REPORT
of the
# DEFENSE SCIENCE BOARD

## 1991 SUMMER STUDY
## ON
## WEAPON DEVELOPMENT AND PRODUCTION TECHNOLOGY (U)

**NOVEMBER 1991**

OFFICE OF THE UNDER SECRETARY OF DEFENSE FOR ACQUISITION
WASHINGTON, D.C. 20301-3140

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-3 140

DEFENSE SCIENCE
BOARD

MEMORANDUM FOR SECRETARY OF DEFENSE
UNDER SECRETARY OF DEFENSE FOR ACQUISITION

SUBJECT: Report of the Defense Science Board (DSB) 1991 Summer Study on Weapon Development and Production Technology - ACTION MEMORANDUM

I am pleased to forward the final report of the DSB Summer Study on Weapon Development and Production Technology, which was chaired by Mr. Bob Fuhrman and Mr. So1 Love. The objective of this study was to review and make recommendations regarding how the DoD should develop and support a manufacturing technology strategy.

The Task Force found that the manufacturing base, which is needed to ensure an adequate supply of technologically superior weapon systems, faces new and difficult challenges. Although every sector, e.g., aircraft, missiles, electronics, etc., has its own peculiar requirements, there are significant interrelated issues which should be addressed. Taking maximum advantage of commercial and industrial developments is essential to improving defense manufacturing.

Of principal importance is the need to integrate and control all production and related design processes, starting with concept and not concluding until retirement. To do so, it will be essential to balance product and process, provide increased incentives for industry investment, remove existing barriers to efficient defense production, encourage early user and producer interface, and have a comprehensive Defense Manufacturing Plan. The Task Force believes that implementation of the recommendations on these issues would have a substantial effect on increasing affordability, reducing costs, increasing quality, and reducing cycle time.

I recommend that you review the Executive Summary and the summary section (pages 37-43) which highlight the specific findings, recommendations and implementation actions.

John S. Foster, Jr.
CHAIRMAN

ATTACHMENT

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-3 140

DEFENSE SCIENCE
BOARD

15 November 1991

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Report of the Defense Science Board (DSB) 1991 Summer Study on Weapon Development and Production Technology

Attached is the final report of the 1991 Defense Science Board Summer Study on Weapon Development and Production Technology. Although increasing the DoD investment in manufacturing process technology was found to be of great importance – in line with the 1990 Summer Study recommendations – the Task Force notes that there is no single "silver bullet" and that a comprehensive approach supported by a Defense Manufacturing Plan is required.

The Task Force basically attempted to answer the question: How can we use what our industries have learned about quality, cost reduction, and cycle time reduction to help produce the required technologically superior weapon systems of the future? We examined all of the elements bearing on the problem including manufacturing practices and procedures, management, obstacles and barriers, the workforce, incentives, and the market for defense systems itself. Our recommendations address three broad areas of the strategy; resources, the management process, and the barriers to efficient defense production. Within these, we found that the single biggest problem was control of the development and production process by management to include early user and producer requirements interface.

We believe that implementation of our recommendations, summarized on pages 37-43, will provide a sound basis for maintaining a strong national defense under declining budgets as we move into the uncertain post cold war era.

We want to make special mention of the outstanding contributions of each member of the Summer Study panel and the fine assistance provided by the government advisors.

Sol Love
Co-Chairman

Robert A. Fuhrman
Co-Chairman

Attachment

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# EXECUTIVE SUMMARY

## EXECUTIVE SUMMARY

This report details the findings of the Defense Science Board Summer Study on Weapon Development and Production Technology. This Task Force was formed as a follow-up to last year's DSB recommendations regarding the need for a manufacturing technology strategy for the Department of Defense. In addition to the delineations in the Terms of Reference, the following general questions were posed for this study:

Given reduced defense budgets, fewer programs, stretched out production far below past economic production rates, overcapacity, a shrinking industrial base, and reluctance of second/third tier suppliers and many commercial producers to participate in the defense industry,

1) How does one achieve unit production cost to a level at, or near equal to, that of higher production rates?

2) How does one incentivize the second/third tier, and commercial producers (where appropriate) to participate in the defense market?

3) How does one mitigate the past record of schedule slippages and cost growth on major programs, through improvements in the efficiency of the production process?

4) Given that production surge capability may be increasingly limited, how does one protect reconstitution of this capability?

The assemblance of a group of experts, all of whom had attained senior status in these fields, was the first step in this process. Each has background and involvement in many programs--both successful and marginal--with many lessons learned that were incorporated into the Task Force findings and recommendations.

The Task Force spent four months investing 4000 total manhours, through 200 meeting hours, and the review of more than 40 separate papers related to these manufacturing issues in preparation for the two week summer study session. Presentations and thoughts were generated from elements of the defense, commercial and foreign industries, from other government agencies, the National Academy of Engineering, and academia.

The Task Force concluded the following:

1) The major driver in defense product unit cost is infrastructure 'overhead' which accounts for 40-60 percent of unit cost. The pie chart in Figure 1 depicts the relative contributors to product cost. "Touch labor" accounts for about 10 percent of the total.

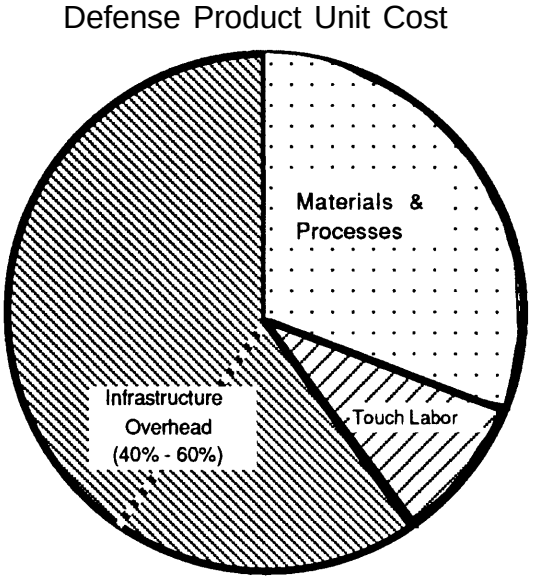



Fig. 1

In essence, the design engineer and the tool box carrying manufacturer are the only direct value added labor. All else is support or indirect labor.

2) Intelligent and proper mitigation of the litany of "how to" military specifications, cost accounting standards, and procurement regulations can provide a vehicle for participation of second/third tier suppliers and commercial producers in the defense market.

3) Schedule slippage and cost overruns are generally attributable to: a) customer requirements that are not reasonably attainable, b) inadequacy and lack of timeliness of risk closures, and c) inadequate front end, time critical planning of the total process flow. In addition, the lack of a fully integrated, real-time management decision or command and control system makes timely control and correction very difficult.

4) Intelligent assessment by individual manufacturing sectors (aircraft, ships, et. al.) with a proper distribution of investment and work tasks can provide the direction to best maintain, and, if necessary, to reconstitute the industrial base.

The Task Force determined nine issues--all of which are considered actionable by DoD and/or industry--that when properly resolved will have significant beneficial effects on the questions posed and are responsive to the Terms of Reference. Eight of these fundamentally break into three categories: resources, management, and achieving efficiency. In addition, the Task Force judges that an integrated Defense Manufacturing Plan is needed to coordinate process investments from 6.1 research to the end of service life.

Details of the recommendations are included in the respective issues which follow in the main report. Several activities are already underway within OSD and the Services related to these recommendations. The Task Force believes that manufacturing can serve as an important tool in meeting our future defense challenges. Top-down emphasis, coupled with a more focused and coordinated effort on the recommendations, will move DoD well toward the attainment of its broader manufacturing-related needs.

# INTRODUCTION

- THE PROBLEM
- THE RESPONSE
- THE RESULTS

# INTRODUCTION

The defense establishment of the United States has entered a period of substantial reduction and change. As part of the effort to manage the coming build-down wisely, the Department of Defense and the Defense Science Board sponsored the 1991 Summer Study on Weapons Development and Production Technology. This report contains the results of that study.

The reasons underlying the ongoing defense build-down are several and complex, as are the steps necessary to manage it wisely. In order to set the stage for what is to follow, it is useful to examine the problem faced by the defense establishment as a result of national and international developments in the past few years. The problem has its roots in politics, national policy, national budgets, and technology. It reached its present, serious proportions through the series of steps, large and small, described below.

## The Problem

Since World War II, the United States has supported a substantial defense system production capability as a major element in its strategy for the Cold War. Initially, defense systems were produced in significant numbers and featured technological superiority as a matter of deliberate policy. Lately, two major developments have caused a restructuring of the national resources allocated to defense. First, the major potential adversary of the Cold War, the Soviet Union, underwent a radical change of policy (rejection of communism and fragmentation of the Soviet Union itself) which drastically reduced at least some of the military threat it had posed for nearly fifty years. Budgets are thus declining and will probably continue to do so for the foreseeable future. Second, a number of factors including the continually advancing technological content of weapon systems and reduced procurement quantities have caused unit costs to increase substantially. This has engendered questions about how much the nation can afford to spend for defense. The combination of these developments has caused deep concern about how technologically superior defense systems can continue to be produced in the necessary numbers and at the right time to maintain the defense of the nation. Although the threat from the Soviet Union has declined, the possibility of continuing peace is remote, as evidenced by recent events in the Gulf. The U.S. must maintain a substantial, effective defense to counter the (more diffuse) threats to its interests which will inevitably arise over the course of time. The question is, how?

## The Response

While these developments were taking place in the area of defense, parallel developments in the world of commerce were showing promise to help solve the problem. In recent years, foreign competition has caused U.S. manufacturing to undergo a wrenching self-criticism, analysis and change to improve quality, lower costs and reduce the time to get products to market. Many lessons were learned and applied, not only in the manufacturing processes themselves, but also in

how to manage and organize in order to compete more effectively in the marketplace. It was natural then, that in considering how to maintain the necessary levels of national defense, DoD should turn to the lessons learned in the manufacturing arena.

One response to the problem was to sponsor this summer study. The Terms of Reference (Appendix A) were based in part on the results of a previous Summer Study in 1990. That study concluded that DoD needed, but did not have, a strategy for manufacturing technology to handle its ongoing defense responsibilities with the reduced resources of the future. The present Terms of Reference originated here. They may be paraphrased: How can the DoD use what industries have learned about quality, cost reduction and cycle time reduction to help produce the technologically superior weapon systems of the future?

The Task Force assembled to address the problem consisted of representatives from government, industry and academia. All members (see Appendix B) had attained senior executive rank in their respective organizations. All had substantial experience in weapon system development, with particular emphasis on the manufacturing process itself. Deliberations and data gathering started in April, 1991 and extended through the summer. The formal meetings of the Task Force and its subgroups occupied over two hundred meeting hours (four thousand man-hours). In addition to the wealth of knowledge provided by members and advisors, the task force received valuable inputs from a wide range of expert sources.

Approximately 40 briefings were received from industry (defense and commercial, domestic and foreign), the National Academy of Engineering, the DoD, other government agencies and the U.S. Congress. Several ongoing defense programs were reviewed, including the U.S.A.F. B2 Bomber and F22 Fighter. In addition, over forty papers and other studies were reviewed, giving the task force a solid foundation on which to understand the relevant issues and develop meaningful, implementable recommendations. The results of all these activities are described in detail later. For emphasis, some of the major points are given below.

## The Results

The Task Force found that a world-wide industrial change is underway. The defense establishment must change in parallel. The modem definition of manufacturing is much expanded and encompasses the entire process beginning with the idea and continuing through the system's life. (Ref. Figure 2). The activity of producing goods must be viewed as a "seamless" process, involving the users, designers, producers, logisticians and maintainers at every point. This emphasis on integrated activity instead of incremental, compartmented steps must be transferred to the world of defense manufacturing. The resulting reduction in cost and cycle time, coupled with enhanced quality, will take DoD a long way towards its goals.

## MANUFACTURING PROCESS EVOLUTION

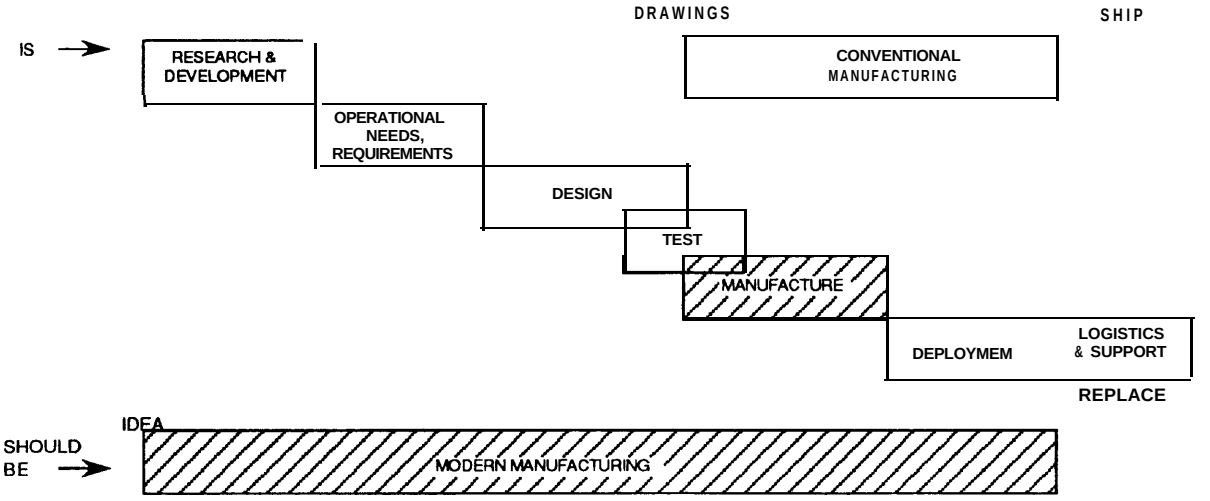



Fig. 2

The ability to have the defense world adopt this philosophy lies, in large part, within DoD. In addition to the changes in policies and procedures, people at all levels will have to be indoctrinated into the requirements of this approach and must embrace the potential and opportunities of the concept. Success will be aided by implementing the specific recommendations of this study including the preparation of a wide-ranging Defense Manufacturing Plan (DMP) to incorporate ongoing, relevant DoD activities. (Ref. Figure 3). The DMP will serve as a roadmap to the future to permit optimum use to be made of defense resources even as they decline.

## THE DEFENSE MANUFACTURING PLAN (FRAMEWORK)

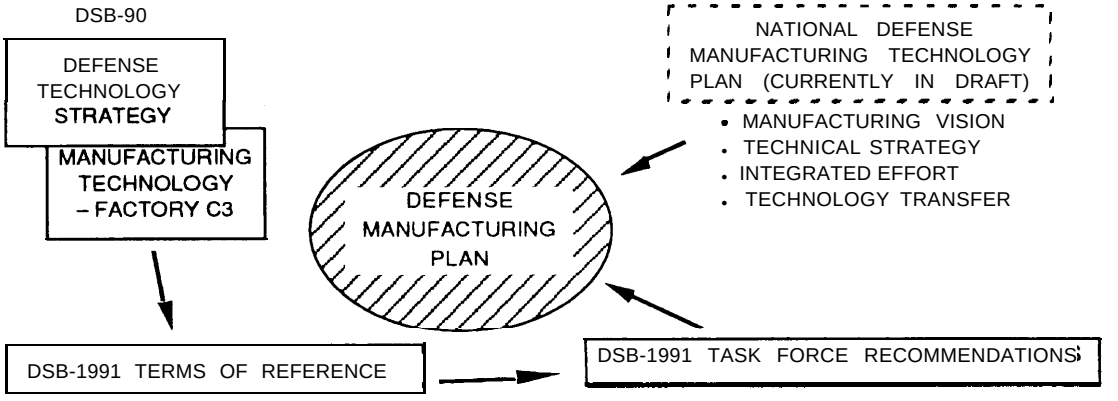



Fig. 3

The transition to a fully integrated process will require moving from the conventional notion of manufacturing that assumes the process starts with a drawing. The system, or production process, must incorporate the expanded notion of manufacturing which focuses on a seamless and totally integrated system process flow for the entire life of the system.

# SPECIFIC ISSUES, RECOMMENDATIONS AND IMPLEMENTATION

- ELEMENTS OF THE STRATEGY

- RESOURCES
  - BALANCE PRODUCT AND PROCESS R&D
  - INDUSTRIAL BASE SECTOR STRATEGY
  - INVESTMENT INCENTIVES

- THE MANAGEMENT PROCESS
  - INTEGRATED PRODUCTION PROCESS AND CONTROL
  - EARLY USER AND PRODUCER REQUIREMENTS INTERFACE

- ACHIEVING GREATER EFFICIENCY
  - REMOVAL OF BARRIERS
  - ADEQUACY OF THE NATIONAL SECURITY WORK FORCE
  - MANAGEMENT OF APPROVED GLOBAL SALES

- THE PLAN
  - DEFENSE MANUFACTURING PLAN

## ELEMENTS OF STRATEGY

Figure 4 depicts the elements of a manufacturing technology strategy which the Task Force believes must be addressed.

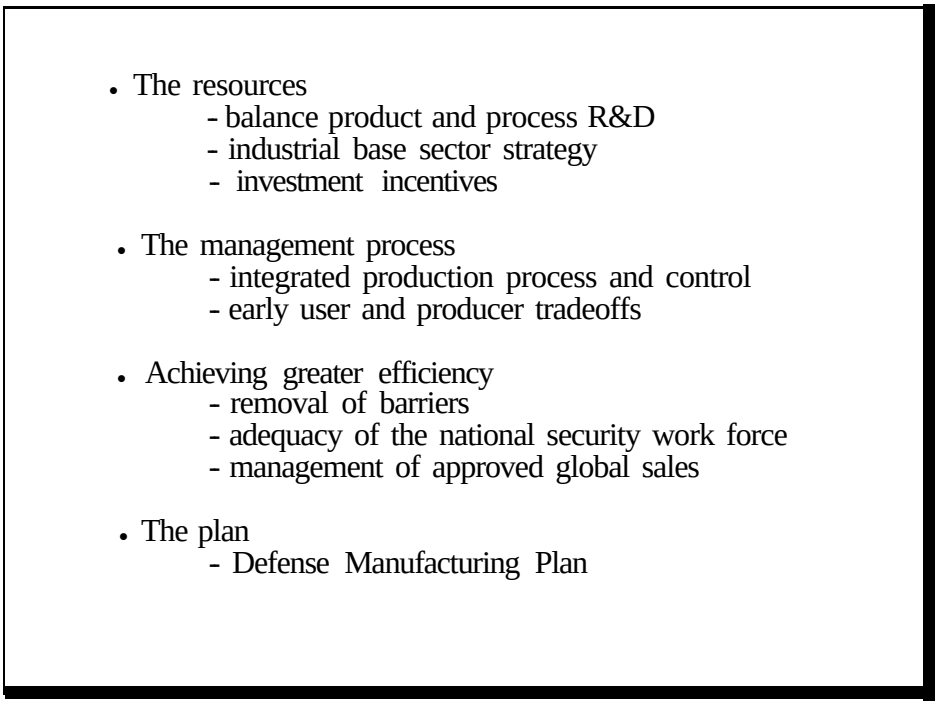



Fig. 4

With regard to resources, both direct and indirect allocation alternatives are suggested. The Task Force feels strongly as to how these resources should be directed for greatest impact. This report also contains suggestions on improving the management of the production process. Finally, attention should be directed to some of the pervasive underlying barriers and infrastructural issues necessary to achieve greater efficiency in manufacturing, design, and production, as well as to required incentives.

The end goal of this strategy is to design what can be built, and built affordably, faster, and better. The recommendations are actionable by DoD, and can help achieve this critical goal in a time of declining defense resources. The issues are addressed in greater detail in the following pages.

## RESOURCES

### 1. BALANCE PRODUCT AND PROCESS R&D

Historically, the DoD and its contractors have emphasized product R&D. During the past decade, new weapon system requirements, new materials development, and advances in manufacturing management and technique have made it necessary to conduct production process R&D in order to successfully enter production. Process is the manufacturing activity required to produce a product. As a result of the continuing emphasis in product R&D by DoD, the transition to production has become more and more lengthy and costly. In addition, weapon system design has been limited by a lack of new production process knowledge. This has resulted in designs which are largely resistant to modification.

In order to rectify this situation, it is necessary to increase the share of R&D allocated to the process of production and, more importantly, to start this R&D during the Science & Technology phase, and continue related R&D throughout the life cycle of systems. DARPA's MIMIC program, promoting early development of microwave process technology, is an excellent example of this approach, which has allowed products to accelerate through learning curves much faster than expected. This "seamless" approach is depicted in Figure 5.

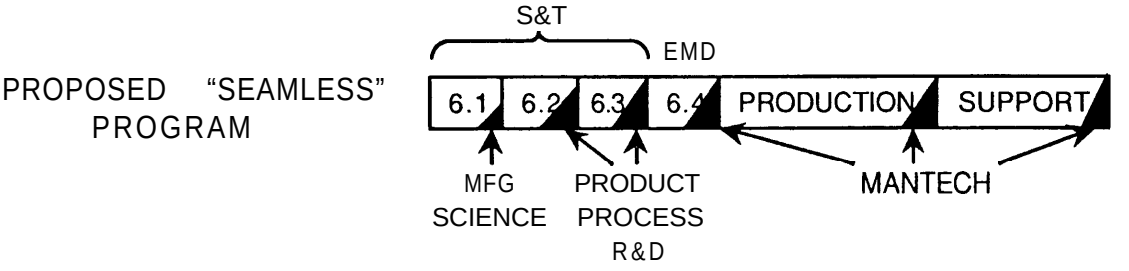



Fig. 5

**Recommendations:**

Introduce a "seamless" program of manufacturing research:

- The proposed new funding policy for R&D should integrate the production process R&D with product R&D by establishing funding levels throughout the S&T program starting with 6.1. Manufacturing Technology (ManTech) funding should be incorporated into the development cycle early in the engineering and manufacturing development phase. In addition, the transition of process development from S&T to ManTech must be continuous and well-planned.

- The defense industry should be incentivized to develop scalable production processes. Scalable processes are those which are sufficiently robust and viable to produce normal production volumes, and do so at acceptable cost and quality levels. This is in contrast to a production process developed only to create demonstrator models of a new product.

- ManTech funding should be allocated to develop and use a methodology to further extend the results of the earlier S&T phases.

- The responsibility for the development of the S&T program and linking it to ManTech should be assigned to DDR&E.

**Implementation:**

In order to implement the recommendations:

DDR&E should set funding goals for S&T programs specifically identified as production process R&D. Ambiguity should be removed by giving such projects a specific suffix or other indicator within its program element. Suggested goals are to increase the estimated level of $150m for FY92 to $600m by FY96.

USD(A) should increase ManTech funding at the same percentage rate as recommended above. Growth should commence from the $300m FY91 baseline.

USD(A) should modify the DoD 5000.1/.2, by inserting the words “and production process” following the word “design”, when appropriate.

## 2. INDUSTRIAL BASE SECTOR STRATEGY

The defense industrial base includes a complex mix of development, manufacturing, and depot-level maintenance activities. It consists of major components, namely:

- Defense contractors (primary component)
- Commercial business
- Organic government managed facilities (laboratories, ammunition depots, maintenance facilities, shipyards, including those operating government-owned/ contractor-operated facilities)

In order to develop a sound strategy for the limited resources available to the DoD for investment in the total production process from design through logistics support, in-depth analyses of each commodity sector is needed.

There is significant overlap of the three components. To achieve better leverage from the commercial and private industry investments and reduce government investments, the strategic objective for most sectors should be to maximize the participation of the commercial component and reduce expansion of DoD organic elements into areas covered by private industry. Duplication between private and government components should be reduced.

An integrated life cycle approach for production and logistics support for each sector will help balance and optimize the investment of resources to modernize and maintain the critical elements of both the government and private components of the industrial base, and would also facilitate surge and mobilization requirements.

### Recommendations and implementation:

Each sector strategy should be developed by a select group of experts from both government and industry. This group would report to USD(A). Their analysis in each sector should include a projection of the needs in each sector for production, reconstitution, and support as well as an assessment of the projected resources across the elements. Primary attention should be given to taking full advantage of private investments in both defense and commercial industries. Results would include recommendations of management actions to remove barriers for commercial businesses providing defense products. Relevant trade associations should be enlisted for support.

The analysis (supported by the Terms of Reference) should:

A) Conduct an assessment of needs in each sector.

B) Consider impact of international defense suppliers and markets. Identify critical capabilities where U.S. independence is imperative.

C) Evaluate projected utilization of capital-intensive resources.

D) Review impact on supplier base across the sectors.

E) Recommend division of life cycle support between government and private elements to best share investments, and rationalize duplication.

F) Determine which critical process technologies are driven by commercial forces.

G) Suggest incentives for commercial manufacturers to become dual-use suppliers to the DoD.

H) Recommend a prioritized investment and management strategy (the Strategy 2000 electronics study and the Manufacturing 2005 Project led by the USAF are good first efforts).

RESOURCES

## 3. INVESTMENT INCENTIVES

There is general recognition that the funding instability inherent in defense acquisition programs, the cost-based profit policy, and the negotiation approach to follow-on procurements greatly inhibit capital investment to improve efficiency and reduce costs.

The current and projected dramatic reduction in the defense acquisition program with the resultant decline in industry revenues and profits will seriously exacerbate this problem.

Additionally, tomorrow's high technology defense systems are characterized by a growing intimacy between the products themselves and their production tools and processes, i.e., the products are becoming more "capital intensive".

Whereas, earlier development programs could be undertaken on the basis of lower cost "soft" tooling, today's first developmental models require nearly the same fully-developed processes and factory equipment 'as required for later production models. This translates to an earlier requirement for capital investment than in the past. For example, low observables and stealth will only act to make the need for production tooling earlier a greater imperative. Shape, contour, and materials are critical to achieving low observable performance and can only be confirmed with production tooling, materials, and processes.

Even with assured program stability, current tax policies, and procurement policies, the need for reasonable industry profitability limits the expeditious write-off of needed capital investments. This capital problem is especially acute at the lower tiers which provide over half of all the components, assemblies, and subsystems of defense weapon systems. Clearly, any initiative to cope with the capital investment problem must be focused on both the prime and sub-tier levels.

Programs and contracting means exist which could be used to mitigate the effects of the above disincentives. They include the Manufacturing Technology (ManTech) program, the Industrial Modernization Incentive Program (IMIP), the Value Engineering (VE) program, Title III of the Defense Production Act (DPA), Independent Research and Development (IR&D), Manufacturing and Production Engineering (M&PE), and multi-year contracting. All of these approaches were developed and proven as viable means to promote increased capital investment on past defense programs. Each needs to be reviewed for more vigorous pursuit.

Obviously, the manufacturing technology developed under the DoD ManTech program and made available industry-wide relieves many companies from devoting duplicate scarce resources in pursuit of the same or similar technologies. IMIP is aimed at a government/ industry sharing of

the capital investment required to implement new technological capabilities into manufacturing, and a joint sharing in the resultant savings. Similarly, the Value Engineering program's objective is the continued pursuit of reduced production costs.

The incentive consists of the contractor's sharing in the cost savings. Finally, the Defense Production Act provides authority for the DoD to procure materials, components and processes which the industrial base could or would not normally provide except for a guaranteed procurement as provided for in Title III.

There is also little incentive for the defense industry to pursue non-capital initiatives aimed at long-term productivity improvements. Such initiatives include improved process control, cycle time reduction, variability reduction, supplier strengthening and associated employee training. In fact, investments made in pursuit of these initiatives, in anticipation of a projected program, increase overhead costs and may degrade the contractor's cost competitiveness.

**Recommendations:**

The Task Force is pleased to see increased attention being paid to certain aspects of the incentives problem in the National Defense Manufacturing Technology plan, which is addressed later. This effort to prioritize the application of resources to the highest payoff technologies is supported. But there is concern that the funding level of ManTech over the past decade has averaged only $160m (0.2% of procurement) per year. Noted also is the fact that Congress added $150m to the FY91 DoD request for ManTech funding. The Task Force believes the criticality of this problem, throughout the tiers of the defense industry and DoD depots, warrants increased resources above the current funding level of $300m/yr even in the current tightly constrained budget environment.

The IMIP program has atrophied. Very few applications are incorporated into system contracts today. The Task Force is pleased to see efforts by the OSD staff to rejuvenate it, and concurs with the proposed restructuring of the program. The restructuring recommendations remove much of the onerous, rigorous proof of projected savings and provides more flexibility in the tailoring of a contractual IMIP agreement to the needs of the specific program. The Task Force recommends approval of the restructuring and the extension of IMIP to all DoD system acquisition programs in order to promote the most efficient manufacturing of those systems.

The VE program of DoD is also languishing. The goal of the program is clear and compelling -- the introduction of changes during production to lower costs without adversely affecting performance. There has never been a more urgent need to lower costs than at present. This in itself is reason to re-energize the VE programs. But additionally, it should be used to promote manufacturing process and technology advances that lower costs with minimal adverse impact on product design and/or performance. It is urged that the VE program be aggressively pursued DoD-wide on all production programs. And it is recommended that incentives be provided to encourage and reward industry for the full range of non-capital initiatives resulting in improved productivity throughout all phases of the acquisition process. These incentives could include weighting for such initiatives in proposal evaluation, and award fees in the post-award environment.

The M&PE account which could have supported investment in process technology has been little used by contractors, probably because the prime contractors are largely assemblers with little incentive to invest in reducing the cost of already won business. This lack of utilization of M&PE investment by contractors has also contributed to the ineffectiveness of IMIP by not uncovering areas for potential process improvement. The targeting of l-2% of procurement funding through an IR&D type ceiling and MP&E investment warrants consideration.

Until very recently, the regulations on IR&D severely restricted or precluded investment in process technology, particularly of a manufacturing or production nature. Fortunately, the Congress as a result of a Rand study (now nearly 5 years old) has recognized the potential productivity benefit of IR&D and has extended applicability to process development. Unfortunately, the current DoD practice couples IR&D with bid and proposal expense (B&P) under a common "ceiling, where a ceiling is a prenegotiated limit on allowable expense within a business. A business may have both defense and commercial components with ceiling expense borne in proportion to revenue. In recent years, the defense industry has seen a significant shift of expense from IR&D to B&P as a result of increasing complexity in DoD procurement that both dilutes IR&D and causes firms to separate commercial efforts to avoid subsidizing defense bids.

A means needs to be found for common incentives to exist and work toward firrns co-investing in defense and comtnercial products and processes to achieve dual objectives of performance and affordability. The recent deliberations to allow full recovery of IR&D expenditures, particularly if the operating overhead accounting burden is removed, could allow IR&D and M&PE to be contiguous accounts to support technology, product, and production process and development in concert to a benefit of both the government and industry. There may also be favorable benefits to providing surge and mobilization capability with such an approach. These efforts should be encouraged.

**Implementation:**

DoD must signal the importance it attaches to the process and capital investment issue to all acquisition managers. This can most effectively be accomplished by including it as a mandatory topic for study in all program plans and reviews. It should be an essential element of all new acquisition strategies and reviewed by appropriate higher acquisition management levels. The provisions of each of the above approaches are somewhat complex and require skilled, talented personnel for implementation. USD(A) should assure that the requisite training is provided to appropriate personnel as required for successful implementation. Finally, it is urged that the modestly increased investment in the various programs be supported in light of their very large potential return. Implementation of the recommendations contained above would provide incentives equivalent to those employed in the best commercial practices, world-wide.

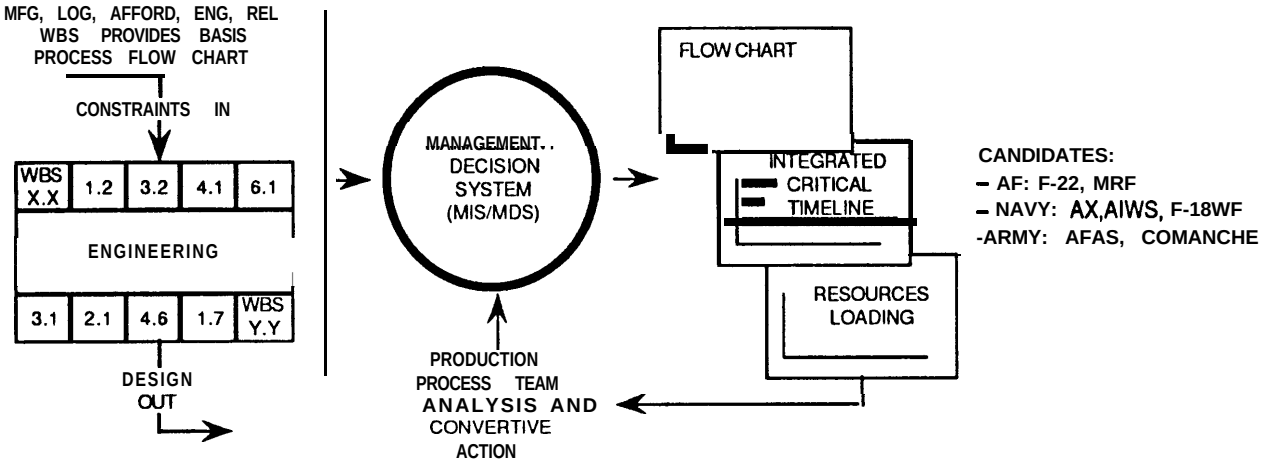
## 4. INTEGRATED PRODUCTION PROCESS AND CONTROL

As stated earlier, the production of a weapon system must reflect a seamless process and continuum from the initial system design concepts through manufacture and the operational life of the system. Integration of a detailed time line critical plan from inception through the end of service life is perhaps the number one requirement of optimum production flow. The output of product design largely determines producibility, facility requirements, maintainability, supportability, reliability, and more. The timeline criticality of inputs to the requirements and engineering design in the total flow diagram is perhaps obvious. The Task Force is convinced that execution of this task has been marginal (with few exceptions) for many reasons, but perhaps singularly because of inadequacies in planning and in the measurements necessary to control the process. Even when this process is in place, management information tools to quickly identify and evaluate problems within the continuum process are not available. These tools cannot disseminate in real-time, useful decision-making information to all functional areas of a management team. This inadequacy of real time information can manifest itself in programmatic cost growth, schedule slides, and weapon system performance decrements.

A seamless management decision-making process that facilitates enterprise integration, and near real-time information system technology, is currently practical. Real-time Management Decision Systems (MDS) or command and control systems are not currently employed within weapon system acquisition teams. Near real-time decisions between DoD and industry, as well as "intra" and "inter" company, are needed to support the requirement for a truly agile, responsive manufacturing system to reduce cycle times and costs. This would allow a program manager to view his entire program for trends, while allowing "by exception"-based reports across all functional areas to address potential problems. The management infrastructure cost element is second only to material as a major cost driver of DoD systems. Utilizing an integrated MDS will reduce data collection, presentation, tracking, and levels of management reporting. Early problem identification and solution will reduce oversight required to manage a program. The MDS will reduce cost of data generation and system delays, as well as total cost of management to control a program. This is situation awareness, and it helps the program manager maintain control. The intent here is to increase the availability of critical data for use by the contractor -- use by DoD to micromanage programs is to be avoided at all costs.

The proposed integrated MDS system has huge potential in reducing overhead costs. In general, an integrated paperless system allows savings of millions on any development program. Assuming approximately $65b/yr spent on defense procurement, it is estimated that up to $35b/yr is spent on system infrastructure activities. Based on commercial experience, yearly savings of 10% to 20% are attainable with the type of MDS system depicted in Figure 6.

## CONTROL FLOW SCHEMATIC




- KEY TO MANAGEMENT VISIBILITY CONTROL, EFFICIENCY, AND EFFECTIVENESS

Fig. 6

**Recommendations and Implementation:**

USD(A) and the Services should designate the candidate programs shown in Figure 6 as MDS Lead-The-Fleet programs. The DoD should fund the supplemental elements that are transportable to other programs. A USD(A) task force should be established to monitor progress, ensure consistency, conduct cost-benefit analyses of these MDS additions, exchange best practices, and expand the program to other systems. Included in this effort, the detailed planning of time-line critical, front-end trades and requirements for these "Lead-The-Fleet" programs should be formalized as part of the MDS system implementation.

In addition, USD(A) should determine from industry/service interface which elements of this system need development for integration into the total DoD system. The common supplemental modules or interfaces of the MDS should be funded by DoD ensuring transportability and supportability to other programs.

## MANAGEMENT

### 5. EARLY USER AND PRODUCER REQUIREMENTS INTERFACE

Recent history is replete with examples of programs in which the iterative exchange between buyer and producer, necessary for a proper analysis of cost and risk vs. operational capability, has not taken place. Among them are the Army's Aquila RPV, the Navy's V-22, and the Air Force SICBM. There are also positive examples, notably the Air Force F-22, where such a dialogue has been carried out with gratifying results for all parties.

The ability for the military user/developer and the industry designer/producer to properly communicate, particularly at program initiation, has become increasingly inhibited. Excessive focus on competition has been one of the main contributing factors. In far too many instances, free and open communications and trade-offs have been excessively constrained by the arms-length relationships established to facilitate administration of competitive acquisition strategies. In other cases, user demands for increased system capabilities have been imposed without adequate appreciation of the consequent costs or risks to the program.

Without detailed analysis and trade-offs&e user will find it difficult to assess properly if a specific incremental hardware capability will produce a military capability that is worth the additional cost. System specifications that greatly increase cost for marginal value are the unhappy consequence.

**Recommendations and Implementation:**

Despite the many bureaucratic barriers to early dialogue between the user and the producer, the benefits are so important that the requirement for early trade-offs should be institutionalized for all programs by the USD(A). It is essential that DoD eliminate the bureaucratic practices and legal restrictions that inhibit this exchange.

The USD(A) should ensure that the results of military requirements and operational specification trade-offs be incorporated into the acquisition strategy prior to the issuance of the draft RFP. This acquisition strategy should then be issued to and reviewed with all participants, including industry

It is also important that the process have the flexibility to continue to make rational changes to the system specifications throughout the program. The USD(A) should ensure that contract forms, such as the fully structured incentive contracts employed in the Navy's fleet ballistic missile program, be employed during prototype or EMD phase to encourage the contractor to balance the conflicting demands of cost, schedule and performance to the net benefit of well-defined program objectives. In addition, the final system specifications are those against which operational tests and evaluations should be measured.

## 6. REMOVAL OF BARRIERS TO MORE EFFICIENT DEFENSE PRODUCTION

This issue addresses the serious and fundamental barriers to a more efficient defense acquisition process: "how to" specifications, cost accounting requirements, and regulations that are unique to government procurement.

The existence of these barriers can be traced to historical relationships between the DoD and its hardware suppliers in which "lessons learned" and "corrective actions" derive from efforts to avoid repetition of negative experiences. Over time, this has resulted in the accumulation of prescriptions and proscriptions aimed at avoiding both error and risk that now preclude progress.

Many of the demands impart non-value added requirements to the production process and resolution of these issues can lead to large cost reductions. Underscoring these are the many examples of highly classified programs and others carried out in time of national emergency that have been produced without excessive requirements and standards and with very positive results. It should also be noted that these programs have had the benefit of robust user-producer exchange.

Non-value added demands also create artificial barriers between defense procurement and best commercial practices. Many companies will not sell to the government because their accounting systems do not segment cost as required by government cost accounting standards. The risk of receiving severe penalties from submitting inaccurate cost or pricing data is much greater than any revenue benefit.

Initiatives are underway by the Defense Contract Management Command and the Services to address this problem. DoD management should take the necessary action to build momentum behind these early positive trends. The recommendations on early user and producer exchange could also provide better alternatives to some existing procurement regulations aimed at ensuring competition.

While DoD management should continue to support programmatic efforts to reduce "how to" specifications and to press for the implementation of the new 5000. 1, there does not seem to be any effort to effect a major change to cost accounting regulations. Many past efforts have been made to improve the situation created by these barriers, but with limited success because of the conflicting views of the several constituencies.

**Recommendations and Implementation:**

USD(A) should support and expand the current actions underway by the Department to address these barriers, particularly the unnecessary "how to" specifications, cost accounting standards, and progress limiting procurement regulations.

More, however, needs to be done. A non-traditional approach is required to fully confront this issue. The DoD, with congressional support, should establish a full-time advisory group of individuals representing all constituencies. Congressional support is essential to effect the required cost accounting standards and procurement regulations changes. The group's tasks should include the following:

- Assess the burdens and their impacts
- Recommend actions to reduce or remove these barriers
- Monitor the implementation of the approved actions

The DSB is ready to assist in writing the terms of reference and advising on the initiation and implementation of this full-time group effort.

ACHIEVING EFFICIENCY

## 7. ADEQUACY OF NATIONAL SECURITY WORK FORCE

Can the defense industrial base meet the need for a skilled work force? Demographic reports indicate that new workers in the 90's will increasingly be members of traditionally disadvantaged groups which may exacerbate the skills gap. At the same time, DoD is putting greater emphasis on manufacturing technologies which require technical workers with greater skills to cope with new kinds of computer-directed machinery and flexible systems.

A number of recent reports, including those by the Secretary of Labor's Commission on Achieving Necessary Skills, the American Society for Training and Development, and the Commission on the Skills of the American Work Force, have concluded that today, American workers are not being given the necessary learning skills in school. In its concern with the defense industrial base of the future, DoD can elevate the conscience and prioritize the need for a work force with adequate skills -- just as it is prioritizing a number of other elements, such as quality, and the reduction of cost and cycle time. These elements require greater skills from today's work force. DoD has experience in the field of training and education. What it has learned in dealing with under-educated military recruits, it can also apply to developing skilled workers to make military products.

### Recommendations:

DoD should:

Enlist support from the Department of Labor and Education to ensure that a well-trained work force will be available to meet national security needs. This may require an assessment of specific industrial work force needs and an increased industry investment in factory worker training programs beyond those in private and public educational institutions.

### Implementation:

DepSecDef should:

- Convene a multi-department standing task force to study and make recommendations on work force needs.

USD(A) should:

- Study the potential for more systematic training programs within DoD, industry, and educational organizations for all levels of the work force.

- Encourage DARPA and ASD (P&L) participation to begin the development of training methodologies using on-the-job graphics presentations for factory floor training, to match the needs of the factory of the future.

- Ensure adequate funding for training programs is established in appropriate contract line items, or for independent training programs.

## 8. MANAGEMENT OF APPROVED GLOBAL SALES

The U.S. defense establishment is experiencing a new era in global sales competition. This is characterized by declining world wide defense budgets, excessive production capacity, and greatly increased competition. Foreign industries are aggressively pursuing and penetrating previous U.S. markets and emerging Pacific rim markets with the financial support of their governments. What results is an asymmetric condition unfavorable to U.S. industry.

In the past, global sales have been a mainstay in supporting not only the U.S. production base but also the underlying defense manufacturing technology base. Current examples include the F-16, C-130, AWACS, and laser-guided bombs.

In addition to base support, global sales are today even more important in that they provide resources to both DoD and defense contractors for purposes of research and development, plant modernization, and support of a skilled work force with the added benefit of reduced U.S. unit procurement cost.

Weapon system export licenses are usually approved or denied more on the basis of individual perceptions of threats to national security and potential compromise considerations rather than a balanced approach, which also considers the impact on the national security industrial base. Many government employees, in various organizations within OSD and the Services, exhibit individual preferences with respect to the export process and are not usually incentivized to promote international sales for the benefit of the industrial base.

In order to achieve greater recognition and consideration of this issue in a more consistent manner, a DoD policy supporting appropriate defense exports is required.

### Recommendations and Implementation:

Consistent with national policy interests, DoD should establish a policy to actively promote international sales of defense products, with a balanced consideration of national security and the U.S. industrial base.

The Deputy Secretary of Defense should request that the USD(A) develop a program review process with the Defense Technology Security Agency that would review requests for technology transfer and export licenses where the industrial base issues would play a role in the decision

criteria. DepSecDef designated focal points should review OSD and Service policies and procedures, and make recommendations promoting consistency regarding the approval process, considerations for international sales, and the elimination of excessive administrative burdens. The review process for these focal points to pursue should include regular and thorough teamed participation between government and industry, and provide an opportunity to discuss the case prior to OSD forwarding a negative recommendation to the State Department.

**PLAN**

## 9. DEFENSE MANUFACTURING PLAN

The 1990 DSB study on Defense Technology Strategy found that "DoD needs, but had not developed, an investment philosophy for process and manufacturing technologies". It cited "a traditional underinvestment in these technologies by the DoD" and concluded that integrated factory information systems, or "factory $C^3$", should have highest priority."

In August, under charter from USD(A), the DoD ManTech Task Force completed a six-month effort to develop a National Defense Manufacturing Technology Plan (NDMTP). The plan will provide the investment framework for OSD ManTech program invested $21.9m in "factory C3" type projects.

> The draft NDMTP investment framework targets the majority of OSD ManTech funds (Congress added $50m in FY91) against factory C3-type projects. A Task Force survey of 30 DoD programs (accounting for approximately 40% of DoD procurement costs over the next decade) confirmed that the greatest opportunity for cost and cycle time reduction lies in attacking manufacturing overhead functions. As an interim step, the OSD ManTech program invested $21.9m in "factory C3" projects, including next generation manufacturing systems, enterprise integration, design for manufacturing, and manufacturing education.

In addition to "factory $C^3$", OSD is also focusing additional funds in a limited number of high payoff process "thrust areas" (initially composites fabrication, precision machining and forming, and electronics packaging). The Service and DLA ManTech programs will continue to invest the majority of their funds in coordinated, service-specific manufacturing technology needs.

The Task Force agrees with and supports this technical strategy for the initial direction of the National Defense Manufacturing Technology Plan. Future efforts should continue to refine this analysis.

**Recommendations:**

ASD(P&L) should further develop the efforts begun by the DoD ManTech Task Force and described in the draft National Defense Manufacturing Technology Plan. Additional resources should be focused on identifying and funding high pay-off total process C3I (broader than factory C3 ) technologies.

In addition, the corporate planning process being written into the revised ManTech DoDI should: consolidate and focus generic process investments across all DoD components, more closely link DDR&E S&T, DARPA, SDIO, and ManTech process investments, and continue coordination and leveraging of the Departments of Energy, Commerce, and Labor, NASA, and National Science Foundation process technology funding.

Finally, mechanisms should be examined to further incentivize industry funding in process technologies of interest to DoD.

## Implementation:

USD(A) should endorse the basic manufacturing investment philosophy included in the proposed National Defense Manufacturing Technology Plan. The OSD ManTech funding line established by Congress in FY91 should be funded by DoD beginning in FY92 and beyond. Both S&T and ManTech process funding should be increased in the outyears, commensurate with the increasing importance of process technology.

USD(A) with industry/academia/Services should begin efforts to develop a broader DoD Defense Manufacturing Plan.

Finally, DepSecDef should consider signing a joint statement with the Service secretaries emphasizing the importance of defense manufacturing and production process technology integration which will enhance our ability to produce lower-cost, higher-quality, more reliable defense hardware in the face of declining defense budgets. This statement would serve as a statement of principles for the Defense Manufacturing Plan .

## SUMMARY

The defense environment is changing significantly as a result of a diminished cold war environment and reduced defense budgets, but the requirement to maintain national defense against the uncertain, diffuse military threat of the future remains. The 1991 Defense Science Board Task Force on Weapons Development and Production Technology was asked to examine how a strategy could be established for defense manufacturing technology such that high quality defense systems could continue to be produced in reasonable time at affordable cost. The Task Force has analyzed this situation.

During its deliberations, the Task Force examined: how weapon systems are currently acquired, and where obstacles to efficiency exist; the operations of organizations widely recognized as exemplifying manufacturing efficiency; and the specific defense and commercial programs where modern practices have produced highly effective results. Lessons learned have been translated into issues, conclusions, and recommendations which appear in this report. The final recommendation was made to emphasize the need for the development of a Defense Manufacturing Plan (DMP) which will build upon the study recommendations and benefit from past activities. Each recommendation was written to be implementable within DoD.

A major conclusion was that production problems could not be solved by simply concentrating on the processes by which hardware was physically made. Although many effective steps have been taken to improve specific operations, that alone will not permit the kinds of substantial advances required. An overall, integrated approach to the entire weapons-producing process is absolutely necessary for success. The production of defense systems must be viewed as a "seamless" process involving the entire community, which will use, design, manufacture, deploy and support them. The production process begins with the concept and ends when the system is retired. Simply concentrating on the processes of physically producing pieces of hardware is not enough. The current step-by-step, "heel-to-toe", compartmented procedure is an obstacle to efficiency by its very nature. As part of a new seamless process, however, the power of modem management information and decision systems should be fully utilized, such that the process is fully planned, executed and corrected in a near real-time manner.

Greater balance must be achieved between the research and development resources devoted to product and production processes. The kinds of R&D activity typically associated with products, i.e. investigation of basic phenomena, codification into theory, and translation into quantified tools for use by engineers, must be extended into the area of production processes. This will require allocation of 6.1, 6.2, and 6.3A resources between engineering/design and manufacturing in a more integrated fashion. These activities also need to include greater user and supportability / logistics emphasis.

The Task Force also found that development of a sound strategy for DoD investment in the total manufacturing process will require in-depth analysis of the various commodity sectors. Aircraft, ships, missiles, and electronics, etc. are all different and must be examined individually.

The efficiency of the entire process is hampered by institutional barriers and procurement regulations which should be reduced or removed. Product requirements should specify "what" a system must do rather than "how to" produce it. This empowers the producers to bring systems into being efficiently and would help to encourage the use of the commercial industrial base. Cost efficiency should be substantially increased by using "best" commercial practices in cost accounting and hardware production. In addition, there is significant merit in using commercial products directly in defense systems wherever possible.

Application of the improved practices should be started as soon as possible. Suggestions have been made for specific programs that would include better requirements trades, investment incentives, and early production process development in the science and technology budget. Expeditious implementation will permit maximum utility. Some of these suggestions have already been used in highly successful commercial and defense programs, providing confidence that the benefits of these concepts are real and are realizable in other programs.

The manufacturing workforce of the future remains a concern. Without attention, it is likely to be composed largely of unskilled and disadvantaged groups who have been marginally prepared by the U.S. educational system. Since well-trained personnel are essential to the weapons producing process, the DoD should expand its efforts to train and educate this workforce, working in concert with other government agencies.

Definition of the market for defense systems should be expanded internationally, consistent with the overriding priorities of national security policy. The Secretary should assume the responsibility for facilitating foreign sales in the same way as overseas competitors use the prestige of their own governments to aid this process.

The Task Force recommended that the Department institute a unified Defense Manufacturing Plan (DMP). This would provide a roadmap to the future and coordinate the results of this study and on-going DoD programs such as the DoD IR&D program, ManTech, IMIP and the National Defense Manufacturing Technology Plan. The DMP would be managed within the Office of the Undersecretary of Defense for Acquisition.

The Task Force estimates the marginal cost to DoD to implement **all** of these recommendations to be less than $5b over the next 5 years. However, the Task Force is confident that, if implemented, the benefits to DoD will vastly outweigh the costs. Yearly savings of at least 10% of system infrastructure costs (currently estimated at $35b/year) are achievable by implementing the management process improvements alone.

# IMPLEMENTABLE ACTIONS

## IMPLEMENTABLE ACTIONS

The Task Force developed a total of 18 recommendations that will have a substantial impact on the efficiency of defense production over the long term. Of the 18, the following six recommendations will have a significant result over the near and intermediate term:

1) USD(A) balance production process with product technology R&D investment by establishing a production process R&D plan (DDR&E), and increasing emphasis on the ManTech program.

2) USD(A) designate lead-the-fleet programs to effect integration of on-time critical detailed planning for the entire program life cycle, from requirements through the end of the system's service.

3) USD(A) reduce the barriers to manufacturing efficiency caused by "how to" specifications, procurement regulations, and cost accounting standards.

4) USD(A) conduct industrial base studies for individual defense sectors, and incorporate results into strategic plans, including the annual Defense Industrial Base Report.

5) USD(A) capitalize on on-going strategic planning efforts of the ManTech Program, and begin development of a broader DoD "Defense Manufacturing Plan" that encompasses all DoD technology, acquisition, and human resource activities related to defense manufacturing.

6) USD(A) should take advantage of all existing means to incentivize industry investment and further defense manufacturing technology and operations.

## SUMMARY OF ACTIONS

-COMPLETE LISTING-

| ACTION | ISSUE # |
|---|---|
| **DEPSECDEF** | |
| Ensure Inter-Departmental Working Group be formed to request assistance in improving work force education and skills | 7 |
| Designate DoD focal point to coordinate approved global defense sales, and review OSD/Service policies in this area | 8 |
| Issue joint statement with Service Secretaries emphasizing importance of defense manufacturing and process technology integration | 9 |
| **USD(A)** | |
| Increase ManTech funding from a base NLT $300M/year (Review progress in increasing process related funding in 2 years) | 1,3 |
| Modify DoD 5000.1/.2 inserting "and production process" after "design" | 1 |
| Conduct industrial base studies by sector; incorporate outputs into budget and annual IB report (include analysis of work force needs) | 2 |
| Require manufacturing to be emphasized in all program plans and review | 3,7 |
| Re-energize manufacturing investment incentives programs | 3 |
| With Services, designate lead-the-fleet programs to incorporate Management Decision System (MDS) | 4 |
| With Services/Industry, determine MDS transportable elements to be funded by DoD | 4 |
| Require early system performance/cost trade-offs by user-developer-producer teams on every new program | 5 |
| Issue acquisition strategy guidance to all participants, including industry, prior to draft RFP | 5 |

Address barriers to manufacturing efficiency caused by "how to specifications", procurement regulations, and cost accounting standards ..... 6
-- Support/expand current actions
-- Form full-time Advisory Group to assess problems, recommend actions, and consult on implementation

- Establish funding line items to address DoD work force training.....7

Support efforts underway on "National Defense Manufacturing Technology Plan" required by Congress, while beginning development of a broader DoD "Defense Manufacturing Plan" . . . . . 9

DDR&E

Establish production process R&D plan (increasing process funding from estimated $150M to $600M/year by 1996 ..... 1

SERVICES/GENERAL

Program managers develop manufacturing investment plans . . . . . 1

Ensure development contracts provide sufficient flexibility to incorporate continuing trade-offs ..... 5

# APPENDICES

- APPENDIX A TERMS OF REFERENCE
- APPENDIX B MEMBERSHIP
- APPENDIX C BRIEFING CHARTS
- APPENDIX D DEFENSE MANUFACTURING TECHNOLOGY PLAN
- APPENDIX E GLOSSARY

## APPENDIX: A

# TERMS OF REFERENCE

THE UNDER SECRETARY OF DEFENSE
WASHINGTON, DC 20301

15 MAY 1991

ACQUISITION

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference -- Defense Science Board Task Force on Weapon Development and Production Technology

You are requested to organize a Defense Science Board Task Force to develop a manufacturing technology strategy for the Department of Defense.

A finding of the DSB's 1990 Summer Study stated that DoD needs an investment philosophy for process and manufacturing technologies. The finding further stated that increasing the DoD investment in manufacturing process technology may be the only "silver bullet" that reallocation of DoD Science and Technology investments can offer in the near future. Accordingly, the Task Force should:

1. Review the adequacy of current and planned DoD efforts toward effectively exploiting the full potential of manufacturing technology to reduce costs, increase quality, and reduce cycle time.

2. Review commercial developments and conduct extensive discussions with designers and manufacturers to benefit from industry lessons learned in dramatically reducing time from concept to fielding of products. Conduct selective benchmarking of US industry compared to the best in the world to establish goals and priorities.

3. Examine potential flexible manufacturing opportunities, and existing regulatory and accounting system impediments.

4. Recommend specific experiments and prototypes of alternative management and technical approaches.

5. Develop an integrated strategy encompassing technical and non-technical components to achieve desired end states.

6. Estimate total resources required to support desired alternative end states.

7. Identify the pacing technologies associated with leading edge manufacturing concepts.

The Assistant Secretary of Defense (Production and Logistics) and the Director of Defense Research and Engineering

will co-sponsor this study. Mr. Robert Fuhrman and Mr. Sol Love will serve as co-chairmen. Mr. Charles Kimzey, Office of the Deputy Assistant Secretary of Defense (Production Resources) will be the Executive Secretary, and Lieutenant Commander Stephen Wiley, USN, will be the DSB Secretariat representative.

Don Yockey
Acting Under Secretary

APPENDIX: B

# MEMBERSHIP

DEFENSE SCIENCE BOARD TASK FORCE ON
WEAPON DEVELOPMENT AND PRODUCTION TECHNOLOGY

Co-Chairmen

**Mr. Robert A. Fuhrman**
Private Consultant

**Mr. Sol Love**
BASLE Corporation

Task Force Members

**Weapon Development Sub-Group**

**Dr. Donald A. Hicks**, Chairman
Hicks & Associates, Inc.

**Mr. Norman E. Betaque**
Logistics Management Institute

**Mr. Arthur E. Flathers**
General Electric Aerospace

**Dr. Jacques S. Gansler**
The Analytic Sciences Corporation

**Maj.Gen. Ralph H. Jacobson, USAF(Ret)**
The Charles Stark Draper Laboratory

**General Donald R. Keith, USA (Ret)**
Cypress International, Inc.

**Admiral Isaac C. Kidd, USN (Ret)**
Private Consultant

**Mr. Milton L. Lohr**
Defense Development Corporation

**General Robert T. Marsh, USAF (Ret)**
Private Consultant

**RAdm. Robert H, Wertheim, USN (Ret)**
Science Applications International Corporation

**Mr. David G. Wolfe**
Motorola Inc.

**Production Technology Sub-Group**

**Mr. Herm Reininga,** Chairman
Rockwell International Corporation

**Mr. Edwin L. Biggers**
Hughes Aircraft Company

**Dr. H. Kent Bowen**
Mass. Institute of Technology

**Dr. Stephen A. Campbell**
University of Minnesota

**Mr. G. Dean Clubb**
Texas Instruments, Inc.

**Dr. Allan E. Dugan**
Xerox Corporation

**Mr. Gordon R. England**
General Dynamics Corporation

**Mr. Bruce Gissing**
Boeing Commercial Airplane Group

**Dr. Robert E. Henderson**
South Carolina Research Authority

**Mr. James L. Koontz**
Kingsbury Corporation

**Mr. James F. Lardner**
Private Consultant

**Mr. Richard C. Messinger**
Cincinnati Milacron

**Mr. Howard D. Samuel**
Industrial Union Dept., AFL-CIO

Government Advisors

**Dr. Gary Denman**
DARPA

**Mr. Anthony Melita**
DDR&E

**Mr. Nicholas Torelli**
DASD / PR

Executive Secretary

**Mr. Charles H. Kimzey**
Office of the DASD (Production Resources)

DSB Secretariat Representative

**Commander Stephen N. Wiley**
OUSD(A) / DSB

Staff

**Lt. Col. Steve Jones**
OSD / P&L

**Mr. Daniel H. Cundiff**
OSD / P&L

**Mr. Edward Burke**
SAIC

**Mr. Steve Arledge**
SAIC

**Mr. A. J. Beauregard**
Lockheed

**Mr. John Fidler**
Lockheed

APPENDIX: C

# BRIEFING CHARTS

# DEFENSE SCIENCE BOARD 1991 SUMMER STUDY

# WEAPON DEVELOPMENT & PRODUCTION TECHNOLOGY

BOB FUHRMAN SOL LOVE

CO-CHAIRMEN

APRIL - NOVEMBER, 1991

# THE PROBLEM

- THE WORLD IS CHANGING -- MILITARY THREAT UNCERTAIN, DIFFUSE

- WE STILL NEED TO PRODUCE TECHNOLOGICALLY-SUPERIOR DEFENSE SYSTEMS, BUT MUST DO IT

  - AFFORDABLY
  - FASTER WITH REDUCED RESOURCES
  - BETTER >

-- HOW? --

# TERMS OF REFERENCE

- DEVELOP A MANUFACTURING TECHNOLOGY STRATEGY FOR DoD
  - DEVELOP **INTEGRATED STRATEGY** ENCOMPASSING TECHNICAL AND NON-TECHNICAL COMPONENTS
  - REVIEW DoD EFFORTS TO EXPLOIT **FULL POTENTIAL** OF MANUFACTURING TECHNOLOGY
  - REVIEW COMMERCIAL DEVELOPMENTS AND INDUSTRY **LESSONS LEARNED** TO DRAMATICALLY REDUCE ACQUISITION TIME
  - EXAMINE POTENTIAL FLEXIBLE MANUFACTURING **OPPORTUNITIES** AND EXISTING **IMPEDIMENTS**
  - RECOMMEND SPECIFIC **EXPERIMENTS/ PROTOTYPES** FOR ALTERNATIVE MANAGEMENT AND TECHNICAL APPROACHES
  - ESTIMATE TOTAL **RESOURCES REQUIRED** TO SUPPORT ALTERNATIVE APPROACHES
  - INDENTIFY **PACING TECHNOLOGIES** ASSOCIATED WITH LEADING EDGE MANUFACTURING CONCEPTS

# MEMBERSHIP & TASK FORCE STRUCTURE

## CO-CHAIRMEN:

Mr. Bob Fuhrman, VChrm/COO-Lockheed Corp. (Ret.)

Mr. Sol Love, Pres/CEO-LTV Aerospace Corp. (Ret)

Executive Secretary: Mr. Charles Kimzey

Military Assistant: CDR Stephen Wiley, USN

Government Advisors:

Dr. Gary Denman, DARPA

Mr. Anthony Melita, DDR&E

Mr. Nicholas Torelli, DASD/PR

### WEAPON DEVELOPMENT SUBGROUP

Dr. D. A. Hicks, Chairman, Pres-Hicks & Assoc
Mr. N. E. Betaque, Jr., VP-Logistics Mgmt. Inst.
Mr. A. E. Flathers, Dir IR&D-GE Aerospace
Dr. J. S. Gansler, Senior VP-TASC
MGEN R. H. Jacobson, USAF (Ret), Pres/CEO-Draper Lab
GEN D. R. Keith, USA (Ret), CEO-Cypress Int'l
ADM Isaac C. Kidd, Jr., USN (Ret)
Mr. M. L. Lohr, Chmn-Defense Development Corp.
GEN Robert T. Marsh, USAF (Ret)
RADM Robert H. Wertheim, USN (Ret)
Mr. D. G. Wolfe, Exec Vice Pres-Motorola, Inc.

### PRODUCTION TECHNOLOGY SUBGROUP

Mr. H. Reininga, Chairman, VP-Rockwell Int'l Corp
Mr. E. L. Biggers, Corp VP-Hughes Aircraft
Dr. H. K. Bowen, Ford Professor of Engineering-MIT
Prof. Stephen A. Campbell, Prof of Enginr-U of Minn.
Mr. G. Dean Clubb, Exec VP-Texas Instruments
Dr. A. E. Dugan, Sen. VP-Xerox Corp
Mr. G. R. England, Exec VP-General Dynamics
Mr. B. Gissing, Exec VP- The Boeing Company
Dr. R. E. Henderson, Dir-So. Carolina Research Auth
Mr. James L. Koontz, Pres/CEO-Kingsbury Corp
Mr. J. F. Lardner, (Ret) John Deere Corp
Mr. R. C. Messinger, VP/Ch Tech Ofc Emer-Cinc Milacron
Mr. H. Samuel, Pres-Industrial Union Dept-AFL-CIO

### SUPPORT

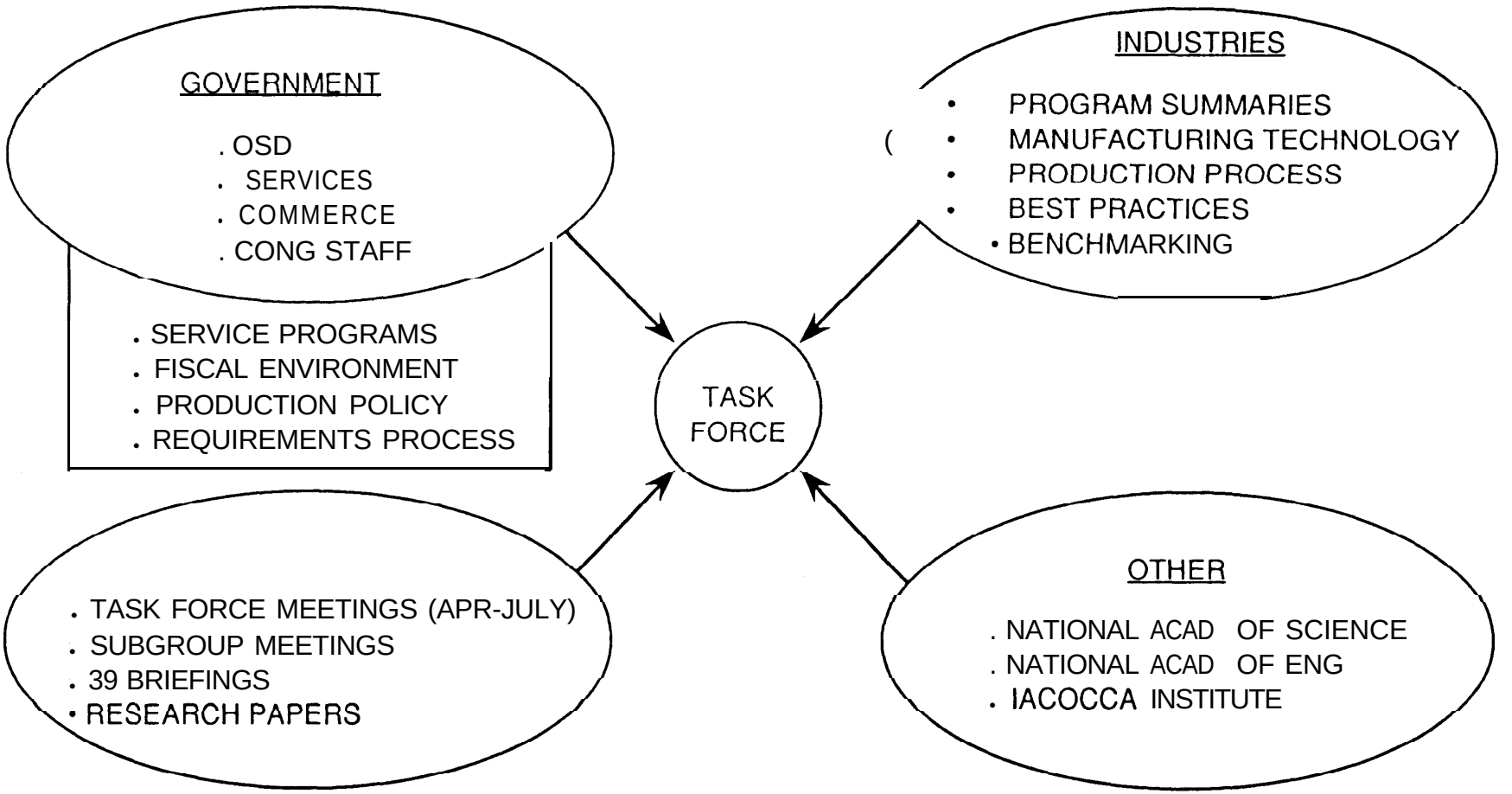
OSD/P&L: Mr. Daniel H. Cundiff
LtCol Steve Jones

Lockheed: Mr. A.J. Beauregard
Mr. John Fidler

SAIC: Mr. Edward Burke
Mr. Steven Arledge

# TASK FORCE DELIBERATIONS

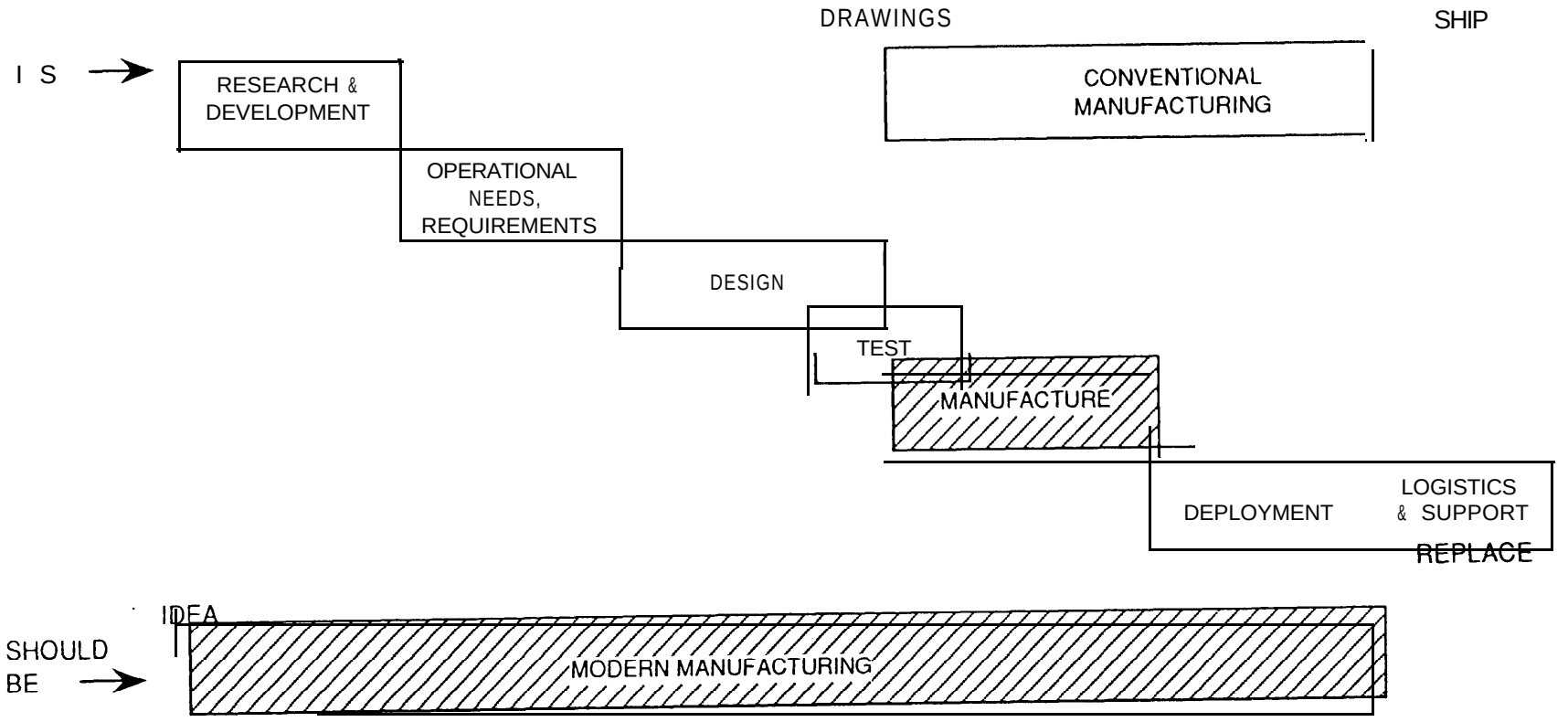
**BASELINE: 1990 DSB TECHNOLOGY STUDY**



# A WORLD-WIDE INDUSTRIAL CHANGE UNDERWAY

| FROM | TO |
|---|---|
| • PRIMARY DESIGN FOCUS ON PRODUCT PERFORMANCE | • INTEGRATED DESIGN FOCUS ON COST, QUALITY, DELIVERY, PERFORMANCE, AND SUPPORT |
| • INCREMENTAL DESIGN AND PRODUCTION PROCESS | • INTEGRATED PRODUCT AND PRODUCTION PROCESS |
| • R&D RESOURCES FOCUSED ON PRODUCT TECHNOLOGY | • R&D RESOURCES BALANCED BETWEEN PRODUCT AND PROCESS TECHNOLOGY |
| • MANAGEMENT EMPHASIS ON SPECIALIZED EXPERTISE | • COMPUTER-BASED INTEGRATED OPERATION ("SYSTEM C3I") |
| • STANDARDIZED, MASS PRODUCTION | • FLEXIBLE, LOW-RATE PRODUCTION |
| • DEFENSE UNIQUE PRACTICES | • INCORPORATE BEST COMMERCIAL PRACTICES |

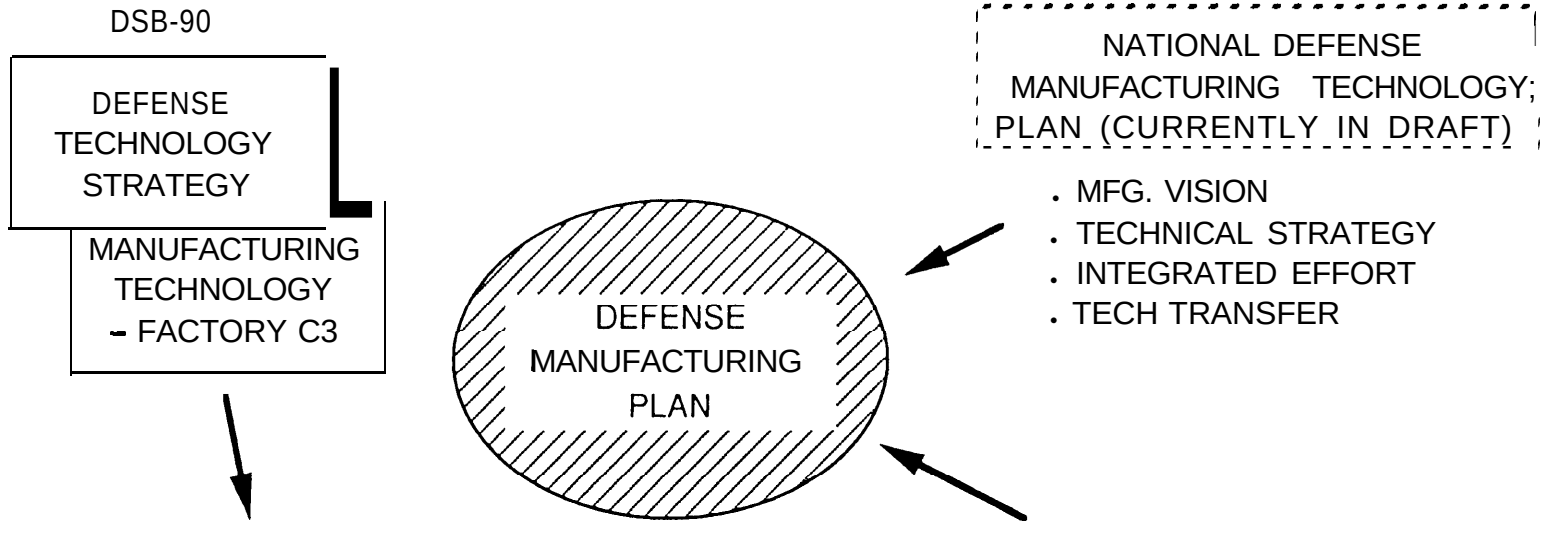
# MANUFACTURING PROCESS EVOLUTION




USER-PRODUCER TRADES
REMOVAL OF BARRIERS
INDUSTRY SECTOR ANALYSES
INVESTMENT INCENTIVES

PRODUCT/PROCESS R&D
INTEGRATED PROCESS CONTROL
DEFENSE MANUFACTURE PLAN
GLOBAL DEFENSE SALES
ADEQUACY OF WORK FORCE

# FRAMEWORK


DSB-90
DEFENSE TECHNOLOGY STRATEGY
MANUFACTURING TECHNOLOGY - FACTORY C3
NATIONAL DEFENSE MANUFACTURING TECHNOLOGY; PLAN (CURRENTLY IN DRAFT)
. MFG. VISION
. TECHNICAL STRATEGY
. INTEGRATED EFFORT
. TECH TRANSFER
DEFENSE MANUFACTURING PLAN
DSB-1991 TERMS OF REFERENCE
. MFG. TECHNOLOGY POTENTIAL
. LESSONS & BENCHMARKING
. OPPORTUNITIES & IMPEDIMENTS
. EXPERIMENTS & PROTOTYPES
. INTEGRATED STRATEGY
. REQUIRED RESOURCES
. PACING TECHNOLOGIES
DSB-1991 TASK FORCE ISSUES
. PRODUCT/PROCESS BALANCE
. SECTOR STRATEGY
. INVESTMENT INCENTIVES
. SYSTEM PROCESS CONTROL
. USER-PRODUCER REQTS INTERFACE
. BARRIER REMOVAL
. WORKFORCE
. GLOBAL SALES

# ELEMENTS OF STRATEGY

THE ELEMENTS OF A MANUFACTURING TECHNOLOGY STRATEGY ARE DESCRIBED WITHIN THE FRAMEWORK BELOW:

- THE RESOURCES
  1. BALANCE PRODUCT AND PROCESS R&D
  2. INDUSTRIAL BASE SECTOR STRATEGY
  3. INVESTMENT INCENTIVES

- THE MANAGEMENT PROCESS
  4. INTEGRATED PRODUCTION PROCESS AND CONTROL
  5. EARLY USER AND PRODUCER REQUIREMENTS INTERFACE

- THE REMOVAL OF BARRIERS/IMPEDIMENTS TO GREATER EFFICIENCY
  6. REMOVAL OF BARRIERS TO MORE EFFICIENT DEFENSE PRODUCTION
  7. ADEQUACY OF NATIONAL SECURITY WORK FORCE
  8. MANAGEMENT OF APPROVED GLOBAL SALES

- THE PLAN
  9. DEFENSE MANUFACTURING PLAN

# BALANCE PRODUCT AND PROCESS R&D

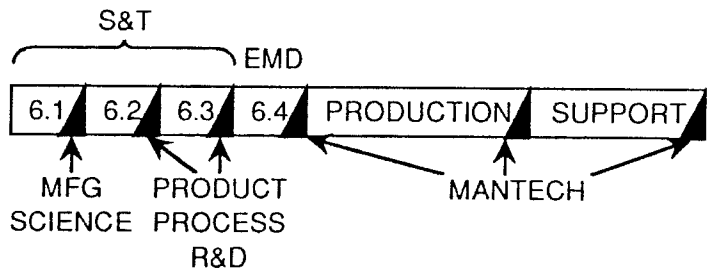
- TIMELY NEW PRODUCTION PROCESS TECHNOLOGY
  - DECREASES CYCLE TIME, COSTS, RISKS
  - FACILITATES TRANSITION TO PRODUCTION
  - IMPROVES PRODUCT DESIGN OPTIONS
  - SUPPORTS WORLD COMPETITIVENESS
- PROCESS KNOWLEDGE CRITICAL TO MANUFACTURING EFFICIENCY
- PRODUCTS DEPEND ON PRODUCTION PROCESSING TECHNOLOGIES
- PROCESS R&D PRIOR TO WEAPON SYSTEM PRODUCTION
- ACHIEVE AN INTEGRATED DoD MANUFACTURING PROGRAM

# BALANCE PRODUCT AND PROCESS R&D (cont.)

RECOMMENDATIONS:

- INCREASE PRODUCTION PROCESS R&D:
  - TECH BASE INTEGRATED PRODUCT AND PROCESS R&D
  - INCREASE MANTECH AND LINK TO S&T PROGRAMS

PROPOSED SEAMLESS PROGRAM




  - FOCUS ON PRODUCTION SCALABLE PROCESSES
  - PROCESS EQUIPMENT FOCUSED ON COST REDUCTION

- INTEGRATE ALL DoD MANUFACTURING DEVELOPMENT

# BALANCE PRODUCT AND PROCESS R&D (cont.)

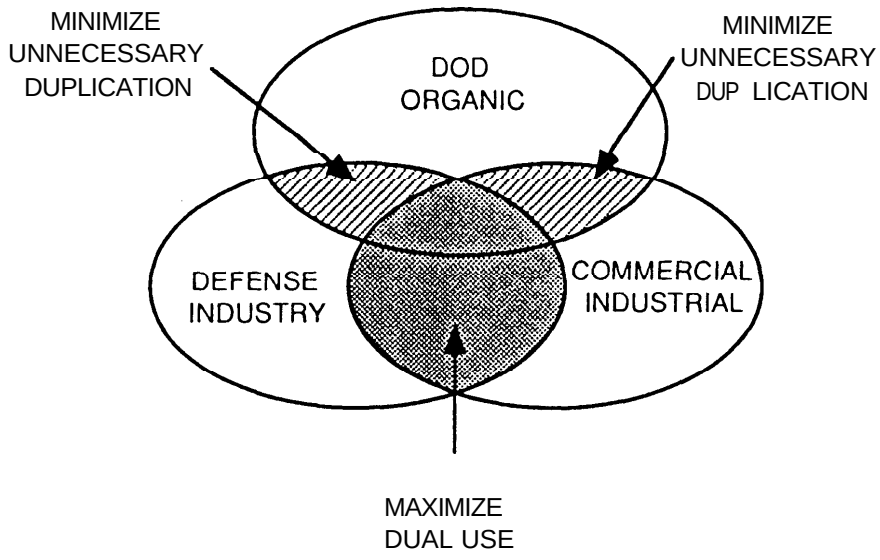
IMPLEMENTATION:

- DDR&E ESTABLISH A PRODUCTION PROCESS R&D PROGRAM WITH DESIGNATED FUNDS TO GROW FROM TODAY'S ESTIMATED BASE OF $150M TO $600M BY 1996 USING REALLOCATED AND ADDITIONAL FUNDS
- USD(A) INCREASE MANTECH FUNDING COMMENSURATE WITH PRECEDING INCREASE IN PROCESS R&D. FUNDING GROWTH SHOULD COMMENCE FROM A BASE OF NOT LESS THAN $300M ('91 DOLLARS)
- ADEQUACY OF FUNDING SHOULD BE REVIEWED IN TWO YEARS
- PROGRAM MANAGERS SHOULD DEVELOP A RESOURCE AND EXECUTION PLAN THAT WILL INTEGRATE ALL DOD MANUFACTURING PROGRAMS
- USD(A) MODIFY THE DOD 5000.1/.2 BY INSERTING "AND PRODUCTION PROCESS" WHEREVER "DESIGN" APPEARS

# INDUSTRIAL BASE SECTOR STRATEGY

AN INTEGRATED STRATEGY ACROSS THE THREE MAJOR COMPONENTS OF THE DEFENSE INDUSTRIAL BASE IS NEEDED ON A SECTOR BY SECTOR BASIS TO ACHIEVE:

- BETTER USE OF CAPITAL INTENSIVE RESOURCES, LEVERAGE, COMMERCIAL CAPABILITY, RATIONALIZE DUPLICATION (e.g., DEPOT FACILITIES)




SECTOR EXAMPLES

- AIRCRAFT
- MISSILES
- ORDNANCE
- COMBAT VEHICLES
- ELECTRONICS & COMMUNICATIONS
- SHIPBUILDING
- SPACE

# INDUSTRIAL BASE SECTOR STRATEGY (cont.)

RECOMMENDATION AND IMPLEMENTATION:

- CONDUCT INDUSTRIAL BASE STUDIES BY SECTOR AND CONSIDER COMMERCIAL CAPABILITIES

  (EACH STUDY MANAGED BY DOD, LED BY RETIRED INDUSTRY EXECUTIVES, AND SUPPORTED BY RELEVANT TRADE ASSOCIATIONS)

- LEADS TO RECOMMENDED INVESTMENT STRATEGY, PROGRAM ACTIONS, AND COMPLEMENTARY NO-COST MANAGEMENT ACTIONS

- USE STUDY OUTPUTS FOR PROGRAM/BUDGET DECISIONS AND ANNUAL DEFENSE INDUSTRIAL BASE REPORT

- TERMS OF REFERENCE SHOULD INCLUDE:

  - ASSESS NEEDS
  - REVIEW INTERNATIONAL IMPACT
  - IDENTIFY CRITICAL U.S. CAPABILITY
  - EVALUATE CAPACITY USE
  - ASSESS SUPPLIER VIABILITY
  - RATIONALIZE DUPLICATION
  - REVIEW MAINTENANCE CONCEPTS
  - ENHANCE DUAL USE
  - ASSESS COMMERCIAL POTENTIAL & RECOMMEND INVESTMENT

# INVESTMENT INCENTIVES

- CAPITAL INVESTMENT LAGGING
  - FUNDING INSTABILITY AND ANNUAL BUYS - DIS INCENTIVES
  - DECLINING DEFENSE BUDGET EXACERBATING
  - CRITICAL PROBLEM AT LOWER TIERS
- NEW GENERATION CAPABILITIES - CAPITAL INTENSIVE
  - CONCURRENT DESIGN/PROCESS EVOLUTION
  - UP FRONT INTERDEPENDENCE
- POLICIES/PRACTICES PRECLUDE FAST INVESTMENT WRITE-OFF
- PROVEN REMEDIES NOT BEING UTILIZED
  - MANTECH, IMIP, VE, MULTI-YEAR, TITLE III, IR&D
- LITTLE INCENTIVE FOR OTHER PRODUCTIVITY INITIATIVES
  - TRAINING, QUALITY, SUPPLIER MGT, ETC.

# INVESTMENT INCENTIVES (cont.)

RECOMMENDATIONS:

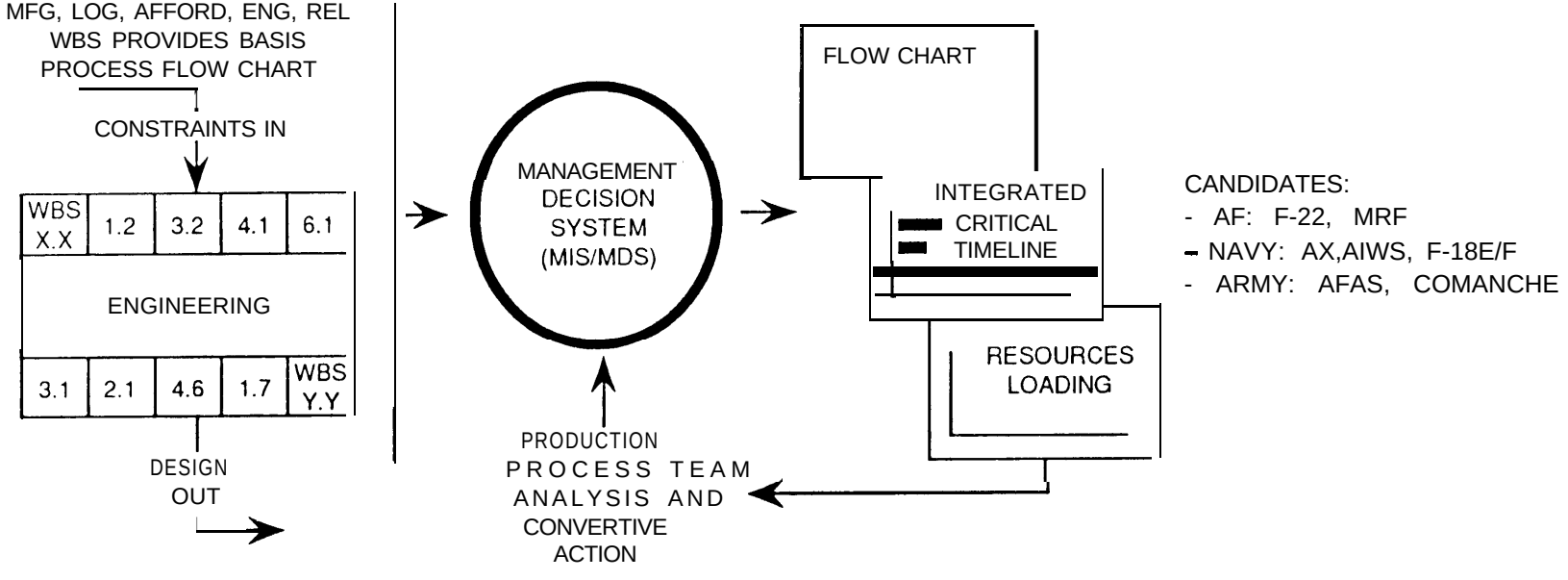
- INCREASE MANTECH - BASE $300M/YR
  - BALANCE/PRIORITIZE BY SECTOR
- PURSUE IMIP AGGRESSIVELY
- RE-ENERGIZE VALUE ENGINEERING PROGRAM
- USE MULTI-YEAR TO FACILITATE PAYBACK
- UTILIZE TITLE III AT LOWER TIERS
- REWARD LONGER TERM PRODUCTIVITY INITIATIVES

IMPLEMENTATION:

- EMPHASIZE MANUFACTURING IN ALL PLANS/REVIEWS
- USE INCENTIVES TO LEVERAGE MANUFACTURING RESOURCES

# INTEGRATED PRODUCTION PROCESS AND CONTROL

## CONTROL FLOW SCHEMATIC




- KEY TO MANAGEMENT CONTROL AND EFFICIENCY

# INTEGRATED PRODUCTION PROCESS AND CONTROL (cont.)

- INTEGRATION OF TIME-LINE CRITICAL PLANS
- MEASURE ON REAL TIME BASIS TO MANAGE PROGRAM
- DECISION-MAKING ACCELERATES THROUGH-PUT
- TECHNOLOGY AVAILABLE TO AUGMENT INDUSTRY SYSTEMS
- REAL TIME FOR AGILITY AND RESPONSIVENESS
- PROCESS CONTINUUM WITH "BY EXCEPTION" INTERVENTION

# INTEGRATED PRODUCTION PROCESS AND CONTROL (cont.)

RECOMMENDATIONS AND IMPLEMENTATION:

- DESIGNATE LEAD-THE-FLEET PROGRAMS FOR MANAGEMENT SYSTEM PROCESS CONTROL MDS
  - F-22, MRF, AX, AIWS, F-18E/F, AFAS, AND COMANCHE
- FORMALIZE TIME-LINE CRITICAL FRONT-END, DETAILED PLANNING
- DETERMINE INFORMATION SYSTEM NEEDS TO BE AUGMENTED (MIS/MDS)
  - DoD FUND TRANSPORTABLE ELEMENTS
  - THIRD PARTY DEVELOPMENT AND SUPPORT
  - OSD INDUSTRY WORKING GROUP

# EARLY USER AND PRODUCER REQUIREMENTS INTERFACE

- MILITARY USER/DEVELOPER INTERFACE WITH INDUSTRY/ PRODUCER CONSTRAINED BY BUREAUCRATIC PRACTICES AND LEGAL RESTRICTIONS
- INADEQUATE ANALYSIS OF COST/RISK VS. OPERATIONAL CAPABILITY WITHIN RESOURCE CONSTRAINT
- SYSTEM SPECIFICATIONS VS. MILITARY NEEDS OFTEN INCREASE COST FOR MARGINAL VALUE

# EARLY USER AND PRODUCER REQUIREMENTS INTERFACE (cont.1

RECOMMENDATIONS AND IMPLEMENTATION:

- USD(A) REQUIRE EARLY TRADE-OFFS ON EVERY NEW DoD PROGRAM
- USD(A) ISSUE ACQUISITION STRATEGY GUIDANCE TO ALL PARTICIPANTS INCLUDING INDUSTRY PRIOR TO DRAFT RFP
- USD(A) AND SERVICES ENSURE DEVELOPMENT CONTRACTS PROVIDE SUFFICIENT FLEXIBILITY TO INCORPORATE CONTINUING TRADE-OFFS

# REMOVAL OF BARRIERS TO MORE EFFICIENT DEFENSE PRODUCTION

- CERTAIN "HOW TO" SPECIFICATIONS AND COST ACCOUNTING STANDARDS ARE SERIOUS IMPEDIMENTS TO EFFICIENT DEFENSE MANUFACTURING
- NUMEROUS CASE STUDIES HAVE SHOWN THAT THIS HAS CREATED LARGE AND UNNECESSARY COSTS AT BOTH THE PRIME AND LOWER TIERS
- WITHOUT CHANGE, DoD DENIES ITSELF ACCESS TO MANY OF THE MOST PRODUCTIVE PORTIONS OF THE COMMERCIAL SECTOR
- DoD AND SERVICE EFFORTS UNDERWAY TO REDUCE SOME OF THESE BARRIERS
- HOWEVER, MAJOR RESISTANCE IN ALL CONSTITUENCIES PERSISTS AND A NON-TRADITIONAL APPROACH IS REQUIRED

# REMOVAL OF BARRIERS TO MORE EFFICIENT DEFENSE PRODUCTION (cont.)

RECOMMENDATIONS AND IMPLEMENTATION:

DOD SHOULD:

- SUPPORT AND EXPAND THE PRESENT PROGRAMMATIC AND STAFF ACTIONS TO ADDRESS THESE BARRIERS
- TAKE THE INITIATIVE TO ESTABLISH A FULL-TIME ADVISORY GROUP OF HIGHLY-QUALIFIED AND EXPERIENCED INDIVIDUALS WITH DOD, INDUSTRY, AND CONGRESSIONAL PERSPECTIVES

  - ADVISORY GROUP TASKS:
    - -- ASSESS THE BURDENS AND THEIR IMPACTS
    - -- RECOMMEND ACTIONS TO REDUCE/REMOVE THESE BARRIERS
    - -- MONITOR THE IMPLEMENTATION OF THE APPROVED ACTIONS

# ADEQUACY OF NATIONAL SECURITY WORK FORCE

- BEST PRACTICES IN PRODUCTION INDUSTRIES INCREASINGLY REQUIRE A TECHNICALLY COMPETENT WORK FORCE

- PRESENT EDUCATION AND TRAINING PROGRAMS ARE INADEQUATE, WHICH THE ADMINISTRATION HAS IDENTIFIED AS A NATIONAL PROBLEM

- NATIONAL SECURITY MISSION OF DoD IS THREATENED BY INADEQUATELY SKILLED WORK FORCE.
  - DoD NEEDS TO PARTICIPATE ACTIVELY IN NATIONAL EFFORTS TO DEVELOP WELL-TRAINED WORK FORCE

# ADEQUACY OF NATIONAL SECURITY WORK FORCE (cont.)

RECOMMENDATIONS:

- ENLIST SUPPORT FROM APPROPRIATE GOVERNMENT AGENCIES TO HELP SUPPLY WELL-TRAINED WORKERS TO MEET NATIONAL SECURITY NEEDS
- ASSESS SPECIFIC INDUSTRIAL WORK FORCE NEEDS
- ENCOURAGE DEFENSE MANUFACTURERS TO INVEST MORE IN TRAINING PROGRAMS FOR FACTORY WORKERS

IMPLEMENTATION:

- SECDEF CONVENE AN INTER-DEPARTMENTAL WORKING GROUP TO REQUEST ASSISTANCE IN IMPROVING WORK FORCE EDUCATION AND SKILLS
- ADDRESS WORK FORCE NEEDS IN SECTOR ANALYSIS RECOMMENDED EARLIER
- ESTABLISH CONTRACT LINE ITEMS FOR PRODUCTION WORK FORCE TRAINING, WHERE WARRANTED, OR GIVE CREDIT IN EVALUATIONS OF COMPETITIVE PROPOSALS
- FUND DEMONSTRATION TRAINING PROGRAMS IN SPECIFIC INDUSTRIES TO BRIDGE THE SCHOOLS-TO-FACTORY SKILLS GAP

# MANAGEMENT OF APPROVED GLOBAL SALES

## *HOW TO ADAPT TO A NEW ENVIRONMENT*

- GLOBAL SALES HAVE BEEN IMPORTANT IN MAINTAINING THE U.S. MANUFACTURING TECHNOLOGY BASE (I.E., F-16, C-130, LASER GUIDED BOMBS, AWACS)

- GLOBAL SALES ARE NOW EVEN MORE CRITICAL TO THE U.S. MANUFACTURING TECHNOLOGY BASE AND TO THE DoD

  - ABSORBS OVERHEAD
  - INCREASES PROD. RATES
  - DECREASES U.S. UNIT COST
  - GENERATES TAX DOLLARS

  INCREASED RESOURCES

  NEW MANUFACTURING TECH.
  PLANT MODERNIZATION
  HEALTHY U.S. DEFENSE R&D
  SKILLED WORK FORCE
  SURGE ABILITY

- FOREIGN GOVERNMENTS SHARE RESOURCES AND ACTIVELY SUPPORT THEIR GLOBAL SALES GENERATING ASYMMETRY

  - U.S. NEEDS A LEVEL PLAYING FIELD
  - DoD POLICY AND SINGLE POINT RESPONSIBILITY LACKING
  - ADMINISTRATIVE PROCEDURES AND REGULATIONS HAMPER EFFECTIVE COMPETITION

# MANAGEMENT OF APPROVED GLOBAL SALES (cont.)

RECOMMENDATIONS:

- CONSISTENT WITH NATIONAL POLICY INTERESTS, ESTABLISH A PROACTIVE POLICY TO SUPPORT GLOBAL DEFENSE EXPORTS
- CONTINUE TO STREAMLINE EXISTING ADMINISTRATIVE AND TECHNOLOGY TRANSFER POLICIES/PROCEDURE
- INCLUDE GLOBAL SALES AS PART OF SYSTEM ACQUISITION STRATEGY
- UTILIZE SOME U.S. PRODUCTION TO ENABLE GLOBAL SALES

IMPLEMENTATION:

- SECDEF DESIGNATE FOCAL POINT OF RESPONSIBILITY
- FOCAL POINT REVIEW OSD/SERVICE POLICIES AND PROCEDURES AND PROPOSE POLICY CHANGES

# DEFENSE MANUFACTURING PLAN

- 1990 DSB STUDY ON R&D STRATEGY:
  - DEVELOP MANUFACTURING PROCESS INVESTMENT PHILOSOPHY
  - HIGHEST PRIORITY ON "FACTORY C3" (INTEGRATED FACTORY INFORMATION SYSTEMS)
- DoD DEVELOPING NATIONAL DEFENSE MANUFACTURING TECHNOLOGY PLAN (NDMTP) [FY 91 CONGRESSIONAL REQUIREMENT]
  - STRATEGIC DoD-WIDE APPROACH
  - TARGETS MAJORITY OF OSD MANTECH FUNDS AGAINST "FACTORY C3"
    - -- INFORMATION INTEGRATION TECHNOLOGY A PRIME DRIVER
  - FACTORY FLOOR ADVANCES REMAIN IMPORTANT
  - DSB AGREES WITH TECHNICAL APPROACH AND GENERAL DIRECTION, BUT MUST BE EXPANDED
  - A TOTAL "DEFENSE MANUFACTURING PLAN" IS REQUIRED TO ADDRESS BROADER MANUFACTURING ISSUES

# DEFENSE MANUFACTURING PLAN (cont.)

RECOMMENDATIONS AND IMPLEMENTATION:

- USD/A SHOULD:
  - BUILD ON EFFORT BY MANTECH TASK FORCE
  - FUND OSD HIGH-PAYOFF "FACTORY C3" TECHNOLOGIES
  - FOCUS GENERIC PROCESS INVESTMENTS ACROSS SERVICES
  - LINK S&T, PROGRAM R&D, AND MANTECH PROCESS INVESTMENTS
  - LEVERAGE DoE, DoC, NASA, NSF AND INDUSTRY FUNDING
  - FLEXIBLE, SCALABLE, LINKED MANUFACTURING UNITS
- DEVELOP A DEFENSE MANUFACTURING PLAN
- DEPSECDEF STATEMENT ON IMPORTANCE

# DEFENSE MANUFACTURING PLAN (cont.)

IMPLEMENTATION:

- USD(A) SUPPORT EFFORTS BEGUN BY NATIONAL DEFENSE MANUFACTURING TECHNOLOGY PLAN (NDMTP)
- USD(A) ESTABLISH SEPARATE OSD MANTECH LINE FOR HIGH PAYOFF MANUFACTURING INTEGRATION TECHNOLOGIES (EXECUTED BY SERVICES)
- USD(A) BEGIN EFFORTS TO DEVELOP A BROADER DoD "DEFENSE MANUFACTURING PLAN"
- DEPSECDEF ISSUE A JOINT STATEMENT WITH SERVICE SECRETARIES EMPHASIZING IMPORTANCE OF DEFENSE MANUFACTURING AND PROCESS TECHNOLOGY INTEGRATION

# SUMMARY

- DECLINING DoD RESOURCES
- OPPORTUNITY TO TAKE A FRESH LOOK
- SUBSTANTIAL IMPROVEMENT BY:

  ALLOCATION OF RESOURCES AND INVESTMENT
  MANAGEMENT PROCESS OF DESIGNING AND BUILDING
  REMOVAL OF CERTAIN BARRIERS

- ALLOCATION OF RESOURCES

  ASSURE PRODUCTION PROCESS TECHNOLOGY
  UNDERSTANDING OF SECTORAL DIFFERENCES
  LEVERAGE DoD RESOURCES BY INCENTIVIZING

- MANAGEMENT PROCESS (SINGLE BIGGEST LEVERAGE IN THROUGH-PUT IMPROVEMENT AND COST REDUCTION)

  ROBUST VISION OF MANUFACTURING
  UTILIZE INFO TECHNOLOGY TO CONTROL PROCESS
  EARLY DIALOGUE WITH PRODUCERS

# SUMMARY (cont.)

- REMOVAL OF BARRIERS
  - "HOW-TO" SPECIFICATIONS
  - COST ACCOUNTING
  - WORK FORCE SKILLS
  - INTERNATIONAL MARKETS
- NATIONAL DEFENSE MANUFACTURING TECHNOLOGY PLAN SHOULD BE EXPANDED TO A COMPREHENSIVE "DEFENSE MANUFACTURING PLAN"
- MARGINAL COST TO IMPLEMENT ALL RECOMMENDATIONS < $5B OVER NEXT 5 YEARS
  - BENEFIT TO THE DoD WILL VASTLY OUTWEIGH ITS COST

APPENDIX: D

# DEFENSE MANUFACTURING TECHNOLOGY PLAN

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# DEFENSE MANUFACTURING TECHNOLOGY

# REQUIREMENTS AND OSD RESPONSE

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# CHALLENGES

**FOR DoD:** FIELDING NEXT GENERATION WEAPON SYSTEMS IN LESS TIME AT LOWER COSTS

**TREND:** FEWER SYSTEMS OR LOWER TECH SYSTEMS?

-A FAULTY DILEMMA?

**ALTERNATIVE:** MANUFACTURING TECHNOLOGY AS DoD STRATEGIC TOOL TO ADDRESS COST, SCHEDULE AND QUALITY

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# DoD MANTECH

**MT PROGRAM:** SOLID RECORD OF SOLVING GENERIC FACTORY FLOOR PROBLEMS

-REDUCED COSTS; IMPROVED QUALITY

**CRITICISM:** BOTTOMS UP

LACK OF OVERALL STRATEGIC FOCUS

LACK OF COORDINATION

LIMITED $ SPREAD OVER MANY PROJECTS

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# NDMT PLAN *

- PROVIDE POLICY **GUIDANCE** FOR DEFENSE MANUFACTURING
- PROVIDE **LINKAGE** FOR OSD & SERVICE MT PROGRAMS
- INVESTIGATE **EXTENSION SERVICE** POTENTIAL FOR TECH TRANSFER
- DEVELOP **INTERAGENCY APPROACH**
- **ALLOCATE FUNDS** IAW PLAN

--- Oct 91 Planned Submittal Date to Congress

* Required by Section 823, PL 101-510, 1990

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# OSD APPROACH

- FORMED TASK FORCE
  - USD(A) Yockey Charter
  - Six Month Effort Through Jul 91
  - Strong Service / MT Director Involvement
  - Mil Depts, DLA, DARPA, DDR&E, SDIO, DoE, DoC, NSF, NASA Participation
- EXECUTIVE COMMITTEE
  - MT Directors
  - Distributed OSD FY 91 Funds to Initial Thrust Areas
- COOPERATIVE APPROACH
  - With Government, Industry, and Academia

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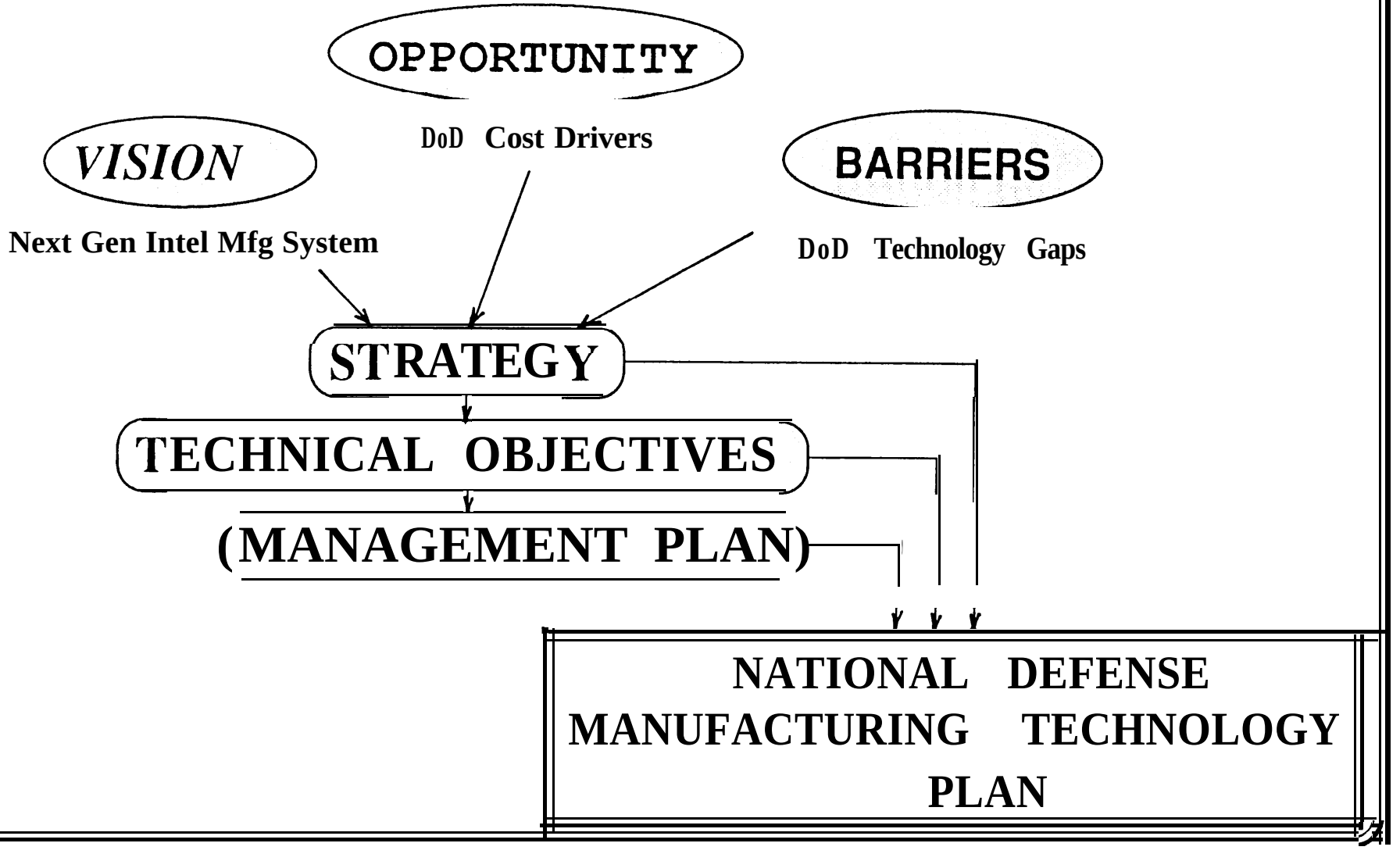
# NDMT PLAN DEVELOPMENT



# TASK FORCE DELIVERABLES

(1) QUALITATIVE: MFG VISION

(2) QUANTITATIVE: DoD MFG COST DRIVERS

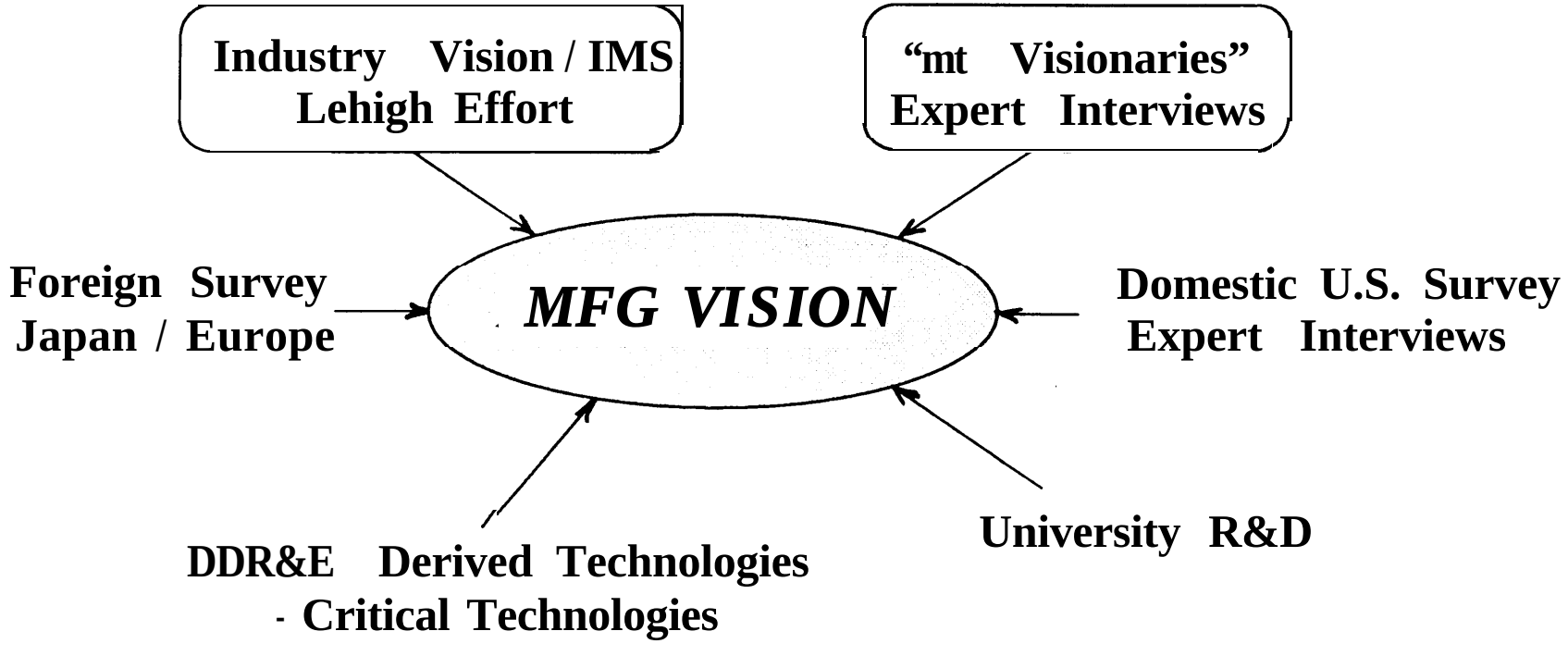
(3) MT INVESTMENT ROADMAP

(4) TECH TRANSFER / MFG EXTENSION SERVICES

(5) MT MANAGEMENT PLAN

# (1) MANUFACTURING VISION

- Survey Manufacturing "Visionaries"
- Identify "mt" Processes Critical to U.S. Over 10-15 Year Horizon



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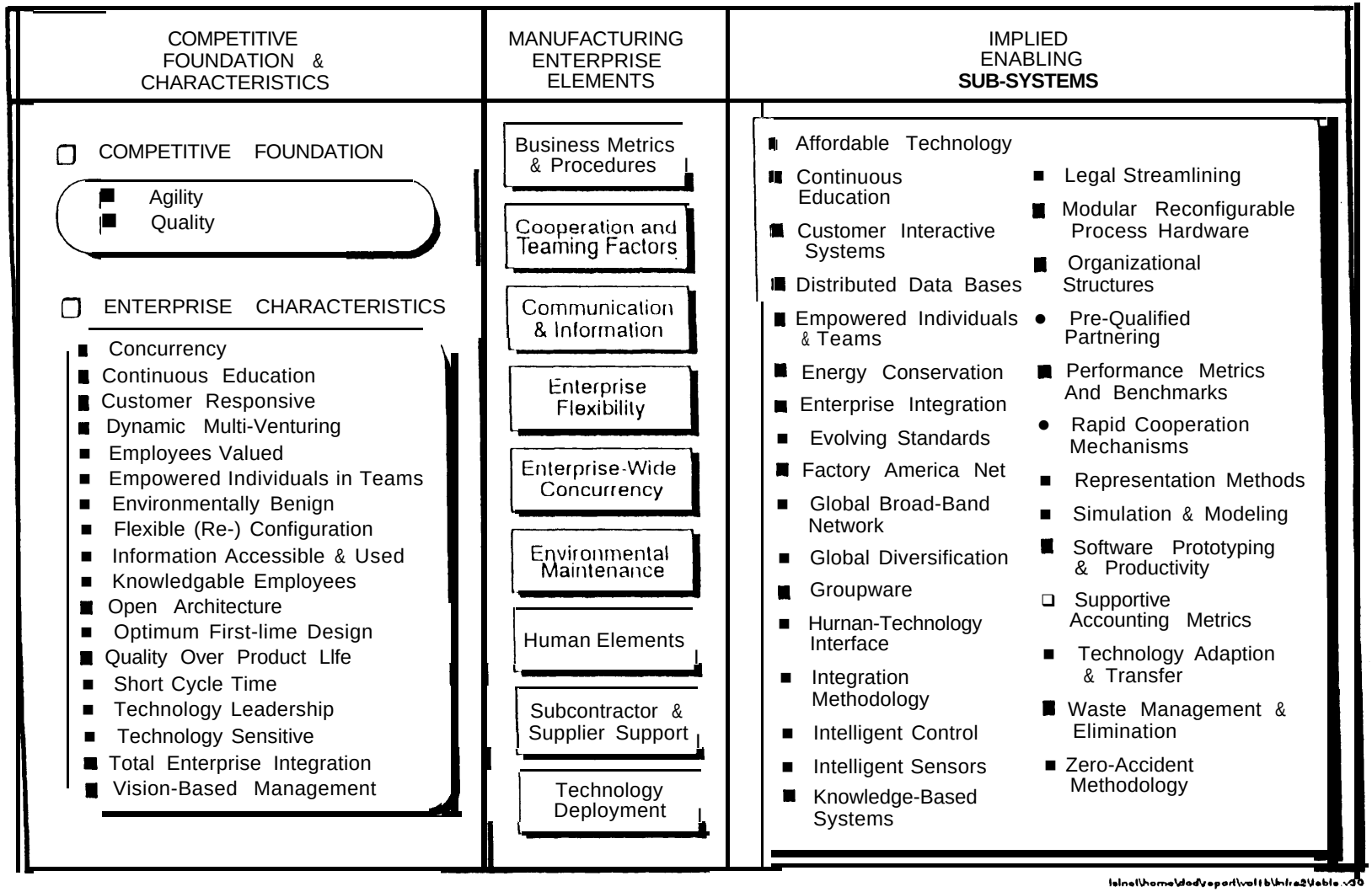
# COMPETITIVE LEADER 2005 - THE AGILE ENTERPRISE



# (2) DoD MANUFACTURING COST DRIVERS

- DEVELOP METHODOLOGY FOR DoD PROCESS COST DATA
- IDENTIFY HIGH COST PROCESSES FOR FUTURE MAJOR WEAPON SYSTEMS
  - To Date: 29 Programs / 36% of Future Procurement Dollars (40% of Pgm $ Allocated to Mfg Processes)
  - Further Analysis of O/H and Purchased Parts Req'd
  - "Soft" Mfg Technology Costs Rank High
- IDENTIFY TECHNOLOGY GAPS / BARRIERS

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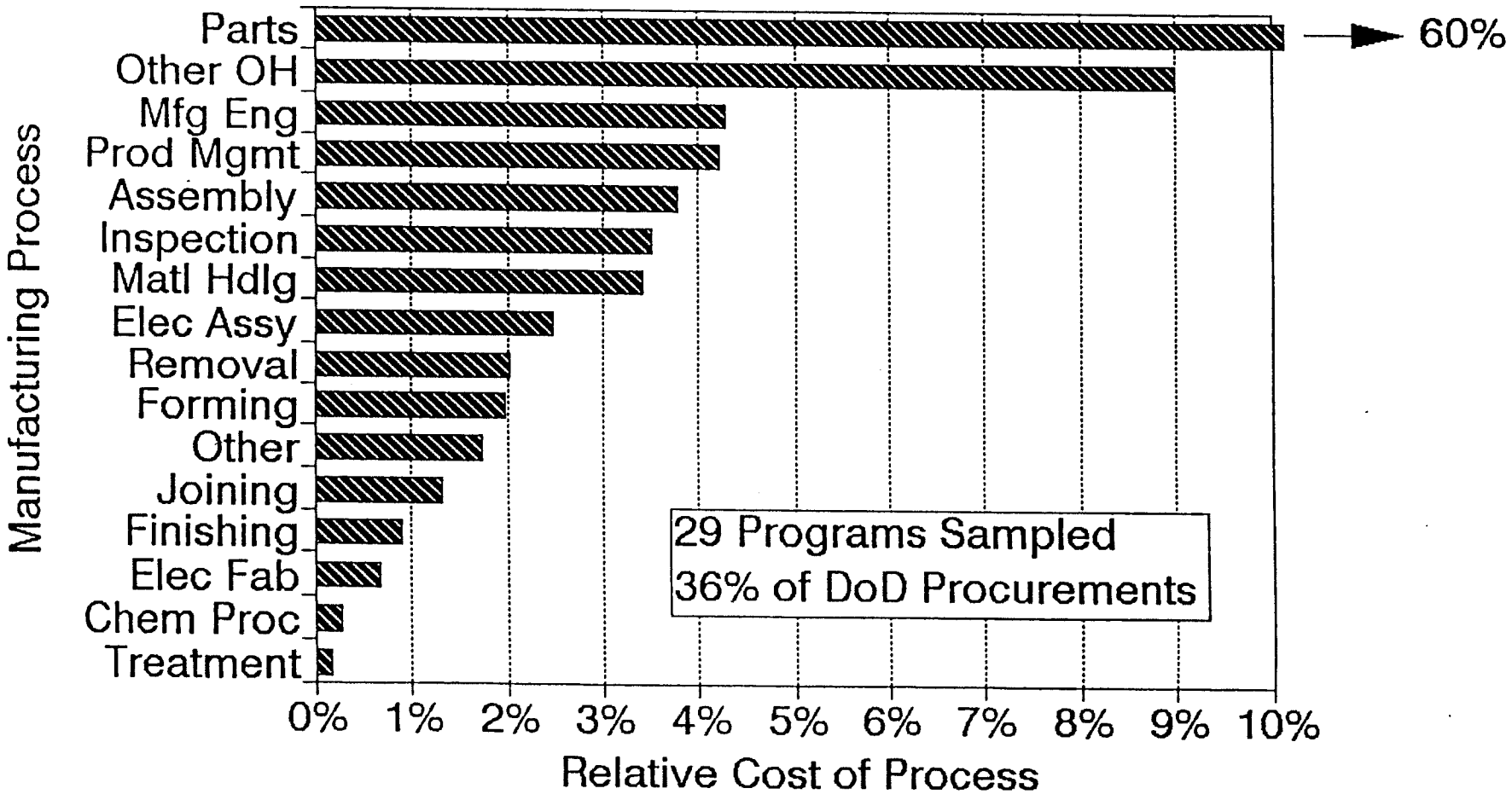
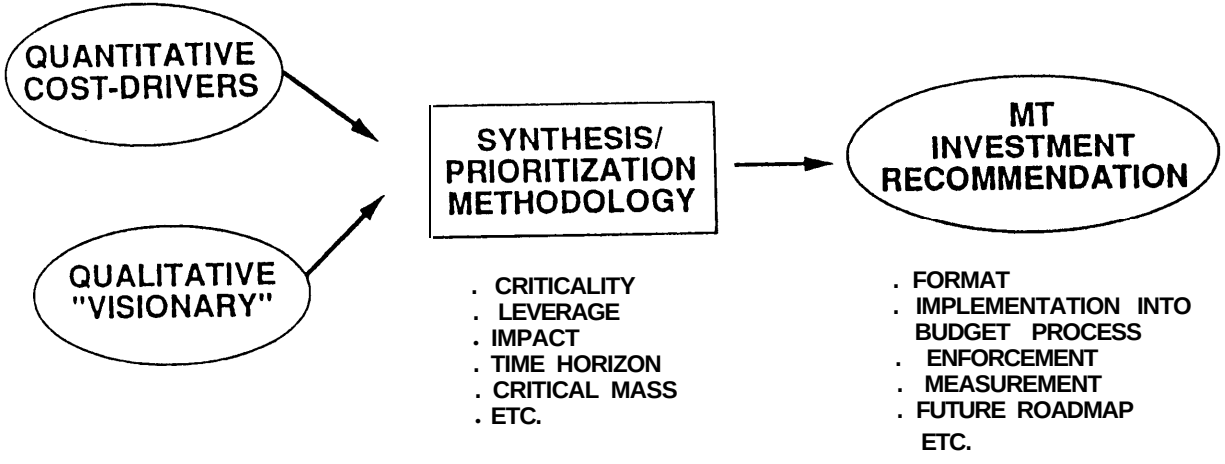
# DoD MANUFACTURING COST DRIVERS

## Summary -- All Programs




13 Jun 91

# (3) MT INVESTMENT ROADMAP




. INITIAL THRUST AREAS

"Soft" ManTech

- Next Generation Mfg System, Enterprise Integration

Three Initial Enabling Technologies

- Composities Fabrication
- Precision Machining / Forming
- Electronics Packaging

. ANALYSIS FRAMEWORK ADOPTED

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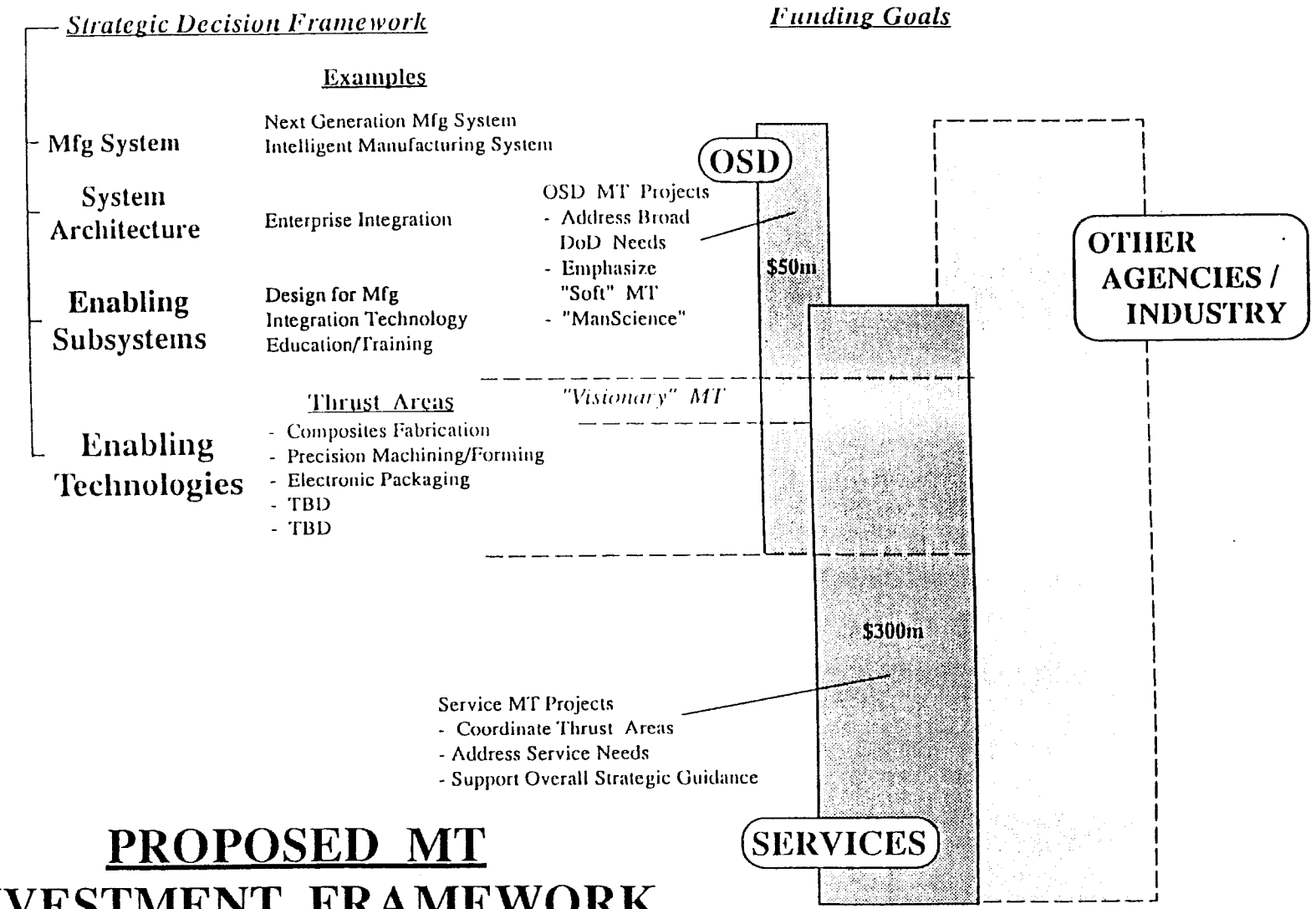


# PROPOSED MT INVESTMENT FRAMEWORK

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# (4) TECHNOLOGY TRANSFER

- GOAL: TO DEVELOP MORE EFFECTIVE WAYS TO TRANSFER MFG TECHNOLOGY TO DoD SUB-TIER SUPPLIERS

- DoE CHAIRING TASK FORCE TECH TRANSFER EFFORT
  - EXAMINING POTENTIAL ROLE OF MFG EXTENSION SERVICES

- REVIEWING TECH TRANSFER LEGISLATION, PAST STUDIES, POLICY, MANTECH PROCEDURES AND INCENTIVES

. CONDUCTING EXTENSIVE INTERVIEWS WITH
  - Policymakers in Congress, DoD, DoC, DOE
  - Extension Services
  - Approx 60 Subtier Suppliers in Regional Concentrations

# (5) MANAGEMENT PLAN

- REVIEW MANTECH PROGRAM
- DoDI REVISIONS
- INTERSERVICE / INTERAGENCY COORDINATION
- INSTITUTE MT CORPORATE PLANNING PROCESS

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# MT CORPORATE PLANNING PROCESS

- DoDI Revisions Propose **MORE ACTIVE MT ROLE**
  - -- OSD: Longer-Range Mfg "Integration" Technologies
  - -- Components: Enabling Technologies Focus + Service Specific
  - – Leverage Interagency, Industry Investments
  - – Broaden "ROI": Quality, Quantity, and Cost

- **MT DIRECTORS COMMITTEE** to Enhance MT Coordination
  - -- OSD & MT Directors (Including DDR&E/DARPA, SDIO)
  - -- DoC/NIST, DoE, NSF, NASA "Ex-Officio" Members

- **STRENGTHEN MT ADVOCACY** in Annual Budget Process
  - -- Overlay BPPBS Process
  - -- MT Executive Level Advocates

- **REINVIGORATE MTAG** Committees
  - -- Recharter, Refocus Committee
  - -- Strategic Planning Focus: Metals; Nonmetals; Electronics; CIM

# OSD RESOURCE ALLOCATION

INITIAL RELEASE OF OSD FY 91 FUNDS IN MAR 91

- Long-Range, Not Business-As-Usual
- $25.5M
  - -- $6M to Vision /Architecture
  - -- $19.5M to Enabling Mfg Technologies
    - --- Composite Fabrication $l0M
    - --- Prec Machining / Forming $8M
    - --- Electronic Packaging $l5M

SECOND RELEASE OF OSD FUNDS PLANNED FOR AUG 91

- Recommended Areas:
  - -- $13.9M "Above the Line" Integration Technologies
    - --- $7.1M Next Generation Mfg Systems
    - --- $1.7M Enterprise Integration / PDES Development
    - --- $3.6M Design for Manufacturing
    - --- $1.5M Mfg Education & Training
  - -- $2.0M "Man-Science" Projects
  - -- $4.75M Add'1 Electronic Packaging

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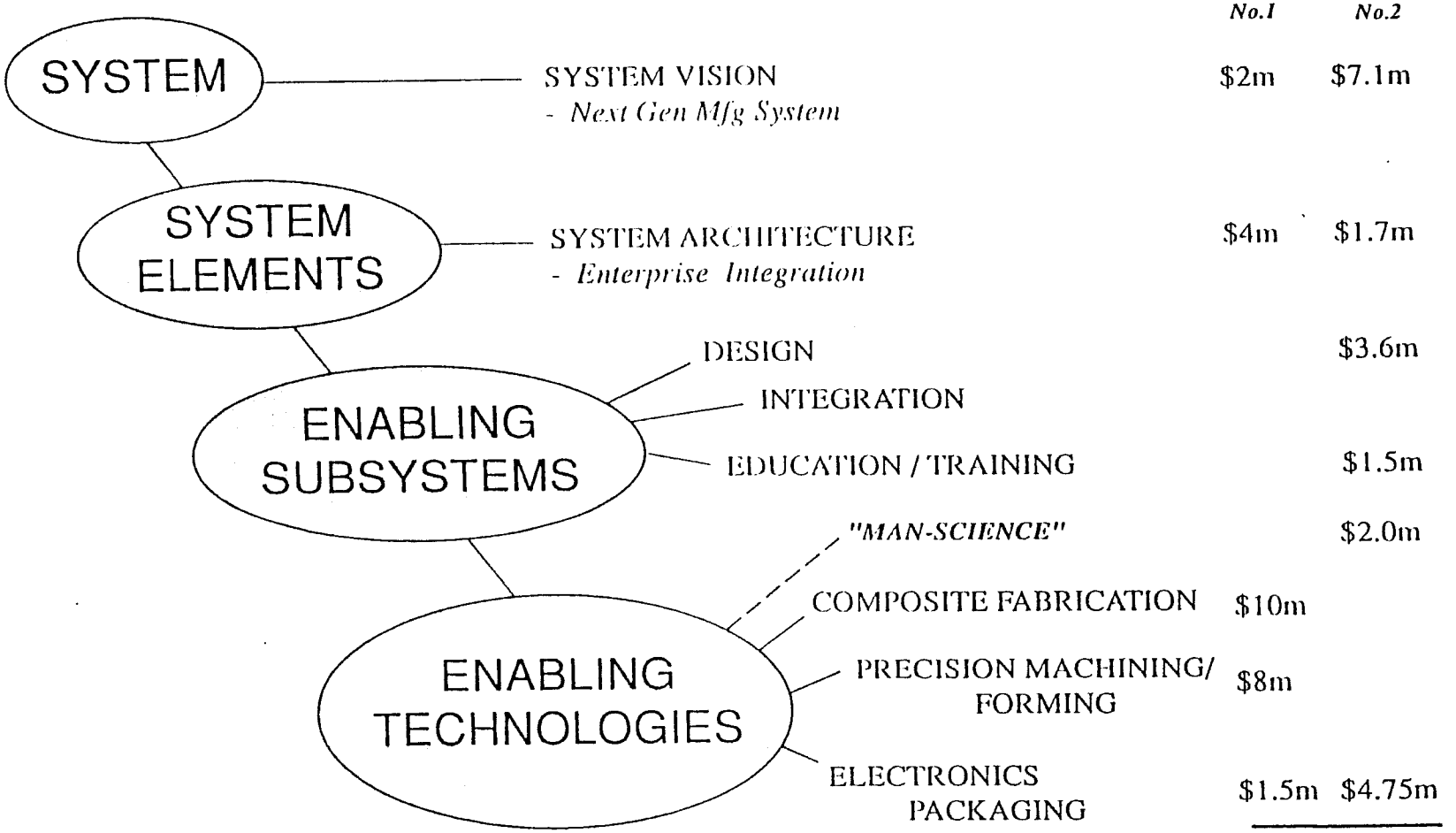
# OSD INTERIM APPROACH




| | Interim Release No.1 | Interim Release No.2 |
|---|---|---|
| SYSTEM VISION<br>- *Next Gen Mfg System* | $2m | $7.1m |
| SYSTEM ARCHITECTURE<br>- *Enterprise Integration* | $4m | $1.7m |
| DESIGN | | $3.6m |
| INTEGRATION | | |
| EDUCATION / TRAINING | | $1.5m |
| *"MAN-SCIENCE"* | | $2.0m |
| COMPOSITE FABRICATION | $10m | |
| PRECISION MACHINING/ FORMING | $8m | |
| ELECTRONICS PACKAGING | $1.5m | $4.75m |
| *Total* | $25.5m | $20.65m |

ManTech

# RELATED INITIATIVES

NUMEROUS "mt" RELATED ACTIVITIES UNDERWAY

- OSTP CRITICAL TECHNOLOGIES
  - FCCSET MANUFACTURING INITIATIVE
- DEFENSE SCIENCE BOARD: WPN DEV & PROD TECH
- MANUFACTURING STUDIES BOARD: NAT'L MFG STRATEGY
- DoD CRITICAL TECHNOLOGY/INDUSTRIAL BASE REPORTS
- DARPA: SEMATECH, et a1
- SERVICES: STRATEGY 2000, ETC
- DoE: ADV MANUFACTURING INITIATIVE
- DoC: ADV TECHNOLOGY PROGRAM
- RECENT BILLS INTRODUCED BEFORE CONGRESS

# UPCOMING ISSUES

- ESTABLISHING PERMANENT OSD MT LINE
- COORDINATION / APPROVAL OF NDMT PLAN
- INSTITUTIONALIZING DoD MT PLANNING PROCESS
- MEANINGFUL INTERAGENCY mt LINKAGES
- RATIONALIZING NDMTP, DSB, MSB RECOMMENDATIONS
- RATIONALIZING WPN SYSTEM PROGRAM $ FOR mt
- LEVERAGING INDUSTRY INVESTMENTS IN mt

APPENDIX: E

# GLOSSARY

# GLOSSARY

**ADVANCED DEVELOPMENT** - That phase of development associated with producing a prototype unit to demonstrate a level of feasibility.

**COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT** - A strategy for the transition from paper-intensive engineering, manufacturing and logistics support to a highly automated and integrated mode of operation for the weapon systems of the 1990s.

**COST ACCOUNTING STANDARDS (CAS) BOARD** - established in 1971 by Congress to develop uniform accounting standards for government agencies.

**COST OF OWNERSHIP** - The purchase price of a product and its necessary support equipment as well as the upkeep cost of the product and support over the life cycle of the product.

**CYCLE TIME** - The time it takes for a process to complete a single cycle.

**DEFENSE GUIDANCE** - The functional direction (excluding fiscal) provided annually by the Secretary of Defense to guide the military force structure including modernization.

**DEFENSE INDUSTRIAL BASE** - The aggregate government and privately owned plants and equipment including government and private technology development efforts encompassing a network of prime weapon system manufacturers and sub-tier fiis with some combination of military and commercial sales.

**DUAL-USE** - Pertains to technologies or manufacturing processes that have military and commercial application.

**ENGINEERING DEVELOPMENT** - That phase of development associated with full-scale design and proof of a production design.

**FLEXIBLE MANUFACTURING** - The process of production with the capability to respond to changing or new situations where well-defined products are designed for simplicity in production utilizing a quality workforce able to respond to change.

**IMIP (Industrial Modernization Incentives Program)** - A DoD program offering incentives to industry for improving the defense industrial base, based on a structured analysis and implemented through a business agreement to increase use of manufacturing technology modernization, and engineering management applications.

**INVESTMENT COSTS** - Those costs associated with development of a product or purchase of capital goods which are normally written off against the cost of operations of an enterprise.

**LEAN PRODUCTION** - A production system employing teams of multi-skilled workers at all organizational levels using highly flexible, automated machines to produce high quality diversified products in greatly varying quantities.

**LONG SHADOW** - The forward or future effect of research and development activities on domestic or foreign policy decisions concerning arms control, deployment, and production. Further important effects of R&D activities concern impact of adversaries behavior(i.e.- incentives for arms control, treaty compliance).

**MANTECH PROGRAM** - A DoD funded, OSD program to develop, evaluate, and prove out manufacturing processes, techniques, and equipment to provide for timely, reliable, economical, and high quality production, maintenance, or repair of weapon systems. The program translates new or improved, feasible process technology from the laboratory to the factory floor.

**MODULAR DESIGN** - A design with a variety of interchangeable parts capable of achieving differing levels of performance or functions.

**OPEN SYSTEMS ARCHITECTURE** - a system allowing the "open" exchange of information among elements of the systems through the use of common standards.

**PACING TECHNOLOGY** - That technology which limits the introduction of a process or product.

**PROCESS FLOW** - The sequence of activities in the form of a network that supports the design, manufacture, test, and operation of a product from inception to disposition.

**PRODUCIBILITY** - The relative ease of manufacturing an item or system. It is governed by the characteristics and features of a design that enables economical fabrication, assembly, inspection, and testing using available manufacturing techniques.

**ROLLOVER** - An acquisition strategy in which industry may be directed to iteratively repeat phases of a weapon system development before proceeding to a successive phase.

**S & T PROGRAM** - DoD Science and Technology program, consisting of Program Elements in the 6.1, 6.2, 6.3a budget categories.

**SCALABLE PROCESSES** - Those processes that are sufficiently robust and viable to produce "normal production volumes", at acceptable cost and quality levels.

**SIMULTANEOUS or CONCURRENT ENGINEERING** - the process of integrating the design of a product and the design of its manufacturing and logistics processes with specific focus on achieving lowest product cost, shortest schedule, and robust quality.

**SURGE** - An increase in the production or repair of defense goods of limited duration.

**SURGE & MOBILIZATION** - The related processes that achieve short-term (surge) or longer-term (mobilization) increased rates of production.

**TECHNOLOGY** - The body of know how which supports the building or designing of a product.

**TECHNOLOGY INSERTION** - The process of introducing a new body of know how into an existing development or production process of a product.

**TECHNOLOGY TRANSFER** - the information flow mechanism by which others may be expected to benefit from modernization efforts at a contractor facility resulting in more efficient use of government resources, and benefits to other DoD acquisition efforts and the commercial / military industrial base.

**TOTAL QUALITY MANAGEMENT (TQM)** - the application of quantitative methods and human resources to continuously improve the material and services supplied to an organization, and the degree to which the needs of the customer are met, now and in the future.