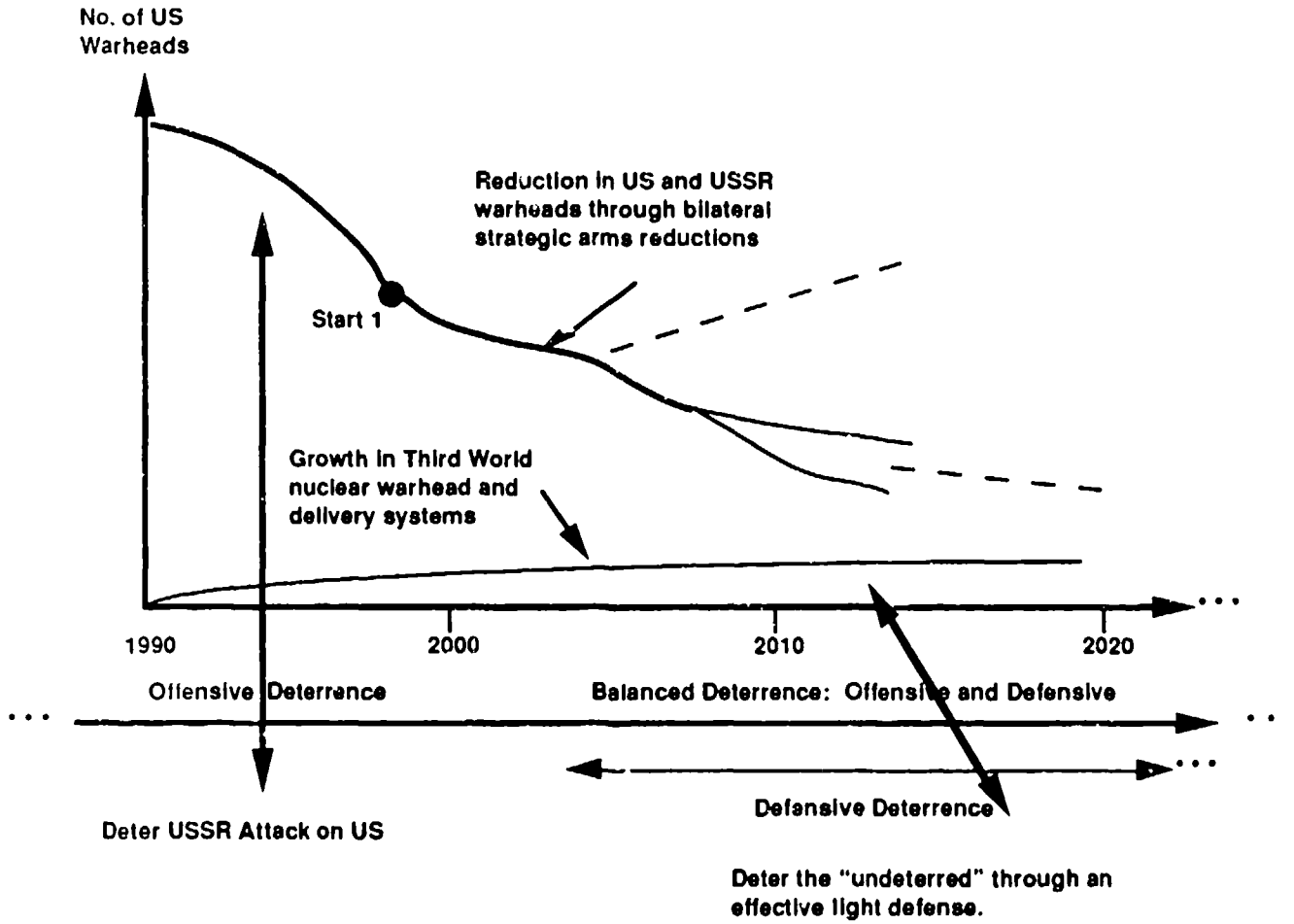
- Establish greater (e.g. economics) and lesser intelligence priorities and reduce or eliminate work on the lesser priorities, restructuring the intelligence community accordingly;
- Accept higher near-term risks associated with thinner or less timely coverage of moderate priority intelligence targets;
- Make more efficient use of dollars and people with greater reliance on reserve forces.
- Recruit only the very best people.

III. Strategic Forces and Supporting C^3 Task Force

1. Strategic Vision

The Strategic Forces Task Force commenced their work by defining a strategic vision for the 1990's and beyond (Figure 4). Following START, the real warhead count will be reduced. Subsequent agreements will reduce this level further. Because the START process applies equally, this will also be the allowed level of Soviet warheads.

Figure 4: Strategic Vision



To hedge against uncertainty, our retaliatory capability is maintained as a Triad. We maintain this retaliatory capability by replacing platforms and systems at the end of their service life. This is, however, not a one-for-one replacement since over the typically 30-year life of a strategic system, the defensive environment (e.g., air defense), targets (e.g., mobility), technical options (e.g., Stealth), numerical limits (e.g., arms control), and available resources change. This aspect of strategic thinking is conventional. It is labeled

"offensive deterrence" and the strategic forces so assigned are for the purpose of deterring our comparable superpower adversary, the USSR.

Central to this strategic vision, is the idea that the future will bring a number of **new** nuclear powers who will possess not only nuclear weapons, but the means to deliver them to intermediate and even longer range. These new nuclear powers are expected to have relatively small inventories, on the order of 10's of warheads; they are likely to acquire weapons for the specific purpose of deterring other new nuclear nations who are their regional enemies; and, most importantly, they may be "undeterrable" by virtue of their potentially irrational behavior. They could, for example, at sometime in the future threaten the U.S. It is this premise that provides the most serious concern.

For these nations, the large U.S. (and USSR) weapon capabilities may not be adequate to deter, nor is it credible to believe that the U.S. would annihilate a small nation that launched a limited attack on U.S. assets. For these nations we add a new component of deterrence, "defensive deterrence." We deter these attacks by building a **light defense** capable of effectively neutralizing 10's of RV's.

This light defense is a reactive defense, and a hedge that may not be needed until the early 21st century. How extensive it is depends on the degree of nuclear proliferation, the sizes of the weapon inventories of new nuclear nations, and the sophistication of delivery systems.

2. Ballistic Missile Forces

Planning for the strategic nuclear forces has always emphasized the diversity provided by the Triad. Three basing modes -- SSBNs hidden at sea on alert, ICBMs in hardened silos (and projected mobile basing) on high alert and bombers on high alert -- contribute to this diversity. Ballistic and aerodynamic means of delivery and a range of weapon types also contribute, and ensure a retaliation of unacceptable consequences if we are attacked.

The ICBMs traditionally have provided important, and in some cases unique, capabilities to the Triad, for example: high alert rates, low operating and support costs, robust connectivity to and from the national command authority, prompt and highly accurate retaliation capability and selective response options. Being sovereignly based, they necessitate a massive nuclear assault against the American homeland. They have short times of flight and are virtually certain to reach their targets against current defenses.

Considered simply as missiles, SLBMs have similar characteristics to ICBMs with respect to time of flight and assured target penetration. As long as submarine security is preserved, the SLBMs provide clear and unequivocal deterrence within the Triad. As long as the SLBMs are less vulnerable to attack, they place the U.S. under little "use or lose" pressure, thereby increasing political response time and increasing the chances of avoiding nuclear conflict.

A first imperative is to preserve the effectiveness of an aging force while improving its capabilities and cost-effectiveness in the face of both declining resources and possible technological or qualitative threat enhancements. Improved payload capabilities are required to place the entire spectrum of targets at risk. The Soviets continue to move to buried, relocatable, and mobile forces. We must also maintain a technology and production base which protects options for system upgrades and ultimate system replacements. At the same time, we need to assure that response options are available for a range of alternative futures.

With the current desire to move toward single RV missiles and the future possibility of a deep reduction in RV number, ICBM basing modes previously considered to be inadequately survivable or affordable, such as fixed silos, become much more attractive. Also, mobile missiles can be made survivable in extremely small deployment areas if hardened sufficiently, and if random movement is employed survival is independent of tactical warning.

In contemplation of significant future ballistic missile reductions, it remains clear that a minimum size fleet of SSBNs is necessary to ensure confidence in the survivability of the SLBM force. We must also continue an extremely aggressive SSBN security program with appropriate technical and operational follow through.

3. Air Breathing Systems

The major stealth programs are essential for two reasons: first, to provide confident penetration in the face of the relentless increase in modern air defenses, both in the Soviet Union and other emerging well armed smaller nations, and second, to provide confident penetration in a manner that corrects major deficiencies of current aircraft in range, flexibility of weapon delivery and on-scene target selection and validation. Only penetration based on stealth can do this. These qualitative characteristics are the distinguishing features of strategic aircraft, and allow them to be useful across a wide spectrum of deterrence and combat situations. This includes conventional campaigns against well-armed smaller nations, a growing security threat.

4. Strategic Defenses

We recommend that the SDIO prepare for Presidential decision the option(s) for an effective defense of the U.S. and/or its allies against small attacks (10's of RV's). Such an option(s) should have the clearly defined objective of defeating such attacks and, secondarily, to discourage some larger attacks by virtue of its preferential defense attributes. Several options would be: should SDI funding be further reduced, it would be necessary to make this option the baseline with Phase 1 representing the growth potential. Or, should SDI funding be further decreased, the program should pursue deployment of the light option vice across the board SDI.

To enable any deployment decision the parallel air defense option should be understood. Accordingly, we would recommend the definition of an air breathing defense architecture that handles the corresponding bomber attack and closes off the "free ride" that the absence of air defense implies. The most difficult technical problem remains the detection of low observable missiles and this is where air defense initiative (ADI) RDT&E assets should be concentrated.

One architecture that should be considered under the above accommodation should include the provision of a U.S. space sensor system which would provide to the U.S. and its allies surveillance and discrimination data to permit the use of their own or exported ground-based interceptors for kill.

5. Strategic C^3

The completion of strategic C^3 modernization by deploying a minimal MILSTAR constellation, the airborne very low frequency NCA-to-forces system, and the Defense Satellite Program (DSP) upgrades for data dissemination will allow a real reduction in backup systems without losing fundamental capability. Particular attention should be given to communications systems and airborne command posts used for line-of-sight relay communications.

With budgets shrinking in the future, we should invest R&D to reduce the ownership costs of minimum essential capabilities, such as tactical warning, instead of only investing R&D for improved capability. A good example is to have the next "Early Warning Satellite" system competition consider the cheapest way to provide existing DSP data, rather than stretching for additional data from space-based IR sensors in the same competition. This approach could free up funds in the future for other missions. A follow-on could consider the minimum cost pre-impact attack assessment system as well, taking into account the data to be provided by the selected DSP replacement. If, as a result of such a competition a Boost Surveillance Tracking System (BSTS) solution were the most cost effective, it clearly could be used to further minimize the cost of the warning system by providing alternative viewing geometries, etc. The result would be a high-low capability mix. A similar high-low mix for MILSTAR terminals should be considered.

6. Weapons Production

The problems of the Weapons Production Complex are about to effect the operational forces. The shutdown of the Rocky Flats facility prevents any new weapons from being produced.

The aging reactors of the production complex at Savannah River have forced the suspension of Tritium and Plutonium **production**, essential materials for almost all of our weapons.

While the aging of the complex is the fundamental cause of these troubles, safety worries have greatly complicated the problem. Safety issues have also been uncovered in the stockpile, resulting in several changes. Short term cures appear possible, but the time for restart is uncertain and in any case long term fixes are needed, particularly a new Tritium production reactor.

Public aversion of nuclear weapons, an impression they are no longer needed, low testing levels, budget reductions, etc., are affecting the weapons design staffs so that there may be a danger of losing the nation's competence in weapons technology. The same trends could also degrade the competence of the nuclear weapon effects community. The recent reduction in grade of the position of the Director of DNA cannot help this matter. Also the new charter of the Office of the Assistant to the Secretary of Defense for Atomic Energy has broadened the scope of the office to non-nuclear matters while reducing his authority in nuclear weapons matters.

A complete test ban or even a severe limitation on testing will cause a threat to the continuing viability of the stockpile. Unforeseen problems such as the present worries over the safety of some stockpile weapons will persist. Without testing, the necessary changes will increase the uncertainties about the reliability of the weapons. Nevertheless, the pressure for further restrictions of testing and for a comprehensive test ban (CTB) remain.

7. Potential Cost Savings

With the implementation of START agreements, the **number of strategic platforms** will decrease. This will have implications for cost reductions across the board. As systems are taken off line and replaced by modernized versions, e.g., MM II, their operating and support (O&S) costs will reduce, eventually going to zero. START will reduce the planned number of TRIDENT hulls procured, with corresponding reductions in O&S.

A recommendation of this study is that, for cost reasons, ICBM's continue to be **silo-based**. This will save the costs of rail garrison basing of PEACEKEEPER as well as the mobile deployment of the SICBM. However, R&D should be continued to protect mobility options for these systems.

Savings in **O&S for the airbreathers** is possible in a number of ways. Low reliability equipment can be taken off-line if it does not compromise the basic mission. With R&D such equipment can be replaced by more reliable versions. Flying time can be reduced in the short run, with more dependence placed on simulators.

If unexpended FY 89-91 R&D money in **compartmented stealth programs is** managed more centrally, it is believed that some savings can be realized. One estimate is that such savings could amount to as much as $2B out of $10B in this category.

Should a light missile defense program be developed, as suggested in this study, its costs could possibly be reduced if it were done on a **multinational basis**. Since a number of nations could find themselves so threatened, the potential for such a development is not unreasonable.

If MILSTAR is deployed, a number of current **backup systems** become redundant and should be considered for elimination.

IV. Tactical Forces and Supporting C^3 Task Force

1. Future Environment

The proliferation of military technology to the Third World means, in essence, that conflict in the Third World is no longer synonymous with low intensity conflict. U.S. contingency forces could be faced by the full spectrum of threat, not only in the case of munitions and weapons systems, but also in C^3I systems. Even if Third World nations do not have indigenous space capabilities, they can buy access to western or Soviet capabilities. In addition, several are pursuing nuclear, chemical and biological weapon R&D.

The RDT&E strategy proposed for tactical forces is oriented toward countering the emerging Third World threats and the proliferation of sophisticated weapons to developing nations. With the advent of reduced budgets and manpower, the strategy recognizes the need to create a leaner, more capable, and deployable force possessing the lethality and survivability to conduct successful military operations. These forces must be equipped with advanced technologies that enhance individual as well as unit performance at all levels of conflict. With the changing world situation, demands on intelligence sources to monitor potential crises worldwide will increase so that nations can make reasoned decisions as to commitment of military forces, selected support units, and/or weapon systems. To enhance survivability of the total force, use of stealth technologies must be incorporated into land, sea, and air platforms and counterstealth capabilities must be incorporated into weapon systems to enhance effectiveness against low observable targets.

It is also necessary to streamline the requirements and acquisition processes to facilitate rapid transition of emerging technologies into the force in an era of constrained resources. Fieldable brassboards, in contrast to full scale engineering development (FSED), may provide an effective means to tailor facilitation to requirements, to reduce overhead costs, to better understand technological risks, to reduce development costs, to validate operational need prior to production, to facilitate product improvements, and to minimize overall procurement costs.

2. Countering the Third World Environment

When the political or military situation demands the removal of a particularly dangerous threat or a very forceful warning, the use of a surgical air strike may be the best response. Such an operation normally requires mission accomplishment with minimum losses, and the attackers must be able to get to and precisely identify the target, accurately deliver ordnance, and return to base safely. Technologies applicable to stealth, self-protection, navigation, sensors, etc., are important to mission success. If surgical strike is not a viable option, the U.S. may support indigenous forces through either inserting U.S. air power or providing modern aircraft and supporting equipment to the favored combatant.

Infra-red guided air-to-air and surface-to-air missile systems are also available to any nation desiring to procure these weapon systems. Many are of U.S. origin or have U.S. technology incorporated as subsystems. Although the U.S. has done much to counter radar guided missile systems based on Soviet threats, counters to IR systems have lagged in comparison.

With the proliferation of IR systems to Third World nations, increased emphasis is needed to counter these weapons for survivability of fixed and rotary wing aircraft. However, with the acquisition of threat multi-mode sensors for AAM and SAM by hostile nations, stealth technology will play a major role in countermeasures to mitigate AAM and SAM effectiveness.

Unmanned air vehicles (UAV) offer the versatility to conduct numerous high utility military missions, such as battlefield surveillance, communications relay, target acquisition, electronic support measures, and electronic countermeasures. The flexibility of UAVs provides the opportunity to configure payloads for military utility that minimize the risk and loss of manpower to conduct similar missions. UAVs also provide a unique capability to penetrate defenses with minimal political risk during increased tensions.

Although a joint program office is in place for developing UAVs for Service use, results to date indicate that the existing process is unlikely to produce satisfactory results. U.S. land forces have a critical need for UAVs. Efforts to date have been fragmented and slow. Lack of hands-on experience further degrades the opportunity to assess military utility and support for UAVs. With the availability of non-developmental items (NDI) to conduct testing and evaluation and attendant contributions to combat effectiveness, early acquisition of NDI systems should be implemented to assess UAV military utility and to provide near term capability for U.S. land forces.

3. Close-In Defense of Ships

Sea skimming anti-ship missiles and torpedoes are serious threats to surface ships. These weapons have been acquired by many Third World countries and pose a major threat to U.S. forces in any future confrontation. Furthermore, low observable sea skimmers will soon be available to any source desiring to procure these weapons.

Close-in defense of surface ships is a major requirement to counter missile and torpedo threats. To be effective, ship defense requires responsive battle management systems and integrated active and passive defense measures to include decoys, active countermeasures, reduced ship signatures/observables, multi-spectral sensors, and active point defense weapon system (s). Current torpedo defense programs are progressing adequately but more needs to be done to counter current and future sea skimmer missiles.

4. Munitions

When the European theater was the biggest concern, military planners treated target sets in a prioritized way and knew what set of weapons should be used to destroy the targets.

With the modernization of the Third World, target sets are now ill-defined, and change markedly from country to country -- the old weapons mixes no longer assure target kill. Surveillance and target acquisition systems must now be capable of discovering and pinpointing varying target sets with unusual configurations. Getting steel on the target in such uncertain circumstances may be done with precision guided missiles (PGM's) using relatively unsophisticated stand-off delivery. Since PGM's delivered in this mode could markedly reduce risks, it is important to field such munitions, even in small quantities.

5. Stealth -- A Special Concept

About once every quarter century a technology appears that can really make a difference. "STEALTH" is just such a technology. Its application will reduce attrition -- thereby reducing the number of systems required in the inventory, and thus lessening total system costs. We dare not ignore the application of STEALTH techniques to all platforms and fixed installations, including the observability of all targeting signatures (IR, visual, acoustic, electronic emissions [intentional or otherwise], radar, etc.).

We must also continue to build on our current cadre of skilled stealth engineers and be particularly adept at countering stealth. Our adversaries are applying stealth techniques to their own systems. Even Third World countries are gaining access to the technology and will, for example, be able to purchase low observable anti-ship missiles.We must be able to field sensors so sensitive that they can guide weapons to a platform or weapon that has been designed to be all but invisible to our current systems. Since low observable anti-ship cruise missiles are available to almost any nation, an urgent requirement is close in defense of ships.

6. More Capable/Deployable Forces -- Rapid Deployment and Lift

The impending reduction in U.S. forces in Europe, coupled with an overall reduction of active forces, and the inability to predict where the next military conflict will occur, all contribute to a reduction in forward basing. As a result the ability to transport men and materials quickly becomes increasingly important. In providing this capability, the design of a lift system must accommodate the systems to be lifted -- and vice versa. It is just as bad to design a tank that can't be lifted by current platforms, as to design an aircraft incapable of delivering a current tank. Units must be configured and equipped for rapid deployment airlift to any place in the world and be able to strike a quick, telling blow or to seize and hold terrain until heavy reinforcements arrive. Although increased use of containers and other commercial shipping packages should continue to be encouraged, it is important to also address the shore facilities required to off-load and transport the material to the receiving units.

7. Lightening the Forces

Recent advances in technologies provide capabilities to reduce manpower intensive functions such as planning, intelligence, target acquisition, and information dissemination. Such technologies allow many of these activities to be conducted in near real time and in

CONUS, thereby minimizing the burden on forces committed to an operation. "Constant source" is an example of technology advances to provide timely information with reduced manpower.

Although the requirement for military satellite communications will continue, the proliferation of commercial communication satellites provides a major source capability to supplement military operations throughout any area of potential commitment of U.S. forces.

8. Defense of Deployed Forces

The key to successful military force insertion is the capability to rapidly deploy manpower and systems for securing and holding initial air and/or beachheads pending link-up with heavier forces if required. With the proliferation of sophisticated weapon systems to Third World nations, it is imperative that the force deployed be equipped to counter these weapon systems.

To defend the air or beachhead against tactical ballistic and/or cruise missile attacks, the force must be equipped with air deployable air defense system(s) capable of defeating rotary and fixed wing aircraft and tactical ballistic and cruise missile systems. Additionally, the force needs anti-armor weapons to counter threat armor systems in the form of lethal KE and CE weapons and light armor vehicles capable of engaging and defeating heavy armor.

9. Armor/Anti-Armor

The tank remains the dominant weapon system on today's battlefield and for the foreseeable future. Proliferation of armor systems requires that the U.S. continue its priority efforts to escape the armor/anti-armor spiral and to lead rather than lag in the deployment of armor systems. The technologies to be exploited are accurate, lethal, indirect fire support systems; standoff weapons to enhance survivability of launch platforms; low observables to reduce adversary targeting; highly lethal KE and CE weapons for defeat of heavy armor; and integrated intelligence and target acquisition systems for effective synergistic employments of these weapons before threat forces can react. Survivability can be enhanced by engaging hostile forces prior to completion of their decision cycle. Providing light insertion forces with these advanced technologies will significantly improve current force capabilities to secure, hold, and expand air and/or beachheads pending arrival of heavier forces. High risk, high payoff opportunities exist especially in the area of KE weapons and anti-armor vehicles.

10. Training

Training is the single most important element of attaining and maintaining force readiness. With field operations constrained by environmental and budgetary considerations, quality training can be enhanced through use of simulation devices. Simulators can be used to improve individual skills and crew and unit performance and can be netted to assess complex weapon and unit interactions. Computer assisted gaming is also cost-effective in training of staffs and commanders at all echelons. Using commercial technology and hardware, opportunities exist for high payoff in force training that would not be otherwise achievable. However, we recognize that this is no substitute for field exercises.

11. ASW

ASW has been and should remain a high national priority. For the foreseeable future, ASW remains an essential capability needed to support all maritime operations. The general reduction in force levels between the super powers makes the assured preservation of the SSBN force more difficult, and our ability to assure SSBN security essential. Further, wherever U.S. forces are called into action, protection of the Sea Lanes of Communication (SLOCs) will remain crucial to our national security. Just as containment of the Soviet Navy is essential in a general war, our ability to execute naval actions successfully in a limited conflict Third World scenario is dependent on our ability to eliminate or neutralize the local submarine threat.

In the context of opposing the Soviet Union, ASW is, in the main, a technology limited problem. The U.S. and its allies would be faced with a large force of competent submarines in the event of general war. The C2 supporting the Soviet force, and their ability to provide off-board targeting for long-range cruise missile attack, make for a complex and demanding ASW problem.

The threat posed by Third World submarines is primarily due to difficulties in detection. This difficulty results both from their mode of propulsion -- primarily diesel electric -- and nature of the seas in which they operate -- shallow, downward refracting water with rocky bottoms. If these submarines can be detected, they can be destroyed.

Rotary wing ASW assets can and will have very effective ASW detection and fire control systems based on variable depth active sonar and adjunct non-acoustic sensors. With these systems, the ASW assets of the surface force can be dispersed over a large area, can target at both short and long detection ranges and will provide a significant capability against the adversary submarine threat.

Both fixed and rotary wing ASW aircraft can benefit from the use of expendable active acoustic sources to provide robust detection capabilities under conditions where passive acoustics are ineffective.

Effective battle management requires responsive C^3 and near real times (NRT) intelligence and target acquisition systems to optimize force deployment and to synchronize the commitment of all elements involved in an operation. NRT intelligence provides such information as weapon systems and force elements are deployed in a contingency. Enhanced battle management also requires efficient cover and deception measures and the ability to counter/disrupt adversary C^3 systems.

To be effective, a C^3 system is required to provide the connectivity without compromising the low observable nature and inherent security of submarines. Such a system would allow the attack submarine to be an element of the U.S. precision strike arsenal for added force flexibility.

12. Potential Cost Saving

How does one pay for the capabilities required by the new international reality?

The first point to be made is that these changes will come over time. Any attempt to implement these recommendations overnight could do irreparable damage.

Cutting programs is one way to achieve cost savings. Current RDT&E programs should be evaluated as to their continued utility in the new international environment. For example, are programs initiated to meet NATO requirements still valid? Given a change in emphasis within the Navy from the outer air battle to point defense, what Navy RDT&E programs can be cut?

But there are other ways to achieve cost savings besides cutting programs. Implementing a "fieldable brassboard" approach, rather than going to full-scale engineering development, provides: the ability to tailor facilitation to requirements modified by exercises, reducing overhead costs; a better understanding of developmental risk, reducing developmental costs; and an operational evaluation of need without commitment to full-scale production, which may reduce procurement costs.

V. Technology and Technology Transfer Task Force

1. DoD Technology Investment Strategy Process

The DSB Summer Study found that a good foundation exists for building a coherent technology investment strategy and an integrated management process.

The Department of Defense Science and Technology (S&T) Program (6.1, 6.2, 6.3A, Technology Demonstrators), through past investment, has developed state-of-the-art capability in most of the spectrum of technologies required to develop weapons systems for force advantage. Indeed, this investment in S&T has been key in the elevation of the U.S. to a position of world leadership in a number of current and emerging technologies, e.g., microelectronics, computers, advanced materials, advanced aircraft. In the most recent DoD Critical Technologies Plan (March 1990), the broad leadership of the U.S. in technology was apparent, although other countries, particularly Japan, were significantly ahead in some niches of technology. This trend, of course, points up the concern of Congress (and the reason that the DoD Critical Technologies Plan is mandated by public law to be prepared annually) that our technological edge is eroding, and this erosion will result in severe consequences for both the military and economic strength of the United States. Currently, however, the national industrial base, built over the last several decades, is in good shape, but the trends are in the wrong direction. Historically, it has provided the technologies and superior weapons systems which have formed the basis for major classes of U.S. production and exports.

2. Weaknesses of Current Process

Fragmented "Strategies" and Guidance: No Stable or Unified Process.

- DARPA, SDI & special programs should be full partners in the process (services represent only slightly more than 40% of DoD S&T investment in FY91).
- A single stable process must be implemented within DoD.
- Leadership at the top is required to institute a stabilized process.

Current DoD investment strategies do not establish linkage between future scenarios, future military capabilities, future technology goals, and future investments. Because technology goals and resulting resource allocation should be driven by future military capabilities (allowing for innovation), a successful investment strategy reflecting the "best" investment can only emerge with the highest level input on probable future scenarios and future military capability needs.

Accountability, performance measurement and evaluation, and a reward system are issues that must be addressed and resolved by a successful investment strategy and process. The current DoD strategies are very weak in these areas and their credibility will

eventually be challenged based on these weaknesses alone. Establishing accountability is the necessary first step towards dealing with the more difficult issues of measurement and reward.

The current program element/project structure used within the DoD Science and Technology program does not provide ready visibility into the allocation of resources to either aggregate technology areas (e.g., materials and structures, electronic warfare, aerospace propulsion) or critical technologies. A budgeting and accounting system that does not provide such visibility makes it exceedingly difficult to ascertain technology investments in any meaningful way.

Considerable evidence exists to support a major increase in the DoD investment in manufacturing process technology. Major segments of U.S. industry are investing over 35% of their S&T budget in process technology with claims that U.S. competitors in Japan are investing over 65% of their S&T budgets. Near term increases in profitability can be directly linked to improvements in process technology. The important question for DoD focuses on "what process technologies" to invest in.

A successful DoD investment strategy should complement and reinforce critical industry's science and technology (S&T) investments. This will focus and catalyze those industry's investments allowing the DoD to focus on investment where critical industries are not concentrated or do not exist, such as mine/countermine warfare, chemical/biological defense, ASW, USW, etc. DoD's current effort demonstrates little attention to the issue. The potential for an improved DoD investment strategy to leverage the commercial base is so great that this issue must be addressed. In addition, in areas where DoD is only one of many customers, the Department may need to accept commercial standards as adequate.

3. OSD Management of the Science and Technology Program

It is important that the management of the S&T program within OSD reflect both the importance of the S&T program and its unique characteristics. We find that the current OSD management of S&T does not adequately reflect either of these imperatives.

Currently, major elements of the S&T program report to three different levels within OSD: the S&T programs of the Military Departments through the DDDR&E (Research and Advanced Technology); those of the Defense Agencies through the DDR&E; and those of SDIO directly to the Secretary of Defense. Obviously, there is no single individual within OSD in charge of the S&T program. In this situation, it is unlikely that the need for the development and execution of a single, unified technology investment strategy can be fulfilled.

We also find that in the words of the Packard Commission "strong centralized policies that are rigidly adhered to" are still needed for the management of the S&T program. There is no policy which requires a common set of goals, strategies, and priorities for the overall DoD S&T program, nor is there a practical mechanism to ensure consistent resource

allocations. Two unique characteristics of the S&T program make this need particularly acute.

First, the majority of the S&T program consists of efforts that are difficult to identify as unique to a specific ultimate application for a specific Military Department, and are therefore of interest to all Military Departments. In practice, this requires a high degree of coordination among S&T efforts. Yet each DoD Component prefers to conduct independent S&T programs and to retain complete flexibility to adjust budgets and priorities. Such independence is not possible if a unified technology investment strategy is to be executed.

Second, relatively small funding changes—say, of the order of $5 million—in an S&T effort can have an enormous impact, because such a change will typically represent 10% or more of total program element funding and because the prevalence of controlling annual growth in each S&T program element ("ramp management") will tend to perpetuate the same percentage adjustments to future years. Changes of this magnitude are currently well below the threshold of formal OSD consideration, with the result that there is no effective overall control of resource allocation in the S&T program. This has left the S&T program vulnerable to "raiding" by the Military Departments to pay for unforeseen obligations (e.g., overruns on major acquisition programs), as well as adjustments with significant impact by both the Comptroller and the Congress.

These difficulties in OSD management are not new, but in our view, they have increased substantially in the last decade. For example, in 1980, a staff-originated action concerning the S&T program would pass through one intermediate office before reaching the Under Secretary level; in 1990, this same action must pass through four intermediate offices before reaching the Under Secretary level. The consequences for proper OSD management of the S&T program are painfully clear.

We believe there is a vital need to place exclusive responsibility and authority for the DoD S&T program firmly in the hands of one person. There is currently no such person, while the current position of DDR&E nominally has responsibility for all S&T except that of SDIO, the position has responsibility for many other non-S&T matters as well, and does not have S&T TOA authority. We do not believe that any position which has significant non-S&T responsibilities will provide for adequate OSD management of the DoD S&T program. We did not conduct a detailed management organization review to determine the proper organizational location of such a position, although it must obviously be consistent with the responsibility and authority assigned.

The centralization of this responsibility would provide for much needed centralization of important functions:

- Development of policy for all S&T matters;
- Development and oversight of the execution of a single, unified DoD technology investment strategy, including goals, objectives, priorities, and resource allocations;

- Establishment of the S&T TOA for each DoD Component;
- Approval/disapproval of the S&T plans and programs of the DoD Components.

Simultaneously, it would provide proper decentralization of:

- Development of detailed S&T plans and programs of the DoD Components;
- Execution of S&T programs of the DoD Components;
- Control of S&T personnel and facilities of the DoD Components.

4. Critical Technologies

Current DoD efforts to identify critical defense technologies include:

- The Defense Critical Technologies List (CTL) compiled at the request of Congress,

- The Defense Technology Strategy and Action Plan (DTSAP), developed by DDR&E, and

- A list of technologies compiled by DARPA.

The CTL and DARPA listings describe in a comprehensive way several technologies important to national security and the opportunities offered by these technologies to meet military requirements. The DTSAP attempts to go further by defining strategies and the interrelationships among required capabilities, strategies, objectives and critical technologies.

In the next round of critical technology selection, the process employed must be capable of giving stronger emphasis to:

- An assessment of technology opportunities versus risks
- Core technologies
- Process and manufacturing technologies
- Potential "Order of Magnitude" improvements
- Technological surprise and paradigm shifts
- Explicit connection between technology milestones and military worth
- Links between critical and core technologies and resource allocation, and
- More focused attention to some technologies embedded in the DoD list (e.g., low-volume, flexible manufacturing, microwave tubes, and simultaneous engineering).

Also, a lack of definition for core and critical technologies contributes, in some cases, to a lack of clarity and focus in identifying critical technologies. To overcome this, the following definitions are offered:

- Core Technology: a technology needed to maintain, strengthen, or establish a continuing competence or capability (Figure 5). Core technologies are the foundation for:

- sustaining technological competencies,
- making evolutionary improvements in warfighting capabilities, and
- supporting revolutionary innovations.

Examples of Core Technologies

- Air Breathing Propulsion
- Chemical Rocket Propulsion
- Aerodynamics/Fluid Dynamics
- Munitions
- Nuclear Technology
- Software Engineering
- Control Systems
- Acoustic Detection -- and several others

Figure 5

• Critical Technology (Figure 6): a technology that promises to meet all of the following criteria:

- provides a significant warfighting advantage (in both quality and quantity),
- represents a high entry barrier (no reasonable substitutes),
- has a relatively long diffusion time constraint for migrating the technology to controlled countries (greater than three years).

Examples of
Critical Technology Aggregates

1. Integrated Circuits: Digital, Analog, Microwave
2. Advanced Software ("Super" Case)
3. Infrared Focal Planes for Space Surveillance and Tactical Targeting *
4. Flexible Manufacturing (Including Low Volume)
5. Auto Target Recognition (Signal Understanding)
6. Counter Stealth *
7. Stealth Technology *
8. Simulation/Modeling/ Training
9. Simultaneous Engineering
10. Brilliant Systems
11. Hypermedia Information Management
12. Satellite Survivability *

* Uniquely Military -- Especially at System Level

Figure 6

Clearly an effective DoD investment strategy must give attention to investments in both critical and core technologies, that is, investments in future military capabilities must be complemented by investments in maintaining and strengthening current military capabilities...also, revolutionary technological developments must be complemented by evolutionary developments. To do that, a scenario-based methodology is best for selecting those technologies that are critical to the future national security of the United States (Fig. 7).

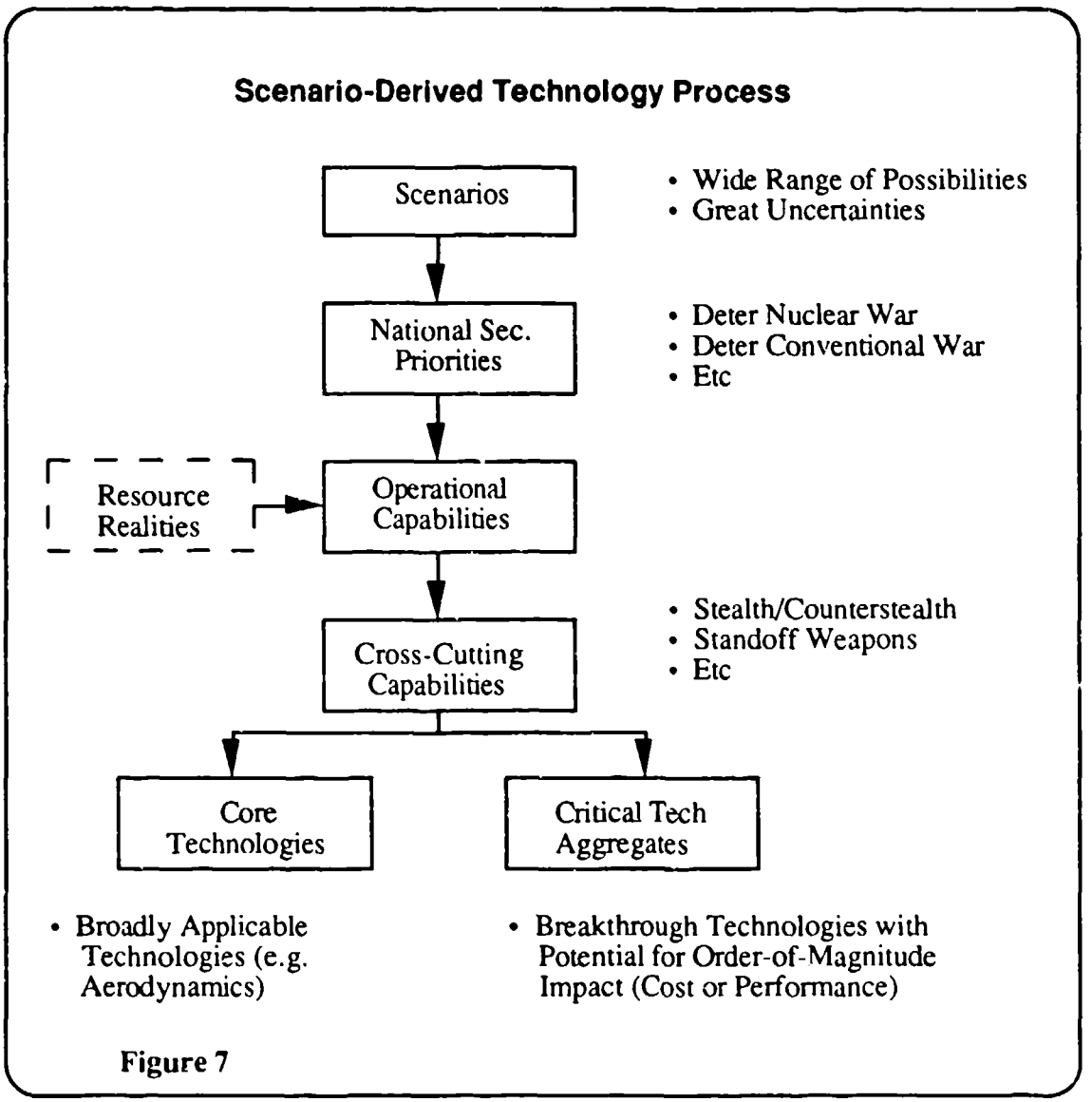


Figure 7

This process consists of the following sequential steps:

A. Establish a multiple set of scenarios which represent a wide range of potential futures, but which also recognizes great uncertainties;

B. Derive from those scenarios a set of national security priorities, e.g., deter nuclear war, deter conventional war, etc;

C. Compare national security priorities with current operational capabilities to identify relative "overshoots" and "undershoots;"

D. Match operational capabilities against resource realities and identify those cross-cutting capabilities essential to more than one set of operational capabilities that have especially high leverage (stealth, counter-stealth, standoff weapons, etc.);

E. Devolve the cross-cutting capabilities into technology aggregates (Figure 8), sorting out both critical technology aggregates that portend order-of-magnitude impact (in either cost or performance) and essential core technologies which have broad applicability and are essential to operations of the forces.

Examples of "Cross Cutting" Military Capabilities

- Precision Standoff and Counter Standoff Weapons
- Stealth and Counter Stealth
- Auto Target Recognition and Identification
- Brilliant Systems
- Assured Access to Space
- Night/All Weather Capability
- Real-Time Command Management Systems (Data--> Info)
- Antijam, Covert Communications
- Active Countering of Enemy Target Acquisition Systems (ECM, ASAT)
- Rapid Response Long-Range Lift for Force Projection
- Lightweight, High Firepower, Minimally Manned, Survivable Forces
- Detection of Concealed Targets

Figure 8

5. Process and Manufacturing Technologies

The DoD needs an investment philosophy for process and manufacturing technologies that is geared to producing lower-cost, higher quality, more reliable defense hardware in the face of declining defense budgets.

Manufacturing capability is defined by:

- Equipment, tools and fixtures;
- Process "recipes" (process design rules and specifications);
- Training and human resource utilization, and
- Process flows, i.e. the collection of process recipes used in manufacturing.
- Iterative interaction with the design team.

It is the integration of these elements into a total manufacturing system, to include information and total quality management systems, that comprise the manufacturing enterprise. From a technological point of view, it is the combination of "know how" (accumulated procedural knowledge), capital investment (today's technology), and R&D (tomorrow's technology) that leads to major innovations. Japan's success in winning world markets has largely come through such innovations in process and manufacturing technologies, many of which are generated by the work force.

Integrated factory information systems (Factory C^3) may be more important than robotics in fostering flexibility and productivity of capital. Factory C^3 integrates:

- simulation
- planning
- dynamic scheduling
- material management
- maintenance, diagnostic, prognostics
- process control
- training
- statistical process control
- testing and quality control

Such information systems, fully integrated, can have the effect of empowering the work force, reducing indirect labor and layers of supervision, facilitating total quality management and just-in-time management, and increasing the flexible control of work cells for the cost-effective manufacture and assembly of low volumes of discrete parts. Therefore, the development and implementation of factory C^3 should have the highest priority in a DoD philosophy for process and manufacturing technologies.

The greater enforcement of concurrent engineering (integrated product design and manufacturing process design to cut span time from conceptual design to production) and cost reduction should also be given high priority. Concurrent engineering facilitates design for manufacture stability, cost, testability, quality and reliability and enables time-based management in major programs where longer span time equates to higher costs. The discipline of concurrent engineering should incorporate the following principles for greatest cost effectiveness:

- Constrain design to make maximum use of existing plant and equipment;
- Provide the necessary tools (computer and software aids) to implement concurrent engineering, i.e. work the data representation and data base issues required to support tool integration;
- Integrate total quality management throughout the multi-tier procurement chain to minimize incoming inspection and to reduce quality appraisal and failure costs;
- Emphasize flexible manufacturing to minimize material handling and inventory (working capital) costs.
- Bring manufacturing into the preliminary design.

In addition to these principles, the defense industry should be encouraged to increase R&D investments and motivate, recognize, and reward innovations that result in major reductions in costs and improvements in quality and productivity. Furthermore, current restrictions on the use of IR&D funding for processing and manufacturing technologies must be lifted.

6. Technological Surprise and Paradigm Shifts

The development of a DoD strategy for long-term development of critical technologies must also ensure that proper attention is focused on anticipating, and defending against, sudden, unexpected enhancements to an enemy's capabilities. The appearance of such "surprises" can evolve from two different mechanisms, namely:

- Technological Surprises - these arise from a previously unforeseen use of an entirely new technological weapon or threat. Examples of such surprises in the past are atomic bombs used by the U.S. against Japan, and V2 ballistic missiles used by the Germans against the U.K.

- Paradigm Shifts - These are radical shifts in doctrine and tactics using known systems. Examples of paradigm shifts employing altered "operational strategies" are the use of Blitzkrieg and modern terrorism tactics. Additional examples, that are more technology related, are represented by the use of air-power in the naval environment made possible by the introduction of aircraft carriers, and by the incorporation of laser guidance into bombs to achieve surgical target destruction.

The impact created by the sudden appearance of such technology surprises or paradigm shifts on the battlefield often go beyond the obvious shift in military balance. They also create confusion and panic the enemy, particularly when the impression is created that no ready defense is available. In other words, this element of surprise acts as additional leverage on the effectiveness of the technology or paradigm change.

Paradigm shifts are generally easier to anticipate than pure technological surprises. A major reason for this is that the element of innovation is often related to tactics and doctrine, an area in which military personnel are very knowledgeable. Hence, military forces have

the basic knowledge to anticipate a possible change in tactics. However, they cannot be expected to have the level of technical expertise needed to anticipate new technological breakthroughs, which often requires a completely different mind set. For example, a knowledge of nuclear physics and the discovery of fission would have been necessary to anticipate the atomic bomb, or a knowledge of atomic physics to anticipate the laser.

Because of the above argument regarding the difficulty of anticipating technology surprises, and also because of the accelerating pace of new technologies being created, the potential for the U.S. to be "surprised" in the future is increasing and therefore merits serious analysis.

7. Leveraging the Commercial Industrial Base

The current DoD "culture" is to maintain a defense industrial base separate from the commercial base. We do not believe DoD can afford the inefficiencies and costs of a separate industrial base. DoD needs to significantly increase selective reliance on the commercial industrial base to:

- Provide DoD access to broader technology at an earlier availability date -- field leading edge technology;
- Drive down manufacturing costs through use of commercial processes, economic volumes, flexible manufacturing systems, and commercial contracting;
- Reduce the cycle time of technology development through product/ prototype/ system design to field applications;
- Increase product quality by using latest manufacturing processes;
- Support surge capability through availability of commercial parts and systems manufacturing capability, and;
- Assist in satisfying critical industry segment requirements.

Historically, DoD has been a major catalyst to the commercial technology base due to its relative size, leading edge technologies and spin-offs to the commercial sector. Additionally, DoD relations with the universities have benefitted both with the universities performing research, providing consultations, and educating scientists and engineers. These relations will be important to the DoD in the future and we must strengthen these traditional leveraging roles.

The DoD must find and implement ways to leverage the commercial industrial base. Numerous studies in the 1980s (including the Packard Commission and the DSB) have addressed this issue and have provided specific, complementary recommendations. Very little progress has been made in implementing the recommendations; however, we believe that the current budget environment demands action.

We believe there are three areas for synergy within the defense and commercial industrial base -- development, manufacturing, and products/ practices:

- Technology/ product development - significant economies can be gained through basic technology planning and coordination. Resulting competitive product development to common standards for dual-use applications will result in lower costs, higher quality and reliability and higher availability.
- Manufacturing capability usage - common usage of commercial manufacturing capability will reduce DoD costs for process development, production and support.
- Buying commercial - benefits will accrue through DoD using common products, common specs and standards and common procurement/cost accounting practices.

Achieving this synergy will require DoD awareness of commercial base "drivers" and commercial requirements for technology, product development and manufacturing processes. It will also require DoD overcoming barriers to using the commercial base.

8. Critical Defense Industries

Continued erosion of defense "critical industries" and whole industry segments is expected to accelerate as funding for some parts of defense RDT&E and production declines over the coming years. "Critical industries" are considered essential to national security needs. The DoD has no structured approach to deal with this problem, either in terms of identifying "critical industry" segments or in developing aggregate strategies. Indeed, the Department of Defense has been operating on an ad hoc basis as issues surface from various quarters, particularly Congressional actions and inquiries.

Ultimate solutions should be focused on assuring the global competitiveness of defense "critical industries" -- not just in terms of DoD or other USG financial support. One element of a strategy should include leveraging of planned DoD investments in the Science and Technology Program, the Manufacturing Technology Program and weapon system development and production programs. This approach would ensure that critical industry support is directly tied to DoD needs and production requirements, thereby avoiding a subsidy scenario. There are also currently existing mechanisms that can be utilized to bolster defense "critical industries." Most notable is Title III of the Defense Production Act which provides for government support to critical commodities that are necessary to meet national security needs. Long range strategies must also seek to integrate civil and military industries in order to enhance competitiveness in the defense industry. Efforts must be directed towards reconciling such areas as different cost and performance considerations, different technical approaches and different types of regulation in order to achieve a greater rapport between civilian and military industry. Civilian producers would find the defense business more attractive and would give the DoD a larger potential industrial pool, particularly at the sub-tier level.

The methodology for identifying a "critical" industry can be described as follows: In our analysis, we considered an industry or industry segment to be "critical" when all of the following seven criteria are met: Defense Test; Technology/ Manufacturing Process Test; Reconstitution/ Surge Capability Test; Vulnerability Test; Linkage Test; Alternate Supply Test; and Government Leverage Test. This methodology and criteria were derived from the

June 1990 DSB study on "Critical Industries."

- The Defense Test determines the industry/ industry segment's relationship to critical defense needs. Industrial products must either go into defense goods or constitute tools or materials in their manufacture.

- The Technology/ Manufacturing Process Test assesses the rate of change of the technology and/ or manufacturing process. This test compares the differential between the leading edge and trailing edge of the technology and/ or manufacturing process. "Criticality" within this context will be the situation where the leading edge is farthest ahead of the trailing edge. (i.e., a high rate of change).

- The Reconstitution/ Surge Capability Test assesses the ability of the industry to rapidly increase or reconstitute its production volume to meet mobilization requirements. Are there barriers to the industry's entry/ re-entry in order to reconstitute its production line and meet surge requirements?

- The Vulnerability Test will assess the vulnerability of the industry/ segment to foreign political intervention (as opposed to market forces), thereby causing a loss of rapid access.

- The Linkage Test indicates the degree of vulnerability of the industry/ industry segment to global market forces. The degree of vulnerability will be raised when the industry/ industry segment is an essential link in a high volume industrial "food chain."

- The Alternate Supply Test looks at the availability of alternative and substitute products/ processes within both the domestic and international market. This test will serve to assess the likelihood of assured access in time of need.

- The Government Leverage Test determines if government policies, laws or investment can have the needed supportive effect on the industry/ industry segment. Government leverage is still necessary even if all the other tests have been met to constitute "criticality."

9. Technology Transfer Policy

Since 1949, an informal organization called the Coordinating Committee (CoCom) has relatively successfully impeded many communist countries' efforts to acquire (legally and illegally) high technology commercial products and data that could be used in their massive military effort. The CoCom cooperating countries' membership has evolved over the years, and they now have 17 countries (NATO members, except Iceland, plus Japan and Australia). The export control list developed by the CoCom countries has been long, complicated, and broad reaching. In addition, different implementations by several of the CoCom members has resulted in often confusing regulations for international companies that operate in different markets.

With the dissolution of the Warsaw Pact and subsequent establishment of burgeoning democracies in certain East European countries and democratizing/ free market trends in all Warsaw Pact members, CoCom members decided in early June 1990 to significantly reduce the export control lists. Certain of the reductions were immediate (liberalization of computers, machine tools, and telecommunications) for all the target countries in the Warsaw Pact. Other liberalizing steps are to be taken in early 1991 when CoCom members would have developed a new "core list." The stated goal by the CoCom members is to have a short export control list that contains only those items that have a direct relevance to Soviet military capability.

CoCom remains a viable institution and has shown flexibility by adjusting to the new realities. It should not be disbanded or significantly modified. While several East European countries have largely "removed" themselves from the military arm of the Warsaw Pact, the long-term stability of the USSR remains unclear. With a functioning CoCom, appropriate steps can be taken, depending on the direction that the USSR takes.

Within the U.S. government, the processing of export licenses is led by the Department of Commerce (DoC), but DoD plays a dominant role. Policy development for export controls is shared between DoD and DoC. Within DoD, the coordination lead is taken by the Defense Technology Security Administration (DTSA), but recently, JCS has been given a significant role. Also the Services play a significant role, especially in the development of new export controls lists.

Lastly, while the target countries remain the communist countries, licenses are required for exports of controlled products to most free world destinations to prevent diversion to communist countries. These East-West licensing requirements have proved burdensome to U.S. industry and have occasionally conflicted with decisions taken in the context of international cooperative armaments agreements with our allies.

A. Munitions Licenses

The sale of defense items which include armaments, support equipment and research and development for such items is governed by ITAR (International Traffic in Arms Regulations).

The regulations are, in principle, intended to foster the interests of the United States by (1) serving as an instrument of U.S. foreign policy, (2) strengthening the defense by allowing our friends to defend themselves and our allies to be able to contribute to effective mutual defense, and (3) through international sales, supporting the technological base of the U.S. defense industry and reducing the cost of such items to the Defense Department. It is also interesting to note that there is no legal or policy basis in considering the impact of ITAR on the national economy or national technological competition.

Unfortunately, in the years since ITAR was implemented, the associated system of technology transfer controls has not kept pace with the above goals that it was designed to serve. As discussed in this section, the system has erred on the side of being too restrictive and cumbersome. It has impaired the effectiveness of U.S. industries' ability to: (1) cooperate with our allies on joint programs (usually because of "Militarily Critical Technology" restrictions); (2) compete in the global free world market (where our allies do not have similar restrictions), and it had a negative effect as an instrument of our foreign policy with friendly nations and allies, because we are perceived as arrogant, insincere, and unreliable partners for defense cooperative programs.

B. Third Country Munitions Re-Transfer Restrictions

Procedures and policies on third country munitions re-transfers are principally rooted in security considerations and some past administrations' desires to minimize U.S. content in military equipment around the world.

These procedures have had a major negative impact on the U.S. industries' technological base by limiting U.S. sub-contracting opportunities around the world. This has been the case because the policy implemented through licensing procedures does not provide for approval in advance for a nation's ability to sell its equipment to free world countries if there is any U.S. content but requires a case-by-case approval in the future before such a sale could be made. Our allies and friends around the world have, therefore, avoided any U.S. content in their defense equipment so as to not be restricted in their ability to market such equipment internationally, without a possible U.S. veto, or at best, a lengthy U.S. approval process.

As this panel has recommended, commercially available technology should become more and more a foundation for our defense equipment. Therefore, an approach similar to that now applicable to commercial third country re-transfers, which is based on automatic approvals below a certain percent of U.S. content for any given equipment, seems appropriate, as long as other control criteria are not violated.

The present procedures dealing with commercial technology place no U.S. restrictions on equipment whose U.S. content is below 25%. This percentage seems arbitrary, and the task force sees no reason for restrictions where U.S. content is below 50%.

C. Proliferation

Concern over proliferation has existed since more and more nations have the capability and desire to produce a nuclear weapon. The potential for a significant balance of power shift resulting from a nation's acquiring the capability to fabricate a nuclear weapon has increased. Today an increasingly large list of countries are considered to be capable of achieving nuclear capability in certain time frames. In the area of missile and chemical

proliferation, the potential for destabilizing a region by introduction of long, stand-off or cheap weapons of "mass destruction" has been increased. Many of the countries that are of concern in all the proliferation areas are politically and militarily unreliable and certainly add to the uncertainty where proliferation is concerned.

In recent years, new proliferation concerns, both missile and chemical, have surfaced. The Missile Technology Control Regime (MTCR) officially started in the Spring of 1987 and stemmed from concerns that more small, lesser-developed, third world countries were demonstrating capabilities to acquire, assemble, and in some cases, launch missiles capable of traveling in excess of 1000km with warheads weighing more that 500kg. The MTCR currently consists of seven countries that, under written agreement, have stated they would limit flow of certain items and technology to other countries that have demonstrated either the desire or intention to become missile capable. In most cases, the items or technology of concern are not first generation, but rather second or even third generation.

The third area of proliferation concern, and one that has received much attention recently, is in the area of chemical munitions that have been made and used by an increasing number of lesser-developed, third country nations. The use of such weapons by these countries has fostered international concern and the call for action. The precursor chemicals that are used to make these weapons have been easily obtained while the technology needed for combining them into chemical weapons is rudimentary.

Many of the nations that have agreed to the MTCR and the chemical proliferation controls do not coordinate or even standardize their control lists or mechanisms, after trying to control lists of equipment and technology that are too narrow while the U.S. list is too broad.

D. DoD Organization of International Activities

Apart from policy making considerations, there are currently three organizational entities within OSD with significant implementation responsibilities in the international arena: the Defense Security Assistance Agency (DSAA), dealing with foreign military sales; the Defense Technology Security Administration (DTSA), dealing with munitions licenses, DoS/DoC commodity jurisdiction cases, and strategic East-West trade; and the Deputy Under Secretary of Defense for International Programs (DUSD (IP)), dealing with international cooperative programs in research, development, and production. There are about 300 people in these organizations. DSAA and DTSA report indirectly to the USD(P) and DUSD(P) reports to USD(A). The DDR&E, also reporting to USD(A), is responsible for providing technical advice to all of these organizations.

The existence of three implementing organizations creates many opportunities for disorder, including: overlapping and duplicative functions; inadequate attention to emerging needs (such as evaluations of proposed foreign investments and acquisitions, and provision of assured access); inconsistent corporate behavior (such as approving transfer of technology as part of an FMS arrangement and denying the transfer of the same technology

as part of a direct sale); an array of confusing focal points for other Departments and Agencies, foreign government, and U.S. and foreign industry. Currently, the only senior OSD official with the responsibility for the entirety of these activities is the Secretary of Defense, and it is not reasonable to expect the Secretary to devote the day-to-day attention required.

Accordingly, there is a need to consolidate these implementation activities under the direction of a single senior OSD official other than the Secretary of Defense. Since the technical content of these activities is high, this official should report through the technical responsibilities and authorities of the USD(R); the role of USD(P), within DoD, is clearly to establish policy regarding relationships with other countries. What is needed is centralized responsibility and authority for technical execution.

VI. R&D INVESTMENT STRATEGY FOR THE 1990s

1. The Strategy

After reviewing the findings and recommendations of each of the Task Forces, the following investment strategy was formulated that responds to a future characterized by lower budgets, fewer opportunities for new starts, and greater uncertainty. Accordingly, this investment strategy safeguards our capacity to rebuild or reconstitute forces which will be an important element in our ability to deter aggression.

Yet in light of this, we recognize the need to modernize an aging inventory and take advantage of the progress that will continue to be made world-wide in technology. Some of our recommendations are in line with actions and initiatives that are already being taken to reform and streamline the acquisition process. Others, we hope, offer some new approaches that will help establish a stronger technology and industrial base for the '90s. In all cases, we expect that our recommendations will help in articulating a sound R&D investment strategy within the Administration and especially in the Congress.

2. Challenges

As previously indicated, we recognize some of the major challenges in establishing a credible R&D investment strategy. These are:

- A smaller budget, which dictates a discipline in our attempt to address where increases in budget could be offset by reductions;
- A defense industry that will be smaller than it is today;
- Much smaller procurement quantities and fewer new starts;
- A force inventory that is growing older and needs to be selectively upgraded; but at the same time recognizing that...
- Technology is advancing at a rapidly growing pace, and it will continue to do so on a global basis, with both our friends and adversaries having greater access to that technology.

- Further recognize that many of the R&D assets we depend on (a healthy university research environment, design teams in industry and in some cases production teams, Government Labs, etc.) are perishable, and if allowed to deteriorate or atrophy, are difficult to restore.
- The need to be mindful of, and hedge against, the possibility of technological surprise; and
- Recognize that there is much greater uncertainty in the kind of missions we will face in the future.
- Also recognize the need to develop systems suitable for quick reaction capability. Here we have in mind hedging against the projected uncertainty by having systems that can use "off the shelf" or commercial parts.

3. Six-Point Strategy

It is within the context of these challenges that we formulated recommendations for a R&D investment strategy for the '90s.

A. Breakthrough Technology

One of the first priorities, and something we think must be vigorously protected, is our ability to generate the breakthrough technology that has the potential to revolutionize military capability. The source of these breakthroughs is ideas, concepts, and basic research that comes from universities, industry, government labs, and other agencies.

The source of funds that nurture the environment that generates the breakthrough technology is 6.1, 6.2, and IR&D. Fortunately, this most important element of the R&D enterprise is also the least expensive. Because of its overwhelming importance in driving a healthy and robust defense R&D strategy, we recommend that the highest priority be placed on this part of the budget: 6.1, 6.2, and IR&D. The specific budget recommendations with offsetting reductions will be addressed at the end.

B. Mainline Development

The mainline development process is in place and will continue, although with far fewer new systems passing through that "pipeline" in the future. This mainline acquisition system is in need of major overhaul to make it more efficient and we know there are USD(A) directed studies (DMR, Acquisition Streamlining, etc.) focused on making the system more effective. We encourage proceeding with these streamlining efforts.

There will continue to be a certain formality to this process, however, that is characterized by:

- Formal requirements with decisions based on ability and readiness to pass through the various gates to production;
- Programs that enter the pipeline are expected to pass all the way through with an intent to deploy;

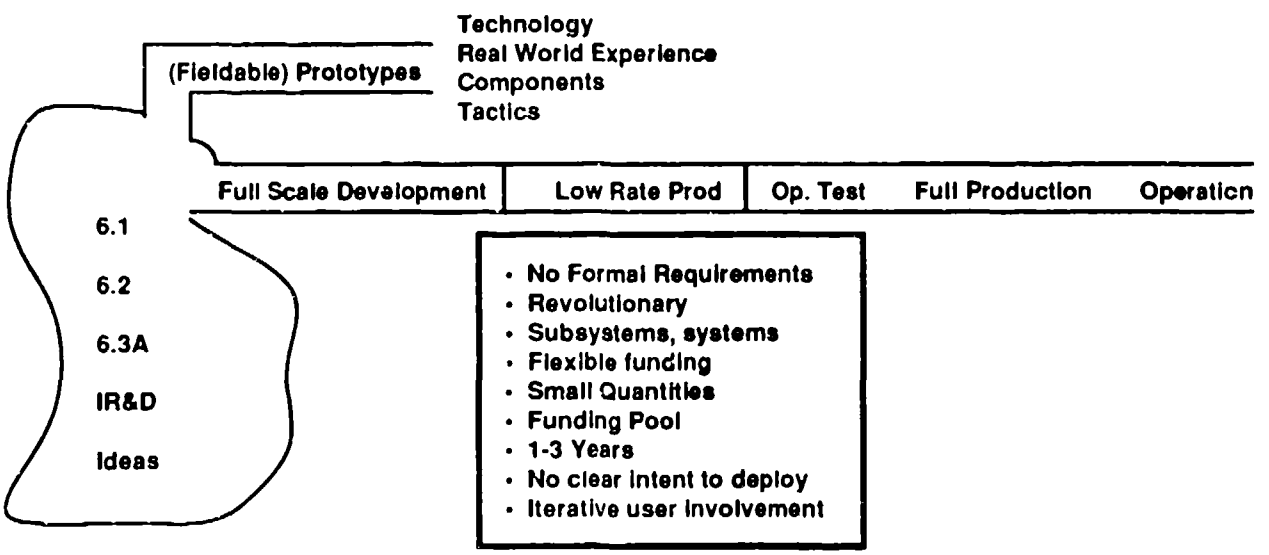
- The process is best suited to major systems acquisitions, often characterized by at least an intent to procure large quantities; and
- The time frame is unduly long (10-20 years);
- All the "ilities" are emphasized from the beginning.

No recommendations are made here concerning streamlining the mainline acquisition system, other than to encourage proceeding with the plans already underway. But in addition to that, we strongly believe that the following additional actions be taken to strengthen the R&D process.

C. Fastrack Initiative

We recommend establishing a new, fast-track technology initiative that will encourage more frequent use of prototyping with the intent of having selective, fieldable prototypes available quickly for real-world experience involving users. Because there will be fewer new systems, it will be more important than ever to have small numbers of advanced technology prototype systems in the hands of the operators. This experience is fed back to the developers for further improvement while at the same time possible changes in tactics can be evaluated. We must not encumber this fastrack technology initiative with hard, formal requirements. The intent of this technology initiative is to rapidly produce fieldable prototypes that have an order-of-magnitude impact on cost, or performance, or tactics over current systems or platforms. The emphasis is mostly on prototyping subsystems (imbedded in proven platforms as systems testbeds), although occasionally new systems are prototyped (see Figure 9).

Figure 9: Fastrack Initiative



Small quantities are built in a "skunk-works" type environment, featuring: streamlined development, with the intent of getting experimental hardware to the field quickly (1-3

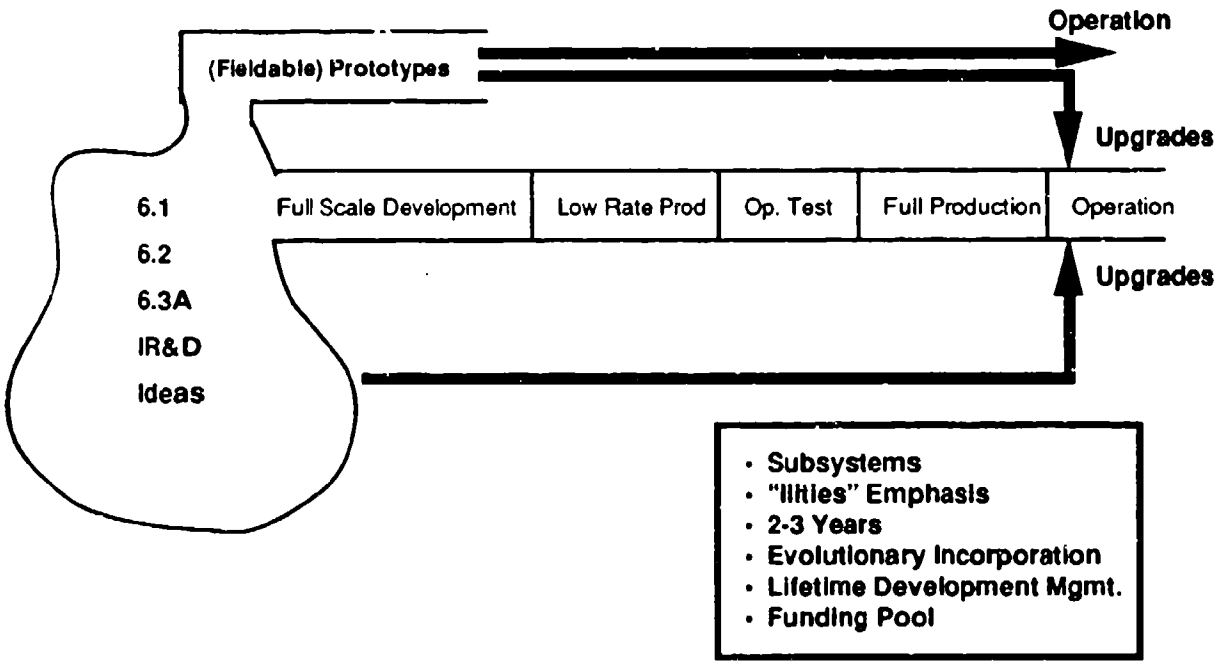
years). The funding is flexible covering concept development, hardware, logistics support, and operational testing from a single funding pool -- one color of money from cradle to grave. There is not a prior intent to deploy, but in fact, technology insertion may be by this path, as illustrated in Figure 10.

D. Technology Insertion

With an aging inventory and fewer new systems projected in the acquisition pipeline, special attention is given to inserting technology in fielded systems to upgrade performance and keep old platforms current. This approach has the two distinct advantages of being much less costly and faster than developing a new system.

There are several paths that we recommend be established to facilitate rapid insertion of technology to upgrade fielded systems. One would be that some of the prototypes on the Fastrack path could find their way directly into operations in some limited, low quantity situations. Or, some of the subsystem prototypes could be incorporated directly into the field in retrofit kits. Some technology, proven through the prototype path, would enter the formal acquisition pipeline. Note that other technology on the Fastrack path might go back to the laboratory for refinement or further exploratory development, and some would just be terminated because it did not achieve its objective (see Figure 10).

Figure 10: Technology Insertion



Another path by which technology insertion, particularly components and subsystems of commercial origin, could be fed directly into upgrades of fielded systems is depicted by the lower path in the figure. Technology insertion also provides a means of incorporating

evolutionary as well as revolutionary ideas, assures that the "ilities" get proper emphasis throughout the process, and requires that program managers stay actively involved throughout the lifetime of the system

E. Commercial Harmonization

The commercial industrial base of the U.S. and the rest of the world is much larger and more robust than our defense industrial base and will continue to be so in the future as defense spending decreases. We need to exploit its use in military systems to the maximum extent possible. Furthermore, with reduced defense budgets and forces in reserve, remobilization and surge can only be accomplished by greater reliance on the commercial base. This is more than a substitution of commercial components for mil spec parts. It requires designing from the beginning around the use of commercial components and commercial manufacturing practices. We accept the fact that systems designed to exploit commercial technology and manufacturing may suffer in performance.

F. Low-Quantity Production

In the recent past, we have tended to develop systems with a plan to sustain full-rate production, but then because of reduced funds, we implemented a low rate production schedule.

In the world we have projected, there will be even less production money and fewer new starts. This drives us to a different concept: the concept of tailoring small factories that can efficiently produce at low quantities. We need to design systems that lend themselves to flexible manufacturing approaches for efficient, low-quantity production. This capability will also provide a hedge against the need to produce something in a quick-reaction mode to answer some real-world threat. Production should then proceed at the most efficient rate for the quantities required and then stop, i.e. do not stretch out production.

3. Funding the R&D Strategy

There is a way to fund the implementation of initiatives in the six-point R&D strategy within the constraints of a declining budget. We should increase the funding of science and technology (6.1, 6.2, 6.3a and IR&D) by about 30% in constant dollars over the next 2 -3 years. But these increases should only be made if management changes such as those outlined by the Technology Task Force are implemented. Reductions in full-scale development and procurement will occur. These reductions, together with the corresponding reductions which should occur in overhead, will be sufficient to establish the "funding pool" for the special fastrack and technology insertion initiatives. We should establish a DARPA-like organization to ensure that the fastrack and insertion initiatives have sponsorship and oversight.

VII. Quality People - A Common Theme

A common theme recurrent in each Task Force throughout the four month study was recognition of the severe decline in numbers of quality people serving throughout the Executive Branch and the serious need to develop a climate for change regarding government service for the future.

The situation our nation is facing in attracting, retaining and motivating the best people in government service has reached crisis proportions and will require a much greater sense of urgency to redress an imbalance that, when viewed from a defense standpoint, has long term risks to the national security of the United States.

The problem is clearly not unique to the Department of Defense and the instant issue is whether the "human resources erosion" that is being experienced among the government's three million-member work force has crippled our nation's ability to make proper decisions and give proper direction to programs vital to our future.

The government relies essentially on two classes of individuals. One class are those who enter government service expecting to make it a lifetime career. These careerists make up the bulk of personnel in the Executive Branch. As their careers develop, some of these people will end up managing national laboratories, commanding military forces, or operating multi-billion dollar space and defense programs. Clearly, we must have the highest quality professionals managing these kinds of critical activities.

One immediate problem is that these professionals are not compensated or supported anywhere commensurate with their responsibilities. Money, of course, should be secondary in any consideration of government service. But, because the pay gap has become too large, too few of our most promising young scientists, engineers and managers are choosing civil service careers.

The federal government's inability to attract, motivate and retain the kinds of people that are needed to do the work that is essential to our nation cuts across all levels of government employees, from senior officials in the Pentagon to lower wage scale employees in every department in the government. When viewed against the defense challenges of the next two decades, it is perhaps the most serious and pervasive problem the government faces today. What then, should be done?

First and foremost, it must be recognized that when it comes to attracting good people, the government is in a head-to-head competition with the private sector, and although it is trying to attract only 3 percent of the total work force, it is just not sufficiently competitive.

To become competitive:

- Congress must remove the over-burdening checks and balances it has established for the Executive Branch so that future public servants can be provided the opportunity and authority to do the job;

- Common standards should be set for all three branches of government;

- Our lawmakers must work to significantly improve the pay structure so that Federal salaries truly compete with the private sector;

- Congress should define reasonable requirements to enable the establishment of fair and equitable blind trust arrangements for those who must forsake their stock and pension plans, including elimination of the tax penalty if assets are rolled over;

- Each government department, including Defense, should establish an Assistant Secretary level position whose primary mission should be to develop an environment conducive to attracting and retraining the best our country has to offer;

- Those in the academic community must be more supportive of people who choose government service, either as a career or on an appointive basis;

- Those in industry must do their part by acting more responsibly in controlling program costs and in working more closely with Congress and the news media to improve their image and that of their customer.

The second class of people who go into government intend to serve only a few years in senior positions. These individuals are attracted to the government because they have achieved excellence in their careers and their talents are needed and sought by the government. Here too it has become increasingly difficult over the last two decades to attract professional people to serve in these "Presidential Appointee" positions. Once again, compensation plays a part, but only a part. A Vice President of research and engineering earns about $200,000 a year in addition to enjoying all the normal executive benefits such as stock options; a well funded retirement plan; and an excellent benefits package. As an Assistant Secretary for research and development, this same individual is expected to serve his government for $80,000 a year.

In addition to severely reduced compensation, conflict of interest laws require divesting stock and buying-out the pension plan which may cost the individual tens of thousands of dollars more because they must pay taxes on this divestiture fund rather than taking it over their retirement years. Finances aside, this same executive, who has held positions of trust and responsibility for the last 20 years, must face microscopic Congressional and public scrutiny, with his personal and professional life, and the lives of his wife and children, becoming an open book to inquiring Congressmen and probing news media.

Two other important issues are raised in the hiring process of Presidential appointees. First, the confirmation process now takes much too long to complete. Lengthy investigations, hearings that are delayed for months and months have all but crippled the government's ability to bring such people on board in a timely manner, further discouraging prospective employees from serving. Second, complex and confusing ethics rules penalize the many good people who wish to serve their country. Of course, Federal regulations to prevent wrongdoing in industry and government are vital to protecting the interest of the government and American taxpayers. But

stringent revolving door policies and Draconian rules governing conflict of interest have severely curtailed the entrance of high quality personnel to government service.

In summary, the Defense Science board believes that an effective technology strategy and plan for the 90's and beyond will require the very highest quality people the nation has to offer. We must begin now to develop a set of activities that will represent our best efforts at assessing and improving the current state of American science, engineering, education and defense, by examining the talent and trends in government and developing inducements for attracting, training and retaining the best people to serve our country.

VIII. DSB Summer Study Task Force Recommendations

(Recommendations are listed in priority order within each task force area.)

1. Scenarios and Intelligence:

a. Reserve Force: The majority of intelligence resources continue to be spent on people. There is considerable potential for cost savings through the shifting of some tasks which are now less time sensitive to a reserve force, including both reserve military and civilians. For the military, analytic tasks can be assigned to service reserve military units. Programs must be established to maintain both clearances and skill levels. In the civilian sector, a new reserve program can be established to utilize the skills developed in the government, the contractor base, and academia.

b. Leap Ahead Strategy: It is essential that we invest now in technology and analysis efforts designed to improve manpower productivity and the quality and timeliness of the intelligence product. At the "front end" of collection, for example, advanced technology can focus resources on the targets of greatest interest and potential, reducing the burden on linguists and analysts. Similarly, automated tools for analysts will enhance their capabilities and productivity significantly.

c. Cooperative Measures: Cooperative intelligence initiatives have been highly beneficial in the past, and hold substantial promise for the future, with our allies, other key countries, and perhaps even the Soviet Union. These nations have both unique collection capabilities and special analytical resources to contribute. In many cases, the U.S. could share information to the benefit of both parties -- particularly space based information. Moving beyond our traditional allies and intelligence partners, the arms control process has made sharing of data in selected areas a possibility which can both save costs and serve as a confidence building measure.

d. Increasing Intelligence Lead Time: To deal with increasing uncertainty in the world, we must expand efforts aimed at increasing the lead time associated with critical events -- by focusing on detection of the indications of change in the political, economic and military spheres and the achievement of technological breakthroughs. As U.S. forces are reduced, and forward basing eliminated in many areas, these lead times take on a new importance. Similarly, as we move toward globalization, advanced indications in the political, economic and technology spheres becomes more important as well.

e. Open Source Collection: Increasing "openness" in what have long been closed societies, such as the Soviet Union and Eastern Europe, as well as greater proliferation of information from other nations, provides the opportunity to meet some intelligence needs without using very costly collection and assessment means, saving these resources for targets that remain truly denied. Similarly, the increased ability to access previously denied

areas permits the deployment of low cost, unmanned sensors which can perform some of the functions performed by more expensive systems. On the other hand, this information explosion places a premium on technology to handle it.

2. Strategic Forces and Supporting C^3 Recommendations:

a. Planning: Create a joint strategic planning System Program Office for the acquisition of strategic planning equipment and software. The development of hardware and software for planning the delivery of a weapon to a target is ill-served by the current platform-oriented program structure and organization. There are at least five different aspects to planning that require central RDT&E management integration which, in addition, potentially provide technical synergies. These are: 1) improved SIOP production capability, allowing the speedup of the process so that "what if" questions can be addressed and provision made for the rapid replanning of strategic forces to facilitate their employment under unforeseen or rapidly evolving circumstances; 2) the comparable capability, but under austere conditions such as would exist in survivable planning elements; 3) the integration of our offensive planning capability with defensive BM/C^3; 4) consideration of NCA decision aids such that status information can be efficiently received, available options can be reviewed and modified, and guidance to planners can be provided; and 5) integration of central planning with on-board re-planning capability so that airbreather platforms can operate both autonomously and in communication with other information-providing and guidance-providing sources in near-realtime. Such enhanced planning capabilities will become increasingly important as arms limitation agreements reduce the number of strategic warheads available to deter aggression.

b. Single Warhead Missile: The Triad of strategic forces should remain the basis of our deterrent posture. This will require replacement of current Minuteman ICBMs as they reach the end of their service life. Arms control directions suggest that ICBMs be de-MIRVed to enhance crisis stability; budget considerations suggest that lower cost basing in silos is preferred to mobile basing. Nevertheless, options for mobile and deceptive basing should be preserved. The goal, therefore, should be the deployment of a single RV silo-based missile. Emphasis should be on low cost guidance at the expense of more accurate guidance. The need to provide for future payloads suggests that the current 37,000 pound missile may not be adequate. An additional advantage of this recommendation is that it could provide a "hot" ICBM production line in the event the Soviets break out of arms limitation agreements. This, taken with ongoing production of bombers and submarines, will serve to maintain an industrial base for strategic systems.

c. Light Attack Air and Missile Defense: As additional nations acquire nuclear weapons and the means to deliver them, the threat of light attacks consisting of at most 10's of RVs or a few airbreather platforms will increase. Such nations can not necessarily be

expected to conform to the concept of deterrence that has shaped U.S and Soviet nuclear strategies. To provide good protection for the nation from the disaster of possible "light" attacks from such undeterred nations, an effective defense should be examined, since such a defense is likely to be attractive to other nations also. Various multinational arrangements for the provision of tactical warning and attack assessment information and ground- or space-based interceptors are possible and should be explored. A strategy for the negotiation of the necessary changes to the ABM treaty to provide for this needs to be developed.

d. Airbreather Flexibility: Intelligence capabilities provide useful pre-mission information to plan bomber search routes of high probability areas for Soviet mobile missiles, but terminal location and identification, in the face of significant cover, concealment and deception, will be required. Furthermore, mobile strategic forces are not the only relocatable targets of potential future interest. This mandates an aggressive program of sensor RDT&E, integration of appropriate sensors on manned and unmanned penetrating platforms, and the exploration of a variety of sensor platforms on-board, off-board, and fly-along.

The evolution of a multipolar world of nuclear nations of diverse sizes and capabilities will require that the U.S. be able to respond to threats or to attacks with strategic forces at levels below that of a nuclear exchange. While a variety of ballistic and airbreather weapon delivery modes are possible, the most credible is the precision delivery of non-nuclear weapons from manned and unmanned platforms. The requirements on range, accuracy, penetrability, and size must be addressed, as well as the weapon integration and C^3 issues for existing and future delivery systems.

e. Nuclear Weapons: Ongoing programs directed at improving the safety of stockpile weapons should continue so that confidence in the deterrent capability of deployed systems can be maintained at the highest possible level. This, as well as the continued deployment of modernized delivery systems, will require that the nation's nuclear weapon production complex be operated at a level consistent with needs, both before and after conclusion of a START agreement. In the longer term, limitations on nuclear testing are possible so that steps should be taken to mitigate their impact. This will require a new class of warheads designed to have broad utility across a wide range of delivery systems, employing the best available technology to enhance their safety and reliability, and designed with margins that will reduce the need for revalidation of their operational effectiveness. Finally, an RDT&E program must be maintained at a level adequate to assure a continued supply of technical personnel to maintain national competence in weapon design, testing, production, certification, vulnerability, and effects.

f. Strategic C^3: The strategic modernization program to provide enhanced tactical warning, connectivity, and endurance should be completed. This will provide highly

credible support for the choice and execution of preplanned options. MILSTAR is the cornerstone of this modernization program; it should be continued. When MILSTAR enters operation, significant numbers of systems currently providing redundant backups should then be phased out.

g. SSBN Follow-on: Replacement of Ohio class SSBN's will be necessary as the current platforms reach the end of their service life. These replacements will become operational in a presumed START II implementation post 2010. Since the requirements on this replacement class will be highly dependent on the evolution of strategic submarine mission requirements and on negotiated force levels, a broad and vigorous RDT&E program to explore and extend the technological horizons on materials, propulsion, navigation, communication, signature reduction, weapons, and operational concepts must be maintained. Initiation of system studies for a wide range of conceptual designs must be undertaken in the near future, possibly employing experimental platforms to establish critical design parameters.

3. Tactical and Supporting C^3:

a. Fieldable "Prototypes": In contrast to FSED, we need to develop a way to provide an effective means to better understand and evaluate the risks (technological, economic, military, and political), to reduce development costs, to validate operational need prior to full scale production, to facilitate product improvements, and to ultimately minimize overall modernization costs (see recommendation 6.c).

b. Stealth/Counterstealth Technology: To enhance survivability of the total force, maximum use of stealth technologies must be incorporated into land, sea, and air platforms and facilities, and counterstealth capabilities must be incorporated into weapons systems to enhance effectiveness against low observable targets.

c. Space: Used both to enhance support of tactical operations, and to develop a global situation awareness system, using U.S. space-based sensors to provide information to allies and threatened countries via a variety of ground stations (see recommendation 1.c). Pay greater attention to Third World arms sales as a likely source of technological surprise.

d. Counter tactical bailistic missiles: Develop deployable air defenses, and develop the ability to target the launchers (especially important when operating against chemical warheads).

e. Ship defenses: Surface ship defense against missiles and torpedoes must be improved with decoys, active/passive countermeasures, low observables, and active point defenses:

- There is an urgent need to upgrade point defense capability of our surface combatants against current and projected L.O. anti-ship cruise missiles. Both active defenses and coordination of point defense weapon and sensor systems are needed.
- Third World Submarines -- Detection is the problem (once detected, submarines can be killed with existing systems). Shallow water ASW emphasizes the need for active acoustic sensors, bottom emplaced sensors, and non-acoustic sensors;
- ASW capability organic to the battle group will have to operate without shore-based support. Upgrade Helo (surface ship active sonars) with improved digital techniques, provide expendable active acoustic sources, and improve non-acoustic detection of periscopes/masts.

f. Aircraft defenses: Counter widely proliferated air-to-air and surface-to-air missiles with emphasis on IR defense; retrofit existing platforms with stealthy features.

g. Tactical C^3: Effective battle management requires responsive C^3 and near real time intelligence and target acquisition systems to optimize force deployment and to synchronize the commitment of all elements involved in the operation.

h. Submarine C^3: Near real-time C^3 for U.S. submarines to conduct missile attacks against land and sea targets is an important force projection element in regional conflict scenarios.

i. Deployability:

- Insist that forces and lift be matched and that most new fighting systems be designed for rapid deployability by air or sea.

- Base intelligence staff in CONUS and uplink/ downlink information to field.

j. Training: Make greater use of simulators and computer-aided gaming to supplement reduced field training.

k. Non-cooperative target recognition: Pursue a multiple technology approach as recommended in an earlier 1989 DSB Summer Study.

4. Technology Recommendations:

a. Technology CEO: Establish a "CEO" who solely has the responsibility, authority, and accountability for:

- A single, unified, balanced technology investment strategy.

- Establishing the S&T TOA for each of the Services & Agencies consistent with the technology investment strategy.
- Measuring performance against strategy;
- Championing specific initiatives, e.g.: technology demonstrations, joint service projects, technology insertion, high risk/ payoff technology, and a manufacturing technology investment posture.
- It should be noted that this position differs from the position of the Director of Defense Research and Engineering in that it has both TOA authority and execution responsibility. It is envisioned that DDR&E would continue to coordinate activities other than the science and technology base.

b. Each service and agency should establish Program Executive Officers (PEO's) who will be responsible for, and have the authority to, execute that service or agency's S&T programs in accordance with the "CEO" established objectives and strategies. Status and progress will be reported to the CEO.

c. The JCS should establish an organization to support scenario based technology investment strategy formulation.

d. Civil/Military Harmonization: Effective integration of the DoD Tech Base activities with those of industry and universities can provide major technology leverage as well as cost and "cycle time" leverage. Responsibility must be assigned to remove the current barriers to harmonization and to measure success. This should be linked to a "critical" defense industries effort (see supporting recommendation 6.e).

e. Technology Funding: The current level 6.1, 6.2, 6.3A funding should be increased by about 30% in real terms over the next three years contingent on implementing the reforms specified in this report.

f. Defense Manufacturing: A manufacturing philosophy must be developed in support of higher investment (including IR&D) in process and manufacturing technology.

5. Technology Transfer Recommendations:

a. DoD Organization: SecDef should consolidate and streamline the three DoD organizations currently involved in the license approval process, international cooperative acquisition and development programs and technology transfer policy. We further recommend that the consolidation include the assignment of sole responsibility for these implementation activities to an Assistant Secretary or Deputy Under Secretary level position reporting directly to USD/A. The activities of this consolidated office should also include

matters concerning defense industrial cooperation, government to government agreements, evaluation of foreign investments in defense critical industries, foreign military sales, and technology export controls. This would not infringe upon the responsibilities and duties of USD(P) within DoD to establish policy regarding relationships with other countries.

b. Export Control Reforms:

- Eliminate dual-use controls except for a small list to a few countries;
- Eliminate munitions licenses on unclassified products to COCOM countries;
- Demand firm compliance by governments and industry to the smaller list of items;
- Eliminate third country transfer controls, consistent with other criteria, when U.S. content is not the majority.

c. Assured Access to Critical Technologies: Foreign investment in defense critical technology companies should be reviewed by DoD through the CFIUS process to insure that there remains an assured access to ese technologies.

6. Investment Strategy Options:

The following R&D investment strategy for the 1990s responds to a future characterized by lower budgets, fewer opportunities for new starts, and greater uncertainty over future adversaries:

a. Breakthrough Technology: Protect the ability to generate breakthroughs that have the potential to revolutionize military capability, including IR&D;

b. Mainline Development: The mainline acquisition system is in need of major overhaul to make it more efficient; USD(A) should continue to place emphasis on reforms to make the system more effective;

c. Fastrack Initiative: Establish a new fast-track initiative that will enable more prototyping with the intent of having selective, fieldable prototypes available quickly for real-world experience involving users (see related recommendation 3.a);

d. Technology Insertion: With an aging inventory and fewer new systems projected in the acquisition pipeline, special attention must be given to inserting technology in fieldable systems to upgrade performance and keep old platforms current;

e. Commercial Harmonization: The commercial industrial base of the U.S. and the rest of the world is much larger and more robust than our defense industrial base and will continue to be so in the future as defense spending decreases. Commercial practice should be exploited in military systems to the maximum extent possible (see related recommendation 4.d);

f. Low-Quantity Production: In the world that we have projected, there will be even less production money and fewer new starts. The use of tailored small factories that can efficiently produce at low quantity and then shut down is encouraged. We need to initiate prototypes of such efforts.

g. People: Implementing these changes will require a culture change in the acquisition community and will require the most capable people our society can produce. Clear responsibility for fixing the DoD acquisition people problems must be assigned.

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