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

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Staff, Secretary of the Army

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ABSTRACT

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ABSTRACT

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BIOGRAPHY

Mr. Richard M. Williams is a civilian employee of the Department of the Army. He began his civilian service in 1962 following graduation with a Bachelor of Science and Master of Arts degree from Kent State University.

From 1962 to 1973 Mr. Williams was a physicist at the National Aeronautics and Space Administration - Lewis Research Center, Cleveland, Ohio working in research and development of space nuclear power systems. From 1973 to 1975 he was design engineer, Ford Motor Company, Dearborn, Michigan, assigned to the development and implementation of reliability improvement processes. From 1975 through 1985, Mr. Williams had a series of assignments as an operations research analyst in the Offices of the Program Manager, Bradley Fighting Vehicle and the Abrams Tank. From 1985 through 1990, Mr. Williams was responsible for the Army's independent cost estimates for combat and tactical vehicles, electronic systems and advanced ammunition at the U.S. Army Cost and Economic Analysis Center (USACEAC), Washington, D.C. In 1990, Mr. Williams was the Acting Deputy Assistant Secretary of the Army, Financial Management Information Systems. From 1991 to 1992, Mr. Williams was responsible for preparation of Army cost policy and the development and integration of Army cost products for the Director, USACEAC.

Upon graduation from the Industrial College of the Armed Forces in 1993, Mr. Williams is assigned to the Assistant Secretary of the Army (Financial Management) in the Pentagon.

SMALL BUSINESS MANUFACTURING - AN IMPORTANT COMPONENT OF THE US DEFENSE INDUSTRIAL BASE

Section 1 - Introduction

Challenges in the US 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 US strategic defense planners with the difficult task of fostering the vitality of the surviving US 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 US national security objectives. This base consists of three broad components: a research and development component, a production component, and a maintenance component, each of which includes private and public sector employees and facilities.[1] The private sector consists of the major defense contractors and their suppliers, which includes small business manufacturers.

US defense companies, both large and small, have implemented different strategies to adjust to industry over-capacity in 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 US

security that the resulting defense industrial base, (government and industry, large and small business) be viable and capable of meeting our future evolving defense needs. One certain outcome of downsizing will be the 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 both US national economic and security interests.

However, all is not well in the US commercial sector. The US is experiencing greater competition in both foreign and domestic markets for all products. US consumers increasingly demand quality products of world class design, products which 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 US commercial reliance on foreign sources for goods and services including those of high technology. Although US science and technology remains world class, US 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, the US 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. There are number of DOD programs that 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. MANTECH is credited with improvements in the manufacture of composite materials, in shipbuilding technology, and in turbine engine repair. It is funded at $297 million for Fiscal Year 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 Fiscal Year 1993, PL 102-396, directed to the issues of national defense technology and industrial base. It authorized $694 million for Fiscal Year 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 non-defense approach to improve the

competitiveness and productivity of small business is the National Institute of Standards and Technology's (NIST) Manufacturing Technology Program. This is a program with Fiscal Year 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.

This Paper's Focus

This paper will focus on the contributions of small- and medium-sized manufacturing business sector to the US defense industry, the state of adoption of modern manufacturing process technology in five indusry groups, a review of the NIST Manufacturing Technology Program, and recommendations for features of future DOD manufacturing improvement programs.

Section 2 - Why small business manufacturing is important

Small Business in the US Economy

The share of the US Gross Domestic Product (GDP) belonging to the manufacturing sector is nearly nineteen percent, sharing with the service sector as the leading sectors of the GDP.[2] 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.[3] In some important industries the small business contribution is larger.

Employment growth in the small business sector is strong. The U.S. 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.[4]

Small Business in the Department of Defense

Surprisingly, small business provides between forty and fifty percent of the dollar value of DOD procurement. Table 1 shows that in the Department of Defense over 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.[5]

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.[6]

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			

Section 3 - The state of process automation in US industry

Bureau of Census Findings

The 1990 report of the MIT Commission on Industrial Productivity observes that, overall, US business has been slow at adapting appropriate process technologies that are required to remain competitive in global markets.[7] This is even more evident for small business.

In the latest survey of manufacturing process capabilities conducted by the Bureau of the Census in 1988[8], nearly 10,000 companies with over 20 employees were reviewed. The survey covered the use of seventeen available manufacturing process technologies in five 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. A detailed four digit listing of the industry classification is listed in Appendix A.

Table 3 summarizes the results. Surprisingly, nearly 24 percent of the companies surveyed used none of the seventeen 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.[9]

	34	35	36	37	38	Ave
Design & Engineering						
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 Manufacturing 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 non-responses.

Table 4. Use of Technologies by Industry Group and Plant Size[10]

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 referenced survey did not prorate non-responses.

Table 5 shows that in each industry, companies with 500 employees or less account for over 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 5. A Summary of Business Statistics for the Five Industry Groups.[11]

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 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.

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.

Table 6. A Summary of Average Productivity Measures for the Five Industries Over the Range of Plant Sizes.[12]

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

In the 1988 survey, 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 (below) shows this trend at the process technology level. Companies that identify the government as their major customer have higher technology 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.

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 US manufacturing productivity and competitiveness should include the needs of the important small- and medium-sized manufacturing sector.

Table 7. Percent Use of Selected Technologies by Market for Most Products[13]

	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

Section 4 - 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 US 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.

The activities of the Centers shall 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 35XX

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 reviewed the performance of the first three centers for the first thirty months of operation. The 1989 and 1990 values of Table 9 are taken from the GAO report.[14] The 1991 and 1992 values were provided by the MTC. 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.[15] 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.

Manufacturing Technology Center Program Evaluation Panel

As required in the law, an independent panel is selected to review the performance of the program and its centers and to report their findings to the Secretary of Commerce. In 1992 the Third Year Review Panel[16] recommended "that NIST, in consultation with the MTCs and others develop, develop criteria for evaluating three areas (1) MTC performance; (2) agreed-upon methods for evaluating the effectiveness of both 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."[17]

As a consequence of these recommendations of the independent panel, NIST established the NIST/MTC Evaluation Working Group to develop the standardized reporting tools. NIST and each MTC had representatives on the Working Group. The products of this Working Group will be discussed in the next section.

The Third Year Review Panel recognized that, in practice, productivity gains for the clients were normally 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 were often achieved through the application of low cost, low technology solutions.

NIST/MTC Evaluation Working Group Proposals

The report of the NIST/MTC Evaluation Working Group is summarized here.[18] The goal of the Working Group was to develop a systematic evaluation tool to monitor the performance of each MTC and its impact on the clients served. The tools are (1) Center Performance Measure, (2) Client Valuation of Center Impact, and (3) Client Performance Measures.

The Center Performance Measure requires all MTCs to report their performance quarterly in the new standardized format. In addition to financial and staffing reports, each MTC provides statistics on services it provided and on the technical assistance it provided (subdivided by category.) The quarterly report summarizes the number of site visits, initiations of informal no fee client contacts, formal client operation assessments, new technical assistance projects, number of sites served and the number of employees at each site, attendance at MTC sponsored training events, and the MTC proposal "hit rate," or projects initiated relative to total projects proposed, expressed in terms of both dollars and number of proposals.

The report records frequency of service provided to clients for a number of technical categories. These include CAD/CAM/CAE, EDI/Communication/LAN, Business Systems/Business Management, Environmental, Quality/Inspection, Plant Layout/Manufacturing Cells, Automation/Robotics, Control Systems/Integration, Market Development, Material Engineering, and Quick Changeover/Setup.

When a project is completed, the second report, Client Valuation of Center Impact, is submitted to the MTC and summarized in the subsequent quarterly report. The client provides the MTC a voluntary, subjective evaluation of the annual benefit that it saw from the MTC service. Six standard measures are requested for the MTC project(s): changes in annual sales, changes in investment, capital spending avoidance, changes in inventory relative to sale levels, changes in labor and material costs relative to sales, and the number of jobs created, saved, [or lost].

Because the client may not have specific values for these measures, the client's subjective judgement is accepted as adequate for the survey. The evaluation form also provides the client with an opportunity for open-ended reactions and a subjective overall evaluation of the project's value. When a client provides partial survey results, the MTC is encouraged to extrapolate the results to complete the response. One potential issue is that lacking a rigorous consistent standard for the evaluation of savings, the MTC's "Estimated Company Savings" value should be used with caveats.

The third evaluation report consists of the Client Performance Measures which are submitted annually by clients that are actively served. The NIST/MTC Evaluator Working Group

selected a limited number of objective measures that they anticipate to be both 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 during the year following the project.

The nine measures of performance selected by the working group are (1) Scrap Rate (Scrap Dollars/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.

Section 5 - Consideration for non Quantifiable Program Benefits.

The NIST measures of company performance meet the dual requirements for measures that are easily accessible and sensitive to the likely desired service results for the client. The effort of the Working Group has been thorough and its selection of a limited number of quantifiable benefits is comprehensive.

Additional useful insights, however, could be easily provided by including a short list of non-quantifiable benefits that addresses additional aspects of the MTC service. Following an extensive review of the literature referenced in the bibliography, I propose 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 improve their overall competitiveness. Table 10

Table 10. Proposed Non-Quantifiable Measures for the Manufacturing Technology Program for inclusion in the Client Progress Measures.

ATTRIBUTES	PRESENT (Yes/ No)
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	

lists these factors in a simple to use format. These elements address improvements in production processes, labor management relations and external measures.

Section 6 - 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.

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.

Section 7 - Conclusions and Recommendations

US 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 US 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 technology 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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APPENDIX A

STANDARD INDUSTRY CLASSIFICATIION

FOUR DIGIT CODE DETAIL DICTIONARY

34 Fabricated Metal Products
35 Industrial Machinery and Equipment
36 Electronic and Other Electrical Equipment
37 Transportation Equipment
38 Instruments and Related Products

Industry and product class code	Description
34	**FABRICATED METAL PRODUCTS**
3411–	Metal cans
34111	Steel cans and tinware products
34112	Aluminum cans
34110	Metal cans, n.s.k.
3412–	Metal barrels, drums, and pails
34121	Steel pails[3]
34122	Steel shipping barrels and drums (more than 12 gallon capacity)[3]
34123	All other metal barrels
34120	Metal barrels, drums, and pails, n.s.k.
3421–	Cutlery
34211	Cutlery, scissors, shears, trimmers, and shears
34212	Razor blades and razors, except electric
34210	Cutlery, n.s.k.
3423–	Hand and edge tools, n.e.c.
34231	Mechanics' hand service tools
34234	Edge tools, hand-operated
34235	Dies and interchangeable cutting tools, for machines and power-driven handtools
34236	Other handtools, n.e.c.
34230	Hand and edge tools, n.s.k.
3425–	Handsaws and saw blades
34250	Handsaws, saw blades (hand and power), and saw accessories
3429–	Hardware, n.e.c.
34292	Furniture hardware (excluding cabinet hardware)
34293	Vacuum and insulated bottles, jugs, and chests
34294	Builders' hardware
34296	Motor vehicle hardware
34297	Other transportation equipment hardware
34298	Other hardware, n.e.c.
34290	Hardware, n.e.c., n.s.k.
3431–	Metal sanitary ware
34310	Metal plumbing fixtures
3432–	Plumbing fittings and brass goods
34320	Plumbing fixture fittings and trim (brass goods)
3433–	Heating equipment, except electric
34333	Cast iron heating boilers, radiators, and convectors, except parts
34334	Domestic heating stoves, except electric (excluding parts)
34335	Steel heating boilers (15 p.s.i. or less), and all hot water boilers, excluding parts
34338	Floor and wall furnaces, unit heaters, *infrared heaters and mechanical stokers*
34339	Other heating equipment, except electric
34330	Heating equipment, n.s.k.
3441–	Fabricated structural metal
34411	Fabricated structural metal for buildings
34412	Fabricated structural metal for bridges
34413	Other fabricated structural metal
34410	Fabricated structural metal, n.s.k.
3442–	Metal doors, sash, and trim
34421	Metal doors and frames, except storm doors
34422	Metal window sash and frames, except storm sash
34423	Metal molding and trim and store fronts
34424	Metal combination screen, storm sash, and storm doors
34425	Metal window and door screens (except combination) and metal weather strip
34420	Metal doors, sash, and trim, n.s.k.
3443–	Fabricated plate work (boiler shops)
34431	Heat exchangers and steam condensers, except for nuclear applications
34432	Fabricated steel plate (stacks and weldments)
34433	Steel power boilers, parts, and attachments
34434	Gas cylinders
34435	Metal tanks, complete at factory (standard line pressure)
34436	Nuclear reactor steam supply systems
34437	Metal tanks, complete at factory (standard line nonpressure)
34438	Metal tanks and vessels, custom fabricated at the factory
34439	Metal tanks and vessels, custom fabricated and field erected
34430	Fabricated plate work (boiler shops), n.s.k.
3444–	Sheet metal work*
34441	Air-conditioning ducts and stove pipe
34442	Culverts, flumes, irrigation pipes, etc.
34443	Bins and vats
34444	Metal roofing and roof drainage equipment
34445	Metal flooring and siding
34447	Metal awnings, canopies, cornices, and soffits
34448	Electronic enclosures
34449	Other sheet metal work
34440	Sheet metal work, n.s.k.
3446–	Architectural metal work*
34461	Grilles, registers, and air diffusers
34462	Stairs, railings, fences, and gates (other than wire)
34463	Open flooring, grating, and studs
34464	Scaffolding, shoring and forming for concrete work
34465	Other architectural and ornamental work
34460	Architectural metal work, n.s.k.

Industry and product class code	Description
34	FABRICATED METAL PRODUCTS—Con.
3448-	Prefabricated metal buildings[2]
34481	Prefabricated metal building systems, excluding farm service buildings, residential buildings, and parts
34482	Other prefabricated and portable metal buildings and parts
34480	Prefabricated metal buildings, n.s.k.
3449-	Miscellaneous metal work
34494	Fabricated bar joists and concrete reinforcing bars
34495	Metal plaster bases
34497	Curtain wall
34496	Custom roll form products
34490	Miscellaneous metal work, n.s.k.
3451-	Screw machine products
34511	Automotive screw machine products
34512	Other screw machine products
34510	Screw machine products, n.s.k.
3452-	Bolts, nuts, rivets, and washers
34524	Externally threaded fasteners (except aircraft)
34525	Internally threaded fasteners (except aircraft)
34526	Nonthreaded fasteners (except aircraft)
34527	Aircraft aerospace fasteners
34528	Other formed parts
34520	Bolts, nuts, rivets, and washers, n.s.k.
3462-	Iron and steel forgings
34625	Hot impression die impact, press, and upset steel forgings
34626	Cold impression die impact, press, and upset steel forgings
34627	Seamless rolled ring forgings (ferrous) (see also code 3312A)[3]
34628	Open die or smith forgings (hammer or press) (ferrous) (see also code 3312B)[3]
34620	Iron and steel forgings, n.s.k.
3463-	Nonferrous forgings
34635	Hot impression die impact, press, and upset nonferrous forgings
34639	Other nonferrous forgings
34630	Nonferrous forgings, n.s.k.
3465-	Automotive stampings
34650	Job stampings, automotive
3466-	Crowns and closures
34661	Metal commercial closures and metal home canning closures
34662	Metal crowns
34660	Crowns and closures, n.s.k.
3469-	Metal stampings, n.e.c.
34692	Job stampings, except automotive
34694	Stamped and spun utensils, cooking and kitchen, aluminum
34695	Stamped and spun utensils, cooking and kitchen, except aluminum
34696	Metal spinning products
34699	Other stamped and pressed metal end products
34690	Metal stampings, n.e.c., n.s.k.
3471-	Plating and polishing
34710	Electroplating, plating, and polishing[4]
3479-	Metal coating and allied services[4]
34790	Etching, engraving, coating, and allied services[4]
3482-	Small arms ammunition
34820	Small arms ammunition, 30 mm or less (or 1.18 inches or less)
3483-	Ammunition, except for small arms, n.e.c.
34831	Artillery ammunition, more than 30 mm (or more than 1.18 inches)
34833	Ammunition, except for small arms, n.e.c.
34830	Ammunition, except for small arms, n.e.c., n.s.k.
3484-	Small arms
34841	Machine guns, 30 mm or less (or 1.18 inches or less)
34842	Small arms, 30 mm or less (or 1.18 inches or less)
34840	Small arms, 30 mm or less, n.s.k.
3489-	Ordnance and accessories, n.e.c.
34891	Guns, howitzers, mortars, and related equipment, more than 30 mm (or more than 1.18 inches)
34892	Ordnance and accessories, n.e.c.
34890	Ordnance and accessories, n.e.c., n.s.k.
3491-	Industrial valves
34911	Gates, globes, and check valves
34912	Valves for water works
34913	Ball valves
34914	Butterfly valves
34915	Plug valves
34916	Industrial valves, n.e.c.
34917	Nuclear valves
34918	Automatic valves (regulating and control type) and parts (except nuclear)[3]
34919	Solenoid valves[3]
34910	Industrial valves, n.s.k.
3492-	Fluid power valves and hose fittings
34921	Hydraulic valves, except aerospace-type[3]
34922	Pneumatic valves, except aerospace-type[3]
34923	Aerospace-type hydraulic and pneumatic valves[3]
34924	Fittings for metal and plastics tubing used in fluid and power transfer systems, except aerospace-type[3]
34925	Hydraulic and pneumatic hose or tube end fittings and assemblies, except aerospace-type[3]
34926	Aerospace-type hydraulic and pneumatic hose or tube end fittings and assemblies[3]
34927	Parts for fluid power valves[3]
34920	Fluid power valves and hose fittings, n.s.k.

Industry and product class code	Description
34	FABRICATED METAL PRODUCTS—Con.
3493-	Steel springs, except wire
34931	Hot formed springs
34932	Cold formed springs
34930	Steel springs, except wire, n.s.k.
3494-	Valves and pipe fittings, n.e.c.
34944	Plumbing and heating valves and specialties, except plumbers' brass goods
34945	Metal fittings, flanges, and unions for piping systems
34940	Valves and pipe fittings, n.s.k.
3495-	Wire springs
34952	Precision mechanical springs
34953	Other wire springs
34950	Wire springs, n.s.k.
3496-	Miscellaneous fabricated wire products
34961	NonInsulated ferrous wire rope, cable, etc., not produced by wire drawers (see also code 33151)[2]
34964	Ferrous wire cloth and other ferrous woven wire products not produced by wire drawers (see also code 33157)[2]
34965	Nonferrous wire cloth and other nonferrous woven wire products not produced by wire drawers (see also code 33575)[2]
34966	Fencing and fence gates not produced by wire drawers (see also code 33156)[2]
34968	Other fabricated wire products not produced by wire drawers (see also code 33159)[2]
34960	Miscellaneous fabricated wire products, n.s.k.
3497-	Metal foil and leaf
34971	Converted unmounted aluminum foil packaging products
34972	Laminated aluminum foil rolls and sheets for flexible packaging uses
34973	Converted foil for nonpackaging applications and foil and leaf
34970	Metal foil and leaf, n.s.k.
3498-	Fabricated pipe and fittings*
34980	*Fabricated pipe and pipe fittings made from purchased pipe*
3499-	Fabricated metal products, n.e.c.*
34991	Safes and vaults
34992	Collapsible tubes
34993	Flat metal strapping
34995	Metal ladders
34996	Powder metallurgy parts
34998	All other fabricated metal products, n.e.c.
34990	Fabricated metal products, n.e.c., n.s.k.

Industry and product class code	Description
35	**INDUSTRIAL MACHINERY AND EQUIPMENT**
3511-	Turbines and turbine generator sets
35111	Turbine generators, turbine generator sets, and parts
35112	Steam, gas, hydraulic, and wind turbines and parts
35110	Turbines and turbine generator sets, n.s.k.
3519-	Internal combustion engines, n.e.c.
35191	Gasoline and gas-gasoline engines[3]
35193	Diesel, semidiesel, and dual fuel engines (nonautomotive)[3]
35194	Diesel, semidiesel, and dual fuel engines (automotive)[3]
35195	Outboard motors (internal combustion)
35196	Natural gas engines (excluding gas turbines)[3]
35197	Tank (except gas turbine) and converted internal combustion engines
35199	Parts and accessories for internal combustion engines
35190	Internal combustion engines, n.e.c., n.s.k.
3523-	Farm machinery and equipment
35231	Wheel tractors and attachments[3]
35232	Farm dairy equipment, sprayers, elevators, and blowers[3]
35233	Planting, seeding, and fertilizing machinery[3]
35235	Harvesting machinery, except hay and straw[3]
35236	Haying machinery[3]
3523C	Plows, harrows, rollers, pulverizers, cultivators, and weeders[3]
3523E	All other farm machinery and equipment[3]
35239	Parts for farm machinery[3]
3523F	Commercial turf and grounds care equipment[3]
35230	Farm machinery and equipment, n.s.k.
3524-	Lawn and garden equipment
35241	Consumer nonriding lawn, garden, and snow equipment[3]
35244	Consumer riding lawn, garden, and snow equipment[3]
35246	Parts and attachments for consumer lawn, garden, and snow equipment[3]
35240	Lawn and garden equipment, n.s.k.
3531-	Construction machinery
3531A	Contractors' off-highway type wheel tractors[3]
3531B	Crawler tractors[3]
3531C	Tractor shovel loaders[3]
3531E	Power cranes, draglines, and shovels[3]
3531F	Mixers, pavers, and related equipment (excluding parts)[3]
3531G	Scrapers, graders, rollers, and off-highway trucks[3]
3531H	Construction machinery for mounting on tractors and other prime movers[3]
3531K	Construction machinery, n.e.c.[3]
3531M	Parts for construction machinery and equipment[3]
35310	Construction machinery, n.s.k.
3532-	Mining machinery
35325	Underground mining machinery[3]
35326	Mineral processing and beneficiation machinery[3]
35327	Crushing, pulverizing, and screening machinery[3]
35328	Drills and other mining machinery, n.e.c.[3]
35329	Parts and attachments for mining machinery and equipment
35320	Mining machinery, n.s.k.
3533-	Oil and gas field machinery
35337	Rotary drilling machinery and equipment
35338	Other drilling machinery and equipment
35339	Oil field and gas field production machinery and equipment
3533A	Portable drilling rigs and parts[3]
3533B	Derricks and well surveying machinery
35330	Oil and gas field machinery, n.s.k.
3534-	Elevators and moving stairways
35341	Elevators and moving stairways
35342	Parts and attachments for elevators and moving stairways (sold separately)
35340	Elevators and moving stairways, n.s.k.
3535-	Conveyors and conveying equipment
35353	Unit handling conveyors and conveying systems, except hoists and farm elevators
35354	Parts for unit handling conveyors
35355	Bulk material handling conveyors
35356	Parts for bulk material handling conveyors
35350	Conveyors and conveying equipment, n.s.k.
3536-	Hoists, cranes, and monorails
35363	Hoists[3]
35364	Overhead traveling cranes and monorail systems
35360	Hoists, cranes, and monorails, n.s.k.
3537-	Industrial trucks and tractors
35373	Industrial trucks and tractors
35374	Parts for industrial trucks and tractors
35370	Industrial trucks and tractors, n.s.k.
3541-	Machine tools, metal cutting types
3541D	Boring machines and drilling machines[3]
35413	Gear cutting machines[3]
35414	Grinding, polishing, buffing, honing, and lapping machines[3]
35415	Lathes[3]
35416	Milling machines[3]
3541A	Machining centers[3]
3541B	Station type machines[3]
3541C	Metal cutting machine tools, n.e.c.[3]
35418	Machine tools designed primarily for home workshops
35419	Parts for metal cutting type machine tools
3541D	Machine tools, metal cutting types, n.s.k.

Industry and product class code	Description
35	INDUSTRIAL MACHINERY AND EQUIPMENT—Con.
3542-	Machine tools, metal forming types
35421	Punching, shearing, bending and forming machines[3]
35422	Presses, except forging and die-stamping[3]
35423	Other metal forming machine tools, n.e.c.[3]
35424	Parts for metal forming machine tools
35420	Machine tools, metal forming types, n.s.k.
3543-	Industrial patterns[4]
35430	Industrial patterns, except shoe patterns
3544-	Special dies, tools, jigs, and fixtures
35441	Special dies and tools, die sets, jigs, and fixtures
35442	Industrial molds and mold boxes
35440	Special dies, tools, jigs, and fixtures, n.s.k.
3545-	Machine tool accessories
35451	Small cutting tools for machine tools and metalworking machinery
35454	Machine tool attachments and accessories, n.e.c.
35455	Precision measuring tools
35450	Machine tool accessories, n.s.k.
3568-	Power transmission equipment, n.e.c.
35681	Plain bearings and bushings
35683	Mechanical power transmission equipment, n.e.c.
35680	Power transmission equipment, n.e.c., n.s.k.
3569-	General industrial machinery, n.e.c.
35692	Filters for hydraulic and pneumatic fluid power systems[3]
35693	Filters and strainers, except fluid power
35697	Industrial robots, attachments and parts
35698	Other general industrial machinery, n.e.c.
35690	General industrial machinery, n.e.c., n.s.k.
3571-	Electronic computers
35711	Computers (excluding word processors, peripherals, and parts)[3]
35712	Parts for computers[3,5]
35710	Electronic computers, n.s.k.
3572-	Computer storage devices
35721	Computer storage equipment, auxiliary[3]
35722	Parts for computer storage equipment, auxiliary[3,5]
35720	Computer storage devices, n.s.k.
3575-	Computer terminals
35751	Computer terminals[3]
35752	Parts for computer terminals[3,5]
35750	Computer terminals, n.s.k.
3577-	Computer peripheral equipment, n.e.c.
35771	Computer peripheral equipment, n.e.c.[3]
35772	Parts for computer peripheral equipment, n.e.c.[3,5]
35770	Computer peripheral equipment, n.e.c., n.s.k.
3578-	Calculating and accounting equipment
35781	Accounting machines and cash registers[3]
35782	Calculators[3]
35783	Parts for calculating and accounting machines[3]
35780	Calculating and accounting machines, n.s.k.
3579-	Office machines, n.e.c.
35792	Automatic typing and word processing machines[3]
35793	Duplicating machines[3]
35795	Mailing, letter handling, and addressing machines[3]
35799	Standard typewriters and office machines, n.e.c.[3]
3579A	Parts for office machines, n.e.c.[3]
35790	Office machines, n.e.c., n.s.k.
3581-	Automatic merchandising vending machines
35811	Automatic merchandising machines[3]
35812	Coin-operated mechanisms and parts for automatic merchandising machines
35810	Automatic merchandising machines, n.s.k.
3582-	Commercial laundry equipment
35820	Commercial laundry
3585-	Refrigeration and heating equipment
35851	Heat transfer equipment[3]
35852	Unitary air-conditioners[3]
35853	Commercial refrigerators and related equipment
35854	Compressors and compressor units, all refrigerants[3]
35855	Refrigeration condensing units (complete)[3]
35856	Room air-conditioners and dehumidifiers[3]
3585B	Refrigeration and air-conditioning equipment, n.e.c.
3585C	Warm air furnaces, humidifiers, and electric comfort heating equipment[3]
3585D	Parts for air-conditioning, refrigeration, and heating equipment
35850	Refrigeration and heating equipment, n.s.k.
3586-	Measuring and dispensing pumps
35860	Measuring and dispensing pumps
3589-	Service industry machinery, n.e.c.[4]
35891	Commercial cooking and food warming equipment
35893	Commercial and industrial vacuum cleaners
35892	Service industry machines, n.e.c., and parts
35890	Service industry machinery, n.e.c., n.s.k.
3592-	Carburetors, pistons, rings, and valves
35921	Carburetors, new and rebuilt
35922	Pistons, piston rings, and piston pins (engine)
35923	Valves (engine intake and exhaust)
35920	Carburetors, pistons, rings, and valves, n.s.k.

Industry and product class code	Description
35	**INDUSTRIAL MACHINERY AND EQUIPMENT—Con.**
3593–	Fluid power cylinders and actuators
35931	Hydraulic and pneumatic cylinders and related items, except aerospace
35932	Aerospace type hydraulic and pneumatic cylinders and related items[3]
35933	Parts for hydraulic and pneumatic cylinders, and related items[3]
35930	Fluid power cylinders and actuators, n.s.k.
3594–	Fluid power pumps and motors
35941	Fluid power pumps, motors, and hydrostatic transmission components[3]
35942	Parts and attachments for fluid power pumps, motors, and hydrostatic transmissions[3]
35940	Fluid power pumps and motors, n.s.k.
3596–	Scales and balances, except laboratory
35961	Vehicle and industrial scales
35962	Retail, commercial, household, and mailing scales
35963	Parts, attachments, and accessories for scales and balances
35960	Scales and balances, except laboratory, n.s.k.
3599–	Industrial and commercial machinery, n.e.c.[4]
35994	Miscellaneous machinery products
35995	Receipts for machine shop job work
35990	Industrial and commercial machinery, n.e.c., n.s.k.

Industry and product class code	Description
36	ELECTRONIC AND OTHER ELECTRIC EQUIPMENT
3612-	Transformers, except electronic
36122	Power and distribution transformers
36123	Specialty transformers except fluorescent lamp ballast
36124	Fluorescent lamp ballasts[3]
36126	Commercial, institutional, and industrial general-purpose transformers
36127	Power regulators, boosters, and other transformers
36120	Transformers, n.s.k.
3613-	Switchgear and switchboard apparatus
36132	Power circuit breakers, all voltages[3]
36133	Low voltage panelboards and distribution boards[3]
36134	Fuses and fuse equipment, less than 2300 volts[3]
36135	Molded case circuit breakers, 1000 volts or less[3]
36136	Duct, including plug-in units, 1000 volts or less[3]
36139	Switchgear, except ducts and relays[3]
36130	Switchgear and switchboard apparatus, n.s.k.
3621-	Motors and generators
36211	Fractional horsepower motors[3]
36212	Integral horsepower motors and generators[3]
36213	Land transportation motors and generators[3]
36214	Prime mover generator sets[3]
36217	Fractional motor generator sets[3]
36216	Integral motor generator sets[3]
36219	Parts for motors and generators[3]
36210	Motors and generators, n.s.k.
3624-	Carbon and graphite products
36241	Electrodes
36249	Carbon and graphite products, n.e.c.
36240	Carbon and graphite products, n.s.k.
3625-	Relays and industrial controls
36251	Relays for electronic circuitry, industrial control, overload, and switchgear type[3]
36252	Specific purpose industrial controls[3]
36253	General purpose industrial controls[3]
36254	Parts for industrial controls and motor-control accessories[3]
36250	Relays and industrial controls, n.s.k.
3629-	Electrical industrial apparatus, n.e.c.
36291	Capacitors for industrial use
36292	Rectifying apparatus
36293	Electrical equipment for industrial use, n.e.c.
36290	Electrical industrial apparatus, n.e.c., n.s.k.
3631-	Household cooking equipment
36311	Electric ranges, ovens, and surface units[3]
36313	Gas ranges, ovens, surface cooking units[3]
36314	Other household ranges and cooking equipment[3]
36310	Household cooking equipment, n.s.k.
3632-	Household refrigerators and freezers
36321	Household mechanical refrigerators[3]
36322	Food freezers, household[3]
36323	Parts for household refrigerators and freezers[3]
36320	Household refrigerators and freezers, n.s.k.
3633-	Household laundry equipment
36330	Household laundry machines, including coin and noncoin[3]
3634-	Electric housewares and fans
36341	Electric fans, except industrial type[3]
36345	Small electric household appliances, except fans[3]
36349	Parts and attachments for small household electric appliances[3]
36340	Electric housewares and fans, n.s.k.
3635-	Household vacuum cleaners
36350	Household vacuum cleaners, including parts and attachments
3639-	Household appliances, n.e.c.
36391	Household water heaters, electric[3]
36392	Household water heaters, except electric[3]
36395	Household appliances, n.e.c., and parts for household appliances, n.e.c.[3]
36390	Household appliances, n.e.c., n.s.k.
3641-	Electric lamps (bulbs and tubes)
36411	Electric lamp bulbs and tubes[3]
36412	Electric lamp (bulbs and tubes) components
36410	Electric lamps (bulbs and tubes), n.s.k.
3643-	Current-carrying wiring devices
36431	Lampholders[3]
36432	Convenience and power outlets[3]
36433	Switches for electrical circuitry[3]
36434	Metal contacts[3]
36435	Wire connectors for electrical circuitry[3]
36436	Current-carrying wiring devices, n.e.c.[3]
36430	Current-carrying wiring devices, n.s.k.
3644-	Noncurrent-carrying wiring devices
36441	Pole and transmission line hardware[3]
36442	Electrical conduit and conduit fittings[3]
36443	Noncurrent-carrying wiring devices and supplies, n.e.c.[3]
36440	Noncurrent-carrying wiring devices, n.s.k.
3645-	Residential lighting fixtures*
36451	Residential lighting fixtures, except portable[3]
36457	Portable residential lighting fixtures
36450	Residential lighting fixtures, n.s.k.
3646-	Commercial lighting fixtures
36462	Commercial and institutional lighting fixtures[3]
36463	Industrial type lighting fixtures[3]
36460	Commercial lighting fixtures, n.s.k.

Industry and product class code	Description
36	ELECTRONIC AND OTHER ELECTRIC EQUIPMENT—Con.
3647-	Vehicular lighting equipment
36470	Vehicular lighting equipment[3]
3648-	Lighting equipment, n.e.c.
36485	Outdoor lighting equipment[3]
36489	Electric and nonelectric lighting equipment, n.s.k.
36480	Lighting equipment, n.e.c., n.s.k.
3651-	Radio receivers, television sets, phonographs, speakers, and related equipment
36511	Home, portable, and automobile radios[3]
36512	Television receivers[3]
36514	Consumer high fidelity components[3]
36515	Speaker systems, microphones, etc.[3]
36510	Radio receivers, television sets, phonographs, speakers, and related equipment, n.s.k.
3652-	Phonograph records and prerecorded tapes and discs[4]
36520	Phonograph records, prerecorded audio tapes and discs
3661-	Telephone and telegraph apparatus
36611	Telephone switching and switchboard equipment[3]
36613	Carrier line equipment and modems, including auxiliary sets[3]
36614	Telephone and telegraph (wire) apparatus, n.e.c.[3]
36610	Telephone and telegraph apparatus, n.s.k.
3663-	Radio and television communications equipment
36631	Communication systems and equipment, except broadcast[3]
36632	Broadcast, studio, and related electronic equipment[3]
36630	Radio and television communications equipment, n.s.k.
3669-	Communications equipment, n.e.c.[3]
36691	Alarm systems[3]
36692	Traffic control equipment[3]
36693	Intercommunication equipment[3]
36690	Communications equipment, n.e.c., n.s.k.
3671-	Electron tubes, all types
36713	Transmitting, industrial, and special purpose electron tubes, except x-ray[3]
36714	Receiving type electron tubes, including cathode ray picture tubes[3]
36715	Electron tube parts[3]
36710	Electron tubes, n.s.k.
3672-	Printed circuit boards[4]
36720	Printed circuit boards[3] [5]
3674-	Semiconductors and related devices
36741	Integrated microcircuits[3] [6]
36742	Transistors[3]
36743	Diodes and rectifiers[3]
36749	Semiconductor and related devices, n.e.c.[3]
36740	Semiconductors and related devices, n.s.k.
3675-	Electronic capacitors[4]
36750	Capacitors for electronic circuitry[3]
3676-	Electronic resistors
36760	Resistors for electronic circuitry[3]
3677-	Electronic coils and transformers[4]
36770	Coils, transformers, reactors, and chokes[3]
3678-	Connectors for electronic circuitry
36781	Coaxial (rf) connectors[3]
36782	Cylindrical connectors[3]
36783	Rack and panel (rectangular) connectors[3]
36784	Printed circuit connectors[3]
36785	Other connectors for electronic circuitry, n.e.c.[3]
36780	Connectors for electronic circuitry, n.s.k.
3679-	Electronic components, n.e.c.
36791	Crystals, filters, piezoelectric, and other related devices[3]
36793	Microwave components and devices[3]
36795	Transducers, electrical/electronic input or output, n.e.c.[3]
36796	Switches, mechanical, for electronic circuitry[3]
36798	Printed circuit assemblies, loaded boards, and modes[3] [5]
36799	Electronic components, n.e.c.[3]
36790	Electronic components, n.e.c., n.s.k.
3691-	Storage batteries
36913	Storage batteries, lead acid type, 1.5 cu ft or .042 cu m and smaller
36914	Storage batteries, lead acid type, larger than 1.5 cu ft or .042 cu m
36915	Storage batteries, except lead acid
36910	Storage batteries, n.s.k.
3692-	Primary batteries, dry and wet[4]
36920	Primary batteries, dry and wet
3694-	Engine electrical equipment
36941	Ignition harness and cable sets
36942	Alternators, generators, and regulators
36943	Cranking motors (starters)
36944	Spark plugs
36947	Complete engine electrical equipment, n.e.c.
36948	Parts for engine electrical and/or electronic equipment
36940	Engine electrical equipment, n.s.k.
3695-	Magnetic and optical recording media
36950	Magnetic and optical recording media (unrecorded)[3]
3699-	Electrical equipment and supplies, n.e.c.
36991	Electronic teaching machines, teaching aids, trainers, and simulators, including units[3]
36992	Laser systems and equipment, except communication[3]
36995	Ultrasonic equipment, except medical and dental[3]
36996	Apparatus wire and cordage manufactured from purchased insulated wire (see also code 33576)[3] [7]
36997	Electronic systems and equipment, n.e.c.[3]
36998	Electrical products, n.e.c.[3]
36990	Electrical equipment and supplies, n.e.c., n.s.k.

Industry and product class code	Description
37	**TRANSPORTATION EQUIPMENT**
3711-	**Motor vehicles and car bodies**
37111	Passenger cars and chassis for sale separately
37113	Buses and fire fighting vehicles (chassis of own manufacture)
37114	Combat vehicles and wheeled tactical vehicles or carriers
37115	Passenger car bodies
37116	Truck, truck tractors, and truck and bus chassis (chassis of own manufacture): (10,000 lb or less)[a]
37117	Truck, truck tractors, and truck and bus chassis (chassis of own manufacture): (10,001 to 19,500 lb)[a]
37118	Truck, truck tractors, and truck and bus chassis (chassis of own manufacture): (19,501 to 33,000 lb)[a]
37119	Truck, truck tractors, and truck and bus chassis (chassis of own manufacture): (33,001 lb or more)[a]
37110	Motor vehicles and car bodies, n.s.k.
3713-	**Truck and bus bodies**
37131	Truck, bus, and other vehicle bodies
37132	Complete vehicles produced on purchased chassis
37130	Truck and bus bodies, n.s.k.
3714-	**Motor vehicle parts and accessories**
37142	Gasoline engines and gasoline engine parts for motor vehicles, new
37144	Filters for internal combustion engines and motor vehicles, new
37145	Exhaust system parts, new
37146	Drive train components, new, except wheels and brakes
37147	Motor vehicle wheels, new
37148	Brake parts and assemblies, new
37149	All other motor vehicle parts and accessories, new, n.e.c.
3714A	Rebuilt parts for motor vehicles, excluding carburetors and engine electrical equipment
37140	Motor vehicle parts and accessories, n.s.k.
3715-	**Truck trailers**
37151	Truck trailers and chassis, with axle rating of 10,000 lb or more[a]
37152	Truck trailers and chassis, with axle rating of less than 10,000 lb
37150	Truck trailers, n.s.k.
3716-	**Motor homes produced on purchased chassis[a]**
37160	Motor homes built on purchased chassis
3721-	**Aircraft**
37211	Military aircraft
37215	Civilian aircraft[b]
37217	Modification, conversion, and overhaul of previously accepted aircraft
37218	Aeronautical services on complete aircraft, n.e.c.
37210	Aircraft, n.s.k.
3724-	**Aircraft engines and engine parts**
37241	Aircraft engines for military aircraft
37242	Aircraft engines for civilian aircraft[b]
37243	Aeronautical services on aircraft engines
37244	Aircraft engine parts and accessories
37240	Aircraft engines and engine parts, n.s.k.
3728-	**Aircraft parts and auxiliary equipment, n.e.c.**
37281	Aircraft parts and auxiliary equipment, n.e.c.
37282	Aircraft propellers and helicopter rotors
37283	Research and development on aircraft parts
37280	Aircraft parts and auxiliary equipment, n.e.c., n.s.k.
3731-	**Ship building and repairing[a]**
37311	Nonpropelled ships, new construction
37312	Self-propelled ships, U.S. military, new construction
37313	Self-propelled ships, nonmilitary, new construction
37314	Ship repair, military
37316	Ship repair, nonmilitary
37310	Ship building and repairing, n.s.k.
3732-	**Boat building and repairing[a]**
37322	Outboard motorboats
37323	Inboard motorboats
37324	Inboard-outdrive boats
37327	Boats, n.e.c. (sailboats, rowboats, canoes, etc.)
37328	Boat repair, military and nonmilitary
37320	Boat building and repairing, n.s.k.
3743-	**Railroad equipment**
37431	Locomotives, both new and rebuilt, and parts[a]
37432	Passenger and freight train cars, new, excluding parts
37433	Street, subway, trolley, and rapid transit cars, all rebuilt railcars, and parts for all railcars
37430	Railroad equipment, n.s.k.
3751-	**Motorcycles, bicycles, and parts**
37511	Bicycles and parts
37512	Motorcycles, motorbikes, motor scooters, mopeds, and parts
37510	Motorcycles, bicycles, and parts, n.s.k.
3761-	**Guided missiles and space vehicles**
37611	Complete guided missiles (excluding propulsion systems)
37612	Complete space vehicles (excluding propulsion systems)
37613	Research and development on complete guided missiles
37614	Research and development on complete space vehicles
37615	All other services on complete guided missiles and space vehicles
37610	Guided missiles and space vehicles, n.s.k.
3764-	**Space propulsion units and parts**
37645	Complete missile or space vehicle engines and/or propulsion units
37646	Research and development on complete missile or space vehicle engines and/or propulsion units
37647	Services on complete missile or space vehicle engines and/or propulsion units, n.e.c.
37648	Missile and space vehicle engine and/or propulsion unit parts and accessories
37640	Space propulsion units and parts, n.s.k.
3769-	**Space vehicle equipment, n.e.c.**
37692	Missile and space vehicle components, parts, and subassemblies, n.e.c.
37694	Research and development on missile and space vehicle parts and components, n.e.c.
37690	Space vehicle equipment, n.e.c., n.s.k.

Industry and product class code	Description
37	TRANSPORTATION EQUIPMENT—Con.
3792-	Travel trailers and campers
37921	Travel trailers
37922	Camping trailers, campers, pickup covers, and parts
37920	Travel trailers and campers, n.s.k.
3795-	Tanks and tank components
37950	Tanks and tank components
3799-	Transportation equipment, n.e.c.*
37993	Golf carts and industrial in-plant personnel carriers, self-propelled, and parts
37996	Automobile and light truck trailers
37998	Transportation equipment, n.e.c., including all-terrain vehicles
37990	Transportation equipment, n.e.c., n.s.k.

Industry and product class code	Description
38	**INSTRUMENTS AND RELATED PRODUCTS**
3812-	Search, detection, navigation, guidance, aeronautical and nautical systems, instruments, and equipment
38121	Aeronautical, nautical, and navigational instruments, not sending or receiving radio signals[3]
38122	Search, detection, navigation, and guidance systems and equipment[3]
38120	Search, detection, navigation, guidance, aeronautical, and nautical systems, instruments, and equipment, n.s.k.
3821-	Laboratory apparatus and furniture
38210	Laboratory apparatus and furniture[3]
3822-	Environmental controls
38220	Automatic controls for regulating residential and commercial environments and appliances[3]
3823-	Process control instruments
38230	Process control instruments[3]
3824-	Fluid meters and counting devices
38242	Integrating and totalizing meters for gas and liquids[3]
38243	Counting devices[3]
38244	Motor vehicle instruments[3]
38240	Fluid meters and counting devices, n.s.k.
3825-	Instruments to measure electricity
38251	Integrating instruments, electrical[3]
38252	Test equipment for testing electrical, radio and communication circuits, and motors[3]
38253	Instruments to measure electricity, n.e.c.[3]
38250	Instruments to measure electricity, n.s.k.
3826-	Analytical instruments
38260	Analytical and scientific instruments, except optical[3]
3827-	Optical instruments and lenses
38271	Sighting, tracking, and fire control equipment, optical type[3]
38272	Binoculars and astronomical instruments[3]
38273	Optical instruments and lenses, n.e.c.[3]
38270	Optical instruments and lenses, n.s.k.
3829-	Measuring and controlling devices, n.e.c.
38291	Aircraft engine instruments, except flight[3]
38292	Physical properties and kinematic testing and inspection equipment[3]
38294	Nuclear radiation detection and monitoring instruments[3]
38295	Commercial, geophysical, meteorological, and general-purpose instruments and equipment[3]
38296	Surveying and drafting instruments and associated equipment[3]
38290	Measuring and controlling devices, n.e.c., n.s.k.
3841-	Surgical and medical instruments
38411	Surgical and medical instruments and apparatus
38412	Hospital furniture
38410	Surgical and medical instruments, n.s.k.
3842-	Surgical appliances and supplies
38421	Surgical, orthopedic, prosthetic, and therapeutic appliances and supplies
38423	Personal industrial safety devices
38424	Electronic hearing aids
38420	Surgical appliances and supplies, n.s.k.
3843-	Dental equipment and supplies
38431	Dental professional equipment and supplies
38432	Dental laboratory equipment and supplies
38430	Dental equipment and supplies, n.s.k.
3844-	X-ray apparatus and tubes
38440	Irradiation (ionizing radiation) equipment[3]
3845-	Electromedical equipment
38450	Electromedical equipment[3]
3851-	Ophthalmic goods
38511	Ophthalmic fronts and temples
38514	Glass ophthalmic focus lenses
38515	Plastics ophthalmic focus lenses
38516	Contact lenses
38517	Ophthalmic goods, n.e.c.
38510	Ophthalmic goods, n.s.k.
3861-	Photographic equipment and supplies
38611	Still picture equipment
38612	Photocopying equipment[3]
38613	Motion picture equipment
38614	Microfilming, blueprinting, and whiteprinting equipment
38615	Photographic sensitized film and plates, silver halide type
38616	Sensitized photographic paper and cloth, silver halide type
38617	Sensitized photographic film, plates, paper, and cloth, other than silver halide type
38618	Prepared photographic chemicals
38619	X-ray film and plates
38610	Photographic equipment and supplies, n.s.k.
3873-	Watches, clocks, watchcases, and parts*
38731	Watches, watchcases, movements or modules, and watch parts
38732	Clocks, timing mechanisms, time switches, clock movements, clock cases, and parts
38730	Watches, clocks, and watchcases, n.s.k.