BY THE COMPTROLLER GENERAL

## Report To The Subcommittee On Economic Stabilization Committee On Banking, Finance, And Urban Affairs House of Representatives

OF THE UNITED STATES

# DOD Manufacturing Technology Program--Management Is Improving But Benefits Hard To Measure

The DOD Manufacturing Technology Program provides money, mainly to defense contractors, to demonstrate initial "factory floor" application of new or improved technology to produce defense items. Goals are to improve productivity and decrease Defense acquisition costs. GAO reviewed the program's effectiveness and management.

Defense officials and defense contractors believe this program is achieving useful results--reductions in defense acquisition costs, and in other ways, such as improved maintainability of defense equipment. However, there is neither a Defense wide system to collect information on program results, nor a consensus on what criteria to apply to judge overall program effectiveness. Accordingly, individual judgments vary as to how successful the program is.

Defense's planning and monitoring of the program has improved since 1979, when GAO last reviewed the program. However, Defense needs to increase the likelihood that successful project results will be used on defense production, and establish a uniform evaluation system for the program. GAO makes recommendations to improve program management.





GAO/NSIAD-85-5
NOVEMBER 30, 1984

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

B-207974

The Honorable John J. LaFalce
Chairman, Subcommittee on Economic
Stabilization
Committee on Banking, Finance and Urban Affairs
House of Representatives

Dear Mr. Chairman:

This report is in response to your letter, dated July 1, 1982, asking that we evaluate the level of success of the Department of Defense's Manufacturing Technology Program. This a two-part report--the basic report and a separate volume commenting on the individual projects we reviewed. The report follows up on several briefings to your staff and a letter dated September 28, 1983, to you in which we discussed the interim results of the study you requested.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days from the date of the report. At that time, we will send copies to the Chairmen, Subcommittees on Defense, House and Senate Committees on Appropriations, and House and Senate Committees on Armed Services; House Committee on Government Operations, Senate Committee on Governmental Affairs; the Director, Office of Management and Budget; and the Secretaries of Defense, Army, Navy and Air Force. Copies will also be made available to other interested parties upon request.

Sincerely yours,

Charles A. Bowsher

Comptroller General
of the United States

COMPTROLLER GENERAL's
REPORT TO THE SUBCOMMITTEE ON
ECONOMIC STABILIZATION
COMMITTEE ON BANKING, FINANCE,
AND URBAN AFFAIRS
HOUSE OF REPRESENTATIVES

# DOD MANUFACTURING TECHNOLOGY PROGRAM--MANAGEMENT IS IMPROVING BUT BENEFITS HARD TO MEASURE

## D I G E S T


The Manufacturing Technology Programs of the Department of Defense (DOD) provides money--primarily to defense contractors--to demonstrate an initial factory floor application of new or improved technology in producing defense items. The program has overall goals, as defined by DOD, of improving productivity and reducing Defense acquisition cost. It is designed to "bridge the gap" between research and development innovations and full-scale production applications by increasing the likelihood of using new, more efficient technologies. The program has existed in various forms since the 1950s and was funded at about $200 million for fiscal year 1984. (See p. 1.)

GAO reviewed the Manufacturing Technology Program to assess

--the program's overall effectiveness and

--the program's management in terms of planning, monitoring, use of program results, and evaluation. (See pp. 4 through 7.)


## PROGRAM EFFECTIVENESS

DOD and defense contractors view the program as providing useful benefits to DOD, defense contractors, and commercial users. However, there is no uniform DOD-wide system for collecting information on project results; nor is there a consensus among involved parties on how to measure effectiveness--either quantitatively, such as number of successful projects, or qualitatively, such as improved readiness.

Given the absence of agreement on a criterion for measuring overall program effectiveness--as well as the lengthy time periods involved, which complicate the task of tracking and


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documenting how, when, and where project results are used--observations on overall program effectiveness are necessarily subject to varying judgments.

How DOD and contractor officials assess program effectiveness

DOD believes that the program is achieving useful results but that there are differing approaches for identifying and assessing results:

--Only the Army routinely collects information on completed projects. It publishes an annual effectiveness report. The most recent report, dated October 1984, on 864 projects funded since 1969 showed that 80 percent were considered technically successful and 48 percent produced results used or planned for use in defense production. For these projects, the Army reported that it could document a return of only about $.94 for each $1 it invested. (See p. 8.)

--The Air Force, in April 1982, contracted with a private firm to assess 75 completed projects which cost about $35 million. The private firm's analysis showed that the results of 29 projects were used in defense production and would reduce production cost by about $534 million over future periods ending in 1992. (See p. 8)

--The Navy has not collected the same type of information as the other two services. However, it has assigned staff to track project results beginning in 1983.

GAO did not verify the accuracy of the information reported by the military services. DOD and contractor officials said that, where the program has not resulted in near-term reductions in Defense acquisition costs, future reductions in acquisition costs sometimes occur. They also said that the program results in other less quantifiable benefits, such as improved maintainability of items produced and increased military readiness.

GAO's review of selected projects

GAO's review of 132 selected Manufacturing Technology projects showed (1) a wide range of

technologies involved, (2) typical project durations of 2-4 years, (3) significant benefits reported for some projects, and (4) various reasons why some projects' results were not used for production. (See pp. 10 through 12.)

Each of the three military services had projects that were considered beneficial--either in reducing defense acquisition costs or in qualitative ways, such as improved maintainability or readiness. One Army project which cost $460,000 had reported savings of $716,000 from recycling gun scrap tubes. A Navy project, which cost $677,000, had an estimated $1.2 million savings from automation of a test system. An Air Force project, which cost $504,000, had reported savings of $918,000 from use of new materials in manufacturing aircraft. GAO did not independently verify the reported savings or qualitative improvements.

For projects whose results were not used in production, GAO found that common reasons for nonuse were (1) changes in anticipated production requirements, (2) lack of technical success of the project, or (3) lack of economic feasibility for production use. During the period of time--typically years--from project approval to completion, defense production requirements can and do change, making it difficult to time project completion to "fit" DOD production needs.

PROGRAM MANAGEMENT:
TWO AREAS NEED IMPROVEMENT

DOD has taken several actions to improve program management since 1979, when GAO made several recommendations aimed at strengthening management practices regarding program planning, project monitoring, technology use, and program evaluation. However, DOD can do more to increase the likelihood that successful project results will be used in defense production and to establish a uniform evaluation system for the program.

Because the program involves an element of risk, GAO recognizes that not all completed projects can be used in actual production. Complete, precise information on how many projects--Defense-wide--result in defense production use is not available. However, on several occasions, DOD has expressed concern that the results of projects should be used more frequently

in defense production than they are, and has selectively tested various approaches to help achieve this aim. One such technique is to obtain early agreement among involved parties, including program officers, acquisition managers, and defense contractors, to use results in production, where practical. Another technique is to follow-up systematically on whether the results are, in fact, being used. (See p. 19.)

Although DOD has undertaken some evaluation efforts, it does not have a uniform and systematic program evaluation approach. The need for an appropriate evaluation mechanism has been previously recommended by GAO, and endorsed by DOD officials in congressional testimony and elsewhere; however, progress has been slow. An appropriate evaluation mechanism would take into account the program's overall goals of improving productivity and reducing Defense acquisition costs, but could also give recognition to the various other benefits that DOD and defense contractors believe are being attained. (See p. 21.)

## Initiatives to Strengthen Top Level Management Oversight

The unit in the Office of the Secretary of Defense which provides policy guidance and general oversight for the Manufacturing Technology Program has recognized a need to strengthen its management role for several years. At the time of GAO's review, DOD was pursuing two initiatives: (1) providing improved overall program policy guidance, and (2) developing a tri-service data base.

DOD has been pursuing these two initiatives since 1981 and 1982, respectively. For various reasons, such as lengthy debate within DOD on what to include in the policy guidance and the data base, action had not been completed as of September 1984. (See p. 25.)

## RECOMMENDATIONS

To increase the chances that the Manufacturing Technology Program will achieve its major goals of improved productivity and reduced Defense acquisition cost, GAO recommends that the Secretary of Defense

--encourage greater use of the results of successful projects in defense production by (a) establishing a DOD-wide system that requires acquisition managers and other appropriate parties--before projects are funded--to be aware of the anticipated benefits of proposed projects and to express a willingness to use the results, and (b) annually surveying selected DOD contractors for 5 years after completion of successful projects to determine whether implementation in defense production, as intended, actually occurs;

--develop a policy specifying how and when projects should be evaluated, incorporate the policy into DOD program guidance, and monitor the services to ensure that program evaluations are systematically made; and

--establish specific target dates for attaining completion of the two management initiatives (on Manufacturing Technology policy guidance and tri-service data base) aimed at improving Office of Secretary of Defense leadership and oversight.

## AGENCY COMMENTS

DOD generally concurred with GAO's recommendations on requiring appropriate parties to express a willingness to use project results, developing an evaluation policy, and completing the two management initiatives. DOD partially concurred with the recommendation on surveying contractors.

While DOD agreed that payback from Manufacturing Technology Program investments should be well documented and reported, it said it would be too costly to annually survey every DOD contractor for 5 years after project completion. Because DOD's suggestion of a selective approach, concentrating on likely users, is consistent with the intent of GAO's recommendation, GAO clarified its recommendation. DOD said revised policy guidance will spell out a new requirement for program evaluation, and hoped to finalize action on the two management initiatives by December 1984. (See app. III for DOD's comments.)

# Contents

## ABBREVIATIONS

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| DOD | Department of Defense |
| GAO | General Accounting Office |
| MT | Manufacturing Technology |
| OSD | Office of Secretary of Defense |

# CHAPTER 1

## INTRODUCTION

The Department of Defense (DOD) Manufacturing Technology (MT) Program provides money, primarily to defense contractors, to demonstrate a first case factory floor application of new or improved technology in producing defense items. The program's overall goals--as defined by DOD--are to improve productivity and reduce defense acquisition costs. Its objective is to develop and improve manufacturing processes, techniques, and equipment to provide timely, reliable, and economical production of defense items. The program thus encourages defense contractors and DOD itself to implement or use the new or improved manufacturing technology in the production of defense items. The MT program is designed to "bridge the gap" between research and development innovations and full-scale production applications.

The MT program provides funds for new or improved manufacturing technology efforts which are beyond the normal risk of industry and directed toward production of current or anticipated defense requirements. As such, there are several challenging tasks involved in carrying out the MT program. MT project proposals must be developed which offer high payback potential based on determinations with respect to (1) technical and economic feasibility of the proposed project, and (2) planning targeted project completion dates to coincide with production of targeted defense items. The MT program planning process, completion of the project demonstration, and implementation of the new or improved manufacturing technology typically takes several years--and in some cases can take longer than 10 years between date of project proposal development and implementation (if any) of the resulting technology.

In the 1950s, the Air Force began its program for improving manufacturing techniques in the aerospace industry. The Army started a similar program in 1964, with particular emphasis on ammunition. The Navy has been performing work related to MT since the late 1960s, but considers its program formally established beginning in fiscal year 1977. Air Force and Navy MT projects are primarily performed in defense contractor plants, while a substantial portion of the Army MT projects are performed in plants owned by DOD.

The program is managed primarily by the military services through centralized MT program offices and engineering support staffs. The MT program management offices are located in the Naval Material Command, the Air Force Systems Command, and the Army Material Development and Readiness Command. Some major subordinate commands also have small MT management offices.

Above the service level, the Office of Secretary of Defense (OSD) maintains a small MT staff to provide policy guidance and

general oversight. In addition, a DOD-sponsored Manufacturing Technology Advisory Group, composed of federal defense and civil officials and private industry representatives, coordinates and promotes the program.

Program funding was small initially, but has recently increased significantly, and even greater cost growth is projected:

--For the 7-year period ended in fiscal year 1979, funding totalled about $660 million.

--For the 5-year period ended in fiscal year 1984, funding totalled about $830 million.

--For the 3-year period ending in fiscal 1987, DOD projects total funding of about $1.1 billion.

The MT program was funded at about $131 million in fiscal year 1983. For fiscal 1984, DOD requested a budget of about $223 million. However, the congressional appropriations committees approved a budget of about $200 million after the House Appropriations Committee expressed concern that the program was not showing documented results.

MT program funding has been included mainly in several procurement accounts within the military services' budgets. Most of the Navy's funding has been listed as one line item in one procurement account, "other procurement Navy." Most Air Force MT funding has been in three procurement accounts while the Army, historically, has used eight separate procurement accounts to fund its MT program. Each of the services has also funded small portions of their MT programs through research and development or operations and maintenance accounts.

In the most recent two fiscal years, the Congress has deliberated whether MT program funding should more appropriately be included mainly in research, development, test and evaluation rather than procurement accounts. In acting on the DOD MT budget request for fiscal year 1983, congressional action put the Army's MT program funding under the research and development account. For fiscal year 1984, all except $28 million of the services' funding for the program was changed from procurement to research and development accounts.

## WHY IS THE MANUFACTURING TECHNOLOGY PROGRAM IMPORTANT?

The MT program has long been recognized for its significant potential for productivity improvement and reduced acquisition costs for defense items. DOD views the MT program as a long-term investment or "seed money" targeted at reducing future procurement and life-cycle costs. After DOD funds an initial

demonstration of the new or improved technology, it expects industry to apply the technology in producing defense systems. DOD believes that these investments reduce the private contractor's implementation risks and motivates them to adopt new technologies using private funds, thereby reducing production costs for defense materials.

In February 1975, the Secretary of Defense, recognizing the MT program's potential value, directed the services to increase their emphasis on and support of the program. Later, on April 11, 1975, the Deputy Secretary of Defense directed the services to (1) establish centralized program management and control and (2) identify new MT efforts and major weapon system programs where the application of MT promises a high return on investment. A DOD directive in October 1977, establishing new production management policy, emphasized the importance of the MT program by requiring that MT deficiencies be identified in proposed weapon systems and that MT projects be initiated to ensure producibility.

The MT program has long enjoyed a good reputation and support by many industry representatives and others outside of the government. MT projects have been directed at improving a wide variety of technologies associated with the production of defense items. The following are some examples:

--Army projects relating to aspects of ammunition production, such as improved safety in manufacturing operations and better quality of items produced;

--Air Force projects involving newer materials used to produce aircraft; and

--Navy projects associated with production of microcircuits and antennae used on Navy equipment.

## PRIOR REVIEWS OF THE MANUFACTURING TECHNOLOGY PROGRAM

In a report to the Congress in June 1976, we concluded that to remain internationally competitive and to maintain a strong industrial base, manufacturing productivity must be a national priority.[1] In a more recent report to the Congress in 1979, based on our review of DOD's MT program, we reported that

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[1]Manufacturing Technology--A Changing Challenge to Improved Productivity (GAO/LCD-75-436), June 1976.

the program had significant potential for contributing to reduced defense acquisition costs but that several improvements were needed in the management of the program. Our recommendations were directed toward the need for (1) better application of criteria for MT project funding, (2) a consistent project ranking system, (3) improved management information systems, (4) better technology implementation planning and tracking of project costs and benefits, and (5) internal program evaluations to identify and correct program deficiencies.2

In March 1980, the Surveys and Investigations Staff, House Appropriations Committee, reported on its review of the MT program. Their report also contained recommendations for various program management improvements related to (1) application of criteria for MT project selection, (2) program effectiveness determinations, (3) program focus being more toward generic application of technology, and (4) portion of MT contract awards for firmly established requirements which are not dual or multi-sourced.

In addition, there have been five internal defense reviews and audits of the services' MT programs since 1980 which were primarily directed toward limited aspects of program management and administration. For example, an August 1982 audit report prepared by staff of the U.S. Army Armament Material Readiness Command contained recommendations for improved practices for administrative close-out of MT projects.

## OBJECTIVES, SCOPE AND METHODOLOGY

The objectives of our review were to evaluate

--the overall effectiveness of the MT program, and

--changes in DOD management of the MT program since our 1979 report.

The review was made at the request of the Chairman, Subcommittee on Economic Stabilization, Committee on Banking, Finance and Urban Affairs, House of Representatives. We earlier issued two interim reports on this work: one addressed to the Chairman, Subcommittee on Economic Stabilization (GAO/AFMD-83-105; 9/25/83) and another addressed to the Chairman, Subcommittee on Defense, House Appropriations Committee (GAO/AFMD-83-97; 9/14/83).

The scope of our review was DOD-wide including the Army, Navy, and Air Force. We visited the central MT program manager in the Office, Under Secretary of Defense, Research and

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2Manufacturing Technology--A Cost Reduction Tool at the Department of Defense That Needs Sharpening (GAO/PSAD-79-99), September 11, 1979.

Engineering and each of the service's MT program and support offices as well as selected major commands, laboratories, and field activities involved in managing the MT program. A list of DOD activities visited is included as appendix I. In addition, we visited 19 private contractors who had implemented new or improved technology resulting from the MT program.

Program effectiveness

As a first step toward evaluating the MT program's overall effectiveness, we interviewed Department of Defense MT program managers and obtained information on the results of their efforts to identify, document, and report on program effectiveness. This included an analysis of their latest effectiveness data and discussions of their future plans for assessing program results.

During the early phase of our work, we concluded that we would not be in a position to offer a firm independent opinion on the overall effectiveness of the MT program. This was because of

--the absence of a consensus within DOD or among other affected parties (such as defense contractors) on appropriate criteria to measure overall effectiveness;

--the lack of a uniform system throughout DOD for collecting, analyzing, and documenting information on the results of completed MT projects;

--the lengthy timeframe between completion of many MT projects and their use (if any) in defense production. (During that timeframe, many other factors can influence productivity and defense acquisition cost.)

Given these circumstances, we agreed with the congressional requestors that our approach to program effectiveness would be to do limited "case studies" on 132 individual MT projects[3]--based on available documentation, observation, and interviews of appropriate parties--and report the results without expressing an opinion on overall program effectiveness.

Our approach in selecting 132 individual projects for review, as well as the detailed results of "case studies," are included in a separate volume (GAO/NSIAD-85-5(a)).

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[3]The three services differ in the terminology they use. For example, the Army uses the term "effort," while the Air Force and Navy use the term "project" when referring to individually identified and funded manufacturing technology efforts. In our report, we use the term "project" for all three services.

Program management

Our review of the MT program's management was directed toward evaluating those actions taken by DOD and the services to improve program management in response to recommendations contained in prior GAO reports--specifically, the areas (1) MT program planning, (2) project review and approval, (3) project monitoring, (4) management information systems, and (5) internal program evaluations. To assess the actions to improve MT program management, we held discussions with program personnel and managers in DOD and in each of the military services and reviewed program instructions, correspondence, program plans, project review documentation, project priority listings, project contracts, project status reports, management information systems, and other pertinent records and documentation.

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Our review of the MT program also included research into its legislative history and an extensive MT program data search. This review was performed in accordance with generally accepted government audit standards.

## CHAPTER 2

## WHAT RESULTS ARE BEING ACHIEVED UNDER THE PROGRAM AND HOW ARE THEY VIEWED?

In the view of responsible defense officials, defense contractor representatives, and other interested parties, the DOD Manufacturing Technology Program is providing useful benefits to DOD, defense contractors, and commercial users. However, in describing the benefits achieved, some observers stress tangible, short-term benefits, others less tangible, future benefits. OSD and the military services used different approaches to collect information and report on MT program results. In our independent review of selected MT projects, we found (1) a wide range of technologies involved; (2) a typical project duration of 2-4 years; (3) significant benefits reported for some projects; and (4) commonly expected reasons why some completed projects are not used in defense production.

### DOD OFFICIALS VIEW PROGRAM AS BENEFICIAL BUT HAVE DIFFERENT WAYS TO REVIEW RESULTS

MT officials in OSD and the military services believe that the MT program is achieving useful results. However, they use differing approaches to describe and discuss MT program effectiveness. Some DOD offices have information on quantifiably measurable results, such as the number of projects that are "technically successful" or the number of completed projects where results were used in defense production. Also, some information on qualitative results, such as improved readiness or maintenance patterns is recorded for some projects. Various DOD offices use this type of information as indicators of program effectiveness. However, there is no generally accepted quantitative or qualitative standard--such as percent of projects that should be successful, or degree of improved readiness.

#### OSD

The MT office within OSD has not routinely collected information on the results of all MT projects. But OSD has reemphasized on several occasions during the past few years that achieving the MT program's primary goal of improved productivity and reduced acquisition cost requires that MT project results be used in production.

#### Army

The MT office of the Army has annually made a survey of most completed MT projects to determine the results achieved. The most recent Army survey, dated October 1984, presents the results of projects funded after 1969 and completed by December 1983.

For 855 MT projects, the Army reported that about 80 percent were technically successful and that the results of about 48 percent of the projects were used or planned for use in defense production. The Army also reported that it could document a return of only about $.94 for each $1 it invested in these 855 projects. However, the Army also cited various technical benefits--such as improved maintainability or readiness--that cannot be readily quantified. A central office in the Army gathers information on completed projects from involved Army offices, and prepares the annual report without auditing the information received.

Air Force

The Air Force has not routinely collected information on the results of all completed MT projects. However, in April 1982, the Air Force contracted with a private consultant to assess the technical results, implementation, and resulting benefits of 75 completed MT projects--in which the Air Force invested about $33 million--at eight contractors. The contractor reported that the results of 29 of the Air Force projects were implemented into production of military and/or commercial end items. Moreover, the contractor projected that the MT project results would reduce production costs by a total of $933 million--$534 million relating to production of military end items, the remainder to commercial end items--over future periods ending in 1992. The contractor also concluded that, even where production cost reductions will not result, various technical benefits may be attained. The contractor found that the average period of time from completion of a project to use in a production environment was over 3 years.

Navy

The Navy, thus far, has done less than the other services to identify and assess the results achieved from completed MT projects. The initial Navy effort was a one-time survey in 1983 to identify project results; the information was obtained centrally in the Navy without an audit. The Navy later in 1983 assigned its MT support staff the task of tracking MT program benefits.

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Many OSD and military service officials are convinced that the MT program has achieved or will achieve beneficial results. They point out that use of completed MT project results in production, and related benefits that accrue, often takes several years after the project has started. The often lengthy time frame before results materialize makes it difficult for OSD and military service officials to substantiate their views on program results in a systematic and convincing manner.

## DEFENSE CONTRACTORS HAVE POSITIVE VIEWS OF BENEFITS BUT DESCRIBE THEM IN VARIOUS WAYS

The defense contractor representatives we talked with also believe that the MT program is achieving beneficial results. In many instances, the contractors believe that the MT program results will reduce manufacturing costs; however, they also often point to other types of less tangible benefits. Several contractor representatives pointed out that the beneficial results do not usually materialize until several years after the MT project is completed. Other than reduced defense acquisition costs, contractor representatives cited such benefits as

-- improved quality of items produced,
-- longer service life of items produced,
-- general advances in the state-of-the-art, and
-- better qualified personnel because of experience gained on MT projects.

Some defense contractor representatives acknowledged that the benefits were not well-documented, but also noted that the process of documenting benefits could be costly and lengthy.

## TECHNOLOGY TRANSFER AND DIFFUSION: A HARD-TO-IDENTIFY SIDE BENEFIT OF THE PROGRAM

The results of MT projects sometimes benefit (1) defense production areas beyond those originally planned or intended, and/or (2) commercial (i.e., non-defense) production. While instances of such benefits exist, they are usually hard to identify or fully document. This is particularly true for commercial production applications since such applications are beyond DOD's stated objectives for the program.

A number of communication mechanisms can be conduits for MT-generated technologies being spun off to other applications. For example, each of the services publishes technical literature on completed or on-going projects. Also, end-of-project demonstrations are attended by a variety of potential users--both defense and commercial. Finally, the various meetings of the Manufacturing Technology Advisory Group bring together many potential users of MT-generated technologies.

DOD does not systematically gather information on all transfer and diffusion of MT-generated technologies. Cost and practical constraints are realistic barriers to doing so.

## OBSERVATIONS ON SELECTED MT PROJECTS REVIEWED

The 132 MT projects we reviewed illustrate the diversity of projects and the technical complexities involved in the MT pro-

gram. Overall, projects are intended to benefit a broad range of defense production needs--including ammunition, tanks, aircraft, ships, and weapons. However, individual projects can be geared to improving the production of one component of an item, such as the tail assembly of an aircraft, or of an entire end item, such as the production line for a particular round of ammunition.

While we cannot generalize about the MT program from the MT projects we reviewed, many of our observations are consistent with views expressed to us by knowledgeable MT officials or with results reported through various OSD and military service reporting mechanisms. In the absence of clear agreement on criteria for judging projects results, observers of completed MT projects necessarily must apply their own individual criteria in assessing the perceived degree of success of the MT program.

## General Observations

In reviewing 132 selected MT projects, we observed that

--projects cover a broad range of technologies;

--projects have durations ranging from less than 1 year to over 10 years, but most have durations of 2-4 years; and

--tracking the results of completed projects, and determining whether and how those results are used in defense production, is difficult.

MT projects address a broad range of technologies including robotics-type equipment, laser techniques, composite manufacture, safety engineering, computer-assisted design, and others. To illustrate this diversity, consider the following: The Air Force had a $1.3 million project to demonstrate and test an integrated quality control and inspection system for tracking composite structures through a production facility. The Army funded a $836,000 project to establish procedures for hazard classification of in-process materials involved in the manufacture and assembly of explosives and propellants in ammunition. The Navy approved a $1.7 million project involving the use of computer-controlled robot tools that work with existing inspection equipment to obtain an automated method of finishing propeller surfaces.

Of 132 projects we reviewed, 76 had durations ranging between 2 and 4 years. Three projects had a duration of a year or less. The durations of 23 projects exceeded 5 years--three of which were approximately 10 years.

Tracking the result of MT projects to clearly determine if and how the results affected defense production is difficult.

First, the results may not be used until years after project completion, during which time many other factors--such as engineering changes, raw material price changes, and other technological advances--can affect the productivity and defense acquisition costs, making it hard to isolate the impact of the MT project. Secondly, as discussed further in Chapter 3, the military services do not have a uniform system to identify and document how MT project results are used.

Examples of benefits reported

In order to understand the nature of benefits achieved or anticipated, we reviewed 42 MT projects for which the results had been used in defense production since 1979. Examples of reported benefits achieved (or anticipated) where the results were actually used in defense production include the following:

Army

--an estimated $3.3 million savings and improved readiness, from a $1,180,000 project for automated loading of propellant flash reducers;

--improved reliability, and reduced lead time, from a $1,365,000 project for automated equipment to assemble a fuze; and

--energy conservation and $716,000 savings, from a $460,000 project involving recycling of gun scrap tubes by rotary forging.

Navy

--an estimated $25 million savings and expansion of the defense industrial base, from a $501,000 project involving fabrication of gallium arsenide wafers; and

--an estimated $1.2 million savings from a $677,000 project involving automation of the test system for phased-array antennas.

Air Force

--an estimated savings of $918,000 from a $504,000 project involving the use of new materials in aircraft production and

--an estimated annual savings of $285,000-$795,000, from a $236,000 project involving a laser pattern generator.

## Reasons why some MT project results are not used in production

MT projects are recognized as having an element of risk. In fact, DOD does not generally intend to fund MT projects that the private sector would fund without DOD support. Because of this known risk factor, DOD does not expect that every MT project will be a technical success nor that the results of every project will be implemented into a defense production environment. To better understand why some project results are not used in a production environment, we selected 58 projects completed since 1979 where the results were not used for production.

For the 58 projects, the most common reasons cited for non-use were as follows:

- --for 10 projects, there were changes in anticipated production requirements;
- --for 9 projects, results were not considered "technically successful";
- --for 9 projects, use of results was not considered economically feasible for production;
- --for 4 projects, further work was considered necessary at project completion to determine feasibility of use.

Other reasons for non-use included defense contractor unwillingness, a need for engineering changes or tooling before production use was possible, or the discovery of a competing technology that was considered to be better.

One common reason--namely changes in defense production requirements--deserves further comment. Based on our observations, the time from an MT proposal to approval, execution, and completion is typically at least 5-6 years, and frequently is much longer. During that lengthy period, defense production requirements can and do change extensively.[4] The lengthy time period to execute MT projects, coupled with changing production requirements, adds to the difficulty of trying (1) to ensure the use of MT project results in a specific defense production application, and (2) to fully track and document the benefits achieved.

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[4]Instability in defense production requirements has been much discussed elsewhere as a continuing obstacle to efficiency and is too exhaustive to discuss in detail here. Documents that discuss instability in defense production schedules include GAO report Impedients to Reducing the Costs of Weapon Systems (GAO/PSAD-80-6), November 8, 1979, and Jacques S. Gansler, Defense Industry (Cambridge: Massachusetts Institute of Technology, 1980).

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For further information on the 132 MT projects which we reviewed, the reader is referred to a separate GAO publication (GAO/NSIAD-85-5(a)) accompanying this report. That publication also describes how we judgmentally selected projects for review.

## CONCLUSIONS

There are honest differences of opinion on how to view the results of the MT program. Many knowledgeable observers generally agree that the program provides benefits, but they describe the nature and extent of the benefits in differing ways and acknowledge that benefits have not been well documented. We believe that, to judge program effectiveness in a balanced way, the various views of MT benefits should be considered. However, we also believe that one criterion that should continue to be applied is whether the MT program is achieving its major objective of reducing defense acquisition costs. Given the absence of agreement on an appropriate quantifiable criteria, observations on the overall program effectiveness are necessarily subject to varying judgement.

## AGENCY COMMENTS

DOD partially concurred with our conclusion. DOD agreed that the criterion which should be used to measure project performance is whether or not the technology developed by the program is used to produce DOD material. However, DOD does not consider "dollars" as the only measure of program effectiveness, and believes that other performance measures may be equally acceptable but not directly comparable (e.g., lead time, materials, man-hours, etc.) (At DOD's suggestion, we added examples to the material above to illustrate some projects which DOD views as effective using these other performance measures.) (See app. III for DOD comments.)

## CHAPTER 3

## HOW WELL HAS DOD RESPONDED TO NEEDED MANUFACTURING TECHNOLOGY PROGRAM MANAGEMENT IMPROVEMENTS?

The Department of Defense has taken several actions to improve its management of the MT program since 1979, when we made several recommendations aimed at strengthening management practices regarding program planning, project monitoring, technology use, and program evaluation. However, further management improvements are needed. Some officials in OSD and the military services have acknowledged this need.

OSD and the military services signed a Statement of Principles in March 1980 for the MT program (see app. II) which stressed the importance of obtaining maximum benefits from every MT dollar invested. The Statement addressed several key MT program management areas--program planning, project selection, technology implementation, and benefits tracking--and emphasized that full benefits can only be achieved if the program's plans, progress and results are readily available to DOD and the defense industrial base in a timely and convenient manner. DOD has taken several other actions since 1979 to improve and strengthen MT program management.

However, even with the top level DOD emphasis and actions taken or planned to improve the program, our current review indicates that additional efforts are needed to further improve program management by

--using more innovative approaches to increase the probability that successful project results will be used to benefit the production of defense items, and

--developing a definitive and uniform policy to be used in systematically evaluating the MT program.

### PROGRAM PLANNING AND PROJECT SELECTION

The military services have made progress in refining their program planning and project selection processes and have recently taken actions which should further enhance their efforts in these program functions.

### Program planning

The need to improve the MT program planning function has been recognized for several years: A June 1978 Under Secretary of Defense memorandum to the services stressed the need for (1) development of a long-range tri-service plan to ensure that key areas are not overlooked and (2) continuing production cost

driver[5] conferences and studies to identify and prioritize high payback manufacturing technology investment areas. The 1980 MT program Statement of Principles also recognized that program planning must constitute a fully integrated tri-service activity. The services have continued, to some extent, to use cost driver studies and conferences and have taken other actions to improve their program planning functions. However, we believe that improving program planning processes to better focus and link the MT program to major defense acquisitions should continue to be a top management concern.

Each military service develops a formal 5-year program plan for their respective MT programs. The OSD MT program manager informed us that the joint review of each service's MT project proposals and other interaction of the services' representatives with the DOD Manufacturing Technology Advisory Group accomplish DOD's intent to develop a long-range tri-service plan. No formal tri-service plan has been prepared; but, according to the OSD program manager, the results of that review and interaction are reflected in the services' program plans.

The services have continued to perform and use cost driver conferences and studies, and have taken or planned other actions to improve their program planning. For example,

--The Army has continued to use planning workshops and conferences to define and rank critical MT needs and has sponsored three cost driver conferences since 1979. Also, the Army now requires that MT project proposals include implementation plans to show how the project results fit into the life cycle of the target systems, and MT program officials informed us that they were making a concerted effort to link projects more in support of major weapon systems.

--The Air Force, too, has continued sponsoring and participating in planning conferences and cost driver studies, conferences, and workshops. It provided us information on two cost driver studies done since 1979. Also, the Air Force Systems Command now requires that its product divisions brief its MT program office on specific production requirements.

--The Navy has not performed any cost driver studies since 1979, but has requested funds for such. Funds were provided in the 1984 budget, and the Navy is currently making plans to conduct such studies. According to the Navy MT program manager, these studies are an important element of MT program planning, and the Navy had been using the previously developed cost driver studies. Further, the Navy recently drafted updated MT program policy guidance

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[5]A factor in the production process that contributes significantly to the cost of the product.

which addressed the identification and use of cost drivers and increased coordination with Army, Air Force, and other agencies.

The military services have also been using or have introduced other tools to accomplish the same objective as cost studies. For example, Army program officials told us that they have recently issued revised policy and guidance for conducting producibility engineering and planning which (1) applies to all major and nonmajor Army systems and (2) incorporates requirements for cost analysis which will ensure producibility and minimize production costs. Another tool cited by the services is the top-down factory analysis which is part (usually phase I) of the Industrial Modernization Incentives Program.[6] This factory analysis generates and screens modernization projects from both direct and indirect operations with an ultimate goal of developing a strategic productivity improvement and cost reduction plan for the entire plant used in production of defense items.

Project selection

The DOD MT program Statement of Principles stressed the importance of selecting MT projects that meet program criteria and are based on an assessment of needs. Each service has various procedures for reviewing MT project proposals in addition to the project review performed by the six technical subcommittees of the Manufacturing Technology Advisory Group. Some actions have been taken since 1979 to improve the MT project selection, and most projects appear to meet the criteria.

Our 1979 report contained recommendations directed toward gaining better application of MT program criteria for project selection and the need for a project ranking system to ensure that the most beneficial projects are funded first. DOD disagreed with these recommendations, stating that project selection criteria should permit the funding of projects that go beyond the primary aims of cost reduction and productivity enhancement--to include safety, health, pollution abatement, energy conservation, and others. Regarding a project ranking system, Defense asserted

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[6]The Industrial Modernization Incentives Program (IMIP) is a "business arrangement" between the military services and defense contractors. It was preceded by the Air Force's Technology Modernization program and consists of contract incentives such as investment protection and shared savings to encourage defense contractors to invest in newer technologies and capital equipment to modernize their production facilities. OSD initiated a test of the IMIP concept in all three military services in late 1982. The "test" phase was still ongoing at the time of our review. If the test is deemed successful by DOD, the IMIP approach could provide a useful mechanism to better ensure the use of successful MT project results.

that a consolidated project ranking system would not improve the project selection process because the program is funded from various appropriations, and funds are not transferred among appropriations. MT program representatives from the Navy and Army told us that they had attempted to use a project ranking system but had not found it beneficial. However, all three services do now rank projects below the service-wide level.

All three services cited other actions they had taken or planned to improve project selection. The following are some examples:

--The Air Force strengthened its formal project documentation by expanding the project description to identify the target system and to better document the need for the project. Also, the Air Force expanded its efforts to review project proposals by formally involving their product divisions in the process.

--The Navy is strengthening its project review process by allowing laboratories other than the proponent laboratory to review the project proposals and by updating its program policy covering project proposal justifications.

--The Army MT program manager stated that their review of new project proposals had been sharpened and that there is now a much clearer understanding of criteria for projects. Specifically, the review is to give more emphasis to the return on investment from a project, to the prospects for implementability on the factory floor, and to ensuring that the project is not used to fix research and development problems.

## CONCLUSIONS

The emphasis placed on the importance of the program planning and project selection processes and the several actions cited by the services as taken or planned relative to those processes have the potential for significantly improving the program.

## AGENCY COMMENTS

DOD pointed out that MT projects are intended to develop technologies that are needed by more than one system. If the technology to be developed supports only one acquisition program, DOD believes that program should pay for the technology developed. DOD did agree that a systematic approach should be used to select projects, but said that the various steps it uses constitute a systematic approach. Even so, DOD said a proposed revision to policy guidance now in process within DOD further addresses this issue.

## PROJECT MONITORING

Effective management level monitoring can help ensure that MT projects are completed on schedule and can identify those projects that are not achieving their objectives. The Army and Navy have recently acted to improve their management level monitoring and now have in place MT program management information systems. The Air Force has a plan for developing a management information system for its program.

Each service assigns project engineers for detailed monitoring of on-going MT projects. The project engineers are tasked with developing contract statements of work and providing general oversight and reporting for the projects. In each of the services, the project engineers or contractors report routinely--monthly, quarterly, and/or semiannually--on project progress and status to the respective MT program management office.

However, as we reported in 1979, our current review disclosed that management level program data was not readily available on the status of the services' MT projects. The services have recognized the need for improvements in their management level monitoring of MT projects and have recently acted to bring about needed changes. Examples of these changes are as follows:

--The Army, which has had a management information system since 1976, formally instituted, in 1982, semiannual on-site reviews of active projects by top level MT program staff to ensure that projects are completed on time and that applicable policies are carried out.

--The Navy has recently shifted the primary focus of its centralized MT program support staff from project proposal review to monitoring, including on-site reviews of MT projects. To assist the monitoring role, the Navy in June 1983 established a management information system for the MT program.

--The Air Force MT office submitted plans for an MT dedicated management information system to its headquarters in October 1983.

The OSD does not yet have the tri-service management information system we recommended in 1979; however, it recognizes that such a system is needed for program oversight. (Its efforts to establish the tri-service data system are discussed further in chapter 4.)

## CONCLUSIONS

We believe that the actions taken by the Army and Navy and the management information system planned by the Air Force should

substantially improve their ability to monitor active MT projects at the management level. In turn, this should provide program managers with significantly better and more timely information on the progress and status of their projects for use in their decision making processes.

## AGENCY COMMENTS

DOD concurred with our conclusion. (See app. III.)

## TECHNOLOGY IMPLEMENTATION

Even if the right projects are selected for funding and successfully completed, optimum program effectiveness cannot be achieved unless the MT project results are put into use on the factory floor in the production of defense items. We believe, as does DOD, that more can be done to increase the likelihood of implementation.

The 1980 DOD Statement of Principles stated that implementation and technology transfer are critical elements of MT program management in order to obtain full benefits from the program. In our 1979 report, we expressed concern that many completed MT projects had not benefited the production of Defense items, and we recommended that the services actively promote the use of MT project results--at the very minimum to have a plan for implementing project results into the production contract of the target system on which the MT project was demonstrated. Since 1979, DOD has on several occasions during events, such as the Manufacturing Technology Advisory Group annual conference, reiterated the importance of obtaining implementation of MT project results.

The military services have also taken various steps to increase the likelihood that MT project results will be used to benefit the production of defense systems. All three services, for example, now require that an implementation plan be prepared before the MT project is completed. Implementation plans encourage the use of MT project results in production by linking projects more directly with specific production requirements.

The Navy has also recently taken some additional innovative steps to help ensure use of MT project results. Beginning with fiscal year 1982 MT projects, the Navy has required that a "memorandum of understanding" be signed by MT officials and responsible acquisition managers before projects are funded. These memoranda are intended to ensure that acquisition managers understand the anticipated benefits and are willing to implement MT project results in the systems they are acquiring. During congressional testimony in May 1983 and discussions with us, Navy managers stated that other actions recently taken or under consideration to encourage maximum use of MT project results include

--the refocusing of the centralized MT program support staff to track and assess the implementation status of completed MT projects as well as monitoring on-going projects,

--more care in the selection of projects to coincide with documented needs, and

--withholding further MT projects from a contractor until satisfactory implementation of a completed project.

The Army has stated that technology implementation has become a major concern throughout the life cycle of a project, and its MT program managers told us that they plan to contract for a study of technology implementation with the ultimate goal to obtain recommendations on ways to further increase the use of MT project results. The Army manager told us that, in the past, many of their projects were directed toward mobilization requirements and, therefore, were not used because the facilities were in lay away and not currently used for producing defense items. We were told, however, that the Army plans to direct their projects more toward current production requirements and, therefore, that this should further increase the use of MT project results. Also, to facilitate technology implementation and transfer, the Army revised its program guidance to encourage end-of-project demonstrations for all MT projects completed under the program. In addition, certain Army commands are now improving their tracking of projects to help ensure that technology implementation is achieved.

The Air Force also stated that it has on occasion (1) made attempts to gain top level intent from contractors to implement the MT project results and (2) funded projects that require significant contractor capital investment to ensure contractor commitment to use the project results.

Even though DOD has taken several actions to improve technology implementation and has plans for other actions, the results of many projects still do not directly benefit the production of Defense systems.

Two areas may need further management attention. First, a mutual understanding among MT program offices, DOD acquisition managers, and other involved parties (such as defense contractors) early in the life cycle of planned MT projects should encourage the ultimate use of successful project results in defense production. Early agreement to utilize the results of a project is a sound indicator of the merits of the investment at the time investment decisions are made. Secondly, an active follow-up system within DOD after completion of successful MT

projects to periodically encourage the use of project results in defense production could add assurance that consideration is continuously given to reaping potential benefits.

## CONCLUSIONS

We believe that there is now a much greater awareness within the defense establishment of the importance and need to obtain technology implementation to the fullest extent possible. Some steps already taken by the military services appear likely to increase the rate of using MT project results on the factory floor.

One such promising technique is to obtain agreements early in the MT project cycle among MT program offices, acquisition managers, defense contractors, and other involved parties to ensure the strongest likelihood possible of obtaining factory floor use of MT project results in the production of defense systems. A second technique is to track successful projects after completion to determine if planned implementation occurs. We believe that the services should continue exploring these and other innovative techniques to help ensure that successful MT projects results are put to use.

## RECOMMENDATION

We recommend that the Secretary of Defense encourage greater use of the results of successful projects in defense production by

(a) establishing a DOD-wide system that requires acquisition managers and other appropriate parties--before projects are funded--to be aware of the anticipated benefits of proposed projects and to express a willingness to use the results. (The Navy's recent approach to documenting this type of understanding is one example of how this might work.)

(b) annually surveying selected DOD contractors for 5 years after completion of successful MT projects to determine whether implementation in defense production actually occurs as intended.

## AGENCY COMMENTS

DOD concurred with the first recommendation, partially concurred with the second, and offered further comments on each.

For the first, DOD considered it reasonable to require potential users to express a willingness to use the results of an investment, but not reasonable to require them to do so after the technology has been developed if real world conditions dictate that it is no longer prudent to do so. We agree and did not

intend to suggest that changing conditions should be ignored. DOD sees the Navy procedures as only one means to an end, and believes that other techniques can be just as effective in increasing the implementation of technology developed by the MT programs. We agree that the Navy's procedures are just one possible technique, and encourage DOD to continue to search for other innovative techniques that will increase the rate of implementation of new technologies into defense production use.

For the second, DOD agreed that payback from MT investments should be well documented and reported. DOD said that it would be more prudent to survey contractors on a selective basis. DOD's suggestion of a selective approach, concentrating on likely users, is consistent with the intent of our recommendation. We clarified our recommendation after obtaining DOD's comments.

For both recommendations, DOD said that a proposed revision of MT program policy guidance--not yet final in September 1984--addresses the issues. (See app. III for DOD comments.)

PROGRAM EVALUATION

The need for management to identify program results and to use those results to assess and demonstrate MT program effectiveness has been recognized by DOD for several years. Without regular program evaluations, there is no systematic way for the services to determine if their management improvement actions have been fully effective. In 1979, we recommended that DOD develop measures of effectiveness that correspond to program goals and require the services to make regular evaluations of their programs to identify and correct deficiencies. The 1980 DOD Statement of Principles for the MT program stated that program benefits must be documented in clear, simple, and unequivocal terms.

The military services and OSD have taken some actions to identify how results of MT projects are used after project completion. However, the efforts to assess the results of completed projects vary, and are subject to differing interpretations because there is no guidance to ensure a uniform approach by the services in making such evaluations. None of the services' efforts to evaluate program results have addressed specifically how the MT program has impacted on defense acquisition costs. Also, the services have been slow in making post audits of completed projects, as directed by DOD in 1982.

The Army has conducted annual surveys since 1979 to determine the benefits derived from completed projects. The Army MT program representative stated that the Army intends to track completed projects for up to 10 years. The results of these surveys are summarized and distributed to interested parties in and out of DOD. In the Army's reports,

--technical success rates include projects reported as technically successful even when they were stated not to be economically or technologically feasible to implement;

--implementation rates include projects available for implementation and planned implementations as well as those actually in use; and

--the savings data represent the 5-year defense plan and are often estimated or projected figures without any independent verification.

In April 1982, the Air Force contracted with a consultant to assess the technical results, implementation, and resulting benefits of 75 completed projects by eight contractors. The consultant's report on the assessment stressed that the results could not be viewed as representative of the MT program or conclusive in their findings. The savings figures of about $933 million identified by the contractor represented projections over the 10-year period ending 1992. The private firm's assessment stressed that the estimated savings were net of the contractor's investment and were very conservative. It further stated that the savings did not represent actual savings to the Air Force because (1) the analysis methodology used did not address overall cost structure of components or systems and (2) direct linkages between MT generated savings and overall production cost or selling price could not be made. For several projects, the contractor believed that benefits had occurred, but could not be quantified.

The Navy has done little to evaluate program results. In 1980, it did publish an effectiveness report covering 11 projects; however, 4 of the 11 projects were not implemented at that time. In 1983, the Navy assigned its program support staff the responsibility to track and assess the benefits of completed projects. In the same year, on a special one-time basis, the Navy inventoried the status of all the projects it had funded since 1977.

OSD testified in 1982 that the military services had been directed to perform post audits of all completed MT projects. At the time of our review, the services had begun to address ways to accomplishing post audits. Although OSD has made some efforts to improve the MT program evaluation function, it still has not defined uniform measures for use by the services in making their program evaluation.

## CONCLUSIONS

The need for effective evaluation of the MT program results has been recognized for some time and OSD and the military services have made some efforts to evaluate the results of completed

projects. However, their evaluation approaches remain fragmented, inconsistent, and inconclusive because of the lack of guidance on how such evaluative efforts should be accomplished.

We believe that DOD needs to set more definitive and consistent policy as to when and how projects should be evaluated, and how the evaluation results should be documented. Further, we believe that while it would be appropriate to consider the various ways in which program results can be viewed, one criterion that should always be applied is whether the projects are achieving the program's primary goals of improved productivity and reduced defense acquisition costs.

## RECOMMENDATIONS

To provide the basis for effective, consistent MT program evaluations, we recommend that the Secretary of Defense develop a policy specifying how and when projects should be evaluated, incorporate the policy into DOD program guidance, and monitor the services to ensure that the program evaluations are systematically made.

## AGENCY COMMENTS

DOD concurred with our recommendation. Further, DOD said that revised policy guidance now in process will specifically spell out a new requirement for MT program evaluation. (See app. III for DOD comments.)

## CHAPTER 4

## DOD IS TRYING TO STRENGTHEN TOP LEVEL MANAGEMENT OF THE MANUFACTURING TECHNOLOGY PROGRAM

DOD has recognized a need to strengthen its top-level management and oversight of the MT program for several years. In this regard, it has identified at least two major initiatives which it considers to be needed:

--improved overall MT policy guidance, and

--development of a tri-service MT data base.

DOD has been pursuing these major initiatives for several years without reaching final action. Given the general agreement within DOD of their importance, we believe that a specific timetable should be established to complete these two management initiatives.

### MT PROGRAM POLICY GUIDANCE UNDER REVISION SINCE 1981

The MT program policy guidance has not been updated since 1972 despite significant program changes at the OSD and military service level. Although a first draft revision of a new DOD Instruction for the MT program was initiated by a task force chartered in May 1981, the instruction had not been issued as of September 1984.

The policy guidance needs to be updated because of several changes that have affected the program since the guidance was last updated in 1972. MT program management terminology, requirements for long-range program plans, project technical reports, post audits, technology implementation plans, and annual program evaluations are some of management areas needing coverage by DOD level policy. DOD attributed delays in finalizing the revised instruction to the numerous recommended revisions made by the military services when they reviewed the draft in May 1982.

### TRI-SERVICE DATA BASE UNDER CONSIDERATION SINCE MID-1970'S

The development of a tri-service data base by DOD has also been delayed. Efforts have been underway for several years to develop a central MT program management information system that would allow program managers to evaluate and control program effectiveness. This effort, too, has been delayed in large part due to a lengthy debate within DOD over what is to be included in the data base and how that data will be used at the various levels. As of September 1984, the data base had not been established.

There is a myriad of automated management information systems in use by the services, with some dedicated to the MT program. By OSD's count, there are at least 10 such systems. For example, the Army has a service-wide data base which it instituted in 1976--about the same time the OSD office began considering the need for a tri-service MT data base. In June 1983, the Navy installed its own service-wide MT data system. Within the Navy establishment there are other MT data systems at certain Systems Commands and laboratories. Also, certain technical subcommittees of the DOD sponsored Manufacturing Technology Advisory Group have developed their own MT dedicated data bases. The Air Force, which is now working on development of a dedicated MT management information system, has two automated data systems which contain some MT program data--one system contains MT program planning information and the other has information on MT contracts.

DOD has recognized the need for a tri-service MT data base for several years. In our 1979 report, we recommended that a uniform centralized management data system be established that would allow program managers to evaluate and control program effectiveness. A May 25, 1982, memorandum from the Under Secretary of Defense for Research and Engineering to the military services stated that development of a centralized data base was the key corrective action needed for achieving the management improvements recommended in our 1979 report. This memorandum also urged complete cooperation and support from the military services in completing the data base. We believe that there are several benefits to be derived from the use of a uniform centralized MT program management information system. Among these are the ability to

--have more current data for routine management monitoring of program functions and operations.

--conduct comprehensive program evaluations to provide for continuing improvement of program management and operations.

--more effectively and efficiently compile and summarize program effectiveness data for use in evaluating and demonstrating program results and success.

The two management initiatives cited above were discussed in the House Appropriations Committee report on the fiscal 1984 Program budget request. The Committee report encouraged DOD to act more definitively on these two initiatives. In a January 30, 1984 letter, DOD advised the House Appropriations Committee that it had made significant progress but that more time would be required to complete the two initiatives. Specific target dates for completion were not provided.

## CONCLUSION

We believe that the two major management initiatives planned by DOD have the potential to fulfill many of the needed improvements in OSD management leadership and oversight. Further, we believe that the prompt completion of these efforts will facilitate the military services' efforts to more uniformly address the needed management improvements at their level. Therefore, we believe that specific realistic timetables should be established to complete these actions.

## RECOMMENDATION

We recommend that the Secretary of Defense establish specific target dates for attaining completion of the two DOD management initiatives (on MT program policy guidance and a tri-service MT data base) aimed at improving OSD leadership and oversight.

## AGENCY COMMENTS

In commenting on Chapter 4, DOD pointed out that the OSD staff had been actively working with the military departments on both of these initiatives. DOD did concur with our recommendation, and said that it expected (1) revised policy guidance to be issued shortly after July 1984 and (2) a tri-service data base to "come on stream on or about December 1, 1984," if all assumptions about availability of hardware and software remain valid. As of September 1984, DOD had not finalized action on either of these two initiatives. (See app. III.)

APPENDIX I

## LIST OF SITES VISITED

### Department of Defense

-- Office of the Under Secretary of Defense for Research and and Engineering
Industrial Resources Office
Washington, DC

-- Office of the Under Secretary of Defense for Research and Engineering
Office of Industrial Productivity Directorate
Washington, DC

### Department of Navy

-- Chief of Naval Operations
Technology Assessment Division
Washington, DC

-- Naval Material Command
Washington, DC

-- Naval Material Command Industrial Resources Detachment
Philadelphia, PA

-- Naval Air Systems Command
Washington, DC

-- Naval Electronics Systems Command
Washington, DC

-- Naval Sea Systems Command
Washington, DC

-- Naval Air Rework Facility
San Diego, CA

-- Naval Avionics Center
Indianapolis, IND

-- Naval Research Laboratory
Washington, DC

-- Naval Ocean Systems Command
San Diego, CA

-- Naval Surface Weapon Center
Dahlgren, VA

-- Naval Air Development Center
Warminister, PA

-- Naval Ship Systems Engineering Station
Philadelphia, PA

-- Mare Island Naval Shipyard
Vallejo, CA

-- Naval Weapons Center
China Lake, CA

-- Naval Surface Weapon Center
Silver Spring, MD

Department of Air Force

-- Manufacturing Management Division
Headquarters, U.S. Air Force
Washington, DC

-- Manufacturing Engineering Division
Directorate of Manufacturing
Air Force Systems Command
Washington, DC

-- Aerospace Industrial Modernization Division
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio

-- Manufacturing Technology Division
Air Force Wright Aeronautical Laboratory
Wright-Patterson Air Force Base, Ohio

-- Directorate of Manufacturing
F-16 Systems Program Office
Wright-Patterson Air Force Base, Ohio

-- Directorate of Manufacturing
B-1 Systems Program Office
Wright-Patterson Air Force Base, Ohio

Department of Army

-- U.S. Army Material Development and Readiness Command
Alexandria, VA

-- U.S. Army Industrial Base Engineering Activity
Rock Island, IL

-- U.S. Army Armament Material Readiness Command
Rock Island, IL

-- U.S. Army Armament Research and Development Command
Dover, NJ

-- Rock Island Arsenal
Rock Island, IL

-- Watervliet Arsenal
Watervliet, NY

-- U.S. Army Munitions Production
Base Modernization Agency
Dover, NJ

-- Milan Army Ammunitions Plant
Milan, TN

-- Crane Army Ammunition Activity
Crane, IN

-- Iowa Army Ammunition Plant
Middletown, IA

-- Indian Army Ammunition Plant
Charleston, IN

-- U.S. Army Missile Command
Redstone Arsenal, AL

APPENDIX II

# DEPARTMENT OF DEFENSE

*Washington, D.C.*

## STATEMENT OF PRINCIPLES FOR DEPARTMENT OF DEFENSE MANUFACTURING TECHNOLOGY PROGRAM

PROGRAM OBJECTIVES. *The productivity and responsiveness of our Defense industrial base is a key element of our national security and military posture. The Manufacturing Technology Program's objective is to significantly improve the productivity and responsiveness of the industrial base by engaging in initiatives which:*

- *Aid in insuring the economical production of qualitatively superior weapon systems on a timely basis*
- *Insure that advanced manufacturing processes, techniques, and equipment are used to reduce DoD materiel acquisition costs*
- *Continuously advance manufacturing technology to bridge the gap from R&D advances to full-scale production*
- *Foster greater use of computer technology in all elements of manufacturing*
- *Assure that more effective industrial innovation is stimulated by reducing the cost and risk of advancing and applying new and improved manufacturing technology*
- *Assure that manufacturing processes are consistent with safety and environment considerations and energy conservation objectives*

ROI CONSCIOUSNESS. *A deeper and more explicit consciousness of Return on Investment must be developed and used by all levels of management of the Manufacturing Technology Program. We must assure the high leverage Return on Investment potential of the DoD Manufacturing Technology Program is realized.*

PROGRAM PLANNING. *Industrial base needs must be identified and manufacturing technology projects programmed to meet these requirements. Program planning must constitute a fully integrated tri-Service activity. Individual manufacturing technology project planning must be well thought out, given wide spread visibility, and provide a mechanism for senior management personnel to impact the project content and priorities.*

IMPLEMENTATION AND TECHNOLOGY TRANSFER. *Full benefit from the program can only be achieved if its plans, progress, and results are readily available to DoD and the industrial base in a timely and convenient manner. Implementation and technology transfer of project results are critical elements of Manufacturing Technology Program management.*

EVALUATION. *The Manufacturing Technology Program must be routinely and continuously evaluated to measure its effectiveness. Program benefits must be documented by each Service in clear, simple and unequivocal terms.*

PROJECT SELECTIVITY. *We must assure maximum benefits from every manufacturing technology dollar invested. We must insure that:*

- *Technical feasibility has been previously demonstrated before procurement-funded manufacturing technology projects are initiated*
- *There is a well-defined DoD requirement for the technology and that it can be delivered in time to meet that requirement*
- *Private industry cannot or will not make the investment in the time frame required*
- *Anticipated project results are generic.*

ASSESSMENT OF NEEDS. *Manufacturing Technology Program investments should be determined by assessing both the generic production-related life-cycle-costs and the potential contribution of existing and emerging technologies to reduce those costs.*

PROGRAM MANAGEMENT. *Each Service will provide strong central program management to promote the requisite centralized fiscal planning and control necessary for direction and orientation of the program to the areas of greatest need and payoff. Multi-Service investments are encouraged. Program Managers will be encouraged to include new manufacturing technology in their acquisition strategies.*

Arden L. Bement, Jr
*Deputy Under Secretary of Defense for Research and Engineering (Research & Advanced Technology)*

Dale W. Church
*Deputy Under Secretary of Defense for Research & Engineering (Acquisition Policy)*

Percy A. Pierre
*Assistant Secretary of the Army (Research, Development & Acquisition)*

Joseph A. Doyle
*Assistant Secretary of the Navy (Manpower, Reserve Affairs & Logistics)*

Robert J. Hermann
*Assistant Secretary of the Air Force (Research, Development & Logistics)*

MARCH 14, 1980

APPENDIX III

THE UNDER SECRETARY OF DEFENSE

WASHINGTON D.C. 20301-3010

RESEARCH AND
ENGINEERING

10 JUL 1984

(AM)

Mr. Frank C. Conahan
Director, National Security and
International Affairs Division
U.S. General Accounting Office
441 G. Street, NW
Washington, D.C. 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) Draft Report, "DoD Manufacturing Technology Program - Management Is Improving But Benefits Being Achieved Remain Hard To Document," Dated April 20, 1984 (GAO Code No. 910358) - OSD Case No. 6497.

The overall objective of this review was to assess: a) the Manufacturing Technology Program's (MTP) overall effectiveness in improving productivity and reducing Defense acquisition costs, and b) actions taken by DoD to improve MTP management since an earlier GAO review.

The report's principal recommendations are primarily directed toward strengthening program policy and management. A revision of DoD Instruction 4200.15 "Manufacturing Technology Program" which addresses most of GAO's concerns has just been formally reviewed by DoD components. Comments have been received and are being reviewed. Because a considerable amount of informal coordination effort took place prior to requesting formal comments, it is anticipated that the Instruction will be issued shortly. Agreement on the DoD Instruction will also provide a critical milestone required for the implementation of the tri-Service data base - an agreed upon set of data elements. This will permit us to establish a realistic completion schedule for the remainder of the implementation of the data base. Because a considerable amount of work has already been done, it is expected that implementation will take six months following agreement on the data elements. However, this could vary depending upon the availability of the appropriate computer systems.

The enclosure provides DoD's detailed response to the draft report's findings and recommendations.

Sincerely,

James P. Wade, Jr.

Enclosure

James P. Wade, Jr.
Principal Deputy Under Secretary of
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GAO DRAFT REPORT DATED APRIL 20, 1984
(GAO CODE NO. 910358) OSD CASE No. 6497)

"DoD MANUFACTURING TECHNOLOGY PROGRAM -- MANAGEMENT IS IMPROVING BUT BENEFITS BEING ACHIEVED REMAIN HARD TO DOCUMENT."

DEPARTMENT OF DEFENSE COMMENTS.

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FINDINGS

- **FINDING A: Results Of The Manufacturing Technology Program And How The Results Are Viewed.** GAO found that while Defense officials, contractor representatives and others believe that the Manufacturing Technology Program (MT Program) is providing useful benefits (quantitative savings or potential long term savings) to defense contractors and commercial users, differing criteria are used to assess program results and evaluate benefits achieved. Where benefits have been reported, GAO found they are usually not fully documented and verified or verifiable. GAO concluded that since there are honest differences of opinion on how to view the results of the MT program, and there is general agreement that the program provides benefits, to judge program effectiveness in a balanced way the various views of MT benefits should be considered. GAO also concluded that, whatever other criteria are used, the one criterion that should continue to be applied is whether the MT program generates new or improved technologies which are used in defense production to reduce defense acquisition costs. (pp. 6-12)*

  **DoD COMMENT**: DoD partially concurs. DoD agrees that the criteria which should be used to measure program performance is whether or not the technology developed by the program is used to produce DoD materiel. However, DoD does not consider "dollars" as the only measure of program effectiveness. Other performance measures may be equally acceptable but not directly comparable (e.g., lead time, materials, man-hours, etc.). It is suggested that the GAO include several examples of program success stories in the final report to illustrate various types of benefits being provided by the program.

  The revised MT policy document currently being staffed required that program effectiveness be evaluated by identifying and quantifying benefits resulting from the implementation of program deliverables. This information will be included in the Military Departments' annual report on the program.

- **FINDING B: Need For Improvement In Manufacturing Technology Program Planning And Project Selection.** GAO found that since 1979 when it made several recommendations aimed at program management weaknesses, the Military Services have made progress in refining their planning and project selection

* Page numbers referred to in DOD's comments have been changed to reflect those in final report.

process, and have recently taken actions which should enhance their efforts in the MT Program. However, GAO found during its current review that additional efforts are needed to further improve program management by:

-- using more innovative approaches to increase the probability that successful project results will be beneficially used in the production of defense items, and

-- developing a definitive and uniform policy to be used in systematically evaluating the MT program

GAO concluded that there is a need for the Services to continue their efforts to refocus the MT program toward major defense acquisitions and toward providing the basis for achieving optimum program benefits. GAO continues to conclude from its 1979 review that the DoD should try to assure that only those projects are funded which meet program selection criteria and have potential for impacting on the production and acquisition cost of major defense acquisitions. (pp. 13-16)

**DoD COMMENT**: DoD partially concurs. DoD agrees that program selection criteria should be structured so as to maximize the overall return on program investments and that individual investments should focus on the needs of major acquisitions. However, there is an additional boundary condition which governs MT program investment selection. The technology must not only be needed, it must be needed by more than one system if MT program funds are to be used. The bases for this criteria are:

First, if the manufacturing techology to be developed is intended to support only one acquisition program, that program should pay for the technology developed. If the MT program supported a single item, DoD could be criticized by the Legislative Branch for attempting to hide portions of the true cost of that system. Second, by providing a program which solves generic manufacturing technology problems, DoD avoids unnecessary duplication of effort which would occur if individual programs each attacked the problems they face. Third, this focus permits DoD to provide "seed money" to solve industry-wide problems which are beyond the scope of any one company to solve.

DoD agrees that a systematic approach should be used to select investments. However, it is DoD's view that the various steps of the Program Planning and Budgeting System now being used provides a systematic approach. DoD contiues to believe that it should rely on experienced managers to make such decisions, rather than attempt to apply a math model which determines program priorities.

The proposed revision to the policy document now in coordination addresses this issue: "Maximum potential

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benefits from each MTP investment shall be sought by insuring that: a) There is a well defined DoD requirement for the technology. . . . d) There is a specific plan to implement results of the investment." It is suggested that the GAO clarify the use of the phrase "major defense acquisitions" in the report. That phrase implies concepts in DoD jargon apparently not intended by the GAO. It is also suggested that GAO not limit program benefits to "acquisition costs" but take a more global view which includes benefits achieved in all phases of the life cycle of DoD materiel where advanced manufacturing technology is utilized.

- **FINDING C. Need For Effective Management Level Project Monitoring.** GAO noted that effective management level monitoring can help assure that MT projects are completed on schedule and can identify those projects that are not achieving their objectives. As reported in 1979, and in its current review, GAO disclosed that management level program data were not readily available on the status of the Services' MT projects. GAO found that OSD and the Services have recognized the need for improvements in their management level monitoring of MT projects and have recently acted to bring about needed changes. GAO concluded that the actions taken should substantially improve active MT project monitoring at the management level. (pp. 17-18)

  **DoD COMMENT:** DoD concurs. Implementation of the tri-Service data base will provide the visibility to program management information recommended.

- **FINDING D: More Can Be Done To Increase Implementation Of MT Project Technology.** In its 1979 report, GAO recommended that the Services actively promote the use of MT project results and found that since 1979, DoD has on several occasions reiterated the importance of obtaining implementation of MT project results. GAO also found that the Services have taken various steps to increase the likelihood that MT project results will be used to benefit the production of defense systems. GAO found, however, that further management actions are necessary since the results of many projects still do not directly benefit the production of defense systems. GAO noted that even if the right projects are selected for funding and successfully completed, optimum program effectiveness cannot be achieved unless the MT project results are used in the production of defense items. GAO concluded that there is still a need for clearer agreements early in the MT project cycle to assure the strongest likelihood possible of factory floor use of MT project results in the production of defense systems. Further, GAO concluded that the Services need to continue placing emphasis on technology implementation by tracking successful projects after completion to determine if planned implementation occurs, and exploring innovative approaches to help assure MT project results are put to use. (pp. 18-20)

**DoD COMMENT**: DoD partially concurs. Up-front commitment to utilize the technology developed is only one factor in a complex process. The maximum return on program investments will occur when several optimum actions occur: a) investments with the highest probability of success and highest probability of implementation are selected based upon both need and commitment to utilize the technology; b) every project is completely successful; c) the results are still needed by and are applied to the system acquisition programs originally identified; d) the availability of the technology is widely known throughout the industrial base: e) applications other than those originally selected are implemented; and f) benefits of every application are clearly identified, perfectly measured, and routinely reported to MT program managers.

DoD agrees that early agreement to utilize the results of a project are a sound indicator of the merits of an investment at the time investments decisions are made. However, the existence of such agreements themselves may not ultimately assure a return on the investment--particularly since two or three years will probably lapse between signing such an agreement and completion of the project. Project managers must re-evaluate the situation at the time the technology is available for implementation.

- **FINDING E: There Is A Need For Increased Program Effectiveness**. GAO found that, as a result of its recommendation in 1979, DoD has recognized the need for management to identify program results and use those results to assess and demonstrate MT program effectiveness. However, GAO found that while the OSD and the Military Services have taken some actions to identify how results of MT projects are used after project completion, the efforts to assess the results of completed projects vary and are subject to differing interpretations because there is no guidance to assure a uniform approach by the Services in making such evaluations. Further, GAO found that none of the Services' efforts to evaluate program results have addressed specifically how the MT program has impacted on defense acquisition costs and the Services have been slow in making post audits of completed projects as directed by OSD in 1982. GAO concluded that the DoD needs to set a more definitive and consistent policy as to when and how projects should be evaluated, and how the evaluation results should be documented. GAO agreed that while it is appropriate to view program results in various ways, one criterion that should always be applied is: are the projects achieving improved productivity and reduced defense acquisition costs. (pp. 21-23)

**DoD COMMENT**: DoD concurs. This requirement has been specifically spelled out in the revision of the program policy document which is being formally staffed throughout the DoD.

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- **FINDING F: Attempts To Strengthen Top Level Management Of The Manufacturing Technology Program.** GAO found that DoD has recognized a need to strengthen its top-level management and oversight of the MT program for several years by identifying the need for two major initiatives: (1) improved overall MT policy guidance and; (2) development of a tri-Service MT management information system. GAO found, however, that implementation of both efforts has encountered delays in implementation for several years because of lengthy debates within DoD over what data is to be included and how that data is to be used. GAO further found that these management initiatives were discussed in the House Appropriation Committee Report on the FY 1984 Program budget request in which DoD was encouraged to act more definitively on the two initiatives. In a January 30, 1984 letter to the Committee, DoD advised that significant progress has been made but more time would be needed (no specific target dates) to complete the initiatives. GAO concluded that the prompt completion of these initiatives will facilitate the Services' efforts to more uniformly address the management improvements needed at higher levels and that specific timetables should be established to complete these actions. (pp. 24-26)

**DoD COMMENT:** DoD partially concurs. The OSD staff has been actively working with the Military Departments to achieve agreement on the data element to be included and submitted to the tri-Service data base. Sufficient agreement has been reached to formally request Military Departments concurrence with the list which was included in the policy document currently being staffed. Work on the tri-Service data base has continued throughout these discussions. Hardware and software requirements have been analyzed and a data base is being designed based upon the results of recommendations provided. It has been estimated that implementation of the data base will take six months following final agreement on the data elements. However, the actual amount of time necessary to implement the data base is a function of many other factors such as the availability of the hardware, software, and an organization and staff to administer the operational aspects of the data base.

**RECOMMENDATIONS**

- **RECOMMENDATION 1.** GAO recommended that the Secretary of Defense establish a DoD-wide system that requires acquisition managers and other appropriate parties to understand the anticipated benefits of proposed projects and to express a willingness to use the results before projects are funded. (That understanding should be documented in a manner similar to what the Navy now requires.)

**DoD COMMENT**: DoD concurs. DoD considers it reasonable to require the potential users to express a willingness to use the results of an investment but does not consider it reasonable to require them to do so after the technology has been developed if real world conditions no longer dictate that it is prudent to do so. GAO should recognize that the procedures being used by the Navy is but one means to an end. Other techniques can be just as effectively utilized to increase the implementation of the technology developed by the program. The proposed revision to the policy document now in coordination addresses this issue: "Maximum potential benefits from each MTP investment shall be sought by insuring that: a) There is a well defined DoD requirement for the technology. . . . d) There is a specific plan to implement results of the investment."

- **RECOMMENDATION 2**. GAO recommended that the Secretary of Defense annually survey contractors DoD-wide, for 5 years after completion of successful MT projects to determine whether implementation in defense production, as intended, actually occurs. (p. 31, GAO Draft Report)

**DoD COMMENT**: DoD partially concurs. DoD agrees that payback from MT investments should be well-documented and reported. The revised policy document now being staffed addresses this issue. First, it requires the Military Departments to compare actual implementation of deliverables with that originally planned (at the time of obligations of funds). Second, it requires each Military Department to prepare an annual report which includes: "As a minimum, the report shall provide the following: . . . e) Benefits achieved from MTP results during the past 5 years and other significant accomplishments."

However, while DoD agrees this information should be collected, DoD differs with GAO on the process of collecting it. It would be entirely too costly for DoD to survey each and every DoD contractor (numbering in the thousands) for five years following the completion of an MT investment. Alternatively, it would appear more prudent to survey only those individuals or organizations which: a) attended the end-of-contract briefing; b) requested copies of the documentation describing investment results; c) are included in the industrial sector where the results would be probably used; or d) are otherwise known to be interested in that particular investment.

- **RECOMMENDATION 3**. GAO recommended that the Secretary of Defense develop definitive and consistent policy specifying how and when projects should be evaluated, incorporate the policy into its revised program guidance, and monitor the Services to assure that the program evaluations are systematically made. (p. 35, GAO Draft Report)

DoD COMMENT: DoD concurs. The revised policy document currently being staffed requires the preparation of an annual report which will contain a description of program accomplishments. The revised policy also requires the Military Departments to maintain four measures of planning and execution performance. Three of them compare what was planned versus what actually happened and the fourth identifies the amount of activity intended to disseminate investment results throughout the industrial base.

In addition, preliminary steps have been taken to request the OSD Inspector General's office to audit compliance with the new policy guidance in FY 1986.

- RECOMMENDATION 4. GAO recommended that the Secretary of Defense establish specific target dates for attaining completion of the two major DoD management initiatives aimed at improving OSD leadership and oversight. (p. 39, GAO Draft Report)

DoD COMMENT: DoD concurs. Formal comments on the proposed revision of the policy document are due on May 30, 1984. Because a considerable amount of effort was expended to informally coordinate the document prior to initiating the formal coordination process, it is envisioned that only minor comments will be received and that the policy can be issued within a relatively short time following the due date.

With respect to the tri-Service data base, it is estimated that the data base can be implemented within six months following agreement on the data elements. They are included in the revised policy document now being reviewed. Thus, if all assumptions concerning the availability of software and hardware availability remain valid, the tri-Service data base should come on stream about December 1, 1984.

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