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THE PRIVATE SECTOR ECONOMIC AND EMPLOYMENT BENEFITS TO THE NATION AND TO EACH STATE OF PROPOSED FY 1990 NASA PROCUREMENT EXPENDITURES

Prepared For

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EXECUTIVE SUMMARY

This report estimates the private sector economic and employment benefits (disaggregated among 80 industries and 475 occupations) of proposed FY 1990 NASA procurement expenditures to the nation and to each state. Nationwide, it finds that FY 1990 NASA procurement expenditures of $11.3 billion will have an economic multiplier of 2.1 and will create, directly and indirectly:

- 237,000 jobs[a]
- $23.2 billion in total industry sales
- $2.4 billion in corporate profits
- $7.4 billion in Federal, state, and local government tax revenues

These benefits are widely dispersed throughout the United States and are significant in many states not normally considered to be major beneficiaries of NASA spending (Figure EX.1).

This study (the first comprehensive analysis of the state-by-state industry and job effects of NASA procurement spending) finds that the industries benefiting the most from NASA procurement include many in the basic manufacturing and the high technology areas. Examining the indirect effects of NASA procurement emphasizes that NASA spending supports such basic industries as Iron and Steel Manufacturing, Metalworking Machinery, and Chemicals (Table EX.1).

Table EX.1 illustrates (for select industries) the indirect economic multipliers resulting from proposed FY 1990 NASA procurement expenditures. For each industry these multipliers show the ratio of total to direct output requirements resulting from NASA procurement spending. The larger the multiplier, the greater are the indirect requirements for the output of the industry generated by NASA procurement. The multipliers are seen to vary widely among individual industries, ranging from a high of 42 for Iron and Steel Manufacturing to a low of 1.2 for Aircraft and Parts.

The jobs created (Table EX.2) are disproportionately concentrated among Scientists, Engineers, and skilled workers, and NASA procurement programs are thus a significant factor in

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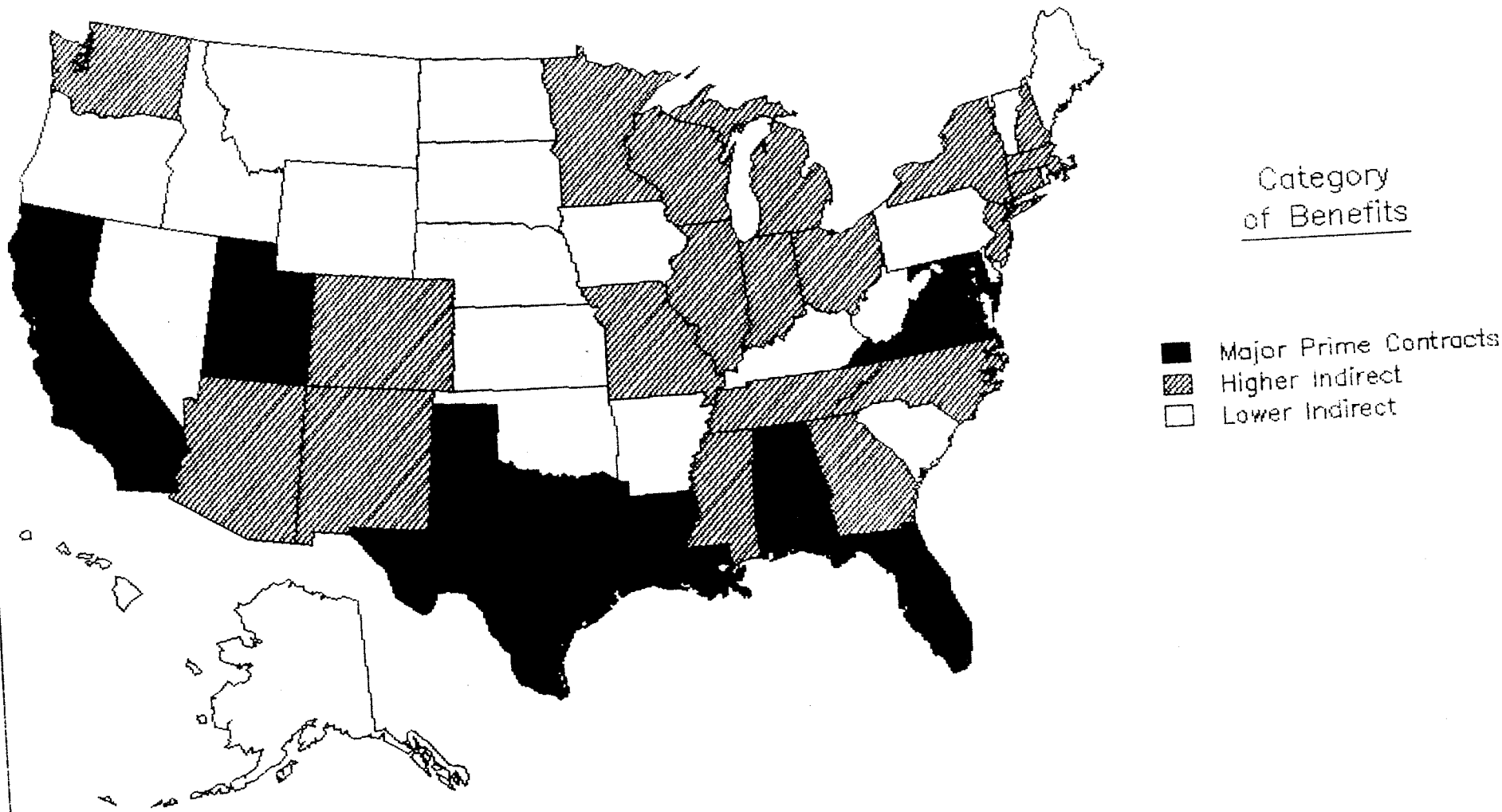
[a]These are jobs in private industry and do not include NASA employees or other Federal workers.

Figure EX.1

States Benefiting Most from U.S. Space Program
Fiscal Year 1990



Source: Management Information Services, Inc.; 1989.

Table EX.1

Indirect Economic Multipliers Resulting from Proposed NASA FY 1990 Procurement Expenditures -- Selected Industries

Industry	Multiplier[a]
Primary Iron and Steel Manufacturing	41.8
Primary Nonferrours Metals Manufacturing	30.0
Electric Lighting and Wiring Equipment	13.5
Rubber and Misc. Plastics Products	8.3
Metalworking Machinery	8.1
Electronic Components	6.7
Misc. Fabricated Metal Products	5.9
Electric, Gas, and Sanitary Services	4.5
Chemicals and Selected Chemical Products	3.2
Metal Containers	3.2
Wholesale and Retail Trade	3.0
Communications, except Radio and Television	2.4
Business Services	2.4
Electrical Transmission Equipment	2.3
Transportation and Warehousing	2.2
Electrical Transmission Equipment	2.3
Transportation and Warehousing	2.2
AVERAGE, ALL INDUSTRIES	2.1
Motor Vehicles and Equipment	2.0
Optical, Ophthalmic, and Photgraphic Equipment and Supplies	1.8
Petroleum Refining and Related Industries	1.8
Office, Computing, and Accounting Machines	1.7
Engines and Turbines	1.4
Aircraft and Parts	1.2
Miscellaneous Transportation Equipment	1.1

[a]Ratio of total to direct output requirements.

Source: Management Information Services, Inc., 1989.

Table EX.2

Jobs Created by Proposed FY 1990 NASA Procurement Expenditures Within Selected Occupations, Ranked by Relative Job Impact

Rank[a]		Jobs Created
1	Aerospace Engineers	3,441
2	Mechanical Engineering Technicians	577
3	Electronic Repairers, Communications Equipment	915
4	Inspectors and Testors	1,556
5	Aircraft Engine Mechanics	881
6	Electrical Engineers	5,304
7	Mathematicians	123
8	Electrical Equipment Asseblers	2,047
9	Solderers and Brazers	395
10	Metallurgical Engineers	344
11	Industrial Engineers	2,288
12	Operations and Systems Researchers	1,359
13	Electrical Technicians	2,404
14	Mechanical Engineers	2,413
15	Grinding and Polishing Machine Operators	1,266
16	Metal Plating Machine Operators	394
17	Tool and Die Makers	1,272
18	Misc. Engineering Technicians	1,653
19	Computer Programmers	2,736
20	Marine Engineers	98
21	Purchasing Agents and Buyers	1,472
22	Technical Writers	329
23	Chemical Engineers	476
24	Computer Systems Analysts	1,620
25	Misc. Engineers	986
26	Misc. Science Technicians	344
27	Drafting Occupations	1,174
28	Civil Engineers	897
29	Mining Engineers	52
30	Chemists, except Biochemists	412

[a]Ranked on the basis of the percent job impact on the occupation.

Source: Management Information Services, Inc., 1989

the labor market for many Science, Engineering, and skilled occupations. Nevertheless, the study determines that NASA expenditures create (in absolute terms) many more jobs for blue collar and lesser skilled labor not normally linked to the Space Program. Substantial numbers of jobs are created in virtually every industry and every occupation.

The total sales and jobs created in each state by proposed FY 1990 NASA procurement expenditures are estimated (Table EX.3). As expected, significant industry and job benefits accrue to those states such as California, Texas, and Florida that are the largest direct recipients of NASA procurement funds. However, as Table EX.3 shows, all states benefit economically from the Space Program and significant benefits accrue to states other than those receiving the prime contract awards.

A major purpose of the analysis is to identify the indirect economic benefits to each state resulting from the U.S. Space program -- the benefits flowing from the second- third- and fourth rounds of industry purchases generated by NASA procurement expenditures. For some states these are found to be very high, with multipliers of total to direct benefits of 10 to 1 and higher (Table EX.4 and Figure EX.2).

Each state is ranked on the basis of several criteria, including the total benefits, indirect benefits, and per capita benefits received from NASA spending. These criteria permit the identification of the states benefitting the most, both directly and indirectly, from proposed FY 1990 NASA procurement (Figure EX.1).

The states receiving the most benefits directly, the major prime contractor award states, are (Figure EX.1): Alabama, California, Florida, Louisiana, Maryland, Texas, Utah, and Virginia.

The states receiving the most benefits indirectly (Figure EX.1) are: Arizona, Colorado, Connecticut, Georgia, Illinois, Indiana, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Tennessee, Washington, and Wisconsin.

The report thus finds that while high prime contract award states such as California, Texas, and Florida benefit greatly from NASA procurement spending, so also do other states such as Michigan, which receive only a relatively small portion of NASA contracts. As shown in Figure EX.1, these "winners" include many states not usually linked to the Space Program, such as New Jersey, Arizona, Minnesota, Illinois, Tennessee, Wisconsin, Michigan, New Hampshire, and North Carolina.

For example, proposed FY 1990 NASA procurement spending will create (directly and indirectly) 5,700 jobs and $550 million in industry sales in Illinois. Further, for every direct dollar of NASA spending in this state, an additional 10 dollars of spending

Table EX.3

Estimated Sales and Jobs Created in Each State by Proposed FY 1990 NASA Procurement Expenditures

State	Sales (millions)	Sales (% of US)	Employment (number)	Employment (% of US)
Alabama	$858.2	3.7	8,582	3.6
Alaska	35.5	0.2	236	0.1
Arizona	229.6	1.0	2,424	1.0
Arkansas	89.0	0.4	876	0.4
California	6,766.6	29.2	70,332	29.7
Colorado	490.3	2.1	5,381	2.3
Connecticut	601.1	2.6	6,224	2.6
Delaware	32.7	0.1	291	0.1
Dist. Columbia	75.2	0.3	990	0.4
Florida	1,297.5	5.6	14,756	6.2
Georgia	299.7	1.3	3,224	1.4
Hawaii	23.0	0.1	278	0.1
Idaho	21.4	0.1	242	0.1
Illinois	549.2	2.4	5,657	2.4
Indiana	348.3	1.5	3,253	1.4
Iowa	94.7	0.4	1,050	0.4
Kansas	172.0	0.7	1,697	0.7
Kentucky	142.4	0.6	1,358	0.6
Louisiana	535.0	2.3	4,583	1.9
Maine	36.0	0.2	386	0.2
Maryland	994.3	4.3	11,122	4.7
Massachusetts	382.3	1.7	4,208	1.8
Michigan	518.9	2.2	4,582	1.9
Minnesota	164.3	0.7	1,791	0.8
Mississippi	231.9	1.0	2,146	0.9
Missouri	342.3	1.5	3,427	1.4
Montana	18.7	0.1	180	0.1
Nebraska	47.7	0.2	566	0.2
Nevada	30.2	0.1	379	0.2
New Hampshire	58.7	0.3	626	0.3

Table EX.3 (continued)

Estimated Sales and Jobs Created in Each State by Proposed FY 1990 NASA Procurement Expenditures

State	Sales (millions)	Sales (% of US)	Employment (number)	Employment (% of US)
New Jersey	506.0	2.2	5,411	2.3
New Mexico	135.5	0.6	1,242	0.5
New York	711.1	3.1	7,820	3.3
North Carolina	231.3	1.0	2,450	1.0
North Dakota	18.0	0.1	183	0.1
Ohio	928.7	4.0	8,545	3.6
Oklahoma	158.7	0.7	1,358	0.6
Oregon	67.3	0.3	731	0.3
Pennsylvania	602.2	2.6	5,955	2.5
Rhode Island	32.3	0.1	347	0.1
South Carolina	109.5	0.5	1,139	0.5
South Dakota	18.3	0.1	221	0.1
Tennessee	209.1	0.9	2,237	0.9
Texas	2,105.4	9.1	19,528	8.3
Utah	590.8	2.6	5,895	2.5
Vermont	21.1	0.1	226	0.1
Virginia	631.2	2.7	6,666	2.8
Washington	308.4	1.3	3,173	1.3
West Virginia	61.0	0.3	502	0.2
Wisconsin	193.0	0.8	1,991	0.8
Wyoming	28.0	0.1	210	0.1
Total	$23,153.2	-	236,679	-

Source: Management Information Services, Inc.; 1989.

Table EX.4

Economic Multipliers for Selected States Resulting From Proposed FY 1990 NASA Procurement Expenditures

	Multiplier[a]
Michigan	14.0 to 1
Indiana	12.0 to 1
Illinois	9.8 to 1
Missouri	8.3 to 1
Oregon	6.7 to 1
North Carolina	5.6 to 1
Georgia	5.5 to 1
Wisconsin	5.2 to 1
Tennessee	5.1 to 1
New York	4.6 to 1
Pennsylvania	4.0 to 1
Kansas	3.8 to 1
Ohio	3.8 to 1
Massachusetts	2.7 to 1
Mississippi	2.1 to 1
Arizona	2.0 to 1
New Jersey	2.0 to 1
Texas	1.8 to 1
California	1.8 to 1
Alabama	1.4 to 1
Florida	1.1 to 1

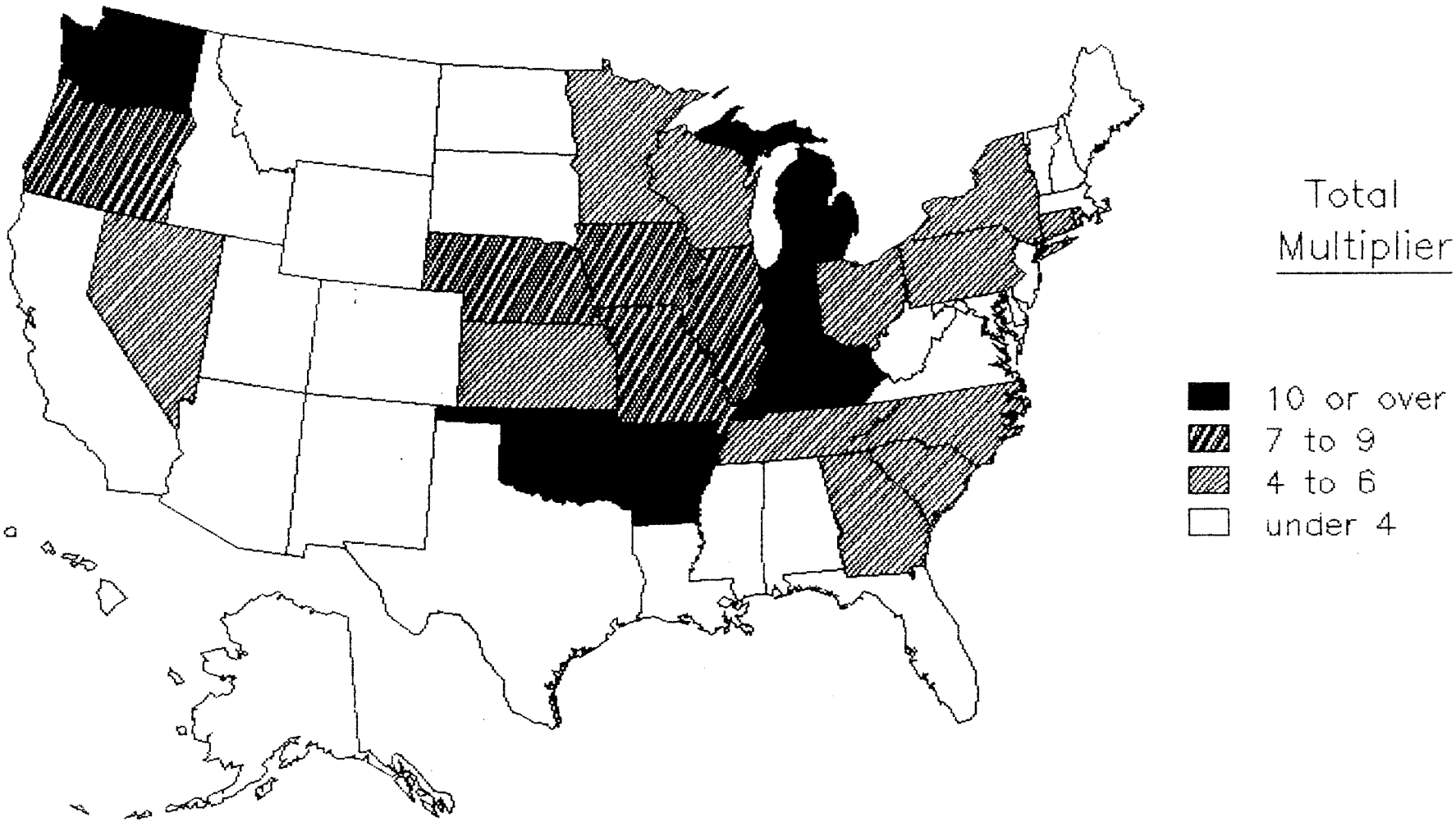
[a]Ratio of total (direct plus indirect) economic benefits to direct economic benefits.

Source: Management Information Services, Inc., 1989.

Figure EX.2

NASA Indirect Economic Benefits by State

Fiscal Year 1990



Source: Management Information Services, Inc.; 1989.

will be generated indirectly by the NASA procurement budget.

This may seem counterintuative, since Illinois is not generally considered to be a state that benefits greatly from the Space Program. However, Illinois benefits substantially from NASA spending. Its industries produce the goods and services required indirectly by the recipients of NASA procurement awards: capital goods, electronic components, scientific instruments, chemical products, primary and fabricated metal products, specialized business services, etc. Further, because of the widely based, indirect nature of these economic benefits to the state, Illinois will benefit greatly from NASA procurement spending in other states on a wide variety of programs, and its benefits are not tied to a specific contract, project, or program. In this sense, a state like Illinois is a more certain beneficiary of NASA spending than are some states receiving sizable prime contract awards.

The implications of these results are discussed.

The major conclusions of this study are:

- The detailed economic and job benefits of the U.S. Space Program can be reliably estimated by industry and occupation for the nation and for each state.

- The total (direct plus indirect) economic and employment benefits are between two and three times larger than is usually assumed, and are much more pervasive than is generally recognized.

- The major beneficiaries -- specific industries, occupations, and states -- include many which have heretofore not been linked closely to the Space Program or to NASA procurement.

- NASA spending plays a key role in supporting U.S. basic manufacturing and high technology industries.

- NASA procurement expenditures have a disproportionately large impact on the labor markets for Scientists, Engineers, and skilled workers.

- The estimates developed here are important for maintaining a viable U.S. Space Program through the remainder of this century.

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PREFACE

This study was undertaken by Management Information Services, Inc. for the NASA Alumni League to determine the effects which the proposed NASA procurement budget for Fiscal Year 1990 will likely have on the nation's economy and on the economies of each state. An earlier study by MISI for the NAL analyzed the impact of FY 1987 NASA procurement expenditures.

I. INTRODUCTION

The long run economic benefits of the U.S. Space Program have been identified over the past three decades. These include spin-offs, support of research and development, creation of public goods, and the development of new space industries. However, the immediate, near term benefits to the nation's economy of NASA expenditures have not been estimated. This is unfortunate, since NASA, like every major Federal agency, should have some idea of the likely impact of its programs on the economy, on specific industries and labor markets, and on regions and states. Such economic impact information would be useful in assessing the effects of agency budgets and could assist in program planning.

Thus, an important question that must be addressed is the impact that NASA spending is likely to have on a particular state, industry, or labor market.

The MISI analysis presented here answers the question by showing the direct and indirect economic benefits of proposed FY 1990 NASA procurement expenditures to the nation and to each state. Specifically, the analysis shows:

- The total economic benefits to the private sector -- increase in economic product -- likely to accrue to the nation and to each state from the proposed FY 1990 NASA procurement budget.
- The jobs and industry sales likely to be created in each state by the procurement program.
- The jobs created within each of 475 occupations by NASA procurement expenditures.
- The total Federal, state, and local government tax revenues generated the NASA programs.
- The direct and the indirect sales created within each industry.
- The multiplier effect which NASA procurement has on the economy of each state.
- The impact on key industries, occupations, and R&D sectors of spending on NASA programs.

This type of analysis, while based on well established and validated economic methodology, has never before been applied to the U.S. Space Program or to the NASA budget. Given the intense current debate over the future of the civilian Space Program, the analysis is long overdue.

II. TRADITIONAL ECONOMIC RATIONALE FOR THE SPACE PROGRAM

Over the years advocates of the Space Program have identified several types of economic benefits of the U.S. Space Program:

- o public goods.
- o spin-offs.
- o R & D support.
- o creation of new space industries.

Public Goods

Public goods are commodities which only the government can provide in sufficient quantity, since their benefits cannot be captured by private investors in the form of profit, and they remain underproduced unless the government intervenes. For the Space Program these include knowledge gained about the universe and it's origins, information on the characteristics and the history of the earth and solar system, and related basic scientific knowledge.

Spin-offs

Spin-offs are those technologically advanced products and processes developed for the Space Program which ultimately find productive uses in other areas--areas often unrelated to space exploration. These include photovoltaics, advances in aerodynamic design, enhanced telecommunications systems, breakthroughs in microelectronics, improved chemical processes, and so forth.

Research and Development Support

The Space Program enhances the nation's technology base and that of specific industries, and Program advocates argue that it is vital to the technological competitiveness of U.S. industry. Studies have shown that investments in NASA R & D have a return of between five and ten to one over a 25 year horizon, and few doubt the importance of R & D programs for the U.S. economy.

Creation of New Space-Based Industries

Advocates of ambitious space programs emphasize the potential for creating new space-based industries, including private launch services, materials processing in space and related applications of a microgravity environment, remote imaging, infrastructure development, and so forth. Obviously, without a strong U.S. government Space Program, development of these new industries will be delayed and

opportunities lost to other nations.

The analysis developed by MISI for NAL provides another measure of the economic effects of the Space Program, for it identifies the specific industries, regions, and jobs benefiting the most from NASA procurement expenditures. It thus provides findings necessary for assessing the economic viability of the U.S. Space Program during the 1990s.

III. THE DIRECT AND INDIRECT ECONOMIC AND EMPLOYMENT BENEFITS OF EXPENDITURES ON THE SPACE PROGRAM

Here we estimate the following benefits of proposed FY 1990 NASA procurement expenditures:

- o direct and indirect
- o economic
- o employment
- o national
- o state-specific

Direct and Indirect

The benefits estimated here include those resulting from the initial procurement expenditures as well as those generated indirectly throughout the economy by the expenditures. Where appropriate, the multipliers (ratio of total benefits to direct benefits) are computed.

Economic

The benefits to each of 80 all-inclusive two-digit SIC industries are estimated. The benefits are the increased output, sales, and profits generated by the Space Program expenditures.

Employment

The total number of jobs created in each of the 80 industries and in each of 475 all-inclusive occupations is estimated. The job data pertain to full-time equivalent (FTE) person-years.

National

Output, sales, profits, and employment are estimated for each industry at the national level, and for each occupation the total number of jobs created nationwide is derived.

State-specific

Output, sales, profits, and employment are estimated for each industry at the state level, for each occupation the total number of jobs created within every state is derived, and the tax revenues generated in the state are computed.

IV. THE MISI APPROACH: ESTIMATING THE TOTAL (DIRECT PLUS INDIRECT) EFFECTS

The economic and employment effects of proposed FY 1990 NASA procurement expenditures were computed using the Management Information Services, Inc. data base and information system. A simplified version of the MISI model is illustrated in Figure IV.1, and the specification of the NASA budget simulations is shown in Figure IV.2.

The basis of the model used here is economic input-output analysis. This analytical methodology was developed by Wassily Leontief (for which he was awarded the Nobel Prize in Economics), and it has been widely used and validated over the past five decades by economists in many nations.

The first step is the translation of expenditures for a program or set of programs into per unit output requirements from every industry in the economy. This is determined by four major factors: 1) the state of technology, 2) the distribution of expenditures, 3) the specific program configuration, and 4) the direct industry requirements structure. While the model contains 500 industries, in the work conducted here an 80-order industry scheme was used -- see Table IV.1.

Second, the direct output requirements of every industry affected as a result of expenditures on the program are estimated. These direct requirements show, proportionately, how much an industry must purchase from every other industry to produce one unit of output.

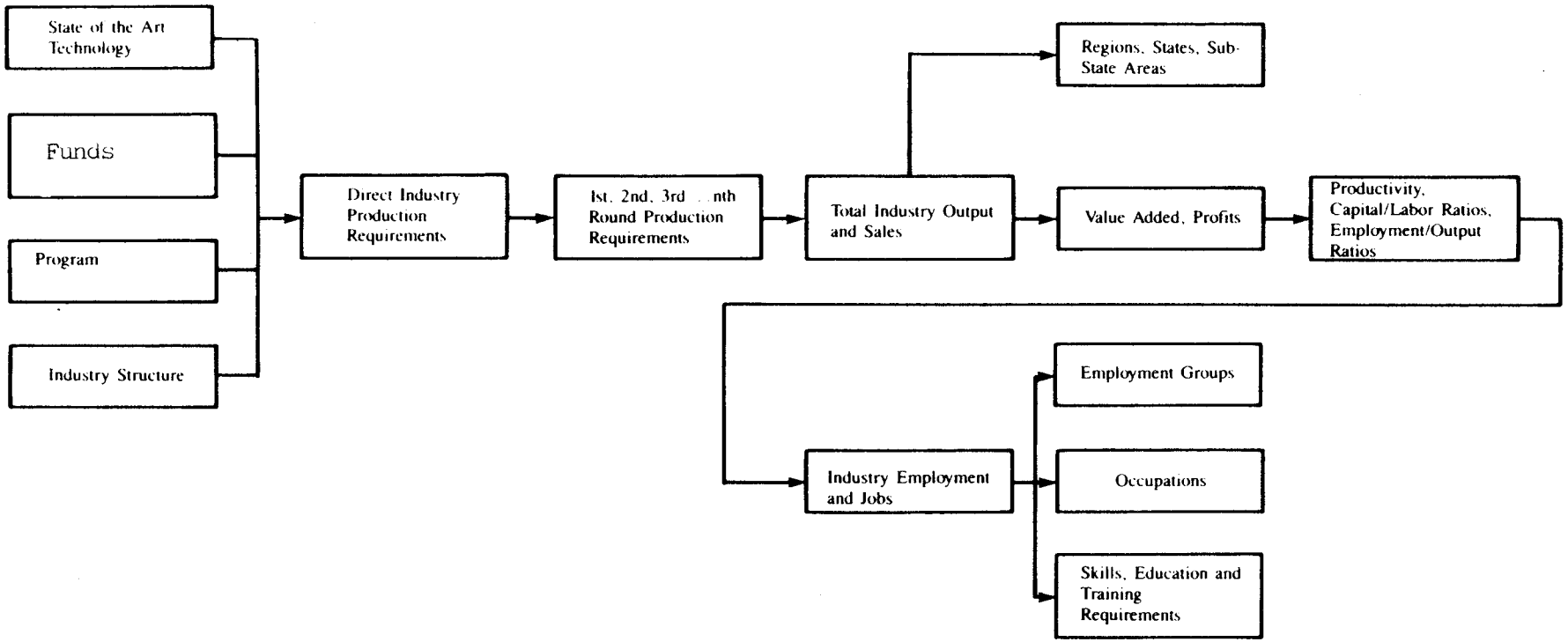
Direct requirements, however, give rise to subsequent rounds of indirect requirements. For example, steel mills require electricity to produce steel. But an electric utility requires turbines from a factory to produce electricity. The factory requires steel from steel mills to produce turbines, and the steel mill requires more electricity, . . ., and so on.

The latter are the indirect requirements. The sum of the direct plus the indirect requirements represents the total output requirements from an industry necessary to produce one unit of output. Economic input-output (I-O) techniques allow us to compute the direct as well as the indirect production requirements, and these total requirements are represented by the "inverse" equations in the model. The ratio of the total requirements to the direct requirements is called the input-output multiplier.

Thus, in the third step in the model the direct industry output requirements are converted into total output requirements from every industry by means of the input-output inverse equations. These equations show not only the direct requirements, but also the second, third, fourth, . . ., nth round indirect industry and service sector requirements resulting from expenditures on the Space program.

Figure IV.1

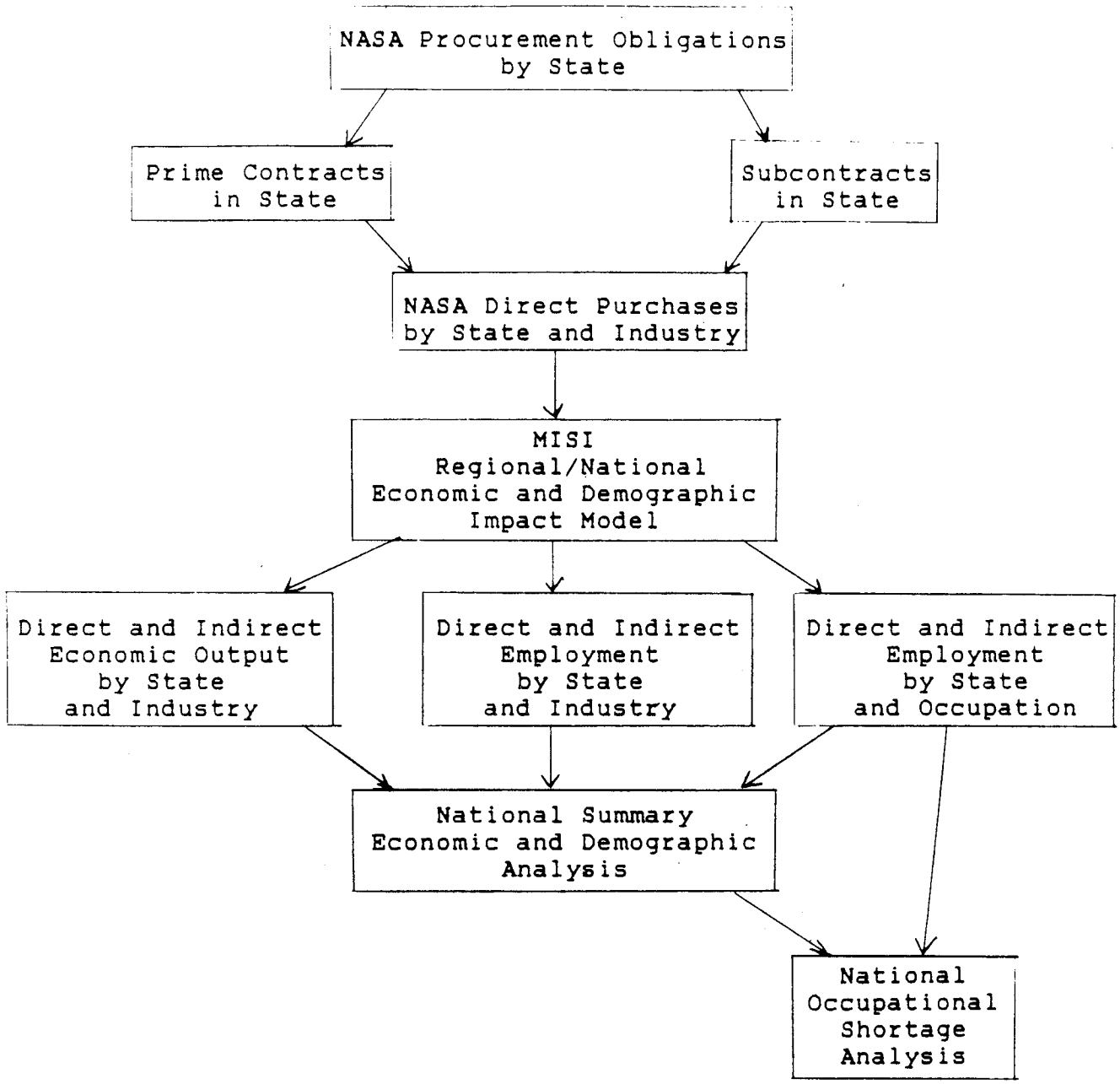
Estimating the Economic and Employment Effects of the U.S. Space Program



Source: Management Information Services, Inc., 1989

Figure IV.2

MISI National and Regional Analysis of the Impacts of NASA Procurements



Source: Management Information Services, Inc., 1989

Table IV.1

80-Order U.S. Input-Output Industries

Industry number and title	Related Census SIC codes (1972 edition)
AGRICULTURE, FORESTRY, AND FISHERIES	
1. Livestock and livestock products	pt. 01, pt. 02
2. Other agricultural products	pt. 01, pt. 02
3. Forestry and fishery products	081–4, 091, 097
4. Agricultural, forestry, and fishery services	0254, 07 (excl. 074, 075), 092
MINING	
5. Iron and ferroalloy ores mining	101, 106
6. Nonferrous metal ores mining	102–5, pt. 108, 109
7. Coal mining	1111, pt. 1112, 1211, pt. 1212
8. Crude petroleum and natural gas	131, 132, pt. 138
9. Stone and clay mining and quarrying	141–5, pt. 148, 149
10. Chemical and fertilizer mineral mining	147
CONSTRUCTION	
11. New construction	pt. 15–17, pt. 108, pt. 1112, pt. 1212, pt. 148
12. Maintenance and repair construction	pt. 15–17, pt. 138
MANUFACTURING	
13. Ordnance and accessories	3482–4, 3489, 3761, 3795
14. Food and kindred products	20
15. Tobacco manufactures	21
16. Broad and narrow fabrics, yarn and thread mills	221–4, 226, 228
17. Miscellaneous textile goods and floor coverings	227, 229
18. Apparel	225
19. Miscellaneous fabricated textile products	239
20. Lumber and wood products, except containers	241–3, 2448, 249
21. Wood containers	2441, 2449
22. Household furniture	251
23. Other furniture and fixtures	252–4, 259
24. Paper and allied products, except containers and boxes	261–4, 266
25. Paperboard containers and boxes	265
26. Printing and publishing	27
27. Chemicals and selected chemical products	281, 286–7, 289
28. Plastics and synthetic materials	282
29. Drugs, cleaning and toilet preparations	283–4
30. Paints and allied products	285
31. Petroleum refining and related industries	29
32. Rubber and miscellaneous plastics products	30
33. Leather tanning and finishing	311
34. Footwear and other leather products	313–7, 319
35. Glass and glass products	321–3
36. Stone and clay products	324–9
37. Primary iron and steel manufacturing	331–2, 339, 3462
38. Primary nonferrous metals manufacturing	333–6, 3463
39. Metal containers	341
40. Heating, plumbing, and fabricated structural metal products	343–4
41. Screw machine products and stampings	345, 3465–6, 3469
42. Other fabricated metal products	342, 347, 349
43. Engines and turbines	351
44. Farm and garden machinery	352
45. Construction and mining machinery	3531–3
46. Materials handling machinery and equipment	3534–7
47. Metalworking machinery and equipment	354
48. Special industry machinery and equipment	355
49. General industrial machinery and equipment	356
50. Miscellaneous machinery, except electrical	359
51. Office, computing, and accounting machines	357
52. Service industry machines	358
53. Electrical transmission and distribution equipment and industrial apparatus	361–2, 3825
54. Household appliances	363
55. Electric lighting and wiring equipment	364
56. Radio, TV, and communication equipment	365–6
57. Electronic components and accessories	367
58. Miscellaneous electrical machinery, equipment, and supplies	369
59. Motor vehicles and equipment	371
60. Aircraft and parts	372
61. Other transportation equipment	373–5, 3792, 3799, 2451
62. Professional, scientific, and controlling instruments and supplies	381, 3822–4, 3829, 384, 387
63. Optical, ophthalmic, and photographic equipment and supplies	383, 385–6
64. Miscellaneous manufacturing	39
TRANSPORTATION, COMMUNICATION, AND UTILITIES	
65. Transportation and warehousing	40–2, 44–7
66. Communications, except radio and TV	481–2, 489
67. Radio and TV broadcasting	483
68. Electric, gas, water, and sanitary services	49
WHOLESALE AND RETAIL TRADE	
69. Wholesale and retail trade	50–57, 59, 7396, 5042
FINANCE, INSURANCE, AND REAL ESTATE	
70. Finance and insurance	60–64, 67
71. Real estate and rental	65–6, pt. 1531
SERVICES	
72. Hotels and lodging, personal and repair services (except auto)	70–7, 762–4, pt. 7699
73. Business services	73 (excl. 7396), 7692, 7694, pt. 7699
74. Eating and drinking places	58
75. Automobile repair and services	75
76. Amusements	78–9
77. Health, educational, and social services and nonprofit organizations	074, 80 (excl. 8042), 82–84, 86, 8922
GOVERNMENT ENTERPRISES	
78. Federal Government enterprises	not applicable
79. State and local government enterprises	not applicable
DUMMY AND SPECIAL INDUSTRIES	
80. Noncomparable imports	
81. Scrap, used, and secondhand goods	
82. Government industry	
83. Rest of the world industry	
84. Household industry	
85. Inventory valuation adjustment	
FINAL DEMAND	
91. Personal consumption expenditures	
92. Gross private domestic fixed investment	
93. Change in business inventories	
94. Exports	
95. Imports	
96. Federal Government purchases, national defense	
97. Federal Government purchases, nondefense	
98. State and local government purchases, education	
99. State and local government purchases, other	

Source: U.S. Department of Commerce, Bureau of Economic Analysis

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Next, the total output requirements from each industry are used to compute sales volumes, profits, and value added for each industry. Then, using data on manhours, labor requirements, and productivity, employment requirements within each industry are estimated. This allows computation of the total number of jobs created within each industry.

The next step requires the conversion of total employment requirements by industry into job requirements for specific occupations and skills. To accomplish this, MISI utilizes data on the occupational composition of the labor force within each industry and estimates job requirements for 475 specific occupations encompassing the entire U.S. labor force. This permits estimation of the impact of the program on jobs for specific occupations and on skills, education, and training requirements.

Utilizing the modeling approach outlined above, MISI estimated the effects on employment, personal income, corporate sales and profits, and government tax revenues in the United States and in each state. Estimates were then developed for detailed industries and occupations. The results of this analysis serve as the baseline and represent comprehensive and detailed estimates of the national and statewide economic benefits of expenditures on the U.S. Space program.

The next step in the analysis (not conducted here) is to assess the economic impact on specific cities and Metroplitan Statistical Areas (MSAs). The MISI approach permits disaggregation to the level of most U.S. MSAs and, if desired, to the county level.

Empirically, the basis of the sub-state estimates is the Regional Input-Output Modeling System (RIMS II) developed by the U.S. Commerce Department's Bureau of Economic Analysis (BEA) over the past two decades.

RIMS II is based on economic input-output analysis which shows, for each industry, industrial distributions of inputs purchased and outputs sold. A typical input-output table in RIMS II is constructed primarily from two sources: 1) BEA's national I-O table, which shows the input and the output structures of more than 500 U.S. industries, and 2) BEA's four-digit Standard Industrial Classification (SIC) county wage-and-salary data, which were used to adjust the national I-O table to show the Rochester MSA's industrial structure and trading patterns.

The main data sources for RIMS II permit economic impacts to be estimated for any region composed of one or more counties and for any industry in the national I-O table. RIMS II can be used to estimate the impacts of project and program expenditures by industry on regional output (gross receipts or sales), earnings (the sum of wages and salaries, proprietors' income, and other labor income, less employer contributions to private pension and welfare funds), and employment. The use of the RIMS II methodology has been validated in independent studies over the past two decades.

For MSAs the MISI model permits estimation of the impact on requirements for specific occupations. To accomplish this it utilizes the MISI occupation-by-industry matrix, the coefficients of which show the percent distribution of occupational employment among all industries. The 80-by-475 matrix was developed from the 1983 Current Population Survey, updated by MISI to 1990, and is aggregated to 39 industries to conform to the RIMS II industry aggregation.

The MISI model was developed using publicly available data from the U.S. Department of Commerce and the U.S. Department of Labor. The data on proposed NASA procurement expenditures used in the study are publicly available from the National Aeronautics and Space Administration.

V. BENEFITS AT THE NATIONAL LEVEL

We first wish to determine the total (direct plus indirect) economic and employment impact at the national level of proposed FY 1990 NASA procurement expenditures. We simulated the effects of the proposed FY 1990 NASA procurement awards ($11.3 billion--see Table V.1) on sales, earnings, profits, and employment within 80 all-inclusive industries.

These impacts at the national level are summarized in Table V.2. This table shows that in 1990 NASA procurement of $11.3 billion is estimated to:

- generate $23.2 billion in total industry sales.
- have a multiplier effect on the economy of 2.1.
- create 237,000 jobs.
- create $2.4 billion in total industry profits.
- generate $7.4 billion in Federal, state, and local government tax revenues.

The total sales generated within each industry are shown in Table V.3, and these industries are ranked in Table V.4. As expected, the largest total impacts of NASA procurement are concentrated in Aircraft and Parts, Ordnance and Accessories, Radio, T.V., and Communications Equipment, and related industries.

The rankings in Table V.4 show the total impact on each industry's output of NASA FY 1990 procurement spending and are useful in determining where the largest dollar impacts will be. However, the size of these industries differs greatly: The output of the Business Services industry ($551 billion) is 17 times that of the Ordnance and Accessories industry ($32 billion); the output of the Transportation and Warehousing industry ($337 billion) is 6 times that of the Electronic Components industry ($58 billion). Thus a somewhat more meaningful measure of the relative importance of NASA procurement for each industry is the total output requirements of that industry generated by NASA procurement as a percent of the total industry output. These rankings of relative impacts are given in Table V.5.

This table shows that, in relative terms (based on industry size), NASA procurement spending impacts a somewhat different profile of industries than indicated in Table V.5. Some industries for which NASA procurement generates small amounts of output requirements, such as Wooden Containers ($5 million), Iron Ore Mining ($23 million), and Misc. Fabricated Metal Products ($98 million), are nevertheless greatly affected because of their relatively small size. In fact, based on percent impact, the Wooden Container industry is one of the main beneficiaries of NASA expenditures.

Table V.1

Summary of NASA Procurement Awards, FY 1988

	Amount (millions)	Percent	
Total	$9,545.1	100	-
Business Firms	7,274.9	76	100
Rockwell International Corp. Downey, CA	1,714.2	-	24
Lockheed Space Operations Co. Kennedy Space Center, FL	474.3	-	7
Morton Thiokol Inc. Brigham City, UT	422.8	-	6
Martin Marietta Corp. New Orleans, LA	341.0	-	5
McDonnell Douglas Corp. Huntington Beach, CA	299.1	-	4
Educational & Nonprofit	499.8	5	100
Stanford University Stanford, CA	27.7	-	6
Assn. Univ. Research & Astron. Baltimore, MD	23.7	-	5
New Mexico St. Univ.(Las Cruces) Palestine, TX	19.2	-	4
Universities Space Research Columbia, MD	17.0	-	3
Mass. Institute of Technology Cambridge, MA	14.3	-	3
Jet Propulsion Laboratory	979.9	10	100
Subcontracts	625.3	-	64
Other Government Agencies	734.6	8	100
Air Force	324.8	-	44
Treasury Department	176.7	-	24
Outside United States	55.9	1	-

Source: NASA Annual Procurement Report, FY1988; MISI; 1989.

Table V.2
Overview of the Economic Benefits of Proposed
FY 1990 NASA Procurement Expenditures

Procurement Expenditures (millions)	$11,300
Total Sales Generated (millions)	$23,153
Economic Multiplier	2.1
Total Jobs Created	236,679
Total Profits Generated (millions)	$2,443
Total Federal, State, and Local Government Tax Revenues Generated (millions)	$7,431

Source: Management Information Services, Inc., 1989

Table V.3

Impact of Proposed FY 1990 NASA Procurement Expenditures on Output by Industry

Industry Title	Sales (millions)
Livestock & livestock products	$33.9
Other agricultural products	117.7
Forestry & fishery products	13.9
Agricultural, forestry & fishery services	20.7
Iron & ferroalloy ores mining	23.2
Nonferrous metal ores mining	41.3
Coal mining	86.0
Crude petroleum & natural gas	776.4
Stone & clay mining & quarrying	18.4
Chemical & fertilizer mineral mining	10.7
New construction	317.2
Maintenance & repair construction	679.3
Ordnance & accessories	2,438.1
Food & kindred products	107.1
Tobacco manufactures	0.1
Broad & narrow fabrics, yarn & thread mills	92.7
Miscellaneous textile goods & floor coverings	23.9
Apparel	62.3
Miscellaneous fabricated textile products	24.0
Lumber & wood products, exc. containers	125.8
Wood containers	4.8
Household furniture	14.6
Other furniture & fixtures	11.4
Paper & allied products	143.6
Paperboard containers & boxes	55.7
Printing & publishing	248.8
Chemicals & selected chemical products	376.9
Plastics & synthetic materials	131.7
Drugs, cleaning & toilet preparations	46.6
Paints & allied products	35.2
Petroleum refining & related industries	949.7
Rubber & miscellaneous plastics products	288.0
Leather tanning & finishing	1.8
Footwear & other leather products	4.8
Glass & glass products	36.3
Stone & clay products	119.2
Primary iron & steel manufacturing	512.0
Primary nonferrous metals manufacturing	671.4
Metal containers	19.0
Heating, fabricated metal products	186.5
Screw machine products & stampings	156.1
Other fabricated metal products	227.0

Table V.3 (continued)

Impact of Proposed FY 1990 NASA Procurement Expenditures on Output by Industry

Industry Title	Sales (millions)
Engines & turbines	152.2
Farm & garden machinery	9.8
Construction & mining machinery	40.3
Materials handling machinery	28.9
Metalworking machinery	98.1
Special industry machinery	19.2
General industrial machinery	156.1
Miscellaneous machinery, except electrical	184.2
Office, computing, & accounting machines	217.9
Service industry machines	35.6
Electrical transmission equipment	197.2
Household appliances	21.8
Electric lighting & wiring equipment	63.7
Radio, TV & communication equipment	1,392.6
Electronic components	722.1
Miscellaneous electrical machinery	50.1
Motor vehicles & equipment	354.7
Aircraft & parts	3,647.1
Other transportation equipment	490.2
Professional & scientific supplies	141.9
Optical & photographic equipment	136.6
Miscellaneous manufacturing	36.3
Transportation & warehousing	982.5
Communications, except radio & TV	257.9
Radio & TV broadcasting	49.4
Electric, gas, & sanitary services	784.0
Wholesale & retail trade	841.2
Finance & insurance	272.6
Real estate & rental	430.9
Hotels & personal services	164.8
Business services	1,244.9
Eating & drinking places	209.3
Automobile repair & service	97.4
Amusements	57.1
Health & educational & nonprofit	80.4
Federal government enterprises	106.2
State & local government enterprises	124.2
Total	$23,153.2

Source: Management Information Services, Inc.; 1989.

Table V.4

Impact of Proposed FY 1990 NASA Procurement Expenditures, Ranked by Industry

Industry Title	Percent of Total
Aircraft & parts	15.8
Ordnance & accessories	10.5
Radio, TV & communication equipment	6.0
Business services	5.4
Transportation & warehousing	4.2
Petroleum refining & related industries	4.1
Wholesale & retail trade	3.6
Electric, gas, & sanitary services	3.4
Crude petroleum & natural gas	3.4
Electronic components	3.1
Maintenance & repair construction	2.9
Primary nonferrous metals manufacturing	2.9
Primary iron & steel manufacturing	2.2
Other transportation equipment	2.1
Real estate & rental	1.9
Chemicals & selected chemical products	1.6
Motor vehicles & equipment	1.5
New construction	1.4
Rubber & miscellaneous plastics products	1.2
Finance & insurance	1.2
Communications, except radio & TV	1.1
Printing & publishing	1.1
Other fabricated metal products	1.0
Office, computing, & accounting machines	0.9
Eating & drinking places	0.9
Electrical transmission equipment	0.9
Heating, fabricated metal products	0.8
Miscellaneous machinery, except electrical	0.8
Hotels & personal services	0.7
Screw machine products & stampings	0.7
All Other 49 Industries	12.7
Total	100

Source: Management Information Services, Inc.; 1989.

Table V.5

Impact of Proposed 1990 NASA Procurement Expenditures, Ranked by Relative Industry Size (millions of dollars)

Rank		Output[a]
1	Ordnance and Accessories	$2,438
2	Aircraft and Parts	3,647
3	Radio, TV, and Communications Equipment	1,393
4	Electronic Components and Accessories	722
5	Primary Nonferrous Metals Manufactuirng	671
6	Engines and Turbines	152
7	Misc. Machinery, Except Electrical	184
8	Nonferrous Metal Ores Mining	41
9	Primary Iron and Steel Manufacturing	512
10	Iron and Ferroally Ores Mining	23
11	Wooden Containers	5
12	General Industrial Machinery	156
13	Electrical Transmission and Distribution Equipment	197
14	Optical, Ophthalmic, and Photographic Equipment and Supplies	137
15	Crude Petroleum and Natural Gas	776
16	Screw Machine Products and Stampings	156
17	Misc. Fabricated Metal Products	227
18	Metalworking Machinery and Equipment	98
19	Professional, Scientific, and Controlling Instruments and Supplies	142
20	Heating, Plumbing, and Fabricated Stuctural Metal Products	187

[a]Total output requirements generated by proposed FY 1990 NASA procurement expenditures

Source: Management Information Services, Inc., 1989

More important, virtually all of the industries in Table V.5 are basic manufacturing and/or high technology industries. While it has often been hypothesized that NASA spending supports the R & D, high technology, electronics, and related industries, the data in Table V.5 show that this is indeed true. However, it is not generally recognized that NASA spending plays a key role in supporting such basic U.S. industries as Iron and Steel Manufacturing, Nonferrous Metals Manufacturing, Ores Mining, and General Industrial Machinery.

This point is further emphasized in Table V.6, which shows (for selected industries) the indirect economic multipliers resulting from proposed FY 1990 NASA procurement expenditures. These multipliers represent, for the specific industry, the ratio of total to direct output requirements deriving from the 1990 NASA procurement budget. The higher the multiplier, the greater are the indirect requirements for the output of the industry generated by NASA procurement spending. Thus, the multiplier for the Electronic Components industry (6.7) is relatively high because large volumes of electronic equipment are required indirectly to produce NASA procurements. Conversely, the multiplier for the Aircraft and Parts Industry (1.2) is low because, although large procurements are made directly from this industry in the NASA program, the indirect requirements generated are relatively low. That is, not many airplanes are required indirectly to produce airplanes, but large amounts of electronic components are.

The data in Table V.6 show that, per dollar of direct procurement expenditure, NASA programs will result in widely varying indirect effects among industries. These range from indirect multipliers as high as 41.8 for Iron and Steel Manufacturing. 13.5 for Electric Lighting and Wiring Equipment, and 8.1 for Metalworking Machinery to lows near two for Motor Vehicles and Equipment and near one for Engines and Turbines and Aircraft and Parts. In other words, the 1990 NASA procurement budget is estimated to create, indirectly, nearly $7 dollars in sales in Electronic Components for every dollar directly procured in that industry, while it will create, indirectly, only about one dollar of sales indirectly in the Aircraft and Parts industry for every direct dollar of procurement in that industry.

As noted, this result is not surprising. Aircraft and motor vehicles are final products whose components do not enter into the production of other commodities, whereas electronic components are products required in the production of most other goods NASA purchases.

The support that NASA procurement provides (indirectly) for basic U.S. manufacturing industries noted in the discussion of Tables V.4 and V.5 is abundantly clear in Table V.6. Virtually all of the industries with the high multipliers are basic manufacturing industries (concentrated, as noted in the next chapter, in the "rustbelt" states).

This illustrates why it is necessary in assessing the impact of NASA procurement to examine the total impact on the economy, not just the direct procurement expenditures:

Table V.6

Indirect Economic Multipliers Resulting from Proposed NASA FY 1990 Procurement Expenditures -- Selected Industries

Industry	Multiplier[a]
Primary Iron and Steel Manufacturing	41.8
Primary Nonferrours Metals Manufacturing	30.0
Electric Lighting and Wiring Equipment	13.5
Rubber and Misc. Plastics Products	8.3
Metalworking Machinery	8.1
Electronic Components	6.7
Misc. Fabricated Metal Products	5.9
Electric, Gas, and Sanitary Services	4.5
Chemicals and Selected Chemical Products	3.2
Metal Containers	3.2
Wholesale and Retail Trade	3.0
Communications, except Radio and Television	2.4
Business Services	2.4
Electrical Transmission Equipment	2.3
Transportation and Warehousing	2.2
Electrical Transmission Equipment	2.3
Transportation and Warehousing	2.2
AVERAGE, ALL INDUSTRIES	2.1
Motor Vehicles and Equipment	2.0
Optical, Ophthalmic, and Photgraphic Equipment and Supplies	1.8
Petroleum Refining and Related Industries	1.8
Office, Computing, and Accounting Machines	1.7
Engines and Turbines	1.4
Aircraft and Parts	1.2
Miscellaneous Transportation Equipment	1.1

[a]Ratio of total to direct output requirements.

Source: Management Information Services, Inc., 1989.

- In terms of direct procurement, NASA requires about $12 million from the Iron and steel industry.

- In total, however, NASA procurement generates requirements for well over $500 million from this industry.

As discussed below, similar relationships exist between direct and indirect effects, and the consequent multipliers, at the state level.

Table V.7 shows the total employment created in each private sector industry by proposed 1990 NASA procurement expenditures.

The jobs estimated here are in private industry and do not include NASA employees or Federal government workers. If these categories of workers were included in the analysis the employment estimates would be increased by about 25,000 jobs. However, the focus here is on the jobs created in the private sector by NASA procurement spending. Further, it is self-evident that the NASA budget pays the salaries of NASA employees. Nevertheless, given the given the high concentration of scientists, engineers, and computer specialists employed directly by NASA, the Agency's employees must be taken into consideration when assessing the overall impact of NASA spending on the labor market for scientists, engineers, and skilled workers.

The data in Table V.7 illustrate that the distribution of jobs by industry differs in important respects from the distribution of sales shown in Table V.3. Thus, while large numbers of jobs are created in industries such as Aircraft, Ordnance, Business Services, and Communications Equipment, where the generated output requirements are large, employment of equal magnitude is also created in service industries such as Wholesale and Retail Trade, Transportation, Warehousing, Restaurants, and Hotels.

Employment created in these latter industries is large because they are very labor intensive and have low capital labor ratios and low productivity. Because of these factors the types of jobs created in these industries is relatively low skilled and pays relatively low wages.

Nevertheless, it is important to note that NASA procurement spending generates large numbers of jobs in industries not usually associated with the Space Program or the aerospace sector. In fact, as Table V.7 shows, 1990 NASA procurement spending is estimated to create more jobs in Wholesale and Retail Trade than in the Communications Equipment industry, and to generate more employment in Transportation and Warehousing than in the Electronic Components industry.

Table V.8 shows the employment created by NASA procurement disaggregated among major occupational groups, and Table V.9 further disaggregates this employment among 115 occupations selected from the 475 occupations for which job requirements were estimated.[1] These tables show that, as expected, the jobs created are disproportionately in technical, skilled, and specialized occupations. Thus, 1990 NASA procurement spending will create jobs for 17,000 Engineers (seven

Table V.7

Employment Created in Each Industry by Proposed FY 1990
NASA Procurement Expenditures

Industry Title	Employment
Livestock & livestock products	322
Other agricultural products	2,568
Forestry & fishery products	111
Agricultural, forestry & fishery services	829
Iron & ferroalloy ores mining	144
Nonferrous metal ores mining	419
Coal mining	511
Crude petroleum & natural gas	3,051
Stone & clay mining & quarrying	216
Chemical & fertilizer mineral mining	57
New construction	3,750
Maintenance & repair construction	7,132
Ordnance & accessories	20,651
Food & kindred products	556
Tobacco manufactures	0
Broad & narrow fabrics, yarn & thread mills	915
Miscellaneous textile goods & floor coverings	179
Apparel	1,190
Miscellaneous fabricated textile products	348
Lumber & wood products, exc. containers	1,475
Wood containers	65
Household furniture	260
Other furniture & fixtures	143
Paper & allied products	837
Paperboard containers & boxes	440
Printing & publishing	3,028
Chemicals & selected chemical products	1,832
Plastics & synthetic materials	552
Drugs, cleaning & toilet preparations	287
Paints & allied products	193
Petroleum refining & related industries	1,225
Rubber & miscellaneous plastics products	3,058
Leather tanning & finishing	18
Footwear & other leather products	110
Glass & glass products	370
Stone & clay products	1,274
Primary iron & steel manufacturing	3,400
Primary nonferrous metals manufacturing	4,035
Metal containers	87
Heating, fabricated metal products	2,278
Screw machine products & stampings	1,436
Other fabricated metal products	2,801

Table V.7 (continued)

Employment Created in Each Industry by Proposed FY 1990 NASA Procurement Expenditures

Industry Title	Employment
Engines & turbines	925
Farm & garden machinery	87
Construction & mining machinery	291
Materials handling machinery	290
Metalworking machinery	1,401
Special industry machinery	210
General industrial machinery	1,547
Miscellaneous machinery, except electrical	2,568
Office, computing, & accounting machines	1,998
Service industry machines	297
Electrical transmission equipment	2,317
Household appliances	175
Electric lighting & wiring equipment	723
Radio, TV & communication equipment	10,319
Electronic components	10,918
Miscellaneous electrical machinery	442
Motor vehicles & equipment	1,664
Aircraft & parts	33,808
Other transportation equipment	5,785
Professional & scientific supplies	1,921
Optical & photographic equipment	996
Miscellaneous manufacturing	510
Transportation & warehousing	12,910
Communications, except radio & TV	2,249
Radio & TV broadcasting	518
Electric, gas, & sanitary services	3,136
Wholesale & retail trade	19,374
Finance & insurance	3,677
Real estate & rental	1,806
Hotels & personal services	4,761
Business services	21,748
Eating & drinking places	6,812
Automobile repair & service	1,044
Amusements	1,219
Health & educational & nonprofit	2,000
Federal government enterprises	2,415
State & local government enterprises	1,667
Total	236,679

Source: Management Information Services, Inc.; 1989.

Table V.8

Jobs Created by Proposed FY 1990 NASA Procurement Expenditures -- Major Occupational Group

Major Occupational Category	Jobs
Managerial and Professional Specialty Occupations	
Executive, administrative, and managerial occupations	26,431
Professional specialty occupations	33,073
Technical, Sales, and Administrative Support Occupations	
Technicians and related support occupations	11,292
Sales occupations	16,319
Administrative support occupations, including clerical	35,399
Service Occupations	
Protective service occupations	1,796
Service occupations, except protective	12,915
Farming, Forestry, and Fishing Occupations	
Farm operators and managers	1,401
Other agricultural and related occupations	1,878
Forestry and logging occupations	309
Fishers, hunters, and trappers	71
Precision Production, Craft, and Repair Occupations	
Mechanics and repairers	12,763
Construction trades	9,551
Extractive occupations	1,129
Precision production occupations	20,930
Operators, Fabricators, and Laborers	
Machine operators, assemblers, and inspectors	32,010
Transportation and material moving occupations	11,083
Handlers, equipment cleaners, helpers, and laborers	8,330
Total	236,679

Source: Management Information Services, Inc.; 1989.

Table V.9

Jobs Created by Proposed 1990 NASA Procurement Expenditures Within Selected Occupations

Occupation	Jobs
Financial Managers	683
Accountants and Auditors	2,604
Management Analysts	355
Personnel and Training Specialists	686
Buyers, Wholesale and Retail Trade	250
Inspectors, Except Construction	139
Architects	181
Metallurgical Engineers	344
Aerospace Engineers	3,441
Chemical Engineers	476
Electrical and Electronics Engineers	5,304
Industrial Engineers	2,288
Mechanical Engineers	2,413
Surveyors	46
Computer Systems Analysts	1,620
Statisticians	40
Chemists	412
Geologists and Geodeists	256
Biological and Life Scientists	27
Registered Nurses	367
Pharmacists	139
Economists	316
Psychologists	103
Lawyers	1,099
Technical Writers	329
Designers	1,029
Photographers	203
Public Relations Specialists	319
Clinical Laboratory Technicians	40
Electrical and Electronics Engineering Technicians	2,404
Drafting Occupations	1,174
Computer Programmers	2,736
Tool Programmers	8
Sales Engineers	167
Sales Representatives	3,000
Cashiers	2,442
Supervisors, Financial Records	173
Computer Operators	2,555
Secretaries	7,733
Receptionists	650

Source: Management Information Services, Inc., 1989.

Table V.9 (Continued)

Occupation	Jobs
Personnel Clerks	146
Bookkeepers and Accounting Clerks	3,424
Payroll Clerks	683
Telephone Operators	226
Dispatchers	327
Production Coordinators	1,307
Shipping and Receiving Clerks	1,284
Weighers and Checkers	299
General Office Clerks	1,333
Proofreaders	36
Supervisors, Guards	146
Kitchen Workers	184
Janitors and Cleaners	3,458
Transportation Attendants	224
Horticultural Specialty Farmers	9
Farm Workers	1,142
Graders and Sorters	32
Timber Cutting and Logging Occupations	275
Automobile Mechanics	945
Bus and Truck Engine Mechanics	694
Small Engine Repairers	156
Heavy Equipment Mechanics	790
Machinery Maintenance Occupations	76
Data Processing Equipment Repairers	361
Telephone Installers	840
Miscellaneous Electronic Equipment Repairers	238
Heating and Air Conditioning Mechanics	416
Mechanical Control Repairers	91
Millwrights	224
Brickmasons and Stonemasons	272
Carpenters	2,490
Electricians	1,713
Glaziers	85
Structural Metal Workers	163
Supervisors, Extractive Occupations	311
Explosives Workers	139
Mining Machine Operators	110
Miscellaneous Mining Occupations	190
Tool and Die Makers	1,272
Machinists	3,476

Source: Management Information Services, Inc., 1989.

Table V.9 (Continued)

Occupation	Jobs
Precision Grinders	154
Sheetmetal Workers	1,523
Upholsterers	126
Patternmakers	182
Electrical Equipment Assemblers	2,047
Inspectors and Testers	1,556
Water and Sewage Treatment Plant Operators	145
Drilling Machine Operators	467
Forging Machine Operators	68
Metal Plating Machine Operators	394
Sawing Machine Operators	188
Photoengravers and Lithographers	88
Textile Sewing Machine Operators	1,024
Packaging and Filling Machine Operators	908
Separating Machine Operators	139
Crushing and Grinding Machine Operators	63
Photographic Process Machine Operators	156
Welders and Cutters	2,375
Assemblers	6,523
Production Inspectors and Examiners	3,579
Truck Drivers	5,892
Parking Lot Attendants	57
Locomotive Operating Occupations	202
Sailors and Deckhands	44
Operating Engineers	320
Hoist and Winch Operators	113
Crane and Tower Operators	490
Excavating and Loading Machine Operators	142
Grader, Dozer, and Scraper Operators	177
Miscellaneous Material Moving Equipment Operators	414
Helpers, Construction Trades	256
Helpers, Extractive Occupations	19
Construction Laborers	956
Stevedores	102
Stock Handlers and Baggers	884
Total, All Occupations*	236,679

*Totals include data for the 360 occupations not listed separately.

Source: Management Information Services, Inc., 1989.

percent of total employment created), including 3,441 Aeronautical engineers (6.3 percent of the total employed in private industry), 5,300 Electrical Engineers (1.3 percent of the total employed in private industry), 2,600 Accountants, 400 Chemists, 1,100 Lawyers, 1,000 Designers, 4,600 Engineering Technicians, 1,600 Computer Systems Analysts, 2,000 Industrial Machinery Repairers, 2,500 Carpenters, 1,500 Sheetmetal Workers, 3,500 Machinists, and 2,400 Welders.

However, Tables V.8 and V.9 also demonstrate that the Space Program generates many jobs for virtually all categories of workers. In fact, the 1990 NASA procurement budget will create more jobs (3,400) for Bookkeepers than for Aeronautical Engineers, it will create more jobs (7,700) for Secretaries than for Electrical Engineers, more jobs (700) for Personnel and Labor Relations Workers than for Chemists, more jobs (3,000) for Cashiers than for Accountants, more jobs for Shipping Clerks (1,300) than for Designers, more jobs (2,200) for Stock Clerks than for Computer Systems Analysts, more jobs (5,900) for Truck Drivers than for Machinists, and more jobs for Janitors (3,500) than for Welders.

This again illustrates the pervasive nature of the economic and employment impacts of the Space Program.

Nevertheless, while the total number of jobs created in different occupations is important, these absolute numbers do not convey the significance of the NASA programs for specific occupations, especially the science, engineering, and related occupations, and several considerations are in order:

- First, there are many times more janitors, clerks, salespersons, etc., than aerospace engineers, computer scientists, or physicists, and a comparison of absolute numbers can be misleading.

- Second, the time and the money required to educate a scientist, engineer, or skilled worker represents a large private and public investment in human capital.

- Third, there is widespread concern that the U.S. faces potential shortages within many science and engineering occupations during the 1990s.

A more meaningful comparison of the effect of NASA spending is given in Table V.10, which shows the estimated impact of FY 1990 NASA procurement on the demand for specific occupations, ranked by the percent impact on total jobs within the specific occupation.

This table shows how important NASA procurement spending is in influencing the private sector labor market for Engineers, Scientists, Computer Specialists, Technicians, and skilled workers in many occupations. In fact, with possibly one or two exceptions, all of the occupations impacted the most heavily are within the above mentioned categories. Broadly speaking, the influence of NASA spending on the jobs is these occupations will be 20 or 30 times higher than its

Table V.10

Jobs Created by Proposed FY 1990 NASA Procurement Expenditures Within Selected Occupations, Ranked by Relative Job Impact

Rank[a]		Jobs Created
1	Aerospace Engineers	3,441
2	Mechanical Engineering Technicians	577
3	Electronic Repairers, Communications Equipment	915
4	Inspectors and Testors	1,556
5	Aircraft Engine Mechanics	881
6	Electrical Engineers	5,304
7	Mathematicians	123
8	Electrical Equipment Asseblers	2,047
9	Solderers and Brazers	395
10	Metallurgical Engineers	344
11	Industrial Engineers	2,288
12	Operations and Systems Researchers	1,359
13	Electrical Technicians	2,404
14	Mechanical Engineers	2,413
15	Grinding and Polishing Machine Operators	1,266
16	Metal Plating Machine Operators	394
17	Tool and Die Makers	1,272
18	Misc. Engineering Technicians	1,653
19	Computer Programmers	2,736
20	Marine Engineers	98
21	Purchasing Agents and Buyers	1,472
22	Technical Writers	329
23	Chemical Engineers	476
24	Computer Systems Analysts	1,620
25	Misc. Engineers	986
26	Misc. Science Technicians	344
27	Drafting Occupations	1,174
28	Civil Engineers	897
29	Mining Engineers	52
30	Chemists, except Biochemists	412

[a]Ranked on the basis of the percent job impact on the occupation.

Source: Management Information Services, Inc., 1989

overall impact on the economy. While it has frequently been stated how important the Space Program is in creating demand for these occupations, Table V.10 clearly illustrates this.

This table also contains some unexpected findings. While it is not surprising to see that NASA programs create demand in private industry for Aerospace Engineers, Aircraft Engine Mechanics, and Computer Programmers, it is important to note that NASA spending is also important in the job market for Inspectors and Testors, Assemblers, Solderes, Machine Operators, and Tool and Diemakers.

A point again worth noting is that these data exclude all NASA employees. Since these employees are overwhelmingly concentrated in the Science and Engineering specialties, if they were included the impact on Scientists and Engineers would be even more pronounced. Thus the data in Table V.10 actually give a somewhat conservative estimate of the the impact of NASA programs on the employment requirements for many types of scientists and engineers. However, this is not true for the manufacturing-related occupations in this table, since these are concentrated in private industry.

Footnotes

1. The jobs created for 475 all-inclusive occupations are given in the appendix.

VI. THE BENEFITS TO EACH STATE

One of the more important questions about the economic effects of the Space Program that must be resolved is how these benefits are distributed among the states. Obviously, the states of Florida, Alabama, and Texas contain major NASA facilities and benefit substantially from Agency programs, as does California, due to the concentration of the aerospace industry in the southern part of the state. But how are the indirect economic benefits of the NASA programs distributed among the states? Does the U.S. Space program have significant effects on most states or are the benefits concentrated in only a relatively few? These types of questions have not heretofore been adequately answered, and they are the focus of this chapter.

The estimated FY 1990 NASA procurement awards classified by type of contractor and by state are given in Table VI.1, the percent distribution of these is shown in Table VI.2, and the ranks among the states of the prime contract awards are illustrated in Figure VI.1. The data in these exhibits appear to indicate that the economic benefits of the Space Program are heavily concentrated in four or five states and that the other 45 or so gain little from NASA procurement spending. Figure VI.1 indicates that five states -- California, Texas, Florida, Maryland, and Alabama -- receive 68 percent of the NASA procurement spending, and that the remainder is distributed in relatively insignificant amounts to all the other states. This is the conventional wisdom: the economic benefits of expenditures for the U.S. Space Program flow primarily to only a few regions of the nation and most states gain little from this spending.

However, this impression is wrong. As we demonstrate below, the economic benefits of the Space Program are widely distributed throughout the nation, and among of the biggest state "winners" are many that few analysts perceive as being closely tied to the Program.

Table VI.3 shows the total (direct plus indirect) economic and employment benefits of the proposed FY 1990 NASA procurement budget to every state. This table demonstrates that in terms of industry sales and jobs every state benefits substantially from the U.S. Space Program. These data are important, for they refute the widespread notion that the NASA budget benefits four or five states at the expense of the rest of the nation.

However, even these data are aggregate and in one sense obscure relevant information, and to further assess the state-specific benefits and their distributions we have developed several rankings of the states.

Table VI.4 ranks the top 20 states on the basis of the total sales generated by the Space Program. Table VI.5 ranks the top 20 states on the basis of the per capita employment created by the Space Program. Table VI.6 ranks the top 20 states on the basis of the economic benefits created indirectly within each state by the Space Program.

Table VI.1

Estimated FY 1990 NASA Procurement Awards by Type of Contractor and by State

State	Total	Business Prime	Business Subcontract	Education Nonprofit	Federal Government
		(millions of dollars)			
Alabama	627.6	487.2	99.6	18.3	22.5
Alaska	11.3	0.1	0.1	3.4	7.7
Arizona	112.9	9.2	76.5	16.3	11.0
Arkansas	5.0	0.1	0.4	0.2	4.3
California	3,728.9	2,251.3	744.5	541.0	192.2
Colorado	217.5	75.0	105.7	18.0	18.8
Connecticut	144.1	84.1	51.1	3.3	5.6
Delaware	12.5	3.4	6.3	1.0	1.9
Dist. Columbia	99.4	40.1	1.8	27.9	29.6
Florida	1,176.4	858.5	249.5	7.0	61.3
Georgia	55.2	13.6	11.4	5.6	24.7
Hawaii	29.6	0.5	1.3	7.9	19.9
Idaho	3.2	0.0	0.0	0.7	2.5
Illinois	61.1	7.2	25.9	11.4	16.5
Indiana	28.6	8.2	10.1	4.6	5.7
Iowa	12.1	0.1	1.5	9.3	1.1
Kansas	45.4	23.5	10.6	1.8	9.5
Kentucky	13.6	0.0	0.8	0.7	12.1
Louisiana	347.4	312.3	22.9	2.1	10.1
Maine	4.4	0.0	0.1	0.6	3.6
Maryland	821.3	700.1	37.6	53.8	29.8
Massachusetts	141.8	24.5	54.5	53.0	9.8
Michigan	37.3	8.2	10.5	13.2	5.5
Minnesota	32.8	8.7	19.8	2.3	2.0
Mississippi	108.3	91.3	5.8	2.7	8.5
Missouri	41.4	13.1	17.2	3.3	7.8
Montana	2.1	0.0	0.1	0.4	1.6
Nebraska	7.4	0.0	1.1	0.6	5.8
Nevada	7.5	0.6	3.1	0.1	3.7
New Hampshire	19.7	2.4	9.0	6.6	1.7

Table VI.1 (continued)

Estimated FY 1990 NASA Procurement Awards by Type of Contractor and by State

State	Total	Business Prime	Business Subcontract	Education Nonprofit	Federal Government
		(millions of dollars)			
New Jersey	256.7	132.3	111.4	4.2	8.8
New Mexico	83.4	42.8	17.9	9.0	13.7
New York	154.3	44.0	74.0	22.6	13.7
North Carolina	40.6	0.7	2.7	6.8	30.4
North Dakota	4.0	0.1	0.0	0.1	3.8
Ohio	245.4	163.3	24.7	23.7	33.7
Oklahoma	16.5	0.0	1.1	4.1	11.3
Oregon	9.7	2.0	4.4	1.6	1.7
Pennsylvania	152.2	107.7	22.8	11.8	9.9
Rhode Island	8.4	0.7	2.4	2.4	2.9
South Carolina	22.7	0.2	0.2	0.8	21.3
South Dakota	5.3	0.1	2.3	0.5	2.5
Tennessee	40.7	20.0	6.3	6.2	8.1
Texas	1,173.9	851.5	184.3	59.6	78.5
Utah	561.1	551.6	4.2	2.1	3.2
Vermont	2.6	0.5	1.7	0.1	0.4
Virginia	486.9	325.2	65.7	26.2	69.8
Washington	40.0	12.1	2.9	6.1	19.0
West Virginia	1.2	0.1	0.1	0.2	0.7
Wisconsin	36.8	19.3	2.3	12.0	3.2
Wyoming	1.8	0.0	0.1	0.2	1.4
Total	11,300.0	7,297.6	2,110.2	1,017.4	874.8

Source: Historical NASA Procurement and Budget documents; and MISI; 1989.

Table VI.2

Estimated FY 1990 NASA Procurement Awards by Type of Contractor and by State (Percent Distribution)

State	Total	Business Prime	Business Subcontract	Education Nonprofit	Federal Government
	(percent of US total)				
Alabama	5.6	6.7	4.7	1.8	2.6
Alaska	0.1	0.0	0.0	0.3	0.9
Arizona	1.0	0.1	3.6	1.6	1.3
Arkansas	0.0	0.0	0.0	0.0	0.5
California	33.0	30.8	35.3	53.2	22.0
Colorado	1.9	1.0	5.0	1.8	2.1
Connecticut	1.3	1.2	2.4	0.3	0.6
Delaware	0.1	0.0	0.3	0.1	0.2
Dist. Columbia	0.9	0.5	0.1	2.7	3.4
Florida	10.4	11.8	11.8	0.7	7.0
Georgia	0.5	0.2	0.5	0.5	2.8
Hawaii	0.3	0.0	0.1	0.8	2.3
Idaho	0.0	0.0	0.0	0.1	0.3
Illinois	0.5	0.1	1.2	1.1	1.9
Indiana	0.3	0.1	0.5	0.5	0.7
Iowa	0.1	0.0	0.1	0.9	0.1
Kansas	0.4	0.3	0.5	0.2	1.1
Kentucky	0.1	0.0	0.0	0.1	1.4
Louisiana	3.1	4.3	1.1	0.2	1.2
Maine	0.0	0.0	0.0	0.1	0.4
Maryland	7.3	9.6	1.8	5.3	3.4
Massachusetts	1.3	0.3	2.6	5.2	1.1
Michigan	0.3	0.1	0.5	1.3	0.6
Minnesota	0.3	0.1	0.9	0.2	0.2
Mississippi	1.0	1.3	0.3	0.3	1.0
Missouri	0.4	0.2	0.8	0.3	0.9
Montana	0.0	0.0	0.0	0.0	0.2
Nebraska	0.1	0.0	0.1	0.1	0.7
Nevada	0.1	0.0	0.1	0.0	0.4
New Hampshire	0.2	0.0	0.4	0.6	0.2

Table VI.2 (continued)

Estimated FY 1990 NASA Procurement Awards by Type of Contractor and by State (Percent Distribution)

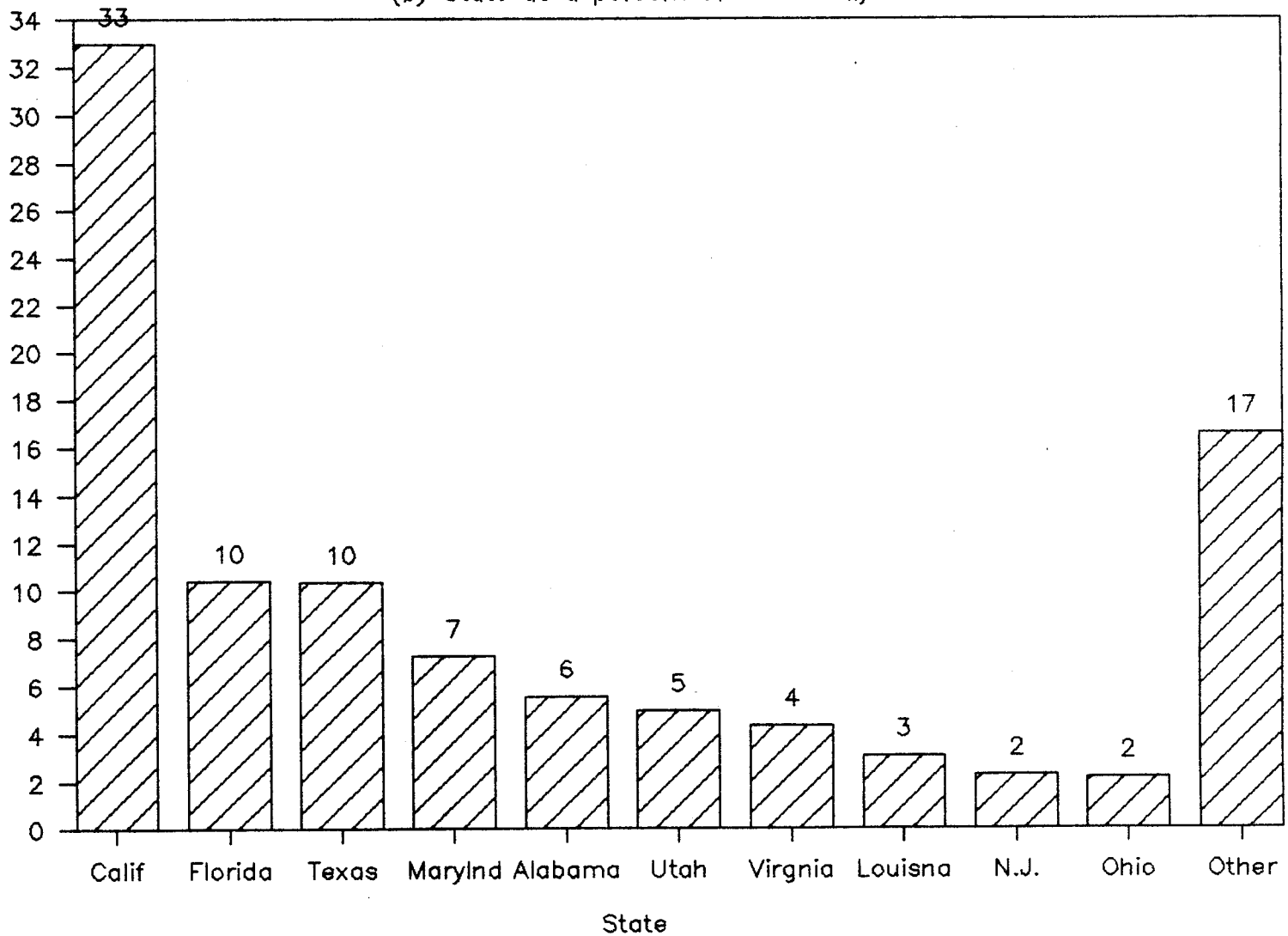
State	Total	Business Prime	Business Subcontract	Education Nonprofit	Federal Government
	(percent of US total)				
New Jersey	2.3	1.8	5.3	0.4	1.0
New Mexico	0.7	0.6	0.8	0.9	1.6
New York	1.4	0.6	3.5	2.2	1.6
North Carolina	0.4	0.0	0.1	0.7	3.5
North Dakota	0.0	0.0	0.0	0.0	0.4
Ohio	2.2	2.2	1.2	2.3	3.9
Oklahoma	0.1	0.0	0.1	0.4	1.3
Oregon	0.1	0.0	0.2	0.2	0.2
Pennsylvania	1.3	1.5	1.1	1.2	1.1
Rhode Island	0.1	0.0	0.1	0.2	0.3
South Carolina	0.2	0.0	0.0	0.1	2.4
South Dakota	0.0	0.0	0.1	0.0	0.3
Tennessee	0.4	0.3	0.3	0.6	0.9
Texas	10.4	11.7	8.7	5.9	9.0
Utah	5.0	7.6	0.2	0.2	0.4
Vermont	0.0	0.0	0.1	0.0	0.0
Virginia	4.3	4.5	3.1	2.6	8.0
Washington	0.4	0.2	0.1	0.6	2.2
West Virginia	0.0	0.0	0.0	0.0	0.1
Wisconsin	0.3	0.3	0.1	1.2	0.4
Wyoming	0.0	0.0	0.0	0.0	0.2
Total	100	100	100	100	100

Source: Management Information Services, Inc.; 1989.

Figure VI.1

NASA Prime Contract Awards, FY 1990

(by State as a percent of U.S. total)



Source: Management Information Services, Inc.; 1989.

Table VI.3

Estimated Sales and Jobs Created in Each State by Proposed FY 1990 NASA Procurement Expenditures

State	Sales (millions)	(% of US)	Employment (number)	(% of US)
Alabama	$858.2	3.7	8,582	3.6
Alaska	35.5	0.2	236	0.1
Arizona	229.6	1.0	2,424	1.0
Arkansas	89.0	0.4	876	0.4
California	6,766.6	29.2	70,332	29.7
Colorado	490.3	2.1	5,381	2.3
Connecticut	601.1	2.6	6,224	2.6
Delaware	32.7	0.1	291	0.1
Dist. Columbia	75.2	0.3	990	0.4
Florida	1,297.5	5.6	14,756	6.2
Georgia	299.7	1.3	3,224	1.4
Hawaii	23.0	0.1	278	0.1
Idaho	21.4	0.1	242	0.1
Illinois	549.2	2.4	5,657	2.4
Indiana	348.3	1.5	3,253	1.4
Iowa	94.7	0.4	1,050	0.4
Kansas	172.0	0.7	1,697	0.7
Kentucky	142.4	0.6	1,358	0.6
Louisiana	535.0	2.3	4,583	1.9
Maine	36.0	0.2	386	0.2
Maryland	994.3	4.3	11,122	4.7
Massachusetts	382.3	1.7	4,208	1.8
Michigan	518.9	2.2	4,582	1.9
Minnesota	164.3	0.7	1,791	0.8
Mississippi	231.9	1.0	2,146	0.9
Missouri	342.3	1.5	3,427	1.4
Montana	18.7	0.1	180	0.1
Nebraska	47.7	0.2	566	0.2
Nevada	30.2	0.1	379	0.2
New Hampshire	58.7	0.3	626	0.3

Table VI.3 (continued)

Estimated Sales and Jobs Created in Each State by Proposed FY 1990 NASA Procurement Expenditures

State	Sales (millions)	(% of US)	Employment (number)	(% of US)
New Jersey	506.0	2.2	5,411	2.3
New Mexico	135.5	0.6	1,242	0.5
New York	711.1	3.1	7,820	3.3
North Carolina	231.3	1.0	2,450	1.0
North Dakota	18.0	0.1	183	0.1
Ohio	928.7	4.0	8,545	3.6
Oklahoma	158.7	0.7	1,358	0.6
Oregon	67.3	0.3	731	0.3
Pennsylvania	602.2	2.6	5,955	2.5
Rhode Island	32.3	0.1	347	0.1
South Carolina	109.5	0.5	1,139	0.5
South Dakota	18.3	0.1	221	0.1
Tennessee	209.1	0.9	2,237	0.9
Texas	2,105.4	9.1	19,528	8.3
Utah	590.8	2.6	5,895	2.5
Vermont	21.1	0.1	226	0.1
Virginia	631.2	2.7	6,666	2.8
Washington	308.4	1.3	3,173	1.3
West Virginia	61.0	0.3	502	0.2
Wisconsin	193.0	0.8	1,991	0.8
Wyoming	28.0	0.1	210	0.1
Total	$23,153.2	-	236,679	-

Source: Management Information Services, Inc.; 1989.

Table VI.4

Ranking of the Top 20 States on the Basis of Total Industry Sales Generated by Proposed FY 1990 NASA Procurement Expenditures

Rank	
1.	California
2.	Texas
3.	Florida
4.	Maryland
5.	Ohio
6.	Alabama
7.	New York
8.	Virginia
9.	Pennsylvania
10.	Connecticut
11.	Utah
12.	Illinois
13.	Louisiana
14.	Michigan
15.	New Jersey
16.	Colorado
17.	Massachusetts
18.	Indiana
19.	Missouri
20.	Washington

Source: Management Information Services, Inc., 1989

Table VI.5

Ranking of the Top 20 States on the Basis of Jobs Created Per Capita by Proposed FY 1990 NASA Procurement Expenditures

Rank	
1.	Utah
2.	California
3.	Maryland
4.	Alabama
5.	Connecticut
6.	Colorado
7.	Florida
8.	Texas
9.	Virginia
10.	Louisiana
11.	Ohio
12.	Mississippi
13.	New Mexico
14.	New Jersey
15.	Washington
16.	Kansas
17.	Missouri
18.	Arizona
19.	Indiana
20.	New Hampshire

Source: Management Information Services, Inc., 1989

Table VI.6

Ranking of the Top 20 States on the Basis of Industry Sales Generated Indirectly in the State by Proposed FY 1990 NASA Procurement Expenditures

Rank	
1.	California
2.	Texas
3.	Ohio
4.	New York
5.	Illinois
6.	Michigan
7.	Connecticut
8.	Pennsylvania
9.	Indiana
10.	Missouri
11.	Colorado
12.	Washington
13.	New Jersey
14.	Georgia
15.	Massachusetts
16.	Alabama
17.	North Carolina
18.	Louisiana
19.	Maryland
20.	Tennessee

Source: Management Information Services, Inc., 1989

Focussing first on VI.4, it is observed that in terms of total sales generated the prime contract award states of California, Texas, Florida, Maryland, and Alabama still clearly dominate. This is to be expected, since the total economic benefits are the sum of the direct benefits and the indirect benefits. What is interesting in this table, however, is that we are beginning to see states emerging as "winners" that get little direct NASA procurement funding. These states include New York, Pennsylvania, Illinois, Michigan, New Jersey, Colorado, and Indiana.

Table VI.5 ranks the states on the basis of the employment created (directly and indirectly) by proposed FY 1990 NASA procurement, normalized by each state's forecast 1990 population. This is an important evaluation criterion, for it indicates how relatively important the jobs created (listed in Table VI.3) are in relation to the number of workers in the state. Obviously, a given number of jobs created in a small state such as Wyoming or New Hampshire are much more significant to the state than the same number of jobs created in a large state such as California, Texas, or New York. Again we observe states beginning to emerge as clear winners that few would normally associate closely with the Space Program. These include Colorado, Indiana, Arizona, New Jersey, Connecticut, Washington, Kansas, Missouri, and New Hampshire.

Tables VI.3 through VI.5 are based on the total impacts of NASA spending and, as noted, are dominated by the five states receiving the large prime contract awards. Table VI.6 ranks the top 20 states on the basis of the indirect benefits received from proposed FY 1990 NASA procurement -- the economic activity generated within a state by the indirect effects of NASA procurement in all the other states. This table can shows there are substantial benefits to those states that do not receive large prime contract awards from NASA.

Once again, California and Texas dominate the ranking of winners in this table, but abstracting from this, the results are rather interesting. First of all, several of the major prime contract award states, such as Florida and Utah -- the latter of which receives the highest per capita benefits -- no long even appear among the top 20 ranked states. Thus, while these two states benefit substantially from the direct procurement awards, they receive relatively little indirect economic stimulus from NASA-induced business in other states.

Second, other major prime contract award states, such as Alabama, Louisiana, and Virginia, are now ranked much lower. Again, these states do not contain the types of industries that benefit from the indirect economic stimulus of the NASA expenditures.

Third, Ohio, which ranks tenth in terms of prime contract awards, now ranks third on the basis of its industrial infrastructure.

Finally, and most interesting, we find a new set of states identified as major (indirect) beneficiaries of the U.S. Space Program. These include the major manufacturing states of New York, Illinois, Michigan, Pennsylvania, Indiana, Missouri, New Jersey, and

Wisconsin. These states represent the manufacturing heartland of the U.S. and benefit substantially by producing the products required by the prime contractors and the subcontractors to NASA. Other states noteworthy in Table VI.6 include Georgia, Massachusetts, North Carolina, and Tennessee.

To illustrate the importance of the indirect impact of NASA procurement on different states we derived the economic multipliers illustrated in Table VI.7. These are computed by deriving the total (direct plus indirect) sales generated in the state by proposed FY 1990 NASA procurement by the direct procurement expenditures in the state. The higher the multiplier, the greater the importance of NASA procurement in generating indirect economic benefits in the state. More significant perhaps, the higher the multiplier, the greater the importance of the "hidden" indirect benefits of NASA spending to the state. Thus:

- For every dollar Michigan will likely receive directly in proposed FY 1990 NASA procurement funds, it will receive $14 indirectly in procurement-induced business.

- For every dollar Illinois will likely receive directly in proposed FY 1990 NASA procurement funds, it will receive $10 indirectly in procurement-induced business.

- For every dollar North Carolina will likely receive directly in proposed FY 1990 NASA procurement funds, it will receive $6 indirectly in procurement-induced business.

- For every dollar New York will likely receive directly in proposed FY 1990 NASA procurement funds, it will receive $5 indirectly in procurement-induced business.

None of the above four states -- Michigan, Illinois, North Carolina, New York -- are traditionally considered to be closely linked to NASA spending, yet each stands to gain considerably from the proposed FY 1990 NASA procurement expenditures.

Figure VI.2 illustrates the pervasiveness of the indirect benefits to the states of NASA procurement spending. States are grouped according to the size of their indirect multipliers:

- Six states have multipliers greater than 10 -- Arkansas (5), Indiana (12), Kentucky (10), Michigan (14), Oklahoma (9), and Washington (77)

- Five states have multipliers between 7 and 9 -- Illinois (9), Iowa (8), Missouri (8), Nebraska (7), and Oregon (7)

- Twelve states have multipliers between 4 and 6 -- Connecticut (4), Georgia (6), Kansas (4), Minnesota (5), Nevada (4), New York (5), North Carolina (6), Ohio (4), Pennsylvania (4), Rhode Island (4), South Carolina (5), Tennessee (5), and Wisconsin (5)

Table VI.7

Economic Multipliers for Selected States Resulting From Proposed FY 1990 NASA Procurement Expenditures

	Multiplier[a]
Michigan	14.0 to 1
Indiana	12.0 to 1
Illinois	9.8 to 1
Missouri	8.3 to 1
Oregon	6.7 to 1
North Carolina	5.6 to 1
Georgia	5.5 to 1
Wisconsin	5.2 to 1
Tennessee	5.1 to 1
New York	4.6 to 1
Pennsylvania	4.0 to 1
Kansas	3.8 to 1
Ohio	3.8 to 1
Massachusetts	2.7 to 1
Mississippi	2.1 to 1
Arizona	2.0 to 1
New Jersey	2.0 to 1
Texas	1.8 to 1
California	1.8 to 1
Alabama	1.4 to 1
Florida	1.1 to 1

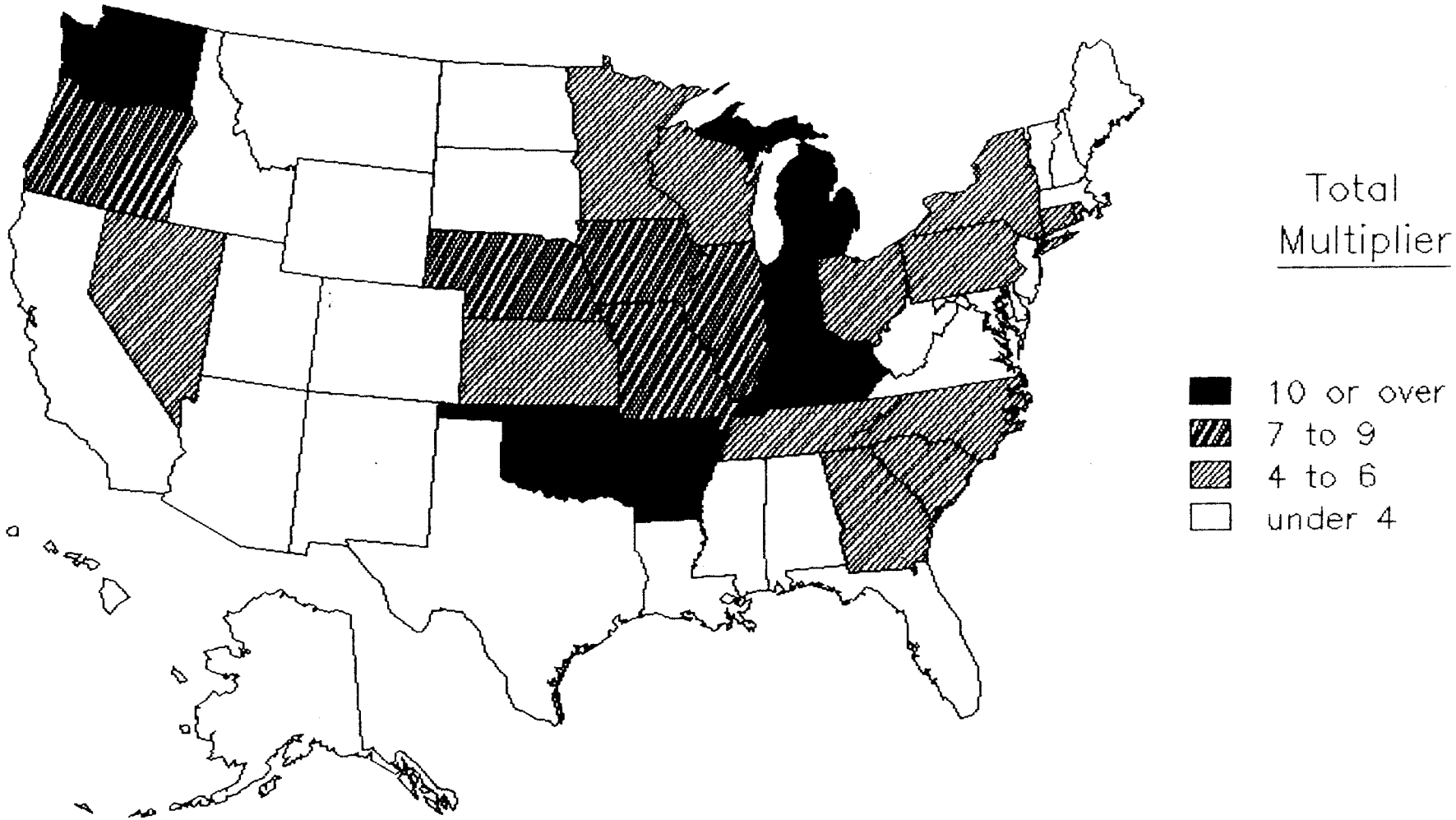
[a]Ratio of total (direct plus indirect) economic benefits to direct economic benefits.

Source: Management Information Services, Inc., 1989.

Figure VI. 2

NASA Indirect Economic Benefits by State

Fiscal Year 1990



Source: Management Information Services, Inc.; 1989.

o All of the other states have multipliers less than 4

These findings are significant. Observing only the direct NASA procurement spending in a state can give a misleading picture of the importance of NASA procurement to the economic well being of that state, and the indirect economic benefits identified here must also be considered. To give only one example, focusing exclusively on the direct procurement expenditures in Indiana would indicate that the state will receive only $29 million out of the entire proposed FY 1990 NASA procurement budget. However, in reality, when the indirect effects of the procurement spending are taken into account Indiana emerges as a major "winner" from the program, and is likely to benefit from $350 million in increased 1990 gross state product due to NASA procurement.

The above analysis allows us to categorize the states which are directly or indirectly (or both) the major benefactors of the U.S. Space Program. These are shown in Table VI.8. Category A contains those states which will receive the major FY 1990 NASA prime contract awards and which have been traditionally assumed to be tied closely to the Space Program. Category B identifies those states that will likely benefit significantly on a per capita basis and/or indirectly from NASA procurement and which have not traditionally been tied closely to the Space Program or to the NASA budget. This grouping is illustrated in Figure VI.3.

We thus find that while high prime contract award states such as California, Texas, and Florida benefit greatly from NASA procurement spending, so also do states such as Illinois, which will receive only a relatively small portion of the FY 1990 NASA direct procurement budget. In 1990, NASA procurement spending will create (directly and indirectly) $550 million in industry sales and 5,700 jobs in Illinois. Further, as noted, in this state for every direct dollar of NASA spending, an additional 10 dollars of spending are generated indirectly by the NASA procurement budget.

This at first glance may seem counterintuative, since Illinois is not generally considered to be a state that benefits greatly from the Space Program. However, Illinois does benefit substantially from NASA spending. Its industries produce the goods and services required indirectly by the recipients of NASA procurement awards: capital goods, electronic components, scientific instruments, chemical products, primary and fabricated metals products, specialized business services, etc. Further, because of the widely based, indirect nature of these economic benefits to the state, Illinois will benefit greatly from NASA procurement spending in other states on a wide variety of programs, and its benefits are not tied to a specific contract, project, or program.

Table VI.8

Categorization of the States Benefiting Most From Proposed FY 1990 NASA Procurement Expenditures

Category A

Major Prime Contract Award States

California	Alabama
Texas	Louisiana
Florida	Utah
Maryland	Virginia

Category B

States Benefiting Indirectly From the U.S. Space Program

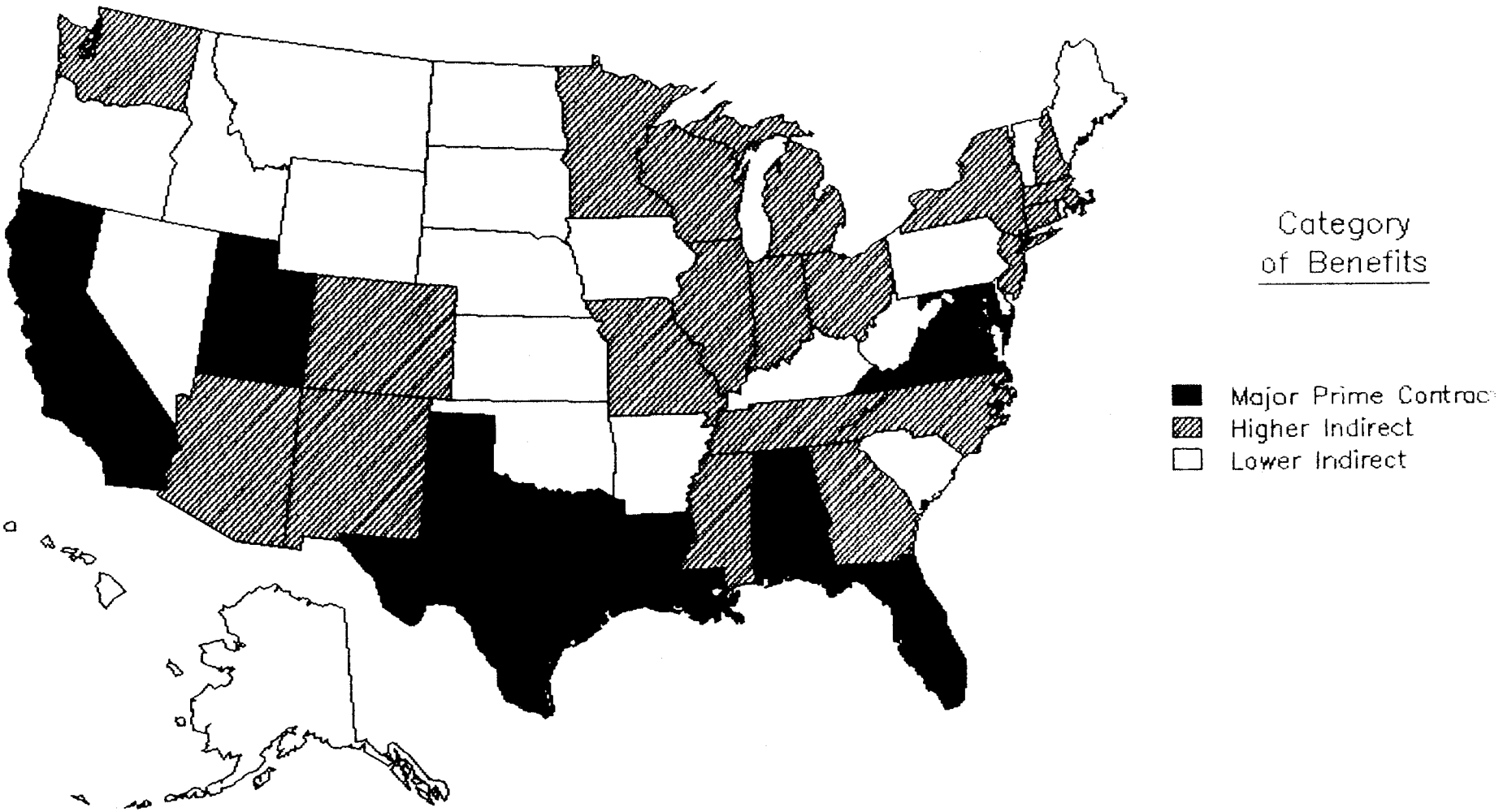
Colorado	Washington
New Jersey	Massachusetts
New York	Missouri
Arizona	Wisconsin
Mississippi	New Hampshire
Ohio	New Mexico
Indiana	Georgia
Illinois	Connecticut
Michigan	North Carolina
Tennessee	Minnesota

Source: Management Information Services, Inc., 1989

Figure VI.3

States Benefiting Most from U.S. Space Program

Fiscal Year 1990



Source: Management Information Services, Inc.; 1989.

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Detailed Occupational Jobs Created by Proposed FY 1990 NASA Procurement Expenditures

Occupational Title	Jobs
Legislators	2
Public administration, chief executives	7
Public administration, officials	159
Administrators, protective services	16
Financial managers	683
Personnel & labor relations	494
Purchasing managers	1,251
Managers, marketing, advertising	1,175
Administrators, education	473
Managers, medicine & health	14
Managers, properties & real estate	388
Postmasters	57
Funeral directors	64
Managers & administrators, n.e.c.	14,107
Accountants & auditors	2,604
Underwriters	24
Other financial officers	1,069
Management analysts	355
Personnel & training specialists	686
Purchasing agents, farm products	18
Buyers, wholesale & retail trade	250
Purchasing agents & buyers, n.e.c.	1,472
Business & promotion agents	56
Construction inspectors	69
Inspectors, except construction	139
Management related, n.e.c.	802
Architects	181
Aerospace engineers	3,441
Metallurgical engineers	344
Mining engineers	52
Petroleum engineers	155
Chemical engineers	476
Nuclear engineers	50
Civil engineers	897
Agricultural engineers	3
Electrical engineers	5,304
Industrial engineers	2,288
Mechanical engineers	2,413
Marine engineers	98
Engineers, n.e.c.	986
Surveyors & mapping	46
Computer systems analysts	1,620
Operations & systems researchers	1,359
Actuaries	18
Statisticians	40
Mathematical scientists, n.e.c.	123
Physicists & astronomers	27
Chemists, except biochemists	412
Atmospheric and space scientists	53
Geologists & geodeists	256

Physical scientists, n.e.c.	20
Agricultural scientists	12
Biological & life scientists	27
Forestry & conservation scientists	47
Medical scientists	5
Physicians	91
Dentists	19
Veterinarians	44
Optometrists	19
Podiatrists	1
Health diagnosing, n.e.c.	4
Registered nurses	367
Pharmacists	139
Dietitian	25
Inhalation therapists	11
Occupational therapists	15
Physical therapists	7
Speech therapists	68
Therapists, n.e.c.	14
Physicians' assistants	28
Earth, environmental science teachers	1
Biological science teachers	5
Chemistry teachers	4
Physics teachers	2
Psychology teachers	3
Economics teachers	3
History teachers	3
Political science teachers	2
Sociology teachers	0
Social science teachers, n.e.c.	1
Engineering teachers	5
Mathematical science teachers	7
Computer science teachers	10
Medical science teachers	5
Health specialties teachers	7
Business teachers	6
Agriculture teachers	0
Art & music teachers	5
Physical education teachers	2
Education teachers	3
English teachers	5
Foreign language teachers	3
Law teachers	1
Social work teachers	1
Theology teachers	1
Trade & industrial teachers	2
Home economics teachers	0
Postsecondary, subject not specified	19
Teachers, prekindergarten & kindergarten	336
Teachers, elementary school	2,784
Teachers, secondary school	2,429
Teachers, special education	11
Teachers, n.e.c.	560
Counselors, educational	170
Librarians	171
Archivists & curators	16
Economists	316
Psychologists	103

Sociologists	1
Social scientists, n.e.c.	12
Urban planners	7
Social workers	105
Recreation workers	8
Clergy	55
Religious workers, n.e.c.	15
Lawyers	1,099
Judges	11
Authors	134
Technical writers	329
Designers	1,029
Musicians & composers	171
Actors & directors	83
Painters & artists	324
Photographers	203
Dances	10
Artists, n.e.c.	61
Editors & reporters	402
Public relations specialists	319
Announcers	57
Athletes	31
Clinical laboratory technicians	40
Dental hygienists	13
Health record technicians	7
Radiologic technicians	16
Licensed practical nurses	107
Health technicians, n.e.c.	140
Electrical technicians	2,404
Industrial engineering technicians	11
Mechanical engineering technicians	577
Engineering technicians, n.e.c.	1,653
Drafting occupations	1,174
Surveying & mapping technicians	184
Biological technicians	43
Chemical technicians	269
Science technicians, n.e.c.	344
Airplane pilots & navigators	227
Air traffic controllers	8
Broadcast equipment operators	43
Computer programmers	2,736
Tool programmers	8
Legal assistants	157
Technicians, n.e.c.	1,132
Supervisors & proprietors, sales	3,716
Insurance sales occupations	417
Real estate sales occupations	596
Securities sales ccupations	160
Advertising sales occupations	224
Sales occupations, other	999
Sales engineers	167
Sales representatives	3,000
Sales workers, motor vehicles	245
Sales workers, apparel	536
Sales workers, shoes	130
Sales workers, furniture	162
Sales workers, ratio, TV	160
Sales workers, hardware	192

Sales workers, parts	185
Sales workers, other commodities	1,701
Sales counter clerks	192
Cashiers	2,442
Street sales workers	477
News vendors	502
Demonstrators, sales	62
Auctioneers	11
Sales support occupations, n.e.c.	44
Supervisors, general office	475
Supervisors, computer equipment	222
Supervisors, financial records	173
Chief communications operators	18
Supervisors; distribution & scheduling	676
Computer operators	2,555
Peripheral equipment operators	26
Secretaries	7,733
Stenographers	308
Typists	1,764
Inverviewers	182
Hotel clerks	120
Transportation agents	382
Receptionists	650
Information clerks, n.e.c.	360
Classified-ad clerks	10
Correspondence clerks	37
Order clerks	322
Personnel clerks	146
Library clerks	99
File cleks	432
Records clerks	147
Bookkeepers, accounting clerks	3,424
Payroll clerks	683
Billing clerks	315
Cost & rate clerks	139
Billing & calculating machine operators	100
Duplicating machine operators	151
Mail preparing machine operators	21
Office machine operators, n.e.c.	226
Telephone operators	321
Telegraphers	15
Communications equip. operators, n.e.c.	33
Postal clerks	663
Mail carriers	686
Mail clerks, exc. postal service	265
Messengers	302
Dispatchers	327
Production ooordinatos	1,307
Shipping & receiving clerks	1,284
Stock & inventory clerks	2,156
Meter readers	95
Weighers & checkers	299
Expediters	562
Material recording clerks, n.e.c.	207
Insurance investigators	153
Investigators, exc. insurance	517
Eligibility clerks, welfare	13
Bill & account clerks	172

General office clerks	1,333
Bank tellers	323
Proofreaders	36
Data-entry keyers	883
Statistical clerks	416
Teachers aides	598
Administrative support, n.e.c.	542
Supervisors, firefighting	13
Supervisors, police	22
Supervisors, guards	146
Fire inspection	20
Firefighting occupations	71
Police & detectives	129
Sheriffs & bailiffs	30
Correctional institution officers	43
Crossing guards	14
Guards & police, exc. public service	1,280
Protective service occupations, n.e.c.	29
Supervisors, food preparation	237
Bartenders	417
Waiters & waitresses	1,811
Cooks, except short order	1,658
Short-order cooks	103
Food counter occupations	442
Kitchen workers	184
Waiters'/waitresses' assistants	500
Miscellaneous food preparation	768
Dental assistants	19
Health aides, except nursing	78
Nursing aides	283
Supervisors, cleaning workers	155
Maids & housemen	417
Janitors & cleaners	3,458
Elevator operators	13
Pest control occupations	38
Supervisors, personal services	18
Barbers	160
Hairdressers & cosmetologists	983
Attendants, amusement facilities	141
Guides	31
Ushers	10
Transportation attendants	224
Baggage porters	42
Welfare service aides	16
Child care workers	554
Personal service occupations, n.e.c.	155
Farmers, except horticultural	1,316
Horticultural specialty farmers	9
Managers, farms, except horticultural	64
Managers, horticultural specialty farms	12
Supervisors, farm workers	55
Farm workers	1,143
Marine life cultivation workers	0
Nursery workers	33
Supervisors, related agricultural	137
Groundskeepers & gardeners	374
Animal caretakers	103
Graders & sorters	32

Supervisors, forestry & logging workers	11
Forestry workers, except logging	23
Timber cutting & logging occupations	275
Captains & officers, fishing vessels	3
Fishers	63
Hunters & trappers	5
Supervisors, mechanics & repairers	609
Automobile mechanics	945
Automobile mechanic apprentices	5
Bus & truck engine mechancis	694
Aircraft engine mechanics	881
Small engine repairers	156
Automoile body repairers	204
Aircraft mechanics, except egine	887
Heavy equipment mechanics	790
Farm equipment mechanics	77
Industrial machinery repairers	2,033
Machinery maintenance occupations	76
Electronic repairers, commun. equipment	915
Data processing equipment repairers	361
Household appliance repairers	59
Telephone line installers	130
Telephone installers	840
Miscellaneous electronic equip. repairers	238
Heating & air conditioning mechanics	416
Camera & watch repairers	69
Locksmiths	46
Office machine repairers	183
Mechanical control repairers	91
Elevator installers	44
Millwrights	224
Specified mechanics & repairers, n.e.c.	1,189
Not specified mechanics & repairers	601
Supervisors; brickmasons	13
Supervisors, carpenters	29
Supervisors, electricians	107
Supervisors, painters	22
Supervisors, plumbers	35
Supervisors, n.e.c.	785
Brickmasons & stonemasons	272
Brickmason & stonemason apprentices	7
Tile setters	49
Carpet installers	177
Carpenters	2,490
Carpenter apprentices	19
Drywall installers	179
Electricians	1,713
Electrician apprentices	90
Electrical power installers	275
Painters	657
Paperhangers	56
Plasterers	71
Plumbers	1,340
Plumber apprentices	6
Concrete & terrazzo finishers	71
Glaziers	85
Insulation workers	150
Paving & surfacing equipment operators	2

Roofers	225
Sheetmetal duct installers	156
Structural metal workers	163
Drillers, earth	17
Construction trades, n.e.c.	291
Supervisors, extractive occupations	311
Drillers, oil well	378
Explosives workers	139
Mining machine operators	110
Mining occupations, n.e.c.	190
Supervisors, production occupations	7,221
Tool & die makers	1,272
Tool & die maker apprentices	221
Precision assemblers, metal	343
Machinists	3,476
Machinist apprentices	178
Boilermakers	136
Precision grinders	154
Patternmakers, metal	19
Lay-out workers	227
Precious stones & metals workers	43
Engravers, metal	43
Sheet metal workers	1,523
Sheet metal worker apprentices	13
Miscellaneous precision metal workers	0
Patternmakers & model makers, wood	30
Cabinet makers & bench carpenters	56
Furniture & wood finishers	40
Dressmakers	146
Tailors	55
Upholsterers	126
Shoe repairers	47
Miscellaneous precision apparel workers	11
Hand molders & shapers, except jewelers	14
Patternmakers	182
Optical goods workes	135
Dental laboratory technicians	30
Bookbinders	36
Electrical equipment assemblers	2,047
Miscellneous precision workers n.e.c.	292
Butchers & meat cutters	258
Bakers	92
Food batchmakers	22
Inspectors & testers	1,556
Adjusters & calibrators	100
Water & sewage treatment plant operators	145
Power plant operators	92
Stationary engineers	387
Miscellaneous plant & system operators	162
Lathe & turning machine set-up operators	175
Lathe & turning machine operators	499
Milling & planing machine operators	88
Stamping press machine operators	683
Rolling machine operators	115
Drilling machine operators	467
Grinding & polishing maciine operators	1,266
Forging machine operators	68
Numerical control machine operators	130

Miscellaneous machine operators	534
Fabricating machine operators, n.e.c.	108
Molding & casting machine operators	503
Metal plating machine operators	394
Heat treating equipment operators	135
Miscellaneous metal machine operators	45
Wood lathe machine operators	28
Sawing machine operators	188
Shaping & joining machine operators	7
Nail & tacking machine operators	22
Misc. woodworking machine operators	29
Printing machine operators	649
Photoengravers & lithographers	88
Typesetters & compositors	210
Miscellaneous printing machine operators	55
Winding & twisting machine operators	233
Knitting & weaving machine operators	85
Textile cutting machine operators	10
Textile sewing machine operators	1,024
Shoe machine operators	51
Pressing machine operators	296
Laundering & dry cleaning mach. operators	171
Miscellaneous textile machine operators	125
Cementing & gluing machine oprators	298
Packaging & filling machine operators	908
Extruding & forming machine operators	219
Mixing & blending machine operators	341
Separating machine operators	139
Compressing machine operators	74
Painting machine operators	657
Roasting & baking machine operators	1
Washing & cleaning machine operators	27
Folding machine operators	63
Furnace & oven operators	854
Crushing & grinding machine operators	63
Slicing & cutting machine operators	557
Motion picture projectionists	13
Photographic process machine operators	156
Miscellaneous machine operators, n.e.c.	4,078
Machine operators, not specified	1,025
Welders & cutters	2,375
Solderers & brazers	395
Assemblers	6,523
Hand cutting & trimming occupations	37
Hand molding & forming occupations	67
Hand painting & decorating occupations	315
Hand engraving & printing occupations	12
Hand grinding & polishing occupations	39
Miscellaneous hand working occupations	90
Production inspectors & examiners	3,579
Production testers	495
Production samplers & weighers	18
Graders & sorters, except agricutlural	111
Supervisors, motor vehicle operators	56
Truck drivers, heavy	5,124
Truck drivers, light	768
Driver-sales worker	167
Bus drivers	1,100

Taxicab drivers & chauffeurs	482
Parking lot attendants	57
Motor transportation occupations, n.e.c.	4
Railroad conductors & yardmasters	67
Locomotive operating occupations	202
Railroad brake & switch operators	139
Rail vehicle operators, n.e.c.	33
Ship captains & mates	156
Sailors & deckhands	44
Bridge & lighthouse tenders	3
Supervisors, material moving equipment	69
Operating engineers	320
Longshore equipment operators	0
Hoist & winch operators	113
Crane & tower operators	490
Excavating & loading machine operators	142
Grader, dozer, & scraper operators	177
Indust. truck & tractor equip. operators	957
Misc. material moving equipment operators	414
Supervisors, equipment cleaners, n.e.c.	21
Helpers, mechanics & repairers	63
Helpers, construction trades	256
Helpers, surveyor	18
Helpers, extractive occupations	19
Construction laborers	956
Production helpers	338
Garbage collectors	170
Stevedores	102
Stock handlers & baggers	884
Machine feeders & offbearers	271
Freight, stock & material handlers, nec	1,197
Garage & service station related occupat.	360
Vehicle washers & equipment cleaners	434
Hand packers & packagers	575
Laborers, except construction	2,664
Total	236,679

Source: Management Information Services, Inc.; 1989.