SUPPLEMENT TO A REPORT BY THE

Comptroller General

OF THE UNITED STATES

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

This supplement contains information on the projects GAO reviewed under the Department of Defense Manufacturing Technology Program.

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INTRODUCTION

This volume contains information on the projects the General Accounting Office (GAO) reviewed. There are three sections--one for each military service. Within each service, projects are grouped into the three categories reviewed. Project status is as of late 1983.

To evaluate program effectiveness, GAO judgmentally selected 132 Manufacturing Technology (MT) projects from a universe of 906 for detailed review. Projects were selected from each of the following categories: (1) projects completed with the resulting new or improved technology implemented on the factory floor, (2) projects completed but the technology not implemented, and (3) new project starts during fiscal years 1980-82. GAO selected the projects to represent each service's proportional representation of each of the above categories.

In selecting projects for review, GAO considered various factors such as different types of technology involved in the MT projects at both contractor and Defense plants, the extent of involvement in the MT program by the services' various major commands, and other known circumstances about the projects. GAO attempted the following:

--To obtain coverage of the electronics, metals, and nonmetals technologies large and small prime and subcontractors for the Air Force MT program. (All Force MT projects are contractor performed.)

--To obtain coverage of each of the three participating systems commands and various types of technology involved in the Navy MT projects at both contractor and Defense plants.

--To obtain coverage of various types of technologies in three armament commodities within four of the largest participating major subordinate Army commands. (Also, within the Army which has a larger universe of MT projects than the other two services, projects were selected to include coverage of both Defense and contractor plants)

AIR FORCE

Projects 1 - 17: Implemented Since 1979

Projects 18 - 30: Completed Since 1979 But Not Implemented

Projects 31 - 44: Started During Fiscal Years 1980-82

Benefits Projected		Benefits in Production				
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Improve reliability of process and reduce costs.	Reliability increased, but no cost analysis in final report.	Mideast Aluminum (Was the subcontractor on the project) for the E3A, TPS 70, and ULSA.	None reported.		None.	This project demonstrates the benefits, in terms of quick adoption by the contractor, of having the subcontractor and the weapons systems office jointly involved in the request for a manufacturing technology (MT) project and its administration. Westinghouse estimates it will save about $343,000 on the E3A system, $851,000 on the TPS 70, and $100,000 on the ULSA system.
Reduce time to produce master boards, reduce costs, and improve quality.	Annual return of $285,000 to $795,000 depending on the software used.	Westinghouse Corp., used technology on all printed wire board designs.	None reported.		We were told many companies have this equipment. They include Western Electric, Atari, General Electric, Control Data, Hughes, IBM, and Hewlett-Packard.	An analysis by Westinghouse estimates cost savings between $93,000 and $322,000 annually. A major reason given for extensive transfer of this technology is that a firm to manufacture the equipment was identified early in the project and worked with Westinghouse throughout the project.

Benefits Projected			Benefits in Production			
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Reduce manufacturing cost of composite structure. Expand manufacturing capability, and demonstrate ability to automate process.	41% cost savings for horizontal stabilizer skins when process is used without other automation. Labor savings of 87.4% in a totally automated clean room facility.	Northrop Corp. (F-18 rudderskins) at Hawthorne, CA.	None reported.		We were advised that Vought Corp., has used this project's results.	Although Northrop has not reported specific benefits, company officials believe the project will reduce costs and is reducing lead time and improving quality.
Lower costs by reducing machinery, scrap and replacement of wrought parts Also, improve quality.	Improve titanium fabrication. Cost saving through reduced repair cycles and replacement of wrought parts. As of final technical report, estimated savings of $1.5 million.	Howmet Turbine Components Corp. and other vendors. General Electric officials said the company had purchased over 130 parts made by this process.	None reported.		According to Air Force and contractor officials, Pratt and Whitney and most vendors of titanium parts use this process.	Air Force officials and contractors credit this project, along with several others, for starting a new industry. While the project shows the gains that are possible if a new technology is pursued through several projects, it also raises the question of how long to keep the MT program in a technological area.

Benefits Projected		Actual Production Application	Benefits in Production		Other Identified Uses of the Technology	GAO Observations
At Project Initiation	At Project Completion		As Reported	Basis		
Improve structural and fatigue performance. Reduce production cost	Increase in structural and fatigue performance. During initial production, labor costs tripled, but it was estimated that increased production would make the new process more cost effective than autoclave bonding.	Fairchild Industries, Hagerstown, MD. A-10 aircraft.	None reported.		According to Air Force officials, Fruehauf Trailer Co. uses this process.	The A-10 is no longer produced. Air Force officials said some records have been maintained to aid in tracking life cycle costs and benefits. At least two other companies have expressed interest in using this process on future aircraft.

Benefits Projected		Benefits in Production				
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Establish process to produce high yield of these amplifiers, improve performance, and ultimately reduce costs.	The cost of the initial approach for a double poly dialectric isolation process was too high. A single poly process, which met relaxed radiation requirements, was less costly and technically successful.	Texas Instruments on Peacekeeper missile.	None reported.		None.	The process is under consideration for the Trident II submarine program.
Reduce rework, improve process reliability, and reduce gold use.	Successful project except failed to meet moisture-resistant requirements.	Hughes and Raytheon on the AMRAAM.	None reported.		None.	The AMRAAM System Project Office asked Hughes Aircraft Co. and Raytheon to conduct various projects before the production contract was awarded. Hughes did a project similar to this one. The companies developed similar processes but the Hughes design, which was not developed with MT funds and which did not have the moisture resistance problem, was judged to be better and won the production award. Raytheon was named the second producer.

Benefits Projected		Benefits in Production				
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Ability to produce a highly reliable yield of traveling wave tubes and cut costs by half—savings projected at $5.7 million per year.	No cost analysis was provided. The I/J band amplifier is projected for high-volume production.	Litton Systems on a generic traveling wave tube used on the F-16 and F-15.	None reported.		None.	This project relates to another project but does address different problems. This project did address several design considerations, but apparently was primarily directed to the manufacturing process.
Simplify rework and repair techniques, reduce maintenance costs, and improve reliability and performance of conformal coatings.	No cost analysis was provided. Several coatings were identified that were expected to provide excellent environmental protection, be easily removed, and reduce costs.	Rockwell International Corp., Cedar Rapids, Iowa, Peacekeeper missile, B-1, ALCM.	None reported.		We were told several companies make the solvent-soluble conformal coatings and that several other companies use them on printed wire boards.	Comparing the old and new processes, Rockwell reported to GAO that labor hours were reduced about 90%. Current military specifications allow use of only 1 of the coatings tested by Rockwell. Unless specifications are changed fuller implementation will not occur.
Increase temperature capabilities and shroud life, and reduce life cycle costs.	Costs would be 10-15% lower than if the hot press shroud manufacturing method was used.	The F404 aircraft engine produced by General Electric.	None reported.		None.	The results were not used on the two targetted engines because a competing technology was chosen.

Benefits Projected		Benefits in Production				
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other identified Uses of the technology	GAO Observations
Reduce labor costs and lead times.	In machining single disks, labor hours were reduced 53%. More complex parts can be machined.	Lehr Precision Tools, Inc. Although not used on bore entry cooled disks, the process is used on a number of parts for various weapon systems.	None reported.		None.	General Electric and Lehr continued to work with machine-tool manufacturers to develop the automated system. Success will ensure that the system can be purchased by other companies. Since the project ended, Lehr has built three other machines which it reports, run three shifts per day, has reduced costs to prime contractors, and has reduced lead times.
Reduce life cycle costs; be production cost-competitive with aluminum honeycomb structure.	Return on invesment of 2.1:1 based on 10-year service life of 800 aircraft. Need for maintenance greatly reduced.	Vought Corp. at Dallas, Texas on the T-38 aileron trailing edge. An Air Logistics Center purchased 30 ailerons for testing.	None reported.		Used by Bell Helicopter and Boeing to make helicopter blades.	This project demonstrates the potential benefits of having a close working relationship between contractors and air logistics centers. We were told the composite trailing edge wedges are planned as the preferred spare for the T-38 and the same process may be used to build other T-38 secondary structures.
Reduce costs of hermetic chip carriers and improve their reliability and use.	Reduce gold use, improve reliability, and reduce costs.	We were told that the chip carriers (primarily those for memories) are used in the Lantirn, AMRAAM, JTIDS, F-15, and B-1 programs.	None reported.		Hughes, Rockwell, Martin-Marietta, and others.	The Joint Electronic Device Engineering Council used this project's results to set industry standards. In Oct. 1980 the single-layer chip carrier was approved. By July 1982, the council had approved a large portion of this project's results as the standard memory package. We were told, however, that companies encounter problems in attaching single-layer chip carriers to printed wire boards. We were told that these problems have not occurred with the memory chip carriers which are 3-layer packages.

Benefits Projected		Benefits in Production				
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Reduce cost and improve quality; improve defense industrial base.	Labor reduced by 60%, material saving, and an estimated total saving of $918,000 for 1,000 F-16 horizontal stabilizers.	General Dynamics Corp., on F-16 composite parts.	None reported.		Boeing.	Because this project was included in the General Dynamics technology modernization program, implementation was ensured if the project was successful.
Reduce scrap and the manufacturing costs of composites, and improve quality	Estimated F-16 savings of $5.4 million from reduced scrap, labor, and time.	General Dynamics Corp., on F-16 composite parts.	None reported.		Vendors of composites use first module; Thiokol uses several modules; Rockwell, Lear, Lockheed, and the Sacremento Air Logistics Center use one or more modules.	This project, a part of the General Dynamics technology modernization program, established 6 modules for composite inspection that follow the product through the entire production process. This modular approach has aided in transferring results because each module can perform independently or be integrated throughout the production process.

Benefits Projected		Benefits in Production				
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Maximize electrical and mechanical tolerance, reduce manufacturing costs, improve yield, and simplify repairs.	Reduction in parts assembly costs, and skill levels required to assemble tubes. No cost analysis provided.	Litton Industries on traveling wave tubes for the B-1 bomber.	None reported.		None	In 1977 the division performing the work at Microwave Associates was acquired by Litton. This delayed and redirected the work. The work's focus shifted to a different traveling wave tube which, at the time, was being addressed in another MT project. The two projects addressed different manufacturing problems. No end-of-project demonstration was held.
Lower production cost, improve engine performance, and reduce life cycle costs for subsonic aircraft by $10 million a year for fleet of 200 aircraft.	Manufacturing costs of large composite fan blades of the F103 size could be reduce to 60 to 70% of the titanium blades.	General Electric Co. at Albuquerque, New Mexico on F101 guide vanes; also used for commercial purposes.	None reported.		None.	This project was considered only partly technically successful since the fan blade did not meet resistance to foreign objects. When used to produce other blades and vanes, the technology was successful. General Electric (GE) plans to use it to produce fan vanes for the F404 and F110. GE officials told us they may automate the process. The project, while establishing new technology, was also directed at fan-blade redesign—an end item. We also question whether feasibility was adequately demonstrated. This project lasted 93 months. We were told that, since GE planned to continue work on its own in this area, the Air Force maintained MT sponsorship so that the technology remained available to the public. An additional $60,000 was spent over initially planned costs.

GAO reviewed the 132 selected MT projects to determine the (1) appropriateness of the service's application of available DOD program criteria for project funding, (2) validity of project results and accompanying cost and other benefits, and (3) reasons why the new or improved technology for completed projects had not been implemented. GAO's review of each project included discussions with personnel of the military services responsible for reviewing, approving, and administering the MT project. GAO also reviewed various records including the MT project proposal, implementation plan, project contract, periodic project status reports, final technical report and cost savings report with supporting documentation. In addition, GAO visited the contractor and Defense plants for most of the implemented projects reviewed to follow-up on the project review and make first-hand observations of the actual factory use of the implemented new or improved manufacturing technology. Also, through discussions with Defense and contractor personnel and review of the various project documentation, GAO identified difficulties and barriers to assessing overall MT program effectiveness.

Because of the method used for project selections, GAO cannot generalize the project review results and conclusions to the total universe of MT projects or the MT program as a whole.

Examples of Manufacturing Technology Projects Implemented Since 1979

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
1.	Waveguide extrusion improvement program	Westinghouse Electric Corp., Baltimore, MD.	To establish improved methods for economical and reliable manufacture of complex thin-walled extruded aluminum alloy precision parts for antenna systems.	$ 270	20	E3A, and all other antenna systems.
2.	Laser pattern generator	Westinghouse Electric Corp., Baltimore, MD.	To establish manufacturing techniques and production equipment requirements for automated printed wire boards photo resist exposure. To establish a dynamic on-line laser pattern generator capable of operating directly from computer-based input.	$ 236	32	All electronic systems.

Examples of Manufacturing Technology Projects Implemented Since 1979

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
3.	Automated composites material transfer	Northorp Corp., Hawthorne, CA.	To establish and demonstrate low-cost composite aircraft component ply layup by adaptation of industrial robotics to automated ply transfer techniques. (See Air Force notes)	$ 625	32	Future aircraft.
4.	Manufacturing methods for the production of high-integrity castings	General Electric Co., Cincinnati, OH.	To establish efficient, less costly processes to produce aircraft quality castings, including materials and specification, quality control, and nondestructive inspection practices.	$ 827	60	Applicable to engines and airframe parts.

Examples of Manufacturing Technology Projects Implemented Since 1979

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Applications
5.	Implementation of weld bonding	Fairchild Industries, Farmingdale, NY.	To demonstrate the production application of weld bonding as a cost-effective durable structural joining technique.	$ 856	30	A-10 aircraft.

Examples of Manufacturing Technology Projects Implemented Since 1979

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Applications
6.	Radiation-hardened plated wire sense amplifier	Texas Instruments, Dallas, TX.	To establish advanced manufacturing processes and controls, and to optimize the circuit design and performance of radiation hardened alternating current coupled sense amplifiers to be used in random access plated wire memory subsystems.	$ 759	82	Peacekeeper missile (formerly MX).
7.	Manufacturing technology III for AMRAAM (copper multilayer manufacturing technology)	Raytheon Co., Bedford MA.	To establish reliable and low-cost manufacturing processes and methods to attach hermetic chip carriers onto larger, module-size ceramic substrates metallized with non-noble conductor inks as a replacement for gold.	$ 818	29	AMRAAM missile

Examples of Manufacturing Technology Projects Implemented Since 1979

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Applications
8.	I/J and E/H band amplifer	Litton Systems, San Carlos, CA.	To establish the manufacturing technology required to make dual-mode, traveling wave tube amplifiers available at reduced acquisition and life cycle costs.	$ 513	39	Amplifier to be used on 6 military systems.
9.	Manufacturing technology for conformal coating	Rockwell International Corp., Anaheim, CA.	To establish and optimize conformal-coating manufacturing processes, techniques, and process controls for reliably coating printed wiring-board electronic assemblies.	$ 282	24	All electronic systems.
10.	Fabrication of low-cost NiCrAlY turbine shroud gas path seals	General Electric Co., Cincinnati, OH.	To establish and demonstrate a cost-effective method of producing NiCrAlY turbine shroud gas path seal segments.	$ 448	50	The TF34 and the F101, aircraft engines.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost	Project Duration (in months)	Intended Production Applications
11. Electrochemical machining	General Electric Co., Cincinnati, OH. Lehr Precision Tools, Inc., Cincinnati, OH.	Establish an automated electrochemical machining system and a process for generating complex shapes in gas turbine engine components using this automated system.	$1,346	36	Air-cooled turbine rotor disks for Advanced-Technology Engine Engine Gas Generators.
12. Composite skin stabilization	Vought Corp., Dallas, TX.	Demonstrate and test low-cost, innovative skin stabilization manufacturing methods for composite secondary structures which are cost-competitive with aluminum honeycomb structures. To demonstrate nonautoclave cure processing techniques.	$ 146	18	T-38 specifically and all aircraft.
13. Manufacturing process for low-cost hermetic chip carrier	Texas Instruments, Dallas, TX.	Optimize production processes and techniques required for low-cost carrier package and to establish that package as an accepted standard for future military and commercial uses.	$ 896	37	All military electronics systems.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Applications
14. Composites manufacturing operations production engineering	General Dynamics Corp., Ft. Worth, TX.	To assess the benefits that will result from improved individual manufacturing concepts for advanced composite aircraft structure. (See Air Force notes).	$ 504	35	F-16 horizontal stabilizers and future aircraft.
15. Advanced composites in-process controls/inspection	General Dynamics Corp., Ft. Worth, TX.	To establish, demonstrate and test an integrated quality control and inspection system for tracking advanced composite structures through a production facility.	$1,300	46	F-16 specifically; applicable to all aircraft.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
16. Dual-mode traveling wave tubes	Litton Industries, San Carlos, CA.	To establish the technology required to make dual-mode traveling wave tube amplifiers at a reasonable life cycle cost.	$1,082	63	Two traveling wave tubes for Air Force aircraft systems.
17. Low-cost, foreign-object damage-resistant organic matrix fan blades	General Electric Co., Cincinnati, OH.	To develop fan blades that resist damage by foreign objects and can be manufactured in large quantities on a reliable and reproducible basis at lower costs than metallic blades.	$1,266	93	Future Air Force engines; TF39 and F103.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Applications
18. Composites manufacturing operations production integration	Grumman Aerospace Corp., Bethpage, NY.	To assess the benefits that will result from improved individual manufacturing concepts for advanced composite aircraft structure. (See Air Force notes)	$ 731	36	Future aircraft.
19. Composite skin stabilization	Grumman Aerospace Corp., Bethpage, NY.	To demonstrate and test low-cost and innovative skin stabilization manufacturing methods for composite secondary structure which are cost competitive with full-depth honeycomb structure.	$ 310	23	All aircraft.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Increase capability for high-volume production of composite structure, and lower the cost.	In constant dollars, the return on investment was calculated at 58.5% with a break even point of 3.24 years.	Lack of production requirements.	This is the second of three Grumman composite production integration projects, with the first being used in production and the third ongoing.
Reduce maintenance inspection and replacement costs, make production and metal honeycomb costs equal, and improve quality.	Minimum 53% life cycle cost saving, 21% production acquisition cost saving, and 14% weight reduction.	No current production requirement.	According to Air Force and Grumman officials the project's tooling has been sent to the Sacramento Air Logistics Center to enable personnel there to gain experience in using composites. This approach addressed the same manufacturing problem as the Vought project (See Air Force project 12) but used a different production method.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Applications
20. Advanced composite engine static structures fabrication	Rohr Industries, Chula Vista, CA.	To establish low-cost manufacturing techniques for organic matrix composite F100 engine augmentor duct.	$ 270	21	F100 engine.
21. MT for advanced rotary launcher	Rockwell International Corp., El Segundo, CA.	To improve methods of manufacturing efficient hybrid composite/steel rotary launcher tube structures.	$ 199	16	B-1 and B-52 nuclear launcher tube, and launcher tubes on other current and future aircraft.
22. MX/AIRS inertial guidance system spherical heat exchanger	Northorp Corp., Hawthorne, CA.	To establish an economical approach for manufacturing the MX/AIRS missile inertial guidance system spherical heat exchanger.	$ 332	35	MX/AIRS inertial guidance system.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Produce composite engine static structure at less cost than metal counterparts. Reduce number of parts and integrate assembly techniques.	Reduce costs 10-25% and weight 10%.	Augmentor ducts require engine qualification tests before they can be used in production.	The Air Force, which did not expect immediate implementation because of the extensive testing required before changing an engine, is having Pratt and Whitney Co. conduct the tests.
Improved, lighter nuclear launcher tubes.	44% weight saving.	This project competed with another to meet the B-1's requirements for a multiple rocket rotary launcher. According to Air Force engineers, the other project was selected for implementation because the Air Force considered it more successful.	Although this project will not be implemented on the intended end item, contractor officials believe the MT results have been and will be useful in solving other production problems. This project is an example of the Air Force knowing only 1 of 2 projects could be used to improve the targetted system, but because of the system program office's needs, 2 competing approaches to the problem were funded.
Reduce cost of providing heat exchanger to well below $4,800 unit cost by developing a less labor intensive manufacturing process.	None.	Technically unsuccessful.	The contractor requested project termination because of the lack of success. We question whether a feasible approach had been demonstrated before project initiation. An end-of-project demonstration was not held since the project was unsuccessful.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Applications
23. Manufacturing technology for computer-controlled electrical wire kit preparation	General Dynamics Corp., Ft. Worth, TX.	To produce a prototype computer-controlled automated wire preparation system for use in F-16 aircraft electrical trunk harness assemblies.	$ 762	47	F-16 specifically; applicable to all aircraft.
24. Adhesively sealed integral fuel tank	General Dynamics Corp., Ft. Worth, TX.	To establish and test the materials and manufacturing processes using structural adhesives as sealants in typical aircraft fuel-tank joints. To analyze the performance results in terms of the joint design/ materials and process interface to provide guidance for future consideration.	$1,294	33	Future aircraft.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Reduce labor costs significantly without adversely affecting quality.	Labor cost saving of 80% over traditional methods.	End-of-project demonstration held in May 1983, and the project was only recently completed at the time of GAOs review. General Dynamics has purchased equipment and plans to begin F-16 implementation soon, according to company and Air Force officials.	This project was part of the General Dynamics Technology Modernization Program. The end-of-project demonstration was part of a workshop that brought together 43 companies in this area to ensure that all important problems are addressed with minimum duplication.
Reduce life cycle costs by reducing fuel leaks which cost between $6 and $14 per flight hour.	Reduced manufacturing costs by 25% and labor costs by 45%. In 75 hours of flight tests on the F-16, no leaks had occurred.	General Dynamics, which submitted a proposal in 1982 for an engineering change to use this process on the F-16 aircraft, is waiting for the Air Force decision.	The Air Force has given high visibility to this project through briefings to top Air Force officials involved in aircraft acquisition, maintenance, and repair. Based on information received in these briefings, Air Force officials are enthusiastic about the process. The reduction in production costs was unexpected. According to company offcals the test aircraft had flown 300 hours by June 1983 without leaks.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
25. Isothermal rolled titanium engine rings	International Harvester, San Diego, CA.	To establish a process of manufacturing net-section titanium alloy rings from bar or plate stock by the use of isothermal ring rolling.	$ 197	43	F101, F100 engines.
26. Laminated structures	General Dynamics Corp., Ft. Worth, TX.	To establish low-cost manufacturing techniques, including lamination of components, for advanced aluminum aircraft primary structure. Specific objectives, in order of emphasis, are low cost, damage tolerance, and lightweight structures.	$ 786	60	Future aircraft.
27. Vacuum hot pressing of large titanium powder metallurgy shapes	General Dynamics Corp., San Diego, CA.	To establish methods of manufacturing large, structural shapes from prealloyed titanium powder utilizing consolidation techniques that can be adapted to existing industrial equipment, thus eliminating the need for large capital equipment expenditures.	$ 831	48	Engines and airframes.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Significantly reduce material consumption, and decrease energy usage.	60% saving.	Competing technologies showed greater advantages.	This project was terminated early since competing technologies showed better economic benefits. According to the project engineer, however, another company is using this approach as a basis for developing new production techniques.
30-40% cost reduction over forged components, increase structural integrity, and reduce weight.	Procurement cost saving of $5,000 per aircraft, fuel saving (due to weight reduction) of 3.146 gallons per flight hour, and increased combat effectiveness. Total saving for procurement, operations, and support is estimated at $816,000 per aircraft.	The project engineer told us that it was not implemented on the F-16 because of tooling requirements and the additional cost of changing production methods on aircraft already in production.	Vought Corp. did much of the work on this contract and also completed an earlier MT project on laminated structures begun in 1970. According to the project engineer, all types of aircraft could use this method. We were concerned this project was directed toward end item design. Air Force officials, while acknowledging that design was part of the project, stated that the primary goal was to establish the manufacturing process.
Reduce costs of titanim structures and provide alternative to hot isostatic pressing process.	Potential major cost savings and potentially higher quality parts.	Alternative methods are more economical.	

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
28. Low-cost innovative composite manufacture	Rohr Industries, Chula Vista, CA.	To establish and demonstrate a new manufacturing technique which is applicable to the fabrication of advance composite airframe or advanced composite airframe or engine structures or both.	$ 402	28	Future aircraft.
29. Weld repair scale-up	General Electric Co., Cincinnati, OH.	To establish a cost-effective, reliable, and reproducible manufacturing process for repair of turbine airfoils by further refining advanced cleaning and crack repair techniques developed from another contract.	$ 449	43	All engines.
30. Manufacturing methods for fabrication and processing high-quality continuously woven quartz broadgoods	Woven Structures, Division of HITCO, Compton, CA.	To acquire the capability to manufacture and process high-quality, 4- by 8-foot widths of 20-harness double-faced satin broadgoods, using 7-micron diameter filament.	$ 648	43	Spacecraft, particularly satellites.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Reduce costs, increase capability to produce composite structures in high volume.	For structures with numerous holes, labor savings from 22 to 59%.	Prime contractor reportedly is unwilling to accept products made using this process until further evaluations are made.	Rohr Industries uses this process for commercial applications. Officials of at least one other company have expressed interest in using the process on military systems.
Define process specification and reduce repair and replacement costs.	None projected.	According to Air Force officials, one Air Logistics Center is considering use of this technology, but needs to purchase equipment and change technical orders.	General Electric uses this progress extensively for commercial purposes; it does not repair blades on military engines. Several commercial airlines and the San Antonio Air Logistics Center are considering use of these results. Although the project was designed to set general rules, the process was successfully established for only one alloy for which the MT contractor has patent rights.
Provide new capability to manufacture the product.	New manufacturing method established.	Alternate technology is more economical.	

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
31. Delta alpha vacuum furnace technology for superplastic formation/diffusion bonding (SPF/DB)	Rohr Industries, Inc., Chula Vista, CA.	To establish cost-effective manufacturing methods for SPF/DB aircraft structure.	$1,036	36	T-38, F-4 and all airframes and engines with titanium parts.
32. Manufacturing technology for printed wire board electrodeposition processes	Rockwell International Corp., Thousand Oaks, CA.	To establish effective process controls for analyzing and controlling acid copper electroplating processes used in printed wire board manufacturing operations.	$ 392	33	All Air Force electronic systems, including the AMRAAM, B-52, ALCM, F-15, JTIDS, F-16, Peacekeeper, and LANTIRN.
33. Manufacturing technology for gallium arsenide solar cells	Applied Solar Energy Corp., City of Industry, CA.	To establish and optimize reliable, low-cost methods for producing space-qualified gallium arsenide solar cells.	$3,514	31	Future space power requirements and Global Positioning System satellite.
34. Composites manufacturing operations production	Northrop Corp., Hawthorne, CA.	To assess the benefits from improved individual manufacturing concepts for advanced composite aircraft structure. (See Air Force notes)	$2,130	65	Future aircraft.

Benefits Projected at Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	GAO Observations
Cost saving of 30-70%, depending on the component produced. Improve product quality and increase ability to produce parts.		This is one of several approaches funded by the Air Force in SPF/DB. This process greatly reduces the amount of machinery required to produce parts.
Significantly improve the reliability and lower the cost of Air Force electronic systems with printed wire boards.		Rockwell has worked with many other companies in this project by sponsoring a workshop, writing joint papers with other companies' employees, holding an industry-wide status review meeting, and using other companies to evaluate the quality of circuit boards produced by this method. This project follows up on an MT project that began in 1979 and was also carried out by Rockwell.
Annual saving of $6 million per satellite.		This project was requested by the Air Force Space Division, which continues to view it as a high priority MT project and plans to use the results soon after completion.
Significantly reduce production costs and expand nation's capability to produce composite structures.		This project is almost complete. Northrop has begun implementation on the night shift and continues to debug the process during the day. Northrop officials said this project, integrated with other composite production projects (See Air Force project 3), has significantly reduced the time needed to produce rudderskins.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
35. Manufacturing technology for composites assembly production integration	Grumman Aerospace Corp. Bethpage, NY.	To extend the production integration concept to include establishment and validation of advanced assembly methods for efficient manufacture of composite aircraft structures. (See Air Force notes).	$1,723	40	F-5; T-38; F-16; all airframes.
36. Advanced machining system	General Dynamics Corp., Ft. Worth, TX.	To establish the technical and economic viability of integrated manufacturing systems for aerospace batch manufactured machine components.	$ 787	61	All airframes and engines.
37. Manufacturing technology for complex composite structure	General Dynamics Corp., Ft. Worth, TX.	To establish and test method of manufacturing complex composite fuselage structures.	$1,982	55	F-16 and advanced tactical fighter (aircraft not yet in production).
38. Manufacturing technology for non-autoclave fabrication of composites	Rockwell International Corp., El Secundo, CA.	To establish and demonstrate generic curing techniques for 350-degree curing organic matrix, and advanced composite structures not requiring the use of an autoclave, which can be used to produce composite aircraft structure.	$1,950	44	F-16; F-15; B-1; advanced cargo aircraft.

Benefits Projected at Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
Reduce labor hours up to 50% and enhance nation's composite production capability.		
Reduce machining costs and capitalization requirements, and increase productivity. Should reduce costs of acquiring Air Force weapon systems by millions of dollars		This project is part of a major Air Force MT effort to improve overall machining productivity. The Air Force predicts that this project's results will be the basis of the automated and integrated aerospace factory of the future.
Save 5-20% in costs, reduce weight by 15-30%, and improve quality.	According to MT officials, MT funds will not be used to pay for any design work.	The Air Force MT program funded Grumman and General Dynamics for this project's first phase but the companies knew only one company would be selected for the additional phases. General Dynamics was named to run the three additional phases. The Air Force requested and obtained the agreement, which is not binding, of top management to implement if the project is successful.
Reduce tooling and other costs significantly, lower energy requirements, increase flexibility of factory production flow, and reduce nonrecurring costs since autoclaves are very expensive.		Although this project is one of several to establish nonautoclave production methods, Air Force MT officials believe it is the primary project addressing this production problem. The autoclave is considered a major bottleneck in composite production due to its cost, size, energy usage, and time for curing composites.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Applications
39. MT for complementary metal-oxide semiconductor integrated silicon on sapphire substrates (CMOS/SOS) read only memory (ROM) and random access memory	TRW, Redondo Beach, CA.	To establish a manufacturing capability for the volume production of specialized silicon-gate CMOS/SOS circuits that can meet the military's reliability and radiation dose requirements.	$ 421 (Phase I only)	41 (Total Project)	Ground-based radar, global positioning systems users equipment; JTIDS, F-16, DSP.
40. MT for composites assembly production integration	Northrop Corp., Hawthorne, CA.	To extend the production integration concept to include establishment and testing of advanced assembly methods for efficient manufacture of composite aircraft structures. (See Air Force notes).	$1,641	25	All aircraft.
41. Integrated blade inspection automated preprocessing and inspection modules for an integrated blade inspection system (IBIS)	General Electric Co., Cincinnati, OH.	To establish, build and test advanced turbine blade and vane inspection modules offering significant improvements over conventional inspection techniques. To determine specific facility requirements and to build, test and install additional turbine blade and vane inspection modules and IBIS information computer systems for other tri-service users.	$7,050	72	Air rework facilities in the 3 military services and all engine manufacturing companies.

Benefits Projected at Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
Reduce weapon systems costs by increasing memory device storage capacity and reducing programming costs by a factor of 4 since one ROM will replace 4 to 8 devices currently used.		Two companies — Rockwell and TRW— were awarded contracts for phase I but only one company will be selected to carry out the additional phases.
Reduce labor hours by up to 50% and enhance nation's production capability for composite structures.		This is the last of 3 projects awarded to Northrop to establish an integrated composite manufacturing center. The contractor informed us it intends to implement the project's results.
Reduce costs by $17 million per year by automation, quality improvement, and reduced inspection time.		Of this project's funding, 53% is provided by the Air Force, 30% by the Navy, and 17% by the Army. The Air Force is the lead service on this project, which is directed at all engine repair facilities. In Jan. 1983, General Electric informed the Air Force it intended to use this project's results in its engine repair facilities on 5 military engines.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
42. Eddy current surface inspection of disks	General Electric Co., Cincinnati, OH.	To extend the technical efforts that were conducted under another project and to establish, fabricate, test, and demonstrate two automated preproduction eddy current scanning systems capable of inspecting critical areas of aircraft turbine-engine rotating parts.	$ 862	34	The TF30, TF34, GF41, J79, J85-21, F100, F103 and TF33 turbine engines.
43. MT for nondestructive evaluation systems to implement retirement-for-cause for gas turbine engine components	Systems Research Laboratories, Dayton, OH. (12 subcontractors)	To conduct a cooperative MT program for an integrated and generic nondestructive evaluation required to establish and implement retirement-for-cause methodology for engine components in an Air Force engine facility.	$11,400	55	F100 and TF34 (turbine engines) and the San Antonio Air Logistics Center.
44. High-speed digital processor packaging techniques	Westinghouse Electric Corp., Baltimore, MD.	To establish and demonstrate manufacturing processes and control for dense packaging of high-speed digital processor circuitry used in airborne radar signal processors.	$ 826	37	Airborne radar signal processors.

Benefits Projected at Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
Reduce life cycle costs and scrap. Decrease maintenance labor hours by 30%, and inspection personnel by 50%.		We were told General Electric installed and demonstrated this project at the San Antonio Air Logistics Center, which by Oct. 1983 was undergoing qualification testing for the F100 engine. The project, by June 1983, was also installed and demonstrated at the Oklahoma City Air Logistics Center.
Significant saving because of reductions in inventory and the need for spare parts, increased parts life, and reduced dependence on strategic minerals, such as cobalt. Projected saving of $50-$250 million on F100 engine-overhaul operations.		We were told because of reanalysis of the F-16's mission, the engine components initially selected to establish this process are no longer considered critical. Change in the components selected for inspection requires new software costing an estimated $5 million. According to the project engineer, the plan is now to fund the additional costs through the F100 engine system program office.
Reduce volume and costs of advanced signal processors, and improve reliability.		

NAVY

Projects 1 - 6: Implemented Since 1979

Projects 7 - 18: Completed Since 1979 But Not Implemented

Projects 19 - 25: Started During Fiscal Years 1980-82

Examples of Manufacturing Technology Projects Implemented Since 1979

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
1.	Gallium arsenide substrate fabrication	Microwave Associates, Burlington, MA.	Establish domestic production capabilities for fabricating high-quality gallium arsenide wafers.	$ 501	34	U.S. electronics manufacturers.
2.	Delidding and resealing of hybrid microcurcuit packages	Westinghouse Electric Corp., Baltimore, MD.	Provide production and remanufacturing methods for delidding and resealing hybrid microcircuits.	$ 256	18	Hybrid microcircuits used in F-14 aircraft, AIM-9, Harpoon, Tomahawk, and other systems, and depot repair facilities.
3.	Automated test system for phased-array antennas	RCA Corp., Moorestown, NJ.	Develop test set and computer program method for nearfield testing of phased array antennas.	$ 677	18	For near-field testing of AEGIS SPY-1A radar antennas.

Benefits Projected			Benefits in Production			
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
$11.96 million savings over 5-year period. Expansion of defense industrial base.	No projection made.	Microwave Associates, Burlington, Mass. F-14 aircraft, Standard ARM, AIM-9L, AMRAAM and Phoenix missiles.	$25 million savings to date. Expansion of defense industrial base.	Part of savings represents comparisons of first application of the new technology during the project to later applications.	Some large weapons-system manufacturers have implemented the technology for in-house consumption. Some smaller firms have become suppliers.	Established domestic production capability thereby broadening defense industry base. Cost savings could not be traced to acquisition costs.
$7.5 million savings over 5 years. Increase in available parts.	$10 million savings per year. Shorten turnaround time in rework.	Westinghouse Electric Corp., Baltimore; MD, Naval Avionics Center, Indianapolis, IN. Selected microcircuits in several systems.	None reported.		Several microcircuit firms have purchased equipment developed under the project.	Military specifications changed to allow debidding/resealing of selected hybrid microcircuits.
$100,000 savings per ship. Decrease testing time.	$400,000 saving per ship. Decrease testing time.	RCA Corp. Moorestown, NJ. For testing AEGIS SPY-1A radar antenna.	$1.2 million savings to date.	Comparison of actual cost to test, using nearfield technology with estimates of cost if antenna had to be measured using conventional testing methods.	None.	Developed specifically for AEGIS, project was vital to meeting AEGIS production schedule. AEGIS manager involved in this project from inception which resulted in timely, successful completion. New technology was available for the first production run. RCA is expanding on the technology for use on the AEGIS SPY-1, now under development.

Examples of Manufacturing Technology Projects Implemented Since 1979

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
4.	Manufacturing technology for crossed-field amplifier tubes	Varian Associates, Beverly, MA.	Modify or simplify the manufacturing process for crossed-field amplifiers to lower production costs.	$ 265	28	For use in producing crossed-field amplifiers in AEGIS SPY-1A radar system.
5.	Power traveling wave tube airborne expendable device	Teledyne MEC, Palo Alto, Calif.; Raytheon, Waltham, MA.	Reduce manufacturing costs of traveling wave tubes used in expandable decoy program.	$ 239	36	Traveling wave tubes.
6.	Manufacturing technology for laser hardening of cams	Naval Surface Weapons Center, Dahlgren, VA.	Develop production methods for laser surface hardening of cams for MK10 guided missile launching system	$ 51	14	Naval Surface Weapons Center, Dahlgren, VA. Hardening cams for MK10 guided missile launching system.

Benefits Projected			Benefits in Production			
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
$4.4 million savings or about $4,000 savings per tube.	$4,000 per tube.	Varian Associates, Beverly, Mass. For use in producing crossed field amplifiers in AEGIS SPY-1A radar systems.	$2.9 million savings to date.	Cost savings are based on actual price of new tube using new technology compared to estimated cost of tubes using prior processes (adjusted for inflation and learning curve).	Technology being used in development of tubes for AEGIS SPY-1B. Use is planned in production of tubes for SPY-1B.	
$44.8 million savings for quantity of 12,000 tubes over 5-year period.	$10 million savings for quantity of 6,000 tubes.	Intended project requirement did not exist at end of project. Results applied to other tubes being produced for DOD by Teledyne and Raytheon.	None reported.		None.	At GAO's request, Teledyne developed estimates of cost savings in 3 of several processes investigated in the project. Savings of $553,000 were estimated. No attempt had been made to assess overall benefits from the project.
$15,000 savings per year	$16,400 savings per year	Naval Surface Weapon Center, Dahlgren, Va. Hardening cams for MK10 missile system.	None reported.		None.	Laser hardening costs appear to be substantially less than for the conventional hardening process. According to Navy officials, the cost was reduced from $1500 to $250. Another benefit was the elimination of the need for a toxic waste removal process. Navy is examining application of technology to other hardening requirements.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
7.	Inertial instrument inspection and test	Charles Stark Draper Laboratory, Cambridge, MA.	Establish automated inspection and test production station for inertial instrument repair, rework and manufacturing.	$ 469	29	For depot level maintenance activity.
8.	Manufacturing technology for radiation hard-optical fibers for aircraft	ITT Electric-Optical Production Division, Roanoke, VA.	To establish cost-effective manufacturing production of radiation hard-optical fibers suitable for aircraft.	$ 316	34	Ground-launch cruise missiles, all future aircraft, and satellites.
9.	Diffraction optics	Hughes Aircraft Co., Los Angeles, CA.	To establish production methods for manufacturing diffraction optical elements to reduce costs and improve yield and quality.	$ 1,196	45	Heads Up Display Units (HUD) for AV-8B, F-14, F-18, A-7 and A-6 aircraft.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$99.6 million savings over 20-year period. Increased instrument reliability.	Increased instrument reliability. No projections made of cost savings.	Naval Air Rework Facility (NARF) engineers advised GAO that the contractor elected not to use the resulting technology.	Litton supplies inertial instruments for Navy depot maintenance work, NARF in San Diego planned to obtain this workload. However after the start of the manufacturing technology project, Litton retained depot maintenance work through 5-year contract and as such was brought into the project to test the new equipment. Litton returned the equipment to NARF San Diego after project completion. NARF plans to implement in the future.
$3.7 million savings per 100-kilometer purchase.	No projection made.	MT project engineers told GAO that a more economical fiber came on the market during the project.	Naval Ocean Systems Command will continue research and development on the fiber optic technology.
Savings range from $4.25 million to $25 million over 5-year period	No projection made.	MT project engineers told GAO that the program managers for the aircraft under investigation chose a different HUD.	Project cofunded with Air Force. Navy cost was $335,000. There is a question whether program criteria apply because no firm requirement was made for the end product. Under the project contract, the Air Force could terminate after each contract phase. The final phase was terminated before funding because the project managers on the targetted aircraft selected different HUD. Hughes Aircraft Co. claimed proprietary rights over some of the technology involved.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
10. Development of computerized thick film printer	RCA Corp., Moorestown, NJ.	Develop thick film printing process which is controlled easily and consistently by computer aided hardware and software.	$ 461	65	Various avionics systems using thick film hybrid circuits.
11. Analysis of material handling in dry docks	Mare Island Naval Shipyard, Vallejo, CA.	Analyze and reduce the cost of overall material handling operations and equipment in dry dock areas and on board ships during overhauls.	$ 95	35	For use in improving operations at Navy shipyards.
12. Powdered metal sintering of jet vanes	Battelle Columbus Laboratories, Columbus, OH.	Utilize existing precision sintering technology to produce airfoil configurations of copper infiltrated tungsten.	$ 395	31	For use on jet vanes for ASROC and Harpoon missiles.
13. High-power klystrons	Varian Associates, Palo Alto, CA.	To advance high-power klystron manufacturing technology by improving and applying modern methods to fabrication and assembly of piece parts, and automating operations to achieve lower acquisition costs for klystrons.	$ 356	29	Navy's Phalanx weapon system and Army's Division Artillery Defense System.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$1 million savings per year.	No projection made.	Project not technically successful in developing the printer.	Did not hold end-of-project demonstration because project was not fully successful. Naval Avionics Center officials state they are working with subcontractor to further develop the process without MT funding.
$290,000 savings per year.	$10.4 million savings per year.	Minimal changes were made as a result of the study.	A question is whether criteria apply because a demonstration of new or improved manufacturing technology is not involved. Funded by MT operations and maintenance.
$2 million savings per year	No projection made.	Development of target systems curtailed for period of time.	According to the project engineer, future implementation may occur.
$2.14 million savings per year	No projection made.	MT version of klystrons must be tested before Phalanx prime contractor will accept klystron in production. Phalanx program manager is currently testing the klystron.	Prime contractor plans to use new version klystron if testing is successful. Would be implemented at the subcontractor level by Varian Associates.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
14. Boiler tube hard deposit removal using cavitating water jet	Hydronautics, Laurel MD.	Apply cavitation nozzle principle to the removal of hard deposits from Navy boiler tubes using standard jet-cleaning equipment already in place at Navy facilities.	$ 167	32	For use in Navy shipyards in repair and overhaul of Navy boilers.
15. Improved method of installing boiler tubes	Foster Wheeler Development Corp., Livingston, NJ.	Develop explosive-forming process to expand heavy-wall boiler tubes in steam and water drums to eliminate the extremely costly process of rolling.	$ 122	32	For use in Navy shipyards in repair and overhaul of Navy boilers.
16. Fabrication of fiber-reinforced metals	Fiber Materials, Biddeford, Maine; AVCO, Lowell, MA.	Reduce the cost of manufacturing wide, long, thin metal matrix composite sheet stock and other structural shapes used in satellite antennas while increasing production yield by reducing product variability.	$ 250	6	None specified.
17. Graphite aluminum tape and tooling	Materials Concepts, Columbus, Ohio; DWA Composite Specialties, Chatsworth, CA.	Establish the production process and equipment to manufacture thin gauge graphite aluminum tape and develop tooling to fabricate tape into structural shapes and systems components.	$ 862	30	Production of complex shapes for tactical missile components.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$1 million savings per year	No projection made.	Project found principle did not work on boiler tubes.	
$570,000 savings per year.	No projection made.	Project was not intended for immediate implementation. A follow-on MT project, funded in Jan. 1981, tested boilers made with new technology.	Project originally investigated magnetic-forming processes but early study indicated that these processes were not feasible. Project then investigated explosive forming.
No projection made. Benefits could not be assessed at time of proposal.	No projection made.	Currently, there is no production requirement for the product.	Project was part of research and development thrust area for metal matrix composites. Thrust area receives funding from Defense Advanced Research Project Agency and MT.
$180 million savings over 5-year period.	No projection made.	Currently, there is no production requirement for the product.	Project is a part of Navy thrust area dealing with metal matrix composites.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
18. Critical aircraft bearing refurbishment	Naval Air Rework Facility, San Diego, CA.	To establish production processes for reworking/ refurbishing rolling element bearings used in Navy aircraft gas turbine engines, transmissions, and gear trains.	$ 240	25	Rework of aircraft bearings at Naval Rework Facility, San Diego, CA.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$1 million savings over 3-year period.	No projection made.	Process had not been totally established when project funds and time expired.	Follow-on project for $180,000 approved to continue the project objectives. Application of program criteria is questionable because bearing refurbishing processes under development are not new according to the project engineer. Industry and the Air Force have used these processes for several years.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
19. Automated finishing of ship propellers	Robotic Vision Systems, Melville, N.Y.	To obtain rapid automated method of finishing propeller surfaces with minimum labor by using computer-controlled robot tools that work with existing inspection equipment.	$ 1,717	22	Finishing of Navy submarine propellers at several Navy shipyards.
20. Closed loop instrumented welding	Massachusetts Institute of Technology, Cambridge, MA.	To reduce cost and improve quality of ship construction in U.S. shipyards by providing for adaptive control and automation of the welding process.	$ 120	15	Ship construction at U.S. shipyards
21. Dual beam dual mode I-J band traveling wave tubes	Northrop Corp., Rolling Meadows, IL., Raytheon Co., Waltham, MA.	To establish manufacturing processes for producing I-J band dual mode traveling-wave tubes to reduce manufacturing cost and improve general productivity.	$ 1,281	34	Traveling-wave tubes used in an airborne self-protecting jammer.

Benefits Projected		
Benefits Projected at Project Initiation	On Whether Project Meets MT Program Criteria	Other GAO Observations
$1.3 million savings per year		Project is part of an overall effort to automate the manufacture of submarine propellers. Before project was funded, the overall concept was submitted to Navy's Propeller Steering Committee and National Bureau of Standards, Department of Commerce for comments on the approach's feasibility.
No projection made.	There is a question whether program criteria apply, because the project is a feasibility study.	Current funding is for Phase I of a three phase effort.
$4.3 million savings over 5-year period.		Raytheon portion of the project terminated after about 60% of funds had been expended because MT project affected Raytheon's ability to meet high-priority production demands for B-1 bomber support.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
22. Hot isostatic pressing of aluminum castings	Northrop Corp., Hawthorne, CA.	To establish a manufacturing process to produce consistently high-quality aluminum castings by hot isostatic pressing.	$ 558	28	F-18 aircraft parts.
23. Corrosion-resistant turbine blade tip	General Electric Co., Evendale, OH.	Establish low-cost manufacturing process to make a turbine-engine blade tip which resists hot environmental attack and joins it to the turbine blade. To establish a process to apply an abrasive coating to the tip.	$ 1,465	26	F404 and F101 aircraft engines.
24. Wide goods infiltration	Materials Concepts, Columbus, OH.	Improve production methods of graphite-metal composites with respect to material quality, production rates, and costs.	$ 640	26	Strategic and tactical missiles, hydrospace weapons.
25. Automated printed circuit board fabrication line	IBM Corp., Owego, NY., Naval Weapons Center, China Lake, CA.	Establish requirements for and demonstrate the capability of a fully automated printed circuit board fabrication line.	$ 1,300	63	All printed circuit board fabrication lines in industry.

Benefits Projected at Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
$4.7 million savings over 5-year period.	Whether program criteria apply to project is questionable because technology under investigation is not completely new, according to the project engineer. Project is also end item oriented.	Project's objective was to replace existing F-18 parts with hot isostatic pressing parts, some of which were critical. Midway through project, prime contractor for F-18 took exception to apply new technology to critical parts so project was redirected to non-critical parts.
$3.99 million savings over 5-year period.	Whether program criteria apply is questionable because project is end item oriented. Blades to be developed will replace existing blades.	Project cofunded with Air Force. Navy cost projected at about $900,000.
No projection made.	Whether program criteria apply is questionable because project is end item oriented. No firm Navy requirement exits for graphite aluminum metal matrix.	Funded with MT research and development funds. This is one of several projects studying metal matrix composites. According to project engineer, Navy may set future requirements after this work on graphite aluminum matrix composites is completed.
No projection made.		Three-phase project. In phase 1 feasibility was studied and a proposal request was developed for Phase 2, which is currently in progress. Project cost is shared equally between contractor and Navy. Phase 2 will result in a complete system design. Phase 3 will implement the system. MT officials plan for the Industrial Modernization Incentives Program (IMIP) to accomodate Phase 3. If not, MT will fund Phase 3. A specific contractor or IMIP has not yet been identified.

ARMY

Projects 1 - 20: Implemented Since 1979

Projects 21 - 48: Completed Since 1979 But Not Implemented

Projects 49 - 63: Started During Fiscal Years 1980-82

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
1. Radio frequency stripline hybrid components	Hughes Aircraft Co., Electron Dynamics Division, Torrance, CA Hughes Aircraft Co., Tucson, AZ Army Missile Command, Redstone Arsenal, AL	Develop a low cost methodology of manufacturing stripline and stripline hybrid devices.	$ 745	38	All military electronic hardware items utilizing low power radio frequency.

Benefits Projected			Benefits in production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Estimated unit cost reduction of 60% from $600. Reduced size and weight. Improved reliability. Eliminate need for complex and expensive components. $107.6 million discounted savings over eight years.	Reduced manufacturing cost (Savings on a system/program level could range from $30,000 to over $3 million).	WASP at Hughes Aircraft, Torrance, California.	Cost reduction. Savings of $45 million over four year period.	Savings per system applied to projected production rate.	None.

GAO Observations

Phase I of this effort had aspects which appear to be research and development in nature.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Applications
2. Flex-printed circuits with integral molded connectors	Army Missile Command Redstone Arsenal, AL Westinghouse Electric Corporation, Systems Development Division, Baltimore, MD	Determine and establish fully automatable processes for connectable termination of flexible printed wiring with other styles of cabling and printed wiring boards.	$ 217	23	All missile systems requiring interconnects between wiring boards.

Benefits Projected			Benefits in Production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Cost reduction. ($1.1 million discounted savings over ten years).	Reduction in weight (80%), volume (20%), and cost (30-50%) of interconnection due to use of flexible printed circuits.	Implemented by Westinghouse in Baltimore, MD, and Boston, MA for the ALQ131 ECM POD, Army RPV (AQUILA), F-16 RADAR, and E3A AWACS.	Improved product quality/reliability. Cost reduction. $903,000 discounted savings over three years. Lead time reduction.	Based on contractor furnished data. Projections based on unit cost savings in the final technical report on this effort. No effort by GAO to validate.	None.

GAO Observations

Westinghouse made extensive effort to disseminate the results of this effort before various groups. Reportedly over 1,600 persons attended the various events. Reported benefits noted above as per IBEA Effectiveness Report of March 1982. Benefits reported by the Missile Command to IBEA were generally higher.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Applications
3. Automatic monitoring and control system for wave soldering machines	Army Missile Command, Redstone Arsenal, AL Westinghouse Electric Corporation, Systems Development Division, Baltimore, MD	Develop an automated control system for wave soldering printed circuit boards.	$ 450	21	Printed circuit boards used in all electronic military equipment.

Benefits Projected		Actual Production Application	Benefits in Production		Other Identified Uses of the Technology
At Project Initiation	At Project Completion		As Reported	Basis	
Cost reduction. ($7.3 million discounted savings over eight years). Improved quality and reliability.	Cost reduction of $1.1 million per year. Rejections reduced by 50%.	DIVAD, RPV, F-16, and ALQ-131 at Westinghouse Co. at Baltimore, MD.	Cost reduction. ($6.2 million discounted savings.) Increased product quality/reliability.	Contractor's estimate. Not validated.	Three Government contractors have reported use of automatic wave soldering machines. One projected a savings of $2.5 million. A fourth contractor reportedly has used the technology on a commercial item and has projected $633,000 cost avoidance.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
4. Low cost quantity production techniques of laser seekers	Army Missile Command Redstone Arsenal, AL Martin Marietta Aerospace, Orlando, FL	Establish optimum processing techniques and the special equipment/ tooling for integrating the alternate "Hellfire" seeker head and "Copperhead" electronics package.	$5,000	34	Seekers for the Hellfire Weapon System.

Benefits Projected			Benefits in Production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Cost savings on the Hellfire System could exceed $50 million.	Not identified.	Hellfire system at Martin Marietta Aerospace Division facility in Ocala, Florida.	Cost reduction. ($87.4 million discounted savings.) Improved product quality/reliability. Improved readiness.	Application of estimated unit cost savings at full production to projected requirements.	Another contractor reported to the Missile Command that this and other MT efforts have contributed substantially to projected significant cost savings (in production quantities) on another Army system. Another contractor reportedly has derived the following benefits on commercial business from this effort: -Cost reduction, (not quantified), -ability to produce, and -sole source elimination.

GAO Observation

Estimated unit cost savings were based on a 1979 value engineering proposal. The figure is probably not current but MT program personnel at the Missile Command sought some corroboration of its validity as a measure of potential savings from the effort. Martin Marietta officials said they could not measure benefits from the effort because they had no basis for comparison. The Missile Command MT program personnel currently project $143 million in cost reduction over 8 years of Hellfire production. The project engineer suggested that cost savings could reach several hundred million dollars. GAO did not verify these estimates. Martin Marietta officials indicated that technology will flow to second generation Hellfire and ADATS.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Applications
5. Manufacturing multi-layer rigid-flex harness	Army Missile Command, Redstone Arsenal, AL McDonnell-Douglas Co., Engineering Technology Division, St. Charles, MO	Develop producibility criteria and process parameters required to manufacture rigid-flex circuits.	$ 380	22	Not identified.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
40. Acceptance of continuously produced black powder	ARRADCOM, Dover, NJ Ballistic Research Laboratories, Aberdeen, MD Indiana AAP, Charlestown, IN Princeton Combustion Research Laboratories, Princeton, NJ	Develop procedures and prototype test device for acceptance of black powder production to assure reliable performance in artillery, mortar, and rocket systems.	$ 363	73	Black powder manufacturing at the Indiana AAP. End items supported include various cartridges, propelling charges, and rockets.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$524,000 discounted 10 year savings. ROI: 24% SIR: 1.60 Major reduction in safety hazard from glazing operation.	Not determined.	Not economically feasible to replace existing equipment.	Project personnel stated that testing of the technique developed was still in progress in hope of ultimately finding an economically feasible approach.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
39. Improved process for polishing, drying, and glazing of black powder	ARRADCOM, Dover, NJ Picatinny Arsenal, Dover, NJ Indiana AAP, Charlestown, IN	Evaluate new and improved process for polishing, drying, and glazing of black powder.	$ 408	Not determined	All end items using black powder, including ignition primers, fuzes, pyrotechnics, flash reducer, and expelling charges.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Not identified.	Not identified.	Not economically feasible, due to discontinuance of mobilization requirements to economically justify modernization efforts and need for high, long-term production effort to justify equipment investment.	Technology was apparently in use in private sector but, according to project personnel, this effort was needed to determine the effect on mortar projectiles, including effect on end-item lethality.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
38. Automatic transfer hot forming presses for mortar ammunition manufacture	Frankford Arsenal Norris Industries, Riverbank, CA	Determine whether automatic transfer horizontal hot forming presses could manufacture mortar body forgings at required rate and quality.	$ 132	44	Riverbank AAP.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$2.5 million cost savings per 9 months operating period.	Process improvements (reduced production costs, decreased pollution, greater safety, higher yields).	Technically unsuccessful.	This effort was redirected from developing a new TNT production process to optimization of the current process. The redirection apparently resulted from an analysis of this effort in 1975 which questionned the economic feasibility of the original objective and because the purpose of MT is not to build pilot plants for general purposes. In 1979 the effort was terminated because remaining unexpended funds would not correct "minor" inadequacies to make the pilot line operational.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
37. Continuous TNT process engineering.	ARRADCOM, Dover, NJ Day & Zimmerman, Philadelphia, PA Illinois Institute of Technology Research Institute, Chicago, IL Radford AAP, Radford, VA.	Establish pilot plant to optimize and improve continuous TNT production process.	$ 2,486	93	TNT production at GOCO plants.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$824,000 annual cost savings due to oil savings of 66,000 barrels.	None.	Not economically feasible.	Project personnel justified effort on basis that waste to be treated is inherent with the production process. Project personnel indicated that as a result of the effort the Navy curtailed plans to adopt pyrolysis. They also indicated that the project tended to contradict commercial firm claims about value of pyrolysis technology.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
36. Pyrolysis of Army ammunition plant solid waste	ARRADCOM, Dover, NJ Georgia Tech University. Iowa AAP, Middletown, IA	Use pyrolysis technology to convert plant refuse into useable fuels.	$ 100	22	All munitions items containing propellants, explosives, or pyrotechnic materials.

Benefits Projected			
At Project Initiation	At Project Completion	Reasons(s) Project Results Not Implemented	GAO Observations
$427,000 cost savings in first year; $640,000 annually thereafter. SIR: 2.11 Improved quality of bags.	Direct labor savings.	Requirement changes.	Work performed was for a feasibility study on alternate ways to manufacture four similarly constructed bags. The feasibility study recommended three manufacturing approaches. ARRADCOM recommended additional MT effort of $625,000 to develop one approach. The recommendation was apparently not adopted because of configuration changes in propelling charge bags. ARRADCOM also recommended limited implementation at the Indiana AAP of another approach recommended in the feasibility study. However, Army personnel at Indiana AAP said the feasibility study recommendations were not applied there because the AAP opted to buy advanced state-of-the-art sewing machines to substantially reduce labor costs.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
35. Development of equipment for automated/ mechanized fabrication of center core propellant charges	ARRADCOM, Dover, NJ Indiana AAP Charlestown, IN Novatronics, Inc. Pompano Beach, CA	Development of equipment/process to mechanize/automate propellant bag fabrication.	$ 215	29	Production of 8 inch and 55mm center core propelling charges at load plant to be selected.

Benefits Projected			
At Project Initiation	At Project Completion	Reasons(s) Project Results Not Implemented	GAO Observations
$162,000 annual cost savings. ROI: 17.0% SIR: 1.43 Insure higher safety, reliability, and end-item performance levels. Reduce inspection.	Not identified.	Work was continued under another MT effort.	

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
34. Automatic inspection system (AXIS)	ARRADCOM, Picatinny Arsenal, Dover, NJ Lockheed Palo Alto Research Laboratory, Lockheed Missiles & Space Company, Inc., Palo Alto, CA	Demonstrate the practicality of, and provide the prototype hardware for an AXIS to automatically read and interpret x-ray film to detect critical cavitational defects in helium filled artillery projectiles.	$ 260	51	A planned automated melt-pour line for the 105mm, HE, M1 projectiles at the Lone Star AAP. Other families of artillery and mortar rounds with x-ray requirements also to be supported.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Cost reduction. Savings of $170,000 estimated on the M16 rifle hand guard assembly. Improved component performance.	Cost savings of 30% over compression molding. Manufacturing capability to produce high quality components with significantly improved service life.	Intended end-item, the M16A1 rifle handguard, is being re-designed.	The effort appears to be linked with a product improvement program for the M16 rifle hand-guard. Equipment is at Rock Island Arsenal but not in production use. According to project personnel the equipment is potentially useable for production of the redesigned handguard.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
33. Low-cost reciprocating screw molding of thermosetting plastic weapons components	Rock Island Arsenal, Rock Island, IL	Manufacturing procedures for the injection molding of reinforced and non-reinforced thermoset plastic materials.	$ 110	81	All army weapons systems, particularly small arms weapons systems components (such as hand guards and magazines) and aircraft armament. Production at Rock Island Arsenal.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Annual cost savings of $19,000 ROI: 78% SIR: 3.6	None.	Technically unsuccessful.	Project completed in April, 1979. Final technical report was still in draft review process in 1983.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
32. Room temperature phosphating	Rock Island Arsenal, Rock Island, IL	Replace hot zinc phosphating process with room temperature process.	$ 37	12	All zinc phosphated components produced by government facilities and private industry. Approximately 75% of Army weapon components require phosphate coating.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Estimated $38 cost savings per item for "thick sectioned rubber end item." Improved process control.	Not identified.	Production schedule did not require increased molding technology.	No plans exist for implementation of results. Microwave curing would be considered as an alternate production process in the event of mobilization. Additional equipment would have to be acquired. Nonimplementation apparently also due to prospects of using an alternate more promising technology being explored under a different MT effort. Potential application to tank track pads apparently exists but extent of transfer of project results is not known.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
31. Fabrication of rubber end items using microwave equipment	Rock Island Arsenal, Rock Island, IL	Manufacturing process procedures for microwave vulcanization of of rubber end-items.	$ 97	46	Rubber items used in current or proposed weapons systems such as rubber springs for M73 and M85 machine guns, obturator pads for cannon, track pads for vehicles and other equipment to be furnished to Rock Island for production purposes.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	CAO Observations
Improved product quality. Elimination of costly equipment and time-consuming operations. Improved process control.	Not identified.	Economic feasibility is questionnable.	First year of effort was a feasibility study which developed the technology. Effort extensions and cost growth had to be justified on more than one occasion. Various complications were encountered during the effort including delays in procuring equipment, technical problems, funding withdrawal/replacement, and extensive personnel turnover (there were seven project managers). In the interim, quality of commercially available springs improved. Equipment is in standby status and potentially usable as alternate production source.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
30. Application of high frequency induction heating method for hot coiling of springs.	Rock Island Arsenal, Rock Island, IL Gogan Machine Corp., Cleveland, OH	Design and implement a hot spring winding capability using induction coil in lieu of gas furnace as a heat source.	$ 607	97+	Rock Island Arsenal primarily for the M140 gun mount on the M60 tank. Also support production, overhaul, and rebuild of weapons components and prototypes for the Army and other DOD customers.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Cost savings of $500,000 annually. Reduced reliance on foreign sources for critical materials. Improved process control.	Not identified.	An Engineering Change Proposal to effect results under review. Effort was completed in March 1983.	Project personnel expect technology transfer to steel industry.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
29. Conservation of critical materials for gun tubes	Benet Weapons Lab, Watervliet Arsenal, Watervliet, NY Contractor not identified by GAO.	Reduce the amount of critical alloying elements in gun tube materials.	$ 236	39	Rotary forging at Watervliet Arsenal.

Benefits Projected		Benefits in Production				
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Cost reduction (.32 per unit). Decreased need for skilled operators/ inspectors. Reduced space needs. Less material handling.	Not identified.	Honeywell produced 2.2 million fuzes at the Twin-Cities AAP beginning February 1979, until May 1981, when machinery was laid away because of low requirements.	Improved product quality/ reliability. Lead time reduction. Improved readiness.	Cost savings possibly realized but apparently not measured. Other benefits plausible but not substantiated by GAO.	Two other contractors established automated assembly lines for fuze production. One produced 1.4 million fuzes but has laid away the equipment due to unsuccessful bid on subsequent procurement. The other reportedly is still producing fuzes.	

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
20. Automated loading of propellant flash reducers	ARRADCOM, Picantinny Arsenal, Dover, NJ. ICI Americas, Indiana AAP, Charlestown, IN.	Provide prototype equipment to automatically load flash reducers for propellant charges.	$ 1,180	87	Indiana AAP for 155mm propelling charge bag mobilization requirements.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Reduce utility costs. Improve heating and production efficiency.	Approximately 50% reduction in fuel consumption in heat treatment operation. (Estimated savings of $71,000 (gas) and $119,000 (oil) annually.	Recovery of energy from rotary forging considered too costly to attempt. Recovery from heat treatment process is considered risky to implement because heat treatment process results could be negatively affected. Recommendations are still under review at Watervliet Arsenal.	Purpose of effort is energy conservation. Some savings, not measured, have been realized as a result of an observation made during the study. Preforms being purchased by Watervliet were apparently longer than needed resulting in extra energy use and additional scrap cost. We were told that specifications were changed so that smaller preforms are now purchased and some reduction in material costs has probably resulted.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
20. Automated loading of propellant flash reducers	ARRADCOM, Picantinny Arsenal, Dover, NJ. ICI Americas, Indiana AAP, Charlestown, IN.	Provide prototype equipment to automatically load flash reducers for propellant charges.	$ 1,180	87	Indiana AAP for 155mm propelling charge bag mobilization requirements.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Ten year discounted cost savings of $567,000 in production and $1.8 million in mobilization due to reduced honing time per tube. SIR: 5.4 (production) 17.2 (mobilization) ROI: 61.9 (production) 140.0 (mobilization) Reduced hone maintenance.	None.	Not technically successful.	

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
29. Conservation of critical materials for gun tubes	Benet Weapons Lab, Watervliet Arsenal, Watervliet, NY Contractor not identified by GAO.	Reduce the amount of critical alloying elements in gun tube materials.	$ 236	39	Rotary forging at Watervliet Arsenal.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Ten year discounted cost savings of $13.5 million in production and $22 million in mobilization. SIR: 68.4 (production) 111.11 (mobilization) ROI: 321.6 (production) 405.0 (mobilization) Savings of lead time to contract for and deliver the forgings.	Development of majority of processing parameters for forging 8 inch M201.	Watervliet reported to IBEA that implementation was not accomplished due to economic non-feasibility, in part, because 8 inch M201 tubes could not be fit into the production schedule at the Watervliet Arsenal.	It is questionnable whether objectives were achieved because the final technical report states that it was not determined that the integrated line heat treating equipment could handle a full size 8 inch M201 forging or if the system could produce the required mechanical properties. The demonstration was not possible because of production scheduling and equipment problems.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
28. Manufacturing processes energy conservation program	Benet Weapons Lab, Watervliet Arsenal, Watervliet, NY Battelle Columbus Laboratories Columbus, OH.	Analyze energy consumption and design energy recovery system for manufacturing facilities and processes at Watervliet Arsenal.	$ 104	39	All large caliber related components at Watervliet Arsenal.

Benefits Projected			
At project Initiation	At project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Cost savings of 40% on primary structures. ($8,000 per missile).	Not identified.	Technically unsuccessful.	

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
26. Rotary forging of 8 inch XM201.	Watervliet Arsenal, Watervliet, NY Various contractors, not identified by GAO.	To expand capability of the rotary forge integrated line to process the 8 inch XM201 tube.	$ 298	34	Cannon gun tube manufacture at Watervliet Arsenal.

Benefits Projected			
At Project Initiation	At Project Completion	Reasons(s) Project Results Not Impelemented	GAO Observations
Annual cost savings of $5.7 million over six years.	Not identified.	Not identified.	Implementation depends on response to technology transfer media since the company that carried out the project does not have production lines. The project engineer stated that the technology transfer prospectives are good since representatives from approximately 45 organizations attended the end-of-project demonstration including all propulsion contractors. Several attendees expressed a high level of interest.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
27. The elimination of facilitating honing operations.	Watervliet Arsenal, Watervliet, NY Various contractors not identified by GAO.	Develop boring heads and change the boring process to produce better tube finishes and eliminate honing operations.	$ 133	28	Cannon gun tube manufactured at Watervliet Arsenal.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Annual cost savings of $450,000. ($720,000 discounted total savings over six years).	Increased productivity of hybrid circuit testing.	Not identified.	

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
25. Internal shear forging of missile structures	Illinois Institute of Technology Research Institute, Chicago, IL Army Missile Command, Redstone Arsenal, AL	Investigate, evaluate and implement techniques for the manufacture of primary missile structures by the internal shear forging process.	$ 657	35	Pershing, Patriot, Improved Hawk, MLRS, and other weapons systems requiring cyclindrical primary structure sections.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Lower manufacturing costs an by estimated 40%. Higher production rate capability. Increased yield rate.	Not identified.	Continuation under another MT effort, Electronics Computer Aided Manufacturing (ECAM).	The study performed under this effort was an investigation of CAD/CAM application to the manufacture of hybrid microelectronics. Project personnel stated that the study could be considered as an initial phase which would ultimately result in factory floor application through the ECAM effort.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
24. Production processes for rotary roll forming	Battelle-Columbus Laboratories, Columbus, OH Army Missile Command, Redstone Arsenal, AL	Establish manufacturing processes for rotary roll forming to produce low cost solid propellant rocket motor components using commercial tubing.	$ 475	40	SRS, STINGER, VIPER, ROLAND and 2.75 but applicable to all weapon systems requiring such components.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Lower motor hardware costs. Improved component reliability. Increased production base.	Foam mandrels found to be less costly than reuseable tooling.	Prime system not yet targetted for application.	According to the project engineer there has been an application to the MLRS and there has been some use of the results in helicopter research.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
23. Digital fault isolation for hybrid microelectronic modules	Army Missile Command Redstone Arsenal, AL Hughes Aircraft Company Ground Systems Group, Fullerton, CA	Develop a manufacturing technology for employing the probe trace method for fault isolation in the production of hybrid microelectronic modules.	$ 300	21	All weapons systems using hybrid microelectronic modules

Benefits Projected		Benefits in Production			
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
$4.4 million annual cost savings due to personnel reduction. Reduced health and safety hazards.	Not identified.	Flash reducer for M119A2 propelling charge at Indiana AAP.	Cost reduction ($3.3 million discounted savings). Improved readiness. Ability to produce.	Based on unit cost savings applied to projected production through FY 1992.	One of a family of projects which apparently contributed to advanced scale control technology.

GAO Observations

Project objectives not totally accomplished but results were adapted by Indiana AAP for production use on M119A2 charge via an $83,000 Value Engineering effort. Cost savings appear to be overstated substantially. ARRADCOM reported 10 year discounted savings of $3.80 million in responding to IBEA's effectiveness survey which was published March 1983. IBEA adjusted the figure downward to $3.3 million apparently by additional discounting. Both figures were overstated. In June 1983, GAO was furnished a revised calculation which projected $2.3 discounted savings over 10 years based on a unit cost savings of $.60. Data obtained at the Indiana AAP suggests that unit cost savings are marginal basically because by the time the adopted equipment was implemented, the unit cost of manual production processes had decreased substantially, i.e., from about $.89 cents to $.42 a unit. Unit costs, by implementing the adapted equipment from this effort, decreased from $.61 cents in August 1982 to $.39 in June 1983. Savings would appear not to have been realized at all in that period and, in the long run, would seemingly be marginal compared with unit costs from annual operations immediately preceding implementation of the adapted equipment. This project is one of a family of ammunition projects in our selection directed toward automation of propellant bag load, assembly, and packout. According to responsible Army personnel one of the lessons learned from these projects is that MT efforts directed at overall automation of propellant bag loading operations should not be undertaken—automation of discrete steps in the process should be investigated as a building-block approach.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
22. Hybrid integrated computer assisted design (CAD) and manufacturing	Army Missile Command, Redstone Arsenal, AL	Produce a detailed plan containing a list of necessary projects, schedules, and funding levels required to achieve a fully computer integrated hybrid microelectronics manufacturing system.	$ 100	11	Hybrid microelectronics manufacturing.

Benefits Projected			Benefits in Production			
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Discounted 10 year cost savings of $29.6 million due to reduced rejection rate. SIR: 47.5 ROI: 50.2%.	Not identified.	Prototype equipment installed at Milan AAP has been used on production basis for loading the M456 projectile since October 1980.	Cost reduction of $25.7 million projected. Ability to produce. Improved product quality, reliability.	Not substantiated.	None.	

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
21. Methodology for producing low cost disposable mandrels	Army Missile Command, Redstone Arsenal, AL Thiokol Corporation, Huntsville Division, Huntsville, AL	Establish the manufacturing methodology for producing low cost, disposable mandrels for solid propellant rocket motors.	$ 437	53	Solid propellant missile systems including such current and future systems as SAM-D, ATI, CHAPARRAL, LRGM, GSRS and VIPER (I-LAW).

Benefits Projected		Benefits in Production				
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Not identified.	Not identified.	Implementation reportedly accomplished by application of results to all modernized plants for manufacturing explosives.	Safety/health improvement. Improved product quality/reliability. Improved readiness.	Data not available summarizing project results.	None.	This effort is one of several in our sample that are in the nature of safety engineering/product assurance intended to update regulatory data affecting design of facilities in support of the Army modernization program. The broad tasks under this effort were continued in follow-on MT efforts.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Applications
19. Automated equipment for assembly of M739 fuze.	Picatinny Arsenal, Dover, NJ. Honeywell Inc., Hopkins, MN.	Make available a prototype automated assembly, high-speed production line capable of producing 100,000 fuzes per month.	$ 1,365	46	M739 fuze production in support of artillery and mortar weapons systems.

Benefits Projected			Benefits in Production			
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Standardized product assurance methods and techniques. Maintenance of product reliability. Improved production efficiency. Higher production yields.	Not identified.	Not identified. Implementation occurred through execution of PBM Pamphlets 702-1 and 702-2.	Improved readiness. Improved manufacturing reliability/ availability. Improved product quality/ reliability.	Not determined.	None.	Effort was funded as "catch-up" quality assurance support of plant modernization projects scheduled for FY 1975 and earlier. Such support had not been provided due to a combination of lack of manpower and priority of effort. Effort tasks applicable to later year projects were to be accomplished using non-MT funds. Project personnel said that the effort was not true MT. Funding occurred simply because there was no other source of funds to accomplish the quality effort considered necessary for the facility projects. The effect on production is seemingly not susceptible to evaluation. Effects on production may not be as extensive as initially intended. Over 50 facility projects were to be addressed by this effort. According to project personnel, many may not now or ever have been in production status.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
18. Controlled production loading system for 105mm HEAT T-M456A1.	Picatinny Arsenal, Dover, NJ. Martin Marietta, Middletown, IA, Milan AAP, Milan, TN	Develop processes, techniques, and equipment for successfully loading the M456 projectile.	$ 843	29	Existing loading lines for 105mm HEAT T-M456A1 projectiles.

Benefits Projected		Benefits in Production				
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
TNT unit cost reduction due to savings in labor and raw materials. Increased personnel safety. Reduced environmental contamination. Increased production reliability.	Increased production rate. Fewer operators. Ease of operation. Improved yield. Improved safety.	TNT production at Volunteer AAP from December, 1974 until March 1977 when shut down due to lack of production require ments.	Cost reduction (not quantified). Ability to produce. Improved readiness.	Benefits were primarily qualitative. Cost savings seemingly realized but apparently not measured.	Similar production system reportedly installed and proven out at Joliet AAP but system not currently in use because there are no TNT production requirements.	

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
17. Safety engineering in support of ammunition plants	ARRADCOM, Dover, NJ. (Other sites not fully identified by GAO)	Develop new safety design criteria to be integrated into existing safety regulatory documents to permit construction of functional and safe munitions manufacturing facilities.	$ 4,981	90	All explosives and explosive-like hazardous materials, such as propellants and explosive end-items.

Benefits Projected		Benefits in Production				
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology	GAO Observations
Procurement of less costly, higher quality steel.	Not identified.	105mm (456 round and 489 training round) and 81mm (M374) mortar rounds.	Ability to produce. Lead time reduction. Improved readiness.		None.	The nature of the project was to facilitate the application of evolving technology in the private sector to Army end items through procurements in the future. Continuous casting was apparently growing in use in the private sector. In this project the Army evaluated the utility of and conditions for using the process to satisfy future procurements. Project resulted in changes to drawings for procurement of metal parts. Effects do not appear to have been validated by Army.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
16. Product assurance in support of ammunition plant modernization	ARRADCOM, Dover, NJ.	Provide quality engineering support for numerous plant modernization and expansion facility projects.	$ 353	39	Ammunition production.

Benefits Projected			Benefits in Production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Non-quantified cost reduction. Reduction in forging design lead time.	Not identified.	Not determined by GAO.	Improved manufacturing equipment reliability/ availability. Improved product quality/ relability.	Benefits appear to be presumptions since actual production application is not easily verified.	None.

GAO Observations

Military specification established to allow powder metallurgy forging of weapons components. However, evidence of procurements of such components forged with CAM techniques developed under this effort was not readily available. GAO's classification of this effort as implemented is tenuous. High volume production is required to make application of CAM powder metallurgy forging economically feasible. Such requirements may not exist. Suppliers may not be willing to make the costly investment to effect the results. Further the computerized powder metallury process reportedly does not offer potential for substantial savings over the current process to produce components. The current process has been in use since the subject effort was initiated.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
15. Computer control application to continuous TNT manufacture	ARRADCOM, Picatinny Arsenal, Dover, NJ. ICI Americas, Hercules, Inc., Radford AAP, Radford, VA.	To provide an advanced process control system for continuous TNT production.	$ 2,156	122	TNT production lines at Volunteer and Radford AAP's.

Benefits Projected			Benefits in production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Not identified.	Alternate source of supply at competitive rates and alleviation of pre-existing procurement problems.	M127 Gun Mount components at Rock Island Arsenal.	Ability to produce. Lead-time reduction. Sole source elimination.	No assessment of benefits identified.	None.

GAO Observations

Effort resulted in in-house capability considered necessary because of problems in procurement of castings such as non-responsive and unfairly priced bids. Problems apparently attributable to low requirements. Implementation occurred in 1976. According to project personnel there may have been cost benefits as a result of this effort but there was no effort to measure any such benefits and they may not be measurable.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
14. Feasibility of using continuous cast steel for ammunition metal parts manufacturing	ARRADCOM, Dover, NJ. Frankford Arsenal National Presto Industries, Inc.	Determine useability of continuous cast steel product for manufacture of munitions components.	$ 350	24	All munitions items made from steel.

Benefits Projected			Benefits in production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Estimated cost savings of $220,000 per year.	$95,000 cost reductions per year.	M198 recoil cylinders at Rock Island Arsenal.	Cost reduction (10 year discounted savings of $29 million for production and $880 million for mobilization).	Unit cost reduction applied to projected production at implementation.	None.

GAO Observations

Final technical report had not been prepared in 1983 although implementation occurred sometime ago.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
13. Computerized powder metallurgy forging design	Rock Island Arsenal, Rock Island, IL University of Pittsburgh, Pittsburgh, PA	Develop computer assisted manufacturing techniques to resolve powder metallurgy forging process design problems.	$ 202	40	M85 machine gun components.

Benefits Projected			Benefits in Production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Discounted ten year cost saving of $72 million for production and $19.3 million for mobilization. ROI: 100% SIR: 20.1 Reduced processing time. Improved surface quality.	Cost savings of $477 million for production and $3.4 million for mobilization due to reduced processing time.	Every chrome-plated cannon processed at Watervliet Arsenal.	Cost reduction (not quantified). Improved material.	See observations.	Project personnel indicated that the process is being used by the Navy.

GAO Observations

Based on data obtained at Watervliet Arsenal savings of $43,000 were realized in 1981 and 1982 for the production of 155mm, M185 and M199 gun tubes. This effort was similar to a Rock Island Arsenal effort. Watervliet's effort reportedly related to a different end item using a different size and type of steel requiring a different kind of cleaning solution.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
12. Determination and and certification of an "in-house" armor steel casting process	Rock Island Arsenal, Rock Island, IL Aberdeen Proving Ground, Aberdeen, MD	Obtain certification of an in-house armor steel casting process to resolve difficulties in procurement of armor steel castings.	$ 83	66	Casting of M127 Gun Mount components and other components at Rock Island Arsenal.

Benefits Projected			Benefits in Production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Discounted ten year cost savings of $313,000. SIR: 2.20 (production) 19.47 (mobilization) ROI: 28.7 (production) 148.8 (mobilization) Increased production and product quality. Reduced heat treating equipment and time.	Reduced process time and cost savings.	Results were implemented at Watervliet Arsenal in March 1978.	Cost savings ($1 million discounted ten year projection). Methods improvement.	See observations.	Project personnel said that that results were transferred to private industry and that firms supplying gun tubes have reduced heat treatment times.

GAO Observations

Data from Watervliet Arsenal indicates that cost savings realized in 1978, 1979, and 1980 totaled $280,000 in the production of 105mm, M68 and M185 gun tubes due to reduced heat treatment time based on a comparison between vendor and Watervliet Arsenal process times.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
11. Coolant-chip-ejector, multi-operation tooling	Rock Island Arsenal, Rock Island, IL	Procure, test, and evaluate new mechanisms for operations on in-house machine tools.	$ 65	34	Rock Island Arsenal on all current and future weapon systems including howitzers and helicopter armament systems.

Benefits Projected		Benefits in Production			
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Discounted ten year cost savings of $262,000 in production and $1 million in mobilization. ROI: 2.74 (production) 9.47 (mobilization) SIR: 36% (production) 83% (mobilization).	Reduced time for honing operation. (Standard time for 105MM M68 tube reduced by 1.1 hours.)	105mm M68 cannon tube at Watervliet Arsenal.	None reported.		None.

GAO Observations

Though not reported, project officials told GAO that savings totaling $206,000 may have been realized between fiscal 1980 and 1982 on cannon tubes due to reduced honing time attributed to this effect. The result was a change in standard honing time applicable to the 105mm M68 tube, effective January 1980. Modified equipment was apparently used until July 1982 and then taken out of production. In 1982, Watervliet reported the non-production status to IBEA. IBEA's effectiveness report of March 1983 reports project as not implemented because requirements changed. Project results have been reflected in the design of new honing equipment acquired under the REARM program. This "spin-off" value is not quantifiable according to Watervliet Arsenal personnel.

Examples of Manufacturing Technology Projects Implemented Since 1979

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
10.	Application of chemical processes to improve surface finish	Benet Weapons Lab, Watervliet Arsenal, Watervliet, NY	Replace mechanical surface finishing operations with an electrochemical finishing process.	$ 30	46	Cannon gun tube production at Watervliet Arsenal.

Benefits Projected			Benefits in Production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Discounted ten year savings of of $.2 million (production) and $5.6 million (mobilization) SIR: 18.8 (production) 16.9 (mobilization). ROI: 169.7 (production) 158.0 (mobilization). Reduced purchase requirements.	Not identified.	Implementation at Watervliet Arsenal in April, 1980 for production of 105mm, M68 cannon from recycled tubes. Implementation discontinued after several months because of 50% success rate.	Discounted cost savings of $716,000. Energy conservation. Improved readiness.	Projection based on use of recycled tubes to produce 80 M68 tubes a year.	Project personnel said that that results were transferred to private industry and that firms supplying gun tubes have reduced heat treatment times.

GAO Observations

Effort was concerned with raw materials for a production process rather than the production itself. Reimplementation may occur but minimal benefits appear to have been realized to date.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
9. Application of rapid heat treating to cannon tubes	Watevliet Arsenal, Watervliet, NY Other contractors not identified by GAO.	Apply new, shorter heat treatment process to the fabrication of large thick-wall gun tube forgings.	$ 189	34	Large thick-wall gun tube forgings at Watervliet Arsenal.

Benefits Projected			Benefits in Production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Improve products. Savings in replenishing, replacing, handling, and storage of fire-safe quenchant concentrates. Safer working environment. Reduce soil, ground and water pollution. Reduce oil usage.	Cost savings of $25,000 per year. Improve safety/health conditions. More uniform product hardness.	All ferrous components at Rock Island Arsenal.	Safety/health improvement. Improved product quality/reliability. Cost savings ($136,000 ten year discounted savings).	Not identified.	None.

GAO Observations

Commercially available synthetic quenchants were introduced into production process prior to MT effort. This effort was two-fold in purpose:

-to provide shop support relating to use of the quenchants, and

-to determine optimum heat treating practices.

Project personnel said that savings computation was not auditable and would have to be reconstructed. Savings estimate, they indicated, reflects avoidance of scrap costs due to misuse of the synthetic quenchants.

Examples of Manufacturing Technology Projects Implemented Since 1979

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
8.	Improvement of honing equipment and procedures.	Watervliet Arsenal, Watervliet, NY Ex-Cello Corp. Encore Electronics	Improve gun tube honing equipment and establish new honing procedures.	$ 178	51	All cannon gun tubes manufactured at Watervliet Arsenal.

Benefits Projected			Benefits in production		
At Project Initiation	At Project Completion	Actual Production Application	As Reported	Basis	Other Identified Uses of the Technology
Cost reduction. Increased reliability. Improved versatility of electronic subassemblies.	Cost savings of $2.9 million for 10,000 production quantity. (Reduced material costs yield).	Copperhead missile at Martin Marietta production facility.	Cost reduction. ($5.1 million discounted total savings). Improved reliability. The Army Missile Command projected $6.7 million discounted savings over 8 years on Copperhead due to updated requirements data.	Application of unit cost savings per final technical report to planned production.	Missile Command survey in 1983 identified technology used on: Navy Cruise Missile (estimated savings of more than $1 million over 8 years); PAM TIMER for the Harrier (estimated $30,000 annual savings for 5 years); Navy AIM 9 missile; and Army CHAPARRAL system. One contractor reported an estimated $10 million return from integration of Army MT results to supplement its development programs including $60,000 from this effort which apparently relates to the Peacekeeper missile system, Navy ASW system, and an Air Force anti-satellite system.

GAO Observations

Contractor officials could not provide data on benefits realized from the effort. They indicated that benefits were not susceptible to measurement because they had no basis for cost comparison. Further, significant production levels have not yet occurred. The contractor is experiencing higher production yield rates than projected at the end of this MT effort. This effort was executed by McDonnell-Douglas but was implemented by Martin Marietta. Martin Marietta and Army officials stated that implementation was facilitated greatly because of Martin Marietta's interaction with McDonnell-Douglas and monitoring of the work during execution of the effort. Martin Marietta officials stated that technology from this effort has or will be extended to Hellfire, TADS-PVNS, Lantirn, Pershing II and the Patriot systems.

Examples of Manufacturing Technology Projects Implemented Since 1979

	Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
7.	Recycling of scrap gun tubes by rotary forging	Watervliet Arsenal, Watervliet, NY Contractors not identified by GAO.	Rotary forge fired out or demilitarized gun tubes without intermediate remelting and casting.	$ 460	48	Cannon gun tube manufacture at Watervliet Arsenal.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$4.6 million cost savings annually due to reduction in personnel. ROI: 28% SIR: 2.1	Reduced labor costs. Increased quality and production rate. Improved safety. Greater mobilization requirements.	Requirements changed. Project was apparently not totally successful based on reassessment of equipment developed under the project.	Feasibility study may have been done under the effort. PBM personnel stated that there were no restrictions against feasibility studies during MT efforts in the early program years but they are not permitted now. Project was to support mobilization requirements. Current modernization program groundrules require economic justification on peacetime production requirements. The changed groundrules were apparently a factor in not continuing the effort.

Examples of Manufacturing Technology Projects Implemented Since 1979

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
6. Synthetic quenchants for heat treating weapon components.	Rock Island Arsenal, Rock Island, IL Marvalaud, Inc., Westminster, MD	Improve heat treatment of complex steel and aluminum alloy work pieces by use of improved quenchant materials.	$ 128	26	Rock Island Arsenal production of end-items that require rapid cooling from austenitizing or solution treatment procedures including M85, M219 machine, M140 gun mount, and M60 A2 tank components.

Benefits Projected			
At Project Initiation	At Project Completion	Reasons(s) Project Results Not Implemented	GAO Observations
Not specified.	Not specified.	Reportedly available for implementation which is dependent on GOCO plant acceptance of engineering study recommendations to correct process control deficiencies. One of the six plants to be specifically supported by this effort reportedly did purchase some recommended equipment using FY 83 funds other than MT, but production application not determined by GAO. According to project personnel the status of acceptance by the other plants is not known.	Results were recommendations of "off-the-shelf" equipment and instrumentation for use by six GOCO's. It is questionable, in our judgment, that a study of available equipment/instrumentation, while probably useful for the plants, fits the intent of the MT program.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
49. Rapid internal threading	Benet Weapons Lab, Watervliet Arsenal, Watervliet, NY Contractor not identified by GAO.	Develop equipment and tooling for producing internal threads in breech rings.	$ 430	35	Cannon production at Watervliet Arsenal.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Increased protection for personnel, equipment, and facilities. Monetary savings may result in certain instances but safer conditions are expected in all cases.	Not identified.	Project results reported to and by IBEA as available for implementation. (Hazard classification procedures have been reported for review, approval, and implementation into existing regulations. Regulatory implementation not yet accomplished at time of GAO review.)	Effort is in essence a safety engineering project. Safety in munitions production is obviously a primary concern and the results of this effort should probably flow through to production in the long run by affecting plant design. However, it is possible that alternate funding sources should have been used for this kind of effort.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
48. Automated bag loading, charge assembly and packout operations	ARRADCOM, Dover, NH. ICI Americas, Indiana AAP, Charlestown, IN. General American Research Corporation, Niles, IL.	Automate increment bag loading, sewing, propellant charge assembly and packout operations for base ignited propelling charges.	$ 4,400	104	8 inch and 155mm propelling charges.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$384,000 savings annually based on mobilization day requirements. $820,000 equipment cost savings under Iowa AAP expansion project.	Increased production rate. $900,000 reduced investment in equipment for mobilization requirements. $1.5 million reduction in peace time operating costs.	No current production application.	There were several other safety engineering efforts in support of the Army Modernization/ Expansion program, apparently not duplicative of this effort—several of the other efforts were MT. IBEA reports project in "implementation complete" category and benefits as cost reduction (not quantified), improved safety/ health, and improved product quality/ reliability. ARRADCOM reported $5.3 million discounted cost savings over 10 years at mobilization production rates. Basis not determined by GAO. IBEA apparently decided not to publish the savings figure.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
47. Improved instrumentation and control for acid plants	ARRADCOM, Dover, NJ.	Engineering study of available technology for use in process control of acid plants.	$ 157	13	All explosives and propellants requiring acid in their manufacture.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Cost effective alternatives to conventional construction on numerous modernization projects. (Cost benefits require case by case analysis.) Increased safety. Greater protection of environment.	Enhanced safety of munitions manufacturing facilities as result of new designs for safety shields applicable to new construction and modernization.	No current production application identified.	IBEA carries the project in the "implementation complete" category and describes benefits as safety/health improvement and manufacturing cost reduction (not quantified). Project application in current production seem doubtful because, according to project personnel, many facilities intended to benefit from the project are no longer being built or heavily utilized because of requirements changes, several facility projects were completed before safety shields were available, and project efforts toward two safety shields were discontinued because changes in modernization expansion plans negated the need for safety approval of the two shields. Although project results have not yet flowed through to production, cost benefits apparently have resulted. The Iowa AAP operating contractor has used a Value Engineering effort to incorporate suppressive shielding into a new facility based on designs developed in this effort. Cost avoidance—audited by DCAA— amounts to $3 million (Iowa AAP share is $458,000). The associate facility is scheduled for lay-away after prove-out. Also, shielding based on results of this effort has apparently been designed by the Corps of Engineers into a production line scheduled for lay-away at the Milan AAP.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
46. Hazards classification studies of propellants and explosives	ARRADCOM, Dover, NJ. Radford AAP, Radford, VA. Illinois Institute of Technology Research Institute, Chicago, IL National Space Technology Labs, St. Louis, MO.	Establish procedures for hazard classification of in-process materials involved in the manufacture and assembly of explosives and propellants.	$ 836	56	Resultant safety design technology to be used to upgrade safety regulatory bulletin TB-700-2 for performing system safety modernized facilities for manufacture or assembly of explosives, propellants, and ammunition end items.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$3.5 million annual savings due to elimination of personnel. ROI: 13.6 SIR: 1.20 Improved operational safety. Increased production reliability and uniformity.	Equipment integration into complete production system and obtainment of long-term reliability characteristics. Improved operations and inspection resulting in reduced manpower requirements. Improved operating controls.	Production facility not yet established.	Project is reported by IBEA in "implementation complete" category because results were incorporated into equipment specifications for production systems under an Indiana AAP facility project. That project is not yet complete and, when it is, it will in all probability be laid away for mobilization. Savings projected at initiation are based on mobilization. Project results were also to be replicated at two other AAP's but the facility plans have not been executed. Indiana AAP operating contractor personnel told GAO that the project did lead directly to cost avoidance of at least $433,000 for hardware because of the establishment of standardized controls that directly resulted from scale control technology developed in this effort. Other benefits are also attributed to standardized scale controls. Project technology has also apparently impacted the facility project although equipment now in place are subsequent generations.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
45. Multi-tooled Iowa detonator loader	ARRADCOM, Dover, NJ., Iowa AAP Middletown, IA.	Increase the output of the single-tooled Iowa detonator loader by developing a multi-tooled machine.	$ 641	39	Production of M55 detonators but to be adaptable to others. M55 detonator is used in various ammunition end items.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$3.1 million annual savings based on mobilization requirements. ROI: 51%. Improved operational safety. Increased production reliability.	$3.80 savings in personnel costs per charge.	Lack of technical success combined with requirements changes.	Project did not result in operational modules. Further debugging was performed at Crane AAP but equipment is being disposed of. Intent was to provide baseline data for procurement of equipment for a facility project at the Indiana AAP. Indiana AAP apparently applied some concepts from the project which has not yet been completed. Crane AAP reportedly gained technical knowledge through association with the project.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
44. Advanced technology for suppressive shielding of hazardous production and supply operations	ARRADCOM, Dover, NJ Other government agencies and contractors.	Design, fabricate, and test seven prototype safety shields for specific applications.	$ 6,874	84	Numerous production base modernization projects, at various installations supporting a broad spectrum of ammunition items.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
$3.9 million annual savings due to reduction in personnel.	Basis provided for future efforts to be undertaken to automatically produce three-dimensional propelling charge bags.	Unsuccessful effort.	Phase one of the effort was apparently a feasibility study.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
43. Operate prototype system for 105mm M67 propelling charges	ARRADCOM, Dover, NJ. ICI Americas,	Integrate individual loading equipment prototypes into a complete system capable of producing 900,000 charges per month.	$ 500	27	Indiana AAP facility for 105mm M67 propelling charges.

Benefits Projected			
At Project Initiation	At Project Completion	Reason(s) Project Results Not Implemented	GAO Observations
Insure safety, reliability, and performance levels of end items using black powder produced by a different process.	$264,000 per year of mobilization due to reduced testing.	Scope of work not completed. Test device installed at Indiana AAP but testing not completed.	Effort was "erroneously closed-out" in 1981 and re-opened in 1983 to complete the scope of work at additional cost of $94,000. Effort supports a facility project to establish the first Army black powder production facility at the Indiana AAP. The facility will be laid away for mobilization.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
42. Automated increment loading and assembly of propellant charges with center core igniters.	ARRADCOM, Dover, NJ. Crane Army Ammunition Activity, Crane, IN. Indiana AAP, Charlestown, IN. MRC Corp. Hunt Valley, MD	Automate load, assembly, and packout production operations.	$ 3,402	95	Mobilization requirements for propelling charges with center core ingiters including 155mm and 8 inch charges. Results to be incorporated into facility project at Indiana AAP.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
50. Computer integrated manufacturing (CIM) for cannon	Watervliet Arsenal Watervliet, NY Contractor not identified by GAO.	Implement a pilot distributed numerical control system to increase efficiency of numerical control operations. Pilot system is intended as "test-bed" for exploitation of CAD/CAM technologies and for technology transfer to CIM facility for cannon production.	$ 430	35	Cannon production at Watervliet Arsenal.

Examples of Manufacturing Technology Projects Completed Since 1979 But Not Implemented

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
41. Modernization and automation of propelling bag manufacturing and process control operations	ARRADCOM, Dover, NJ Indiana AAP, Charlestown, IN IITRI, Chicago, IL ZIA Associates, Boulder, CO	Provide prototype equipment to automatically manufacture propellant bags and to inspect cloth and printing on bags.	$ 1,420	106	Indiana AAP facility project supporting production of propelling charges. (81mm, 105mm, 155mm, 8-inch and 175m).

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
52. Hot isostatic pressing (HIP) of large components	Watervliet Arsenal, Watervliet, NY Contractors not identified by GAO.	Establish production technique for using HIP process to fabricate large weapon components.	$ 506	36	Watervliet Arsenal for purchase of components based upon revised technical data package. Primary intended components are breech blocks for 8 inch and 155mm cannons.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
Ten year discounted cost savings of $740,000 in production; $790,000 in mobilization. SIR: 2.42 (production) 2.58 (mobilization). ROI: 100% (production and mobilization).		Project is intended to address problems which caused production use of results of a prior, related MT effort to be discontinued.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
51. Application of low-cost mandrels	Benet Weapons Lab, Watervliet Arsenal, Watervliet, NY Contractors not identified by GAO.	Develop method to produce hybrid mandrels for use in swaging cannon barrels.	$ 168	20	Watervliet Arsenal for production of cannons for combat tanks and howitzers.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
Increase: numerical machine control tool utilization by 10-20%; programmer efficiency by 20-40%; and production by 10-20%. Reduce: scrap and rework by 10-20%); numerical machine tool maintenance by 10-20%; and future numerical control machine acquisition cost by 10-20%.		Project will interface directly with results of three other MT CAD/CAM efforts.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
53. Manufacturing guide for elastomeric seals	Rock Island Arsenal, Rock Island, IL Contractors not identified by GAO.	Elimination of sole-source procurement by documenting processing techniques and formula variations for publication into guide for use by industry.	$ 123	13	Manufacturing guide to be used by Rock Island Arsenal for production and by other installations requiring purchase of non-metallic seals.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
Ten year discounted cost savings of $536,000 in peacetime production and $2.7 million in mobilization SIR: 4.05 (production) 60.41 (mobilization) ROI: 20.2% (production) 100% (mobilization) A significant reduction in need for cobalt.		Total savings may not reach expectations because of unstable production quantities. Project personnel indicated that unit cost savings may be greater than at the project's start because mandrels in production use are now more costly.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
54. In-process control of machining	Rock Island Arsenal, Rock Island, IL Contractor not identified by GAO.	Establish improved manufacturing methods of inprocess gauging and machining control.	$1,445	34	Rock Island Arsenal production of hydraulic recoil mechanisms for M174 and M178 gun mounts and M45, M2A5, and M37A1 recoil mechanisms.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
$233,000 annual cost savings. Conservation of critical alloying elements and energy.		Other efforts, possibly not MT, by other organizations relating to HIP were identified at project initiation but were not considered applicable to this effort which was proposed as unique in addressing the use of HIP for large components composed of low alloys.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
55. Boring breech ring lugs.	Benet Weapons Lab, Watervliet Arsenal, Watervliet, NY	To use ejector drilling and indexable carbide insert hole drilling technology to bore breech ring lug holes.	$ 200	22	Cannon tube manufacture at Watervliet Arsenal.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
Estimated minimum price reduction of 25% due to competitive procurement. Possibly improved seals with extended use life allowing for less maintenance and increased shelf/storage life.	Project does not establish new or improved technology but will provide process data not otherwise available.	Project results reportedly will also be used in production at Rock Island Arsenal.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
56. Portable engraving system.	Benet Weapons Lab, Watervliet Arsenal, Watervliet, NY	Design and fabricate a portable programmable data engraving system which will mark and identify cannon tubes and breech ring faces.	$ 255	36	All large cannon components at Watervliet Arsenal.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
$435,000 annual cost savings. SIR: 2.17 ROI: 17%		Scheduled completion will apparently slip.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Project Duration (in months)	Intended Production Application
57. High speed abrasive benet grinding	Benet Weapons Lab, Watervliet Arsenal, Watervliet, NY	Develop a new machine with a capacity to drive a wide abrasive belt for metal removal on gun tube hoop zones.	$ 464	48	Cannon gun tube manufacture at Watervliet Arsenal.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
Ten year discounted cost savings of $487,000 (production) and $973,000(mobilization) due to reduction in machining time. SIR: 2.36 (production) 4.17 (mobilization) ROI: 100% (production and mobilization) Reduced tool grinding and inventory cost.		Economic justification in large part apparently based on 8 inch M201 tube. Justification may not be currently valid because of change in requirements for that item. Project efforts redirected after discovery that the originally proposed ejector drilling technique was unsuccessful.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
58. TNT crystallizer for large caliber munitions	ARRADCOM, Dover, NJ Automated Systems, Arlington, TN Iowa AAP, Middletown, IA	Develop a remote controlled continuous TNT crystallizer system for processing a "slurry" of molten TNT containing up to fifty per cent solids.	$1,227	64	Items in or scheduled for production using TNT explosives including 8 inch and 155mm projectiles.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
Discounted cost savings over ten years of $195,000 (production and $1.2 million (mobilization). SIR: 1.20 (production) 7.05 (mobilization ROI: 13% (production) 53% (mobilization) (Due to labor cost reduction of 75%.) Elimination of a safety hazard. Increase in product quality.		Results, we were told, will also have application at the Naval Ordinance Station for the 5 inch gun tube.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
59. Manufacture of precision cones for HEAT projectiles	ARRADCOM, Dover, NJ AVCO Systems Division Wilmington, MA Milan AAP, Milan, TN	Establish production process and equipment parameters for manufacture of precision cones for HEAT projectiles.	$1,647	Not identified.	Future 105mm and 120mm HEAT shaped charge liners.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
$89,000 annual cost for products due to reduction in machining time. SIR: 1.49 (production) 1.76 (mobilization ROI: 15.0% (production) 17.86 (mobilization) Introduction of new technology to Watervliet Arsenal.	Question exists whether this is a capital investment project. Project tasks are essentially to prepare equipment specifications; procure, install, and test the equipment; prove the equipment out in production, and then implement the equipment in production at Watervliet Arsenal.	

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
60. Nondestructive test equipment for large caliber munitions	ARRADCOM, Dover, NJ Mason Chamberlain, Inc., Mississippi AAP, Picayune, MI	Provide for design and fabrication of a prototype automatic magnetic flux leakage inspection system to detect all flaws in projectile bodies.	$ 680	Not identified.	Production line for M483A1, 155mm projectile.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
$654,000 annual savings per line. Increased know-how and experience. Significant safety improvement due to less personnel exposure and elimination of human judgment.		Effort is intended to replace labor intensive batch processing. Effort is intended to utilize results of Iowa AAP program in 1950's which was terminated due to technical problems. There is interrelationship with other projects several of which are MT but other projects reportedly not duplicative.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
61. Disposal of final sludge From acid recovery operations	ARRADCOM, Dover, NJ Holston Defense Corp. Holston AAP, Kingsport, TN	Determine process to dispose of final sludge from acid recovery operation, recover ammonium nitrate for resale, and abate pollution.	$1,364	Not identified.	All items containing RDX/HMX and composition explosives thereof.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
No projection.		Original effort intent has changed. Candidate production processes apparently were to be compared and one would be selected for detailed evaluation and optimization. A contract could not be satisfactorily negotiated relating to one of the processes. Effort was redirected toward shear forming.

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
62. Automated lacing of jackets for center core charges	Picatinny Arsenal, Dover, NJ, ICI Americas, Indiana AAP, Charlestown, IN	Automate the assembly of jackets for the 155mm and 8 inch center core propelling charges.	$ 612	24	155mm and 8 inch propelling charges.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
$144,000 annual savings. ROI: 33% SIR: 2.69		

Examples of New Manufacturing Technology Projects Started During Fiscal Years 1980-82

Project Title	Project Site(s)	Project Purpose	Project Total Cost (in 000)	Scheduled Project Duration (in months)	Intended Production Application
63. Infrared monitoring of pyrotechnical blending	Picatinny Arsenal, Dover, NJ Hercules, Inc., Radford AAP, Radford, VA	Provide for the use of thermographic equipment to monitor pyrotechnic blending operations and prevent fires.	$ 250	24	All pyrotechnic items requiring blending operations.

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
$524,000 annual savings. ROI: 34% SIR: 2.94	Basic nature of project is to eliminate pollution caused by residual solutions from the HMX/RDX production process. Project seems questionable because the problem being addressed is the result of a production process. The process itself seems not be be addressed.	Effort is one of several (not all MT) addressing the disposal of pollution-causing by-products of production at the Holston AAP. A preceding MT effort included an evaluation of possible alternatives for dealing with acid plant sludge. This effort is intended to develop one of the alternatives.

Air Force Notes

1. Project sites, unless otherwise stated, refer to the prime contractor only. Subcontractors for the project are not listed.

2. The project duration is from the date the MT project contract was awarded to the publication of the final technical report.

3. No reported benefits for Air Force projects are listed because the Air Force does not have a formal reporting system.

4. Projects 3, 14, 18, 34, 35 and 40 are part of an Air Force effort to automate the production of composite structures. Northop and Grumman Corporations were awarded 3 contracts and General Dynamics Corporation was awarded 2 contracts to address different aspects of the production process. The first 3 contracts were awarded in 1977 and each company established one computer-controlled machine that addressed one part of the composite lay-up process. The ensuing contracts built on the first. Each company has used different approaches and solves somewhat different problems. These projects are to result in establishing fully integrated, automated composite facilities.

Navy Notes

1. Project duration is from the date the MT project contract was awarded to the date of the end-of-project demonstration. The final technical report had not necessarily been completed.

2. Reported benefits are based on information gathered by the Naval Material Command.

Army Notes

1. Project duration is from the date MT funds were received in the first proejct year to the last project execution month identified in the final project status report.

2. Army Abbreviations: SIR = Savings-to-Investment Ratio; ROI = Return on Investment; GOCO = Government-owned, Contractor-operated; AAP = Army aummunition plant

Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
$480,000 annual cost savings. Reduced personnel hazards.	Feasibility apparently had not been demonstrated.	Effort was funded although IBEA questioned its risky nature. Effort was terminated after one and a half years on the basis that its objective was determined not to be feasible. Also a requirements change resulted in little demand for the intended application.

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Benefits Projected At Project Initiation	GAO Observations On Whether Project Meets MT Program Criteria	Other GAO Observations
Increased personnel safety and equipment security. Better end product.	Because this project is apparently looking to adapt proven equipment for a new application, it is uncertain if criteria regarding prohibition of feasibility studies and intent to establish new or improved technology are met.	The effort is part of a Safety Enhancement Program initiated as a result of fatalities within the preceding year during pyrotechnic operations.