Small Business Manufacturing:
An Important Component of the U.S. Defense Industrial Base

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This article reviews the small- and medium-sized manufacturing business sector's contribution to the U.S. defense industrial base, the state of adoption of modern process technology in small- and medium-sized manufacturing in five industry groups. It reviews the National Institute of Standards and Technology (NIST) Manufacturing Technology Program and its performance evaluation processes, and recommends features of future Department of Defense manufacturing improvement programs.

CHALLENGES IN THE U.S. DEFENSE INDUSTRIAL BASE

The end of the Cold War has caused profound global political and economic changes. The resulting downsizing and restructuring of global defense industries has left U.S. strategic planners with the difficult task of fostering the vitality of the surviving defense technology industrial base.

The defense technology industrial base is that alliance of people, institutions, technological know-how, and facilities used to design, develop, manufacture, and maintain the weapons and supporting defense equipment needed to meet national security objectives. This base consists of three broad components: a research and development component, a production component and a maintenance component, each with private and public sector employees and facilities (OTA, 1991). The pri-

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vate sector consists of the major defense contractors and their suppliers, which includes small business manufacturers.

United States defense companies, both large and small, have implemented different strategies to adjust to the shrinking market. These strategies include commercialization of defense technologies, restructuring, consolidation, or even abandonment of the defense business. Additionally, there is intense competition between government and industry for their *proper* share of the remaining research and development and depot work. When this process of government and private downsizing reaches dynamic equilibrium, it is crucial to U.S. security that the resulting defense industrial base be viable and capable of meeting future, evolving defense needs. One certain outcome will be increased dependence of the defense sector on the commercial base for both production capacity and technology advancements, particularly for common components where a strong commercial market exists.

THE COMMERCIAL INDUSTRIAL BASE

One aspect of the increased integration of the industrial bases is the undeniable reality that a strong and competitive commercial industrial base is vital to our national economic and security interests.

However, all is not well in the commercial sector. The United States is experiencing greater competition in both foreign and domestic markets for all products. American consumers increasingly demand quality products of world class design that incorporate timely innovations and are supported by easily accessible, comprehensive customer service. These demands are often met by more responsive foreign suppliers.

One consequence of global competition is that there is a growing U.S. commercial reliance on foreign sources for goods and services including those of high technology. Although U.S. science and technology remains world class, our industry has been unable to exploit many commercial possibilities of new technologies, e.g., consumer electronics, fax machines, and the copying machine industries. As markets are lost, America loses manufacturing jobs, industrial capabilities, sources of export income and opportunities to expand its future technological frontiers. Without changes in the way government and business operate, this declining cycle is expected to continue.

GOVERNMENT'S ROLE IN PROMOTING TECHNOLOGY

There is general political acceptance that one role for government is to provide policies and programs, when needed, that improve the operation of the private sector. A number of Department of Defense (DoD) programs are structured to improve manufacturing efficiency and competitiveness of

the defense industrial base.

One successful program is the DoD manufacturing technology program, or MANTECH, which focuses on improvements to manufacturing technologies that support defense needs. The MANTECH is credited with improvements in the manufacture of composite materials, in shipbuilding technology, and in turbine engine repair. It was funded at $297 million for FY 1993.

The latest DoD program is the Advanced Research Projects Agency (ARPA)-managed technology reinvestment program, whose objectives are to facilitate diversification and deployment of defense technologies to commercial processes and products. The National Defense Authorization Act for FY 1993, PL 102-396, directed to the issues of national defense technology and industrial base. It authorized $694 million for FY 1993.

In downsizing the defense industrial base, one should not overlook the need to improve the manufacturing capabilities and commercial competitiveness of small business manufacturers as future sources of defense hardware components. However, no defense program is directed specifically to needed improvements in the competitiveness of the small business manufacturing sector of the defense industrial base. One nondefense approach to improve the competitiveness and productivity of small business is the National Institute of Standards and Technology's (NIST) Manufacturing Technology Program with FY 1993 funding of $15.7 million. The NIST program provides a useful model for industry-government cooperation in improving the competitiveness of the small business manufacturing sector of the industrial base.

WHY SMALL BUSINESS MANUFACTURING IS IMPORTANT SMALL BUSINESS

The share of the Gross Domestic Product (GDP) belonging to the manufacturing sector is nearly 19 percent, sharing with the service sector as the leading sectors of the GDP (Bureau of Census, 1992). Small firms represent a sizable portion of US manufacturing. Small- and medium-sized firms (those below 500 employees) account for 35 percent of the manufacturing work force (Census, 1992). In some important industries the small business contribution is larger.

Employment growth in the small business sector is strong. The Small Business Administration reports that for the period 1988 to 1990 job growth for all small business was 3.1 million, while jobs in large business decreased by .5 million. In the manufacturing sector the total loss of nearly 1 million jobs was confined to big business while in the same period the number of jobs in small manufacturing businesses showed a slight increase (SBA, 1992).

SMALL BUSINESS IN THE DEPARTMENT OF DEFENSE

Surprisingly, small business provides 40-50 percent of the dollar value of DoD procurement. Table 1 shows that in DoD more than 20 percent of the prime contract dollars goes to small business. Table 2 shows that of the remaining 80 percent that does not go directly to small business, 34 percent of that dollar value is subcontracted to small business.

Table 1.
DEPARTMENT OF DEFENSE PRIMARY CONTRACT AWARDS FOR FISCAL YEAR 1992 CATEGORIZED BY TOTAL BUSINESS AND SMALL BUSINESS FOR THE TOTAL DEPARTMENT AND FOR THE SERVICES (OSD, 1992)

CATEGORY	ALL BUSINESS ($ Billion)	SMALL BUSINESS ($ Billion)	PERCENT SMALL BUSINESS
TOTAL	117.2	24.0	20.8
ARMY	25.3	6.1	24.2
NAVY	38.2	7.6	20.0
AIR FORCE	33.7	4.7	13.8
DEFENSE LOGISTICS AGENCY	7.3	3.0	40.6
OTHER DEFENSE AGENCIES	9.9	1.6	15.9
CIVIL FUNCTIONS	2.7	1.0	38.3

Table 2.
SMALL BUSINESS SCORE CARD, PERCENT OF ALL SUBCONTRACTING DOLLARS AWARDED TO SMALL BUSINESSES BY LARGE DEFENSE CONTRACTORS, FISCAL 1991 (PEARLSTEIN, 1992)

Company	Percent Small Business	Company	Percent Small Business
Boeing	10.2	Martin Marietta	21.4
General Dynamics	38.4	McDonnell Douglas	15.8
General Electric	38.9	Northrup	12.5
Grumman	30.0	Raytheon	51.8
Hughes Aircraft	42.9	TRW	37.2
Lockheed	3.9	United Technologies	46.1

Large Defense Contractor Average 34.0

THE STATE OF PROCEESS AUTOMATION IN U.S. INDUSTRY: BUREAU OF CENSUS FINDINGS

The 1990 report of the Massachusetts Institute of Technology (MIT) Commission on Industrial Productivity observes that, overall, U.S. business has been slow at adapting appropriate process technologies that are required to remain competitive in global markets (Dertouzos, et al.,1992). This is even more evident for small business.

In a 1988 Bureau of Census survey of manufacturing process capabilities, nearly 10,000 companies with more than 20 employees were reviewed. The survey covered the use of 17 available manufacturing process technologies in 5 basic manufacturing industries. This survey is an indicator, although imperfect, of overall industry modernization.

The five industries reviewed in this survey are identified by the standard industry classification (SIC) two digit codes. They are: 34 Fabricated Metal Products, 35 Industrial Machinery and Equipment, 36 Electronic and Other Electrical Equipment, 37 Transportation Equipment and 38 Instruments and Related Products.

Table 3 summarizes the results. Surprisingly, nearly 24 percent of the companies surveyed used none of the 17 process technologies. Technology use varied among industries. For example, computer use on the factory floor, an indicator of computer integrated manufacturing, ranged from a low of 21 percent for Fabricated Metal Products, (SIC 34), to a high of 35 percent in Industrial Machinery, (SIC 36). Guided vehicle systems exhibited the lowest use in all five industries, perhaps indicating that this is either an inappropriate technology for these industries or one that is not cost effective.

Table 4 shows that the degree of adoption of process technology strongly increases with plant size. In addition to utility, one consideration affecting technology acceptance is its relative affordability, which increases with capitalization and plant size. Clearly, the decision to invest $100,000 in new technology has a greater impact on the survival of a small business than it does on a larger business.

Nearly one-third of the Fabricated Metal Products (SIC 34) plants used none of the technologies, which is the lowest adoption rate of the five industries. As shown later, this industry (SIC 34) has also the highest fraction of small plants.

Table 3.
INDUSTRY USE OF PROCESS TECHNOLOGY BY TWO-DIGIT INDUSTRY CODE

Design & Engineering	**34**	**35**	**36**	**37**	**38**	**Ave**
Computer Aided Design	26.8	43.2	48.5	39.9	48.9	39.0
CAD controlled machines	13.1	21.6	16.0	16.6	14.6	16.9
Digital CAD	6.5	11.0	12.8	10.0	12.5	9.9
Flexible Machining & Assembly						
Flexible Mfg Systems	9.0	11.0	11.9	12.6	10.8	10.7
NC/CNC Machines	32.2	56.7	34.9	37.3	33.6	41.4
Materials working Lasers	2.9	3.6	7.5	6.0	4.3	4.3
Pick/Place Robots	5.7	5.8	13.1	10.4	8.6	7.7
Other Robots	4.4	5.2	6.9	10.5	4.4	5.7
Automated Material Handling						
Automatic Storage/ Retrieval Systems	1.0	3.6	4.9	4.7	4.2	3.7
Guided Vehicle Systems	0.8	1.7	1.8	3.3	1.3	1.5
Automated Sensor Based Inspection						
Materials Receiving	6.7	8.5	16.2	12.7	12.2	10.0
Final Product	8.3	9.9	22.2	14.4	15.4	12.5
Communication & Control						
LAN for Tech Data	13.4	18.5	24.9	22.0	25.8	18.9
Factory LAN	11.6	16.3	21.1	18.7	21.3	16.2
Intercompany Computer Network	14.9	12.4	16.2	21.7	13.8	14.8
Programmable Controllers	26.8	33.9	38.0	32.0	32.7	32.1
Computer Used on Factory Floor	21.1	28.1	34.5	27.4	32.3	27.3

Note: The report did not prorate nonresponses.

Table 4.
USE OF TECHNOLOGIES BY INDUSTRY GROUP AND PLANT SIZE

Technologies Used	None	At Least 1	5 or More
Employment Size			
20 to 99	30.5	60.9	13.2
100 to 499	10.1	83.2	27.4
500 and over	1.5	93.7	79.4
SIC Major Industry			
34 Fabricated Metal Products	32.6	58.6	17.0
35 Industrial Machinery	18.1	75.6	23.1
36 Electronic Equipment	17.1	73.4	30.1
37 Transportation Equipment	28.2	62.7	28.7
38 Instruments	21.3	72.3	25.8

Note: The reference survey did not prorate nonresponses.

Table 5.
A SUMMARY OF BUSINESS STATISTICS FOR THE FIVE INDUSTRY GROUPS (CENSUS BUREAU, 1987)

SIC	34	35	36	37	38
			Total Industry Data		
Companies	31,181	47,465	12,818	8,727	8,407
Employees (Thousands)	1,363.7	2,101.7	1,630.0	3,081.8	1,389.9
Payroll ($ Billions)	31.7	60.8	40.6	101.6	40.3
Sales ($ Billions)	130.0	207.7	153.2	459.2	135.7
			Industry Data for Companies with 500 employees or less		
Companies	30,916	46,748	12,505	8,527	8,225
Employees (Thousands)	806.9	869.9	462.1	244.4	229.6
Payroll ($ Billions)	17.4	21.3	8.9	5.1	5.4
Sales ($ Billions)	70.8	71.7	34.3	22.3	19.3
			Percent of Industry with 500 employees or less		
Companies	99.2	99.2	97.6	97.7	97.8
Employees	59.2	41.4	26.1	7.9	16.5
Payroll	55.0	35.0	21.9	5.0	13.5
Sales	54.5	34.5	22.4	4.9	14.2

Note: Total industry data is projected from the survey sample.

Table 5 shows that in each industry, companies with 500 employees or less account for more than 97 percent of the plants. The small business share of total industry varies greatly among the five industries. However, in the Transportation Equipment industry (SIC 37), which includes both automotive and aircraft manufacture, small business suppliers account for only 4.9 percent of the sales with 7.9 percent of the employment. In Fabricated Metal Products (SIC 34), small business represents the largest percent of the sales and employment, 54.5 percent and 59.2 percent respectively.

Table 6 is a summary analysis of census data providing a macro look

at measures of change in average productivity with factory size. There are two productivity measures: sales per employee and payroll per employee. Average sales per employee varies among industries, representing, in part, industry differences in the portion of purchased material used in their final products.

Table 6.
A SUMMARY OF AVERAGE PRODUCTIVITY MEASURES FOR THE FIVE INDUSTRIES OVER THE RANGE OF PLANT SIZES

Number of Employees	34	35	36	37	38
		$ Sales/Employee			
1 to 49	80,439	70,088	77,496	87,425	80,091
50 to 99	85,754	85,796	76,365	88,576	83,049
100 to 249	95,247	94,703	79,339	96,891	89,375
250 to 499	98,886	103,580	90,147	92,661	84,686
500 & over	106,322	110,372	98,744	153,957	100,284
Average	95,349	98,817	93,997	148,997	97,616
		$ Payroll/Employee			
1 to 49	20,395	22,769	20,198	19,723	22,870
50 to 99	22,369	25,929	21,050	20,889	23,161
100 to 249	22,539	25,941	20,537	21,753	24,059
250 to 499	23,320	26,297	22,085	21,593	24,627
500 & over	25,610	32,131	26,348	33,997	30,095
Average	23,232	28,950	24,917	32,960	29,029

Review of Table 6 shows two features of interest: (1) productivity, using either measure, increases with plant size and (2) the most technology rich industry, Transportation Equipment (SIC 37), shows the highest average salary, while the least technology-adopting industry, Fabricated Metal Products, (SIC 34), shows the lowest average salary.

In the 1988 survey, more than over 42 percent of the responding companies reported that they did business with the defense sector. The reported use of the process technologies was higher for these companies than for the total, with 82 percent reporting using at least one technology, versus 76 percent for the whole sample.

Table 7 shows this trend at the process technology level. Companies that identify the government as their major customer have higher tech-

nology adoption rates than those companies supplying either the consumer or commercial sectors. One may conjecture whether the DoD acquisition requirements and processes fosters the growth of higher technology companies, or whether only those companies that have the assets to acquire technology have the capability of also dealing with DoD or its prime contractors.

Table 7.
PERCENT USE OF SELECTED TECHNOLOGIES BY MARKET FOR MOST PRODUCTS (DEPT. OF COMMERCE, 1988)

	Consumer	Commercial	Government	Average
Design & Engineering				
Computer Aided Design	27.6	49.1	**57.0**	39.0
CAD controlled machines	9.7	19.3	**30.1**	16.9
Digital CAD	8.8	13.2	**17.8**	9.9
Flexible Machining & Assembly				
Flexible Manufacturing Systems	11.8	13.8	**12.7**	10.7
NC/CNC Machines	23.9	41.7	**62.0**	41.4
Materials Working Lasers	3.6	5.2	**10.4**	4.3
Pick Place Robots	12.5	8.7	**10.1**	7.7
Other Robots	7.3	5.7	**8.4**	5.7
Automated Material Handling				
Automated Storage/ Retrieval Systems	2.7	4.5	**5.9**	3.2
Guided Vehicle Systems	1.9	2.0	**2.0**	1.5
Automated Sensor Based Receiving Inspection	10.2	11.5	**19.2**	10.0
Automated Sensor Based Final Inspection	11.0	14.4	**23.0**	12.5
Communication & Control				
LAN for Tech Data	16.1	24.4	**28.8**	18.9
Factory LAN	17.2	22.0	**22.8**	16.2
Intercompany Computer Network	17.5	16.4	**13.9**	14.8
Programmable Controllers	34.5	34.3	**39.4**	32.1
Computer Used on Factory Floor	27.1	33.0	**41.0**	27.3

SUMMARY
Nearly 50 percent of DoD procurement is with small business. Companies with 500 employees or less are a major component of commercial manufacturing plant and sales. For the five manufacturing industries reviewed, businesses with less than 500 employees represent over 97 percent of the companies and over $215 billion in total sales.

On the average these businesses are less productive, with average productivity decreasing with decreasing plant size. These companies are also less modern, as measured in the rate of adaption of modern process technologies.

Companies that report doing business with either DoD or government indicate a higher use of process technologies than do the average companies. The reason for this effect is open to conjecture.

All government and DoD initiatives to improve U.S. manufacturing productivity and competitiveness should include the needs of the important small- and medium-sized manufacturing sector.

NIST PROGRAM – MANUFACTURING TECHNOLOGY CENTERS

Manufacturing Technology Centers: The Concept and its Legislation

One successful government program to improve the efficiency and competitiveness of small manufacturing businesses was the establishment of regional manufacturing technology centers by the Japanese government following World War II. These centers provided small businesses with technical support on a range of manufacturing problems. The concept gained wide acceptance and today there are over 170 centers throughout Japan.

A prototype manufacturing technology center program was begun here under the Omnibus Trade Act of 1988. Title V, Subtitle B, Part I of Public Law 100-418, of this Act is known as the "Technology Competitiveness Act." It authorizes the Director of the National Institute for Standards and Technology (NIST) to provide assistance in the creation and support of Regional Centers for the Transfer of Manufacturing Technology. These Centers are affiliated with non-profit organizations. The objectives of the Centers are to enhance productivity and technological performance in U.S. manufacturing through:

(1) the transfer of manufacturing technology and techniques developed in the Institute to the Center and, through them, to manufacturing companies throughout the United States;

(2) the participation of individuals from industry, universities, state governments, other federal agents, and, when appropriate, the

Institute in cooperative technology transfer activities;

(3) efforts to make new manufacturing technology and processes usable by the United States-based small- and medium-sized companies;

(4) the active dissemination of scientific, engineering, technical, and management information about manufacturing to in industrial firms, including small- and medium-sized manufacturing companies; and,

(5) the utilization, when appropriate, of the expertise and capability that exists in Federal laboratories other than the Institute.

Center activities include:

(1) the establishment of automated manufacturing systems and other advanced production technologies, based on research by the Institute, for the purpose of demonstrations and technology transfer;

(2) the active transfer and dissemination of research findings and Center expertise to a wide range of companies and enterprises, particularly small- and medium-sized manufacturers; and,

(3) loans, on a selective, short-term basis, of advanced manufacturing equipment to small manufacturing firms with less than 100 employees.

The Secretary of Commerce is authorized to fund a Center for up to six years. For the first three years federal funding is at level not to exceed either $3 million or 50 percent of the Center's capital, operating and maintenance requirements. The Center and its sponsor provide the remaining support. During the third year, the Act requires that an independent review board assess each Center's performance against the objectives of the Act. If the evaluation is positive, the Secretary may continue funding at declining levels through the sixth year. At year seven, each Center will be self supporting.

Manufacturing Technology Center Program Implementation

There are currently seven Manufacturing Technology Centers. The Centers serve client needs that are unique to their particular regions. They

provide services such as in-depth assessments of client business operations, aid in selecting and implementing new technologies, technical service, project work and training.

Each Center is required to report quarterly on its accomplishments, program and personnel changes, marketing, budgets, and general program information. Center accomplishments include technology transfer, training, demonstrations, projects involving industry/user collaborations, patents and inventions, publications and presentations, and equipment and facility acquisitions. Program information includes an evaluation of the economic benefits realized by the industrial clients. The Centers are listed in Table 8.

Table 8.
THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY MANUFACTURING TECHNOLOGY CENTERS

Center	Location	Founded	Region Served	Major SIC
Northeast Manufacturing Technology Center	Troy, New York	1989	New York, Massachusetts, Pennsylvania, and Maine	34XX 35XX
Great Lakes Manufacturing Technology Center	Cleveland, Ohio	1989	Ohio, Pennsylvania, Indiana and Great Lakes	34XX 35XX
Southeast Manufacturing Technology Center	Columbia, South Carolina	1989	South Carolina	24XX 308X 36XX
Mid-America Manufacturing Technology Center	Overland Park, Kansas	1991	Kansas and Kansas City, MO area	34XX 352X 372X
Midwest Manufacturing Technology Center	Ann Arbor, Michigan	1991	Michigan	3429 371X
California Manufacturing Technology Center	Torrance, California	1992	Torrance Area	376X
Upper Midwest Manufacturing Technology Center	Minneapolis, Minnesota	1992	Minnesota	308X 34XX 3SXX

Table 9.
YEAR END SUMMARY OF THE ACTIVITIES OF THE GREAT LAKES MANUFACTURING TECHNOLOGY CENTER

ACTIVITY	1989	1990	1991	1992
Manufacturers contacted	1,254	1,601	2,028	675
Projects started	151	332	94	154
On-site assessments	9	16	26	29
Workshops, seminars and forums	16	18	20	37
Companies using demonstration facilities	0	0	142	118
Federal technologies transferred	1	0	NA	NA
Estimated company benefits ($ Million)	10	80	34	74

Table 9 summarizes the services provided by Great Lakes MTC, which are typical of MTC activity. In 1991 the Government Accounting Office (GAO) reviewed the performance of the first three centers for the first 30 months of operation. The 1989 and 1990 values of Table 9 are taken from the GAO report. The 1991 and 1992 values were provided by the MTC. The NIST reports that for the first three centers, the clients reported a total dollar benefit to their companies of $226 million from 1989 through March 1993. This is an unusually high return on the government's investment, greatly exceeding the government's maximum annual contribution of $9 million for the three centers.

The major benefit of the program was not that it succeeded in transferring the latest technologies to the client, but that it provided the

appropriate, and generally low technology solution that satisfied the client's immediate needs.

MTC PROGRAM EVALUATION PANEL

A unique feature of the MTC program, required in the law, is that an independent panel reviews the performance of the program and its centers and reports their findings to the Secretary of Commerce.

The 1992 Third Year Review Panel recognized that, in practice, productivity gains for the clients usually were achieved using proven technology that was appropriate to the problem. The transfer of advanced technologies, emphasized in the current legislation, did not meet the immediate needs of most small- and medium-sized manufacturers. Major productivity gains often were achieved through the application of low-cost, low-technology solutions.

This panel additionally recommended "that NIST, in consultation with the MTCs and others, develop criteria for evaluating three areas (1) MTC performance; (2) agreed-upon methods for evaluating the effectiveness of individual MTCs and the MTC program; and (3) standardized means of describing program activities." These program-wide tools might include the following:

- Measures for assessing the needs of small- and medium-sized firms for advance manufacturing technology and technological assistance.

- Measures for assessing the needs for new and existing manufacturing technologies so that MTCs can identify service delivery priorities among clients, industries and regions. MTCs can identify service delivery priorities among clients, industries, and regions.

- Measures for determining the rate of adoption of new and existing technologies by MTC clients.

- Evaluation methods, including specification of control groups, for identifying the MTC's contribution to the technological modernization of their clientele.

- Standardized formats among MTCs for assessing the benefits of their service to clients.

- Criteria for establishing and evaluating an MTC broadened beyond federal technology.

The NIST established an independent working group to act on these recommendations. the NIST/MTC Evaluator Working Group selected a limited number of objective measures that they anticipate to be easily available to the clients and sensitive to the results most clients expect. The Client Performance Measure establishes a baseline of the client's performance for the year prior to service, and compares that to the performance durnig the year following the project.

The nine measures of performance selected by the working group are (1) scrap rate (scrap dollrs/sales); (2) number of employees using computers, or programmable machine controllers, at least weekly; (3) overall inventory turns (sales/inventory); (4) sales per employee; (5) manufacturing lead time; (6) total sales; (7) export sales; (8) employment; and (9) average payroll per employee.

Additional useful insights could be provided by including a short list of nonquantifiable measures, whose increased presence addresses many aspects of the MTC service. Following an extensive review of the literature referenced in the bibliography, I have proposed an additional survey instrument, which is found in Table 10. These are common features seen in those companies that compete effectively in the global market. Addressing these features provides focus for companies that are striving to im-prove their overall competitiveness. Table 10 lists these factors in a simple to use format. These elements address improvements in production processes, labor management relations and external measures.

NIST PROGRAM SUMMARY

The NIST Manufacturing Technology Program effectively addresses one major shortcoming of the industrial base—the need for productivity improvements in the small- and medium-sized manufacturing business. The program is well structured to provide a range of consulting services at low cost that have resulted in significant client benefits.

The overall structure of the Manufacturing Technology Center program has a number of valuable management features that can provide a useful model for any future related DoD programs.

The low rate of program growth provided NIST with the opportunity to easily make early program adjustments and obtain the maximum benefit from lessons-learned. The program's cost-sharing and sunset provisions provides a self limiting number of pre-qualified extension center sponsors who demonstrate their commitment to the program objectives through their initial financial participation and their later obligation for future self sufficiency.

Table 10.
PROPOSED NONQUANTIFIABLE MEASURES FOR THE MANUFACTURING TECHNOLOGY PROGRAM FOR INCLUSION IN THE CLIENT PROGRESS MEASURES

PRESENT (Yes/No)	ATTRIBUTES
	PRODUCTION PROCESS
	INCREASED FOCUS ON PRODUCTION PROCESSES
	IMPROVED PROCESS FLEXIBILITY
	INCREASED PRODUCT VARIETY
	DECREASED LOT SIZE
	ADOPTION OF BEST MANUFACTURING PRACTICES
	CONCURRENCY IN PRODUCT DESIGN AND PROCESS ENGINEERING
	REDUCED REWORK
	REDUCED INSPECTION
	EMPHASIS ON CONTINUOUS IMPROVEMENT
	IMPROVED PRODUCT QUALITY
	LABOR/MANAGEMENT RELATIONS
	EMPLOYEE EMPOWERMENT
	REDUCED DIRECT MANAGEMENT INVOLVEMENT
	INCREASED WORKER TRAINING PROGRAMS
	USE OF WORK TEAMS
	OPERATIONAL PERFORMANCE MEASUREMENT/REWARD SYSTEM
	IMPROVED EMPLOYEE MORALE
	EXTERNAL MEASURES
	IMPROVED SUPPLIER COOPERATION, DELIVERY, QUALITY
	REDUCED ORDER SHIP TIME
	INCREASED ON TIME DELIVERY
	EDI LINKS TO CUSTOMERS/SUPPLIERS
	IMPROVED CUSTOMER SERVICE
	OVERALL INCREASED CUSTOMER SATISFACTION
	IMPROVED ENVIRONMENTAL QUALITY

The MTC service is focused on first gaining a thorough understanding of the client's problem, processes and resource limitations, e.g. equipment, manpower, and financial. With this understanding, the resulting proposed actions often require minimal capital investments and result in high pay-back returns.

Consistent with the program goal of productivity improvements, NIST seeks to limit and simplify any necessary program reporting requirements.

Another useful feature of the program is the Review Panel of outside experts which provides valuable feed-back for continuing improvement in the operation of both NIST and the Manufacturing Technology Centers. Implementation of the Review Panel's findings as a joint NIST/

MTC team action produces team ownership of both the issues and their resolution.

An additional evaluation tool is proposed to survey the presence of desirable non-quantifiable features that are found in global competitive companies that also provides a useful questionnaire for MTC client interviews.

CONCLUSIONS AND RECOMMENDATIONS

United States global competitiveness in technology and manufacturing are key elements to its future economic and military security. One result of the ongoing downsizing of the defense industries is that in the future U.S. defense needs will rely more heavily on the commercial industrial base for technology, capacity and flexibility. Small- and medium-sized manufacturing businesses are an important component of the industrial base and represent between 40 and 50 percent of DOD procurement.

In five major industry groups studied, small- and medium-sized manufacturing businesses have a significant share of both employment and sales. These sectors are less efficient and less modern than the industry average. Current manufacturing tech-nology practice in small- and medium-sized companies require significant upgrading to meet the competitive demands of domestic and global markets.

The National Institute of Standards and Technology Manufacturing Technology Program provides a valuable model for an effective government-industry partnership for future DOD defense base improvement programs.

In a period where the Department of Defense is taking a leading role in the management of technology reinvestment programs, the defense contributions and needs of small- and medium-sized manufacturing business should not be overlooked.

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