An Introduction to DEIMS

The Defense Economic Modeling System

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Background

Defense in the U.S. Economy

In spite of the end of the cold war and the concomitant reduction of defense spending in the economy, defense purchases are still an important factor in the federal budget, as well as in the overall output and employment outlook of the U.S. Defense spending continues to be an interesting current political topic, as evidenced in recent congressional hearings on the A-12 Stealth bomber and the C-17 transport plane. What makes defense spending so politically important is the concentration of defense dollars from procurement and other programs on certain industries and states. During the period of the Reagan defense budgets, these industries and states experienced a strong stimulus from the rise in defense spending. However, since about 1991, they have suffered from the concomitant reductions. The tales of woe arising from aircraft and electronics producers in states such as California and Massachussetts now have a familiar ring.

Recent trends in overall U.S. defense spending can be found in figures 1 and 2 below. Figure 1 shows historical spending on defense in 1996 constant dollars.[1]   This graph shows that, in constant prices, average post-war spending has oscillated around a mean of about 300 billion dollars per year. It reached its lowest point since the early 50s in 1977, and is expected to return to about that level by 1997.

Figure 2 shows that as a share of GDP, defense has ranged from nearly 18 per cent in 1952 to a little over 4 per cent by 1994, and is expected to decline to about 3 percent. As a share of total federal government purchases, defense spending as fallen from the level of 88 per cent

[1] Total defense outlays are specified by the Department of Defense in constant 1996$. A projected spending series from 1994 to 2001 was linked to the constant price series published in the NIPA, tables 1.1 and 3.7.

Figure 1

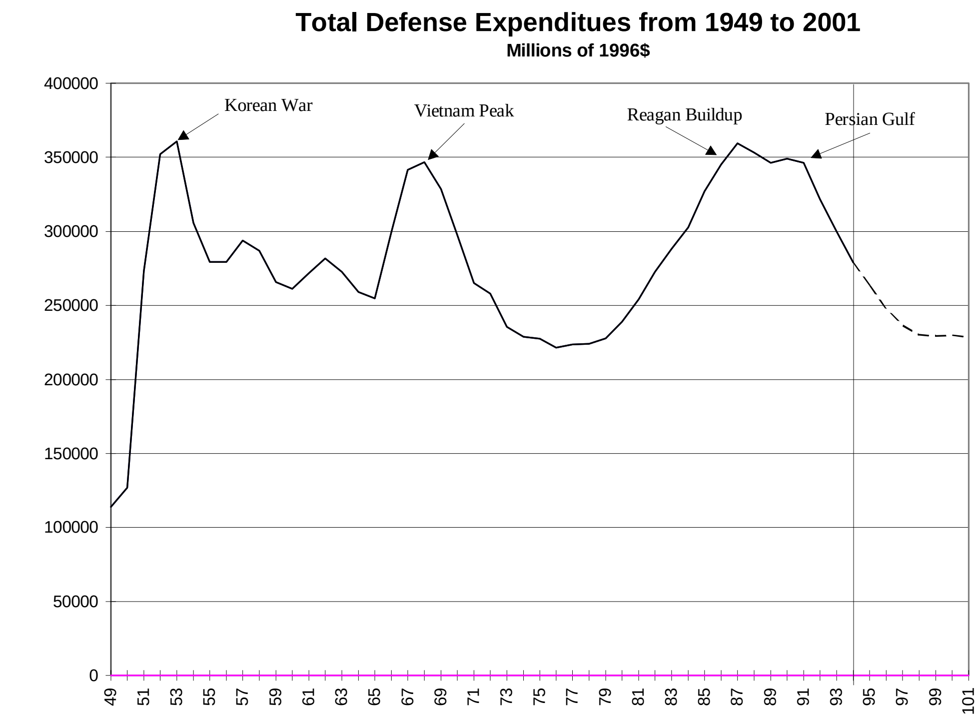
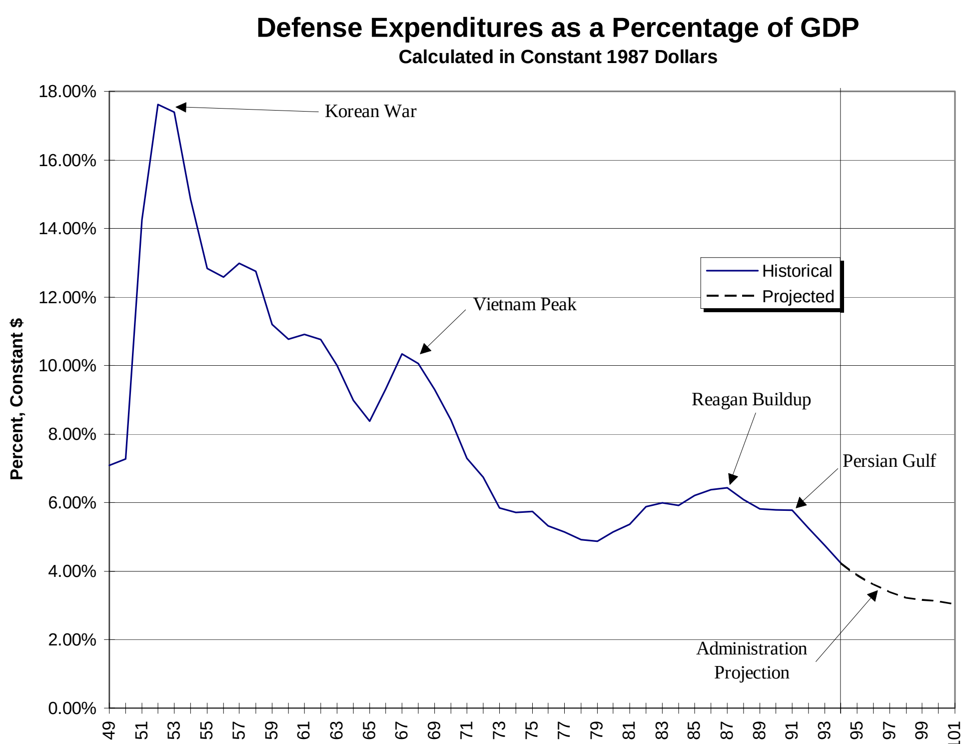


Figure 2



(in constant dollars) in 1952 to just under 67 per cent in 1994. As a share of the budget, defense spending is now about where it was during the middle years of the Carter administration. As a share of GDP, defense spending is now at its lowest level since World War II.

However, at a 1994 level of $292.3 billion, this is still quite a lot of expenditure, and the U.S. still spends a high percentage of GDP compared to other countries. Figures 3 and 4 indicate that the U.S. spends more on defense as a percentage of GDP than its NATO allies. The United Kingdom and France are not too far behind however, while Russia and China actually spend a larger percentage of GDP on defense. The U.S. still spends the largest total amount on defense. The next largest is Russia, which spent less than a third of the U.S. in 1993. Even the total defense expenditures of belligerent countries such as Iraq and Libya are tiny, when compared to that of the U.S.[2]

When viewed at a detailed industry level, certain industries are more significantly affected than others by defense spending. Table 1 on the next page is calculated using the DEIMS and *Iliad* database. It shows total requirements for defense (direct plus indirect) as a percentage of total domestic production and imports for 1994. The industries are ranked by this percentage, and the top 20 are shown. In addition to industries whose purpose is obviously

Figure 3

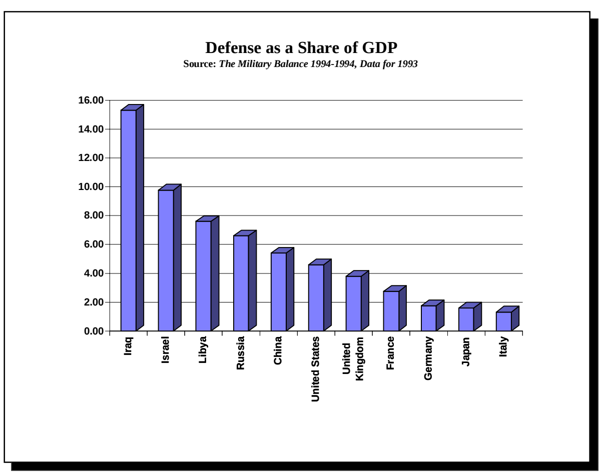
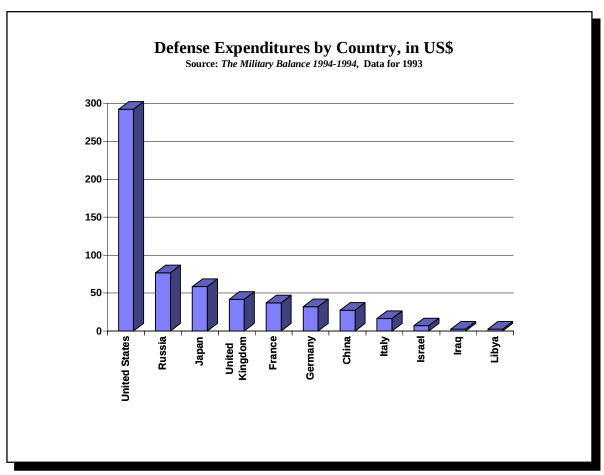


Figure 4



[2] Source: *The Military Balance: 1994-1995*, International Institute for Strategic Studies, London, 1994.

Table 1. Percent of Total Requirements for Defense out of Total Output plus Imports

Rank	*Industry*	*Percent*
1	22 Ammunition, except small arms	98.90%
2	240 Ship building and repairing	88.86%
3	26 Other ordnance and accessories	87.86%
4	23 Tanks and tank components	75.37%
5	21 Complete guided missiles	62.64%
6	25 Small arms ammunition	40.21%
7	239 Aircraft and missile equipment, nec	36.80%
8	103 Explosives	25.34%
9	267 Water transportation	22.15%
10	237 Aircraft	19.87%
11	180 Industrial trucks and tractors	19.83%
12	153 Nonferrous castings and forging	17.61%
13	317 Government industry compensation	16.68%
14	296 Engineering and architectural serv.	14.97%
15	159 Boiler shops	14.15%
16	238 Aircraft and missile engines	13.89%
17	291 Mgmt and consulting, research labs	13.52%
18	144 Primary lead	12.50%
19	269 Pipelines	12.03%
20	223 Radio and TV communication equipment	11.11%

Source: DEIMS Calculations for 1994

the production of weapons, there are also many industries that would be considered "high-tech", such as Engineering and architectural services (296) or Radio and TV and communication equipment (223) which also owe much of their production to defense. Strong U.S. export industries, such as Aircraft (237) and Industrial trucks and tractors (180) are also strongly affected by the pattern of defense purchases.

DEIMS: Rationale and Development

The purpose of DEIMS is to gain an understanding of the impacts of federal defense spending on the U.S. economy. It was originally constructed in the early 1980s, for the Office of Program Analysis and Evaluation, in the Office of the Secretary of Defense. This first version of DEIMS was based on a top-down approach, with macroeconomic assumptions driving the calculations of an input-output model. As such, it suffered from difficulties in the correct determination of import requirements, and in a lack of consistency between the industry details and the macroeconomic aggregates.

In late 1994, INFORUM undertook a project to build a new version of DEIMS, working in a DOS environment, using the Interdyme[3] modeling package. The new system, which has been recently completed, is based on the LIFT integrated macro/interindustry model, the *Iliad* detailed interindustry model, and various special purposes modules to determine defense impacts by detailed industry, by state and by occupational categories, described in the following sections.

Overview of DEIMS

There are six major components of the new version of DEIMS. These are listed below:

1. *Processing the Defense Translator and Other Assumptions* - The defense translator disaggregates the total defense budget by budget category, as well as by category of armed services. The first stage in the operation of DEIMS is to organize this translator data as well as other defense assumptions for input to the other models. The defense translator is described in more detail below.
2. *The INFORUM LIFT Model* - This model is used to determine the macroeconomic and industry context of defense spending. A LIFT simulation is developed, based on a series of projected defense purchases, compensation and employment.
3. *The INFORUM Iliad Model* - The detailed *Iliad* model calculates requirements for domestic production (output) and imports for 320 sectors comprising the U.S. economy. A series of projected defense purchases is also developed at this level, and the LIFT forecast developed in the first stage is used to provide other inputs to *Iliad*.

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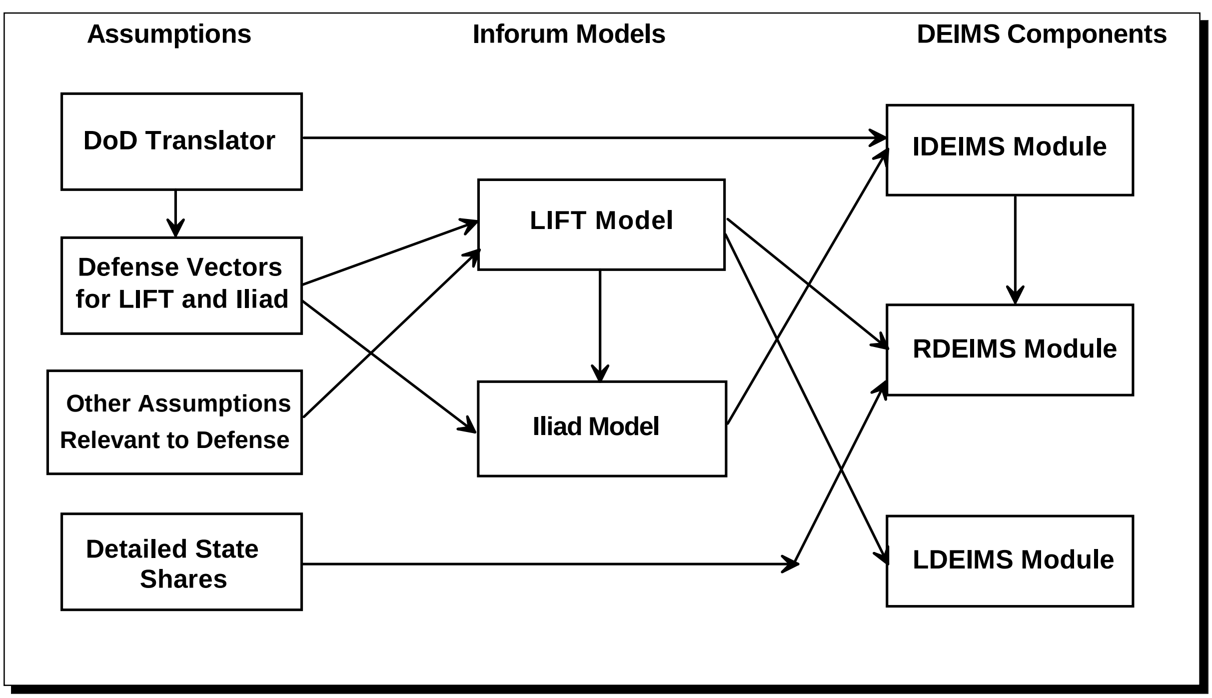
[3] Interdyme is a system for building economic models consisting of matrices, vectors and econometric equations, which has primarily been applied to the development of interindustry models, but which has much broader uses, such as in the defense modeling system described. It is written in C++ and works with the *G* regression package.

4. *IDEIMS: The Interindustry Defense Module* - This module uses detailed defense expenditure data provided in the defense translator to determine total domestic requirements, imports and indirect requirements associated with each budget category of defense spending.
5. *RDEIMS: The State-Level Module* - This module calculates defense impacts by state associated with each budget category of defense. It also calculates defense impacts due to the defense compensation account in each state.
6. *LDEIMS: The Defense Skilled Labor Module* - This is an occupational forecasting module that calculates employment by occupation due to defense, both direct and indirect, at the LIFT sectoral level. It is based on current and projected occupational matrices from BLS.

The following subsections will discuss the above steps in more detail. Figure 5 below outlines the flow of data, assumptions and results between the various components of DEIMS. Note the close relationship of the *Iliad* model to IDEIMS. The LIFT model provides national or industry control totals for the RDEIMS and LDEIMS results.

Figure 5. Relationships Between Assumptions, Inforum Models and DEIMS



Processing the Defense Translator and Other Assumptions

The defense translator represents a summary of many detailed program accounts maintained by the Department of Defense (DOD). As such, it serves as the critical link between defense budget outlays and associated purchases from U.S. industries. In each year's unified federal budget, a section relating to the defense department describes expenditures for major categories of defense spending, for each branch of active armed forces service and reserve categories. Future defense expenditures are also projected in the Five Year Defense Plan (FYDP), and detailed implications of this plan are spelled out in the projections of the translator for future years. Lying behind the aggregate numbers in each budget category (such as "Aircraft Procurement - Army") are many separate programs, which may be as detailed as a single weapons system. Where possible, detailed data is collected on the industry composition of inputs to each of these programs. These detailed vectors of inputs are called *subtranslators*. These are then aggregated to the appropriate budget account using expenditure weights to form the translator vectors. The aggregate translator vectors are available for 14 budget categories listed in Table 2. For each of these budget categories, there may be as many as a few dozen to a few hundred sub-translator vectors.[4]

As a first approximation, a translator matrix may be viewed as similar to an input-output bridge matrix, where the columns sum to 1.0, and whose purpose is simply to share out expenditures to each input-output industry. However, there is an extra wrinkle in using the translator that is due to a procedure that attempts to account for the distinct input requirements for certain defense goods, as opposed to goods in the same industry that are sold to civilian businesses. This procedure is called *unbundling*, and is described in the next section.

[4] More information about the translator can be obtained from *The Revised Defense Translator*, by T. Frazier, C. Campbell and R. Cheslow, Institute for Defense Analysis, October 1989.

Table 2. Translator Budget Categories

	Spending Categories
1	Military Personnel
2	Military Retirement Payments
3	Operations and Maintenance
4	Aircraft Procurement
5	Missiles Procurement
6	Weapons and Tracked Vehicles Procurement
7	Ammunition Procurement
8	Ships Procurement
9	Other Procurement
10	Research, Development, Test and Evaluation
11	Military Construction and Family Housing
	Procurement by Service Category
12	Army Procurement
13	Navy Procurement
14	Air Force Procurement

"Bundled" vs. "Unbundled" Translator Vectors

In the initial trials with DEIMS in the early 80s, unreasonable results were obtained for some industries, particularly aircraft. This was seen to be due to the fact that defense aircraft are comprised of a significantly different set of input requirements than commercial aircraft, or small aircraft purchased by civilian enthusiasts. There was also the problem of the treatment of government furnished equipment (GFE) in the BEA input-output table. When the government purchases a large item such as a ship or an advanced aircraft, it usually buys the major components directly from the various manufacturers. For example, an F-16 jet will require a jet engine, electronics and weapons, which are all purchased separately by the government, and then shipped to the aircraft manufacturer for installation. BEA treats these purchases as final demands, even they are logically intermediate goods. Therefore, the BEA engine coefficient for aircraft is less than the actual share of aircraft cost accounted for by engines.

One way to solve this problem would be to create separate industries in the input-output table, specific to defense procurement. For example, one could create two columns for aircraft, one for defense aircraft, and one for commercial aircraft. Then the defense translator could specify that defense purchases are made only from the defense aircraft industry. The defense aircraft industry would be comprised of input-output coefficients calculated according to the mix of aircraft in the defense budget.

However, for various reasons, this approach was not followed. For one, re-calculating the input-output table was viewed as too costly. In addition, such a re-calculated table would still not be accurate to the extent that the composition of the defense budget changed. DOD maintains separate detailed information on the input structure of different defense programs, and this detail would be lost by including it in the input-output table. Instead, the "unbundling" approach was used. In this approach, certain defense final demands to be unbundled are replaced by direct requirements of inputs to produce those demands. The pattern of coefficients is distinct for each DOD program item. Two adjustments are made to prevent double-counting and to account for lost value added. The double counting comes about because part of the subtranslator column for an aircraft will in fact be the aircraft industry. In this case, it merely represents the airframe and other assembly components needed to produce the final aircraft. However, the aircraft column in the input-output table will then generate more demand for engines because of this airframe purchase, and that will be double-counting, since engines have already been allocated. Therefore, a certain amount of engines is removed from the translator column to prevent this double-counting. The adjustment for lost value added is necessary because when we replace the final demands for the unbundled good by its first pass direct requirements, the output that went to pay value added is not counted. For this reason the unbundled coefficients sum to less than one, and the full value of the unbundled good is not passed to the input-output solution as final demand. At the end of the input-output solution, this value added is calculated and added back to the unbundled industry (such as aircraft).[5]

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[5] The mathematics and assumptions used in implementing this procedure are discussed in more detail in "Modification of an Input/Output Table to Reflect the Input Requirements of Major Weapons Systems", by David McNichol.

The translator vectors are prepared by DOD at the 320 sector level, which corresponds to the sectoring of the INFORUM *Iliad* model. The first step in processing this data is to read the translator data into an Interdyme file. The *Vam* program includes spreadsheet capabilities, that allow the raw data to be viewed and checked. With a total for Federal Defense Expenditures by year also available, in the same constant dollars as the translator data, the coefficient data will also be converted to flows in these dollars in the same *Vam* file.

Next, the total defense expenditures by industry from the translator are converted to constant 1977$, in which LIFT currently operates, and aggregated to the LIFT sectoral level. The 320 sector data is also converted to 1982$ for input into *Iliad*.

The INFORUM LIFT Model

LIFT (**L**ong-term **I**nterindustry **F**orecasting **T**ool) is run to examine the macroeconomic and industry effects, at the 85 sector level, of a given defense budget, budget distribution, and level of defense employment. LIFT calculates variables such as aggregate GNP, the CPI deflator, the savings rate and the unemployment rate, as well as sectoral variables such as output, employment and prices by industry, as well as final demands and value added components by industry.

The necessary inputs to LIFT are listed in Table 4. Levels of defense compensation and total expenditures are derived in the previous step above. Defense compensation is treated as an industry in the translator.

The LIFT model furnishes the macroeconomic environment as well as industry controls for some of the more detailed industry variables in *Iliad* and the Interindustry defense module. LIFT outputs are used further on in the calculations of RDEIMS, and LIFT employment forecasts are used in LDEIMS. LIFT can be used to analyze the macroeconomic and industry impacts of various alternative budgets.

Table 4. Exogenous Variables for LIFT Simulation

LIFT Input Variable	*Description*
Defense Final Demand Projection	Exogenously projected defense vector at the 85-sector level, in 1977$, calculated in the previous step.
EMP91M	Total Military Defense Employment.
EMP91C	Total Civilian Defense Employment
WDEFC	Total level of Federal Defense Compensation
GFDP	Total level of Federal Defense Purchases, in 1977$
TRPMR	Military Retirement Benefits
Construction, category 21	New Construction of Military Facilities
Other Variables...	

The INFORUM Iliad Model

Iliad (**I**nterindustry **L**ong-run **I**ntegrated **a**nd **D**ynamic Model), maintains detail for 320 industries, in 1982$. It includes a set of detailed employment equations, forecasting employment for 320 industries, as well as import equations. Other final demand components are forecast by linking their growth rates to the corresponding LIFT industries. After the LIFT model has been run, the 320 element vector of defense expenditures in 1982$ is input into the detailed interindustry model.

Results from *Iliad* can be viewed using the table-making program *Compare*. *Compare* can also generate row or column matrix listings, which show either the sources of demand for a given industry, or the patterns of input use. Tables can be created that show total requirements by industry, or any of the final demand vectors included in the model.

IDEIMS: The Interindustry Defense Module

IDEIMS is the first of the three modules that comprise the defense-specific part of DEIMS. It is an Interdyme forecasting program, and reads inputs from both the translator Vam file and the *Iliad* forecast Vam file. This module performs a number of related tasks.

The first task is to read in translator data at the *Iliad* sectoring level from the translator Vam file described above. Next, these data are deflated to 1982$, using price indexes from the *Iliad* model. A special deflator is used to deflate compensation. Next, at the detailed industry level, total requirements generated by defense expenditures are calculated, for each of the 14 budget categories, using the "unbundled" version of the defense translator data. Total requirements for all categories is formed as the sum of total requirements of the first 11 detailed categories. In calculating this solution, import requirements are calculated based on the share of imports with respect to domestic demand as calculated in the *Iliad* solution. After the total requirements solution is complete, "add-ons" are added back to get the final total requirements solution. They are used to restore the value added lost in the three industries for which unbundling was done, namely Aircraft, Guided missiles and Tanks.

During each stage of the input-output solution, imports are determined according to the formula:

$$M = R * TR$$

where: M = imports

R = imports/domestic demand ratio

TR = Total requirements necessary at each stage.

The ratio R is formed for each industry in *Iliad* as:

$$R = M/(Q-X-Def+M)$$

where: Q = output

X = exports

Def = defense expenditures

Note that imports are removed from requirements at *every* stage of the solution, including the first stage, at which the direct final demand requirements are calculated. In this way, the detailed solution is automatically and consistently "import adjusted" as an integral part of the solution process.

The second task is to account for indirect purchases for each budget category. This is accomplished in the following way. Indirect demands consist of total requirements (domestic output plus imports) less direct requirements. But which direct requirements? We should use the "bundled" direct requirements, which are the raw defense final demands before the unbundling adjustment. In some sense they are the vector of demands most closely representing direct demands, even if they still contain some GFE entries. Therefore, to obtain indirect demands, the bundled final demands are subtracted from total requirements. The results of the model are domestic requirements, imports, indirect requirements, and direct requirements (bundled and unbundled) by industry, by budget category. In the current IDEIMS model, the bundled and unbundled matrices are 320 rows by 14 columns.

Table 5. Ranking of Industries by Defense Indirect Demands: 1994

Rank	*Industry*	*Indirect*
1	276 Wholesale trade	8266.7
2	293 Advertising	5831.8
3	239 Aircraft and missile equipment, nec	4993.2
4	294 Other business services	4424.0
5	285 Real estate	4314.4
6	279 Banking	4136.2
7	290 Computer and data processing serv.	4114.5
8	113 Petroleum refining except fuel oil	3918.0
9	227 Electronic components,nec	3792.9
10	297 Accounting and misc. prof. services	3593.1
11	273 Electric utilities	3177.0
12	16 Crude oil extraction	3157.1
13	271 Telephone and telegraph	3056.9
14	20 Maintenance construction	2829.9
15	226 Semiconductors and related devices	2289.8
16	139 Steel mills, blast furnaces	2243.3
17	121 Miscellaneous plastic products	2216.8
18	266 Trucking	2210.8
19	295 Legal services	2068.5
20	274 Natural gas	2063.7

Figure 6

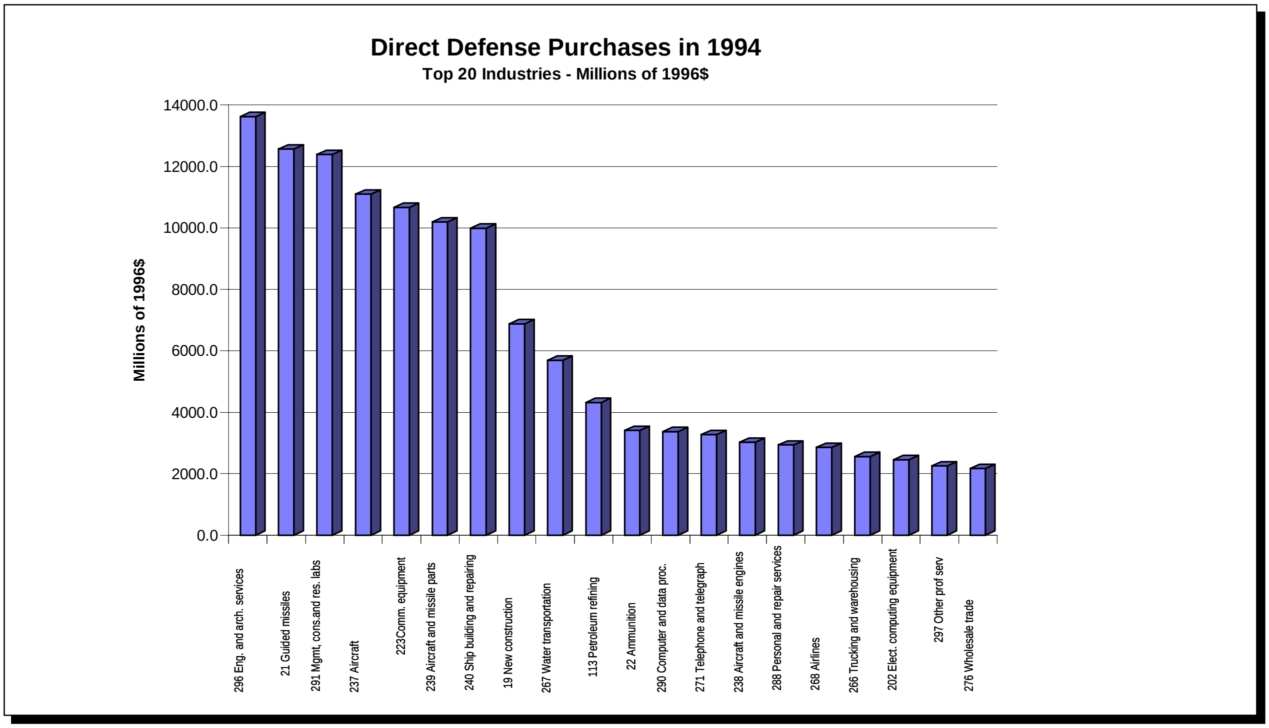
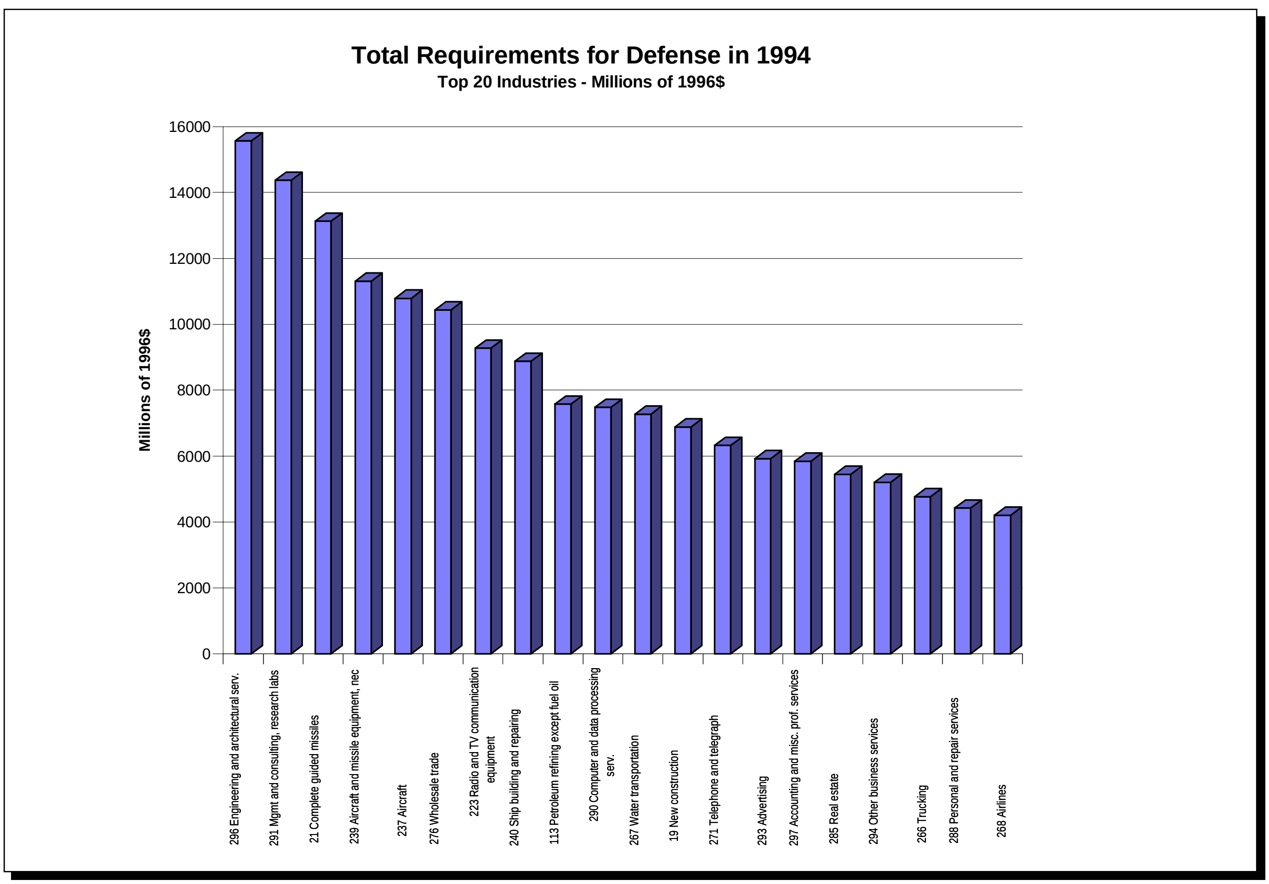


Figure 7

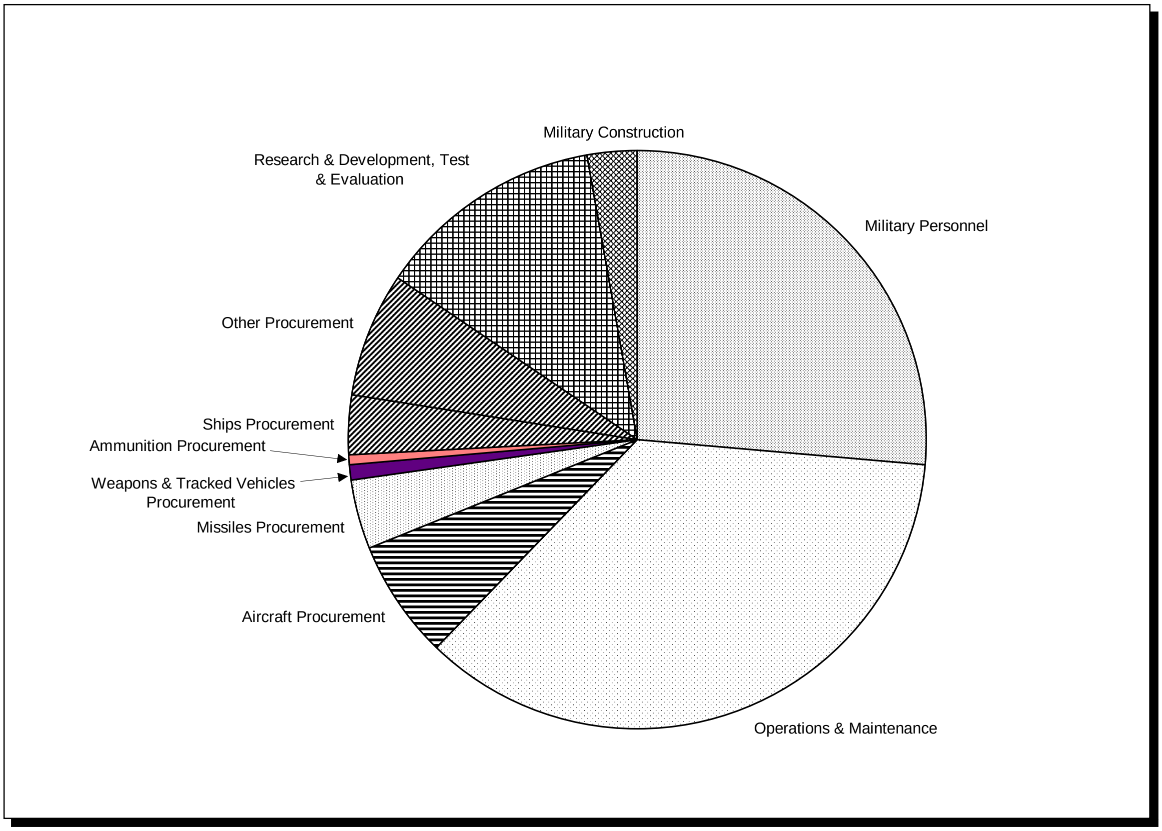


Tables can be created of the results of the Interindustry Defense Module using the *Compare* program. Stub files for *Compare* can be used to generate tables of direct requirements, total domestic requirements, imports and indirect demands, by industry, either by budget category or for the total of all the expenditure categories. A ranking of total defense requirements as a percentage of total output was shown on page 4 (Table 1). Table 5 shows a ranking of the largest industries in terms of defense *indirect* demand. This table shows that defense purchases generate large indirect demands for many support industries, such as Wholesale trade, Banking, Telephone and Telegraph and Business services.

Figures 6 and 7 show column graphs of the top 20 industries in terms of total direct defense expenditures, and in terms of total requirements, for 1994. It is interesting that two of the largest industries in terms of direct defense expenditures are service industries providing engineering and research services. 13.6 billion dollars was spent on Engineering and architectural services (*Iliad* 296*)*, and 12.4 billion on Management consulting and research laboratories (*Iliad* 291). Other important industries are Guided missiles and space vehicles (12.6 billion), Aircraft (11.1 billion) and Radio and TV broadcasting and communication equipment (10.7 billion).

Figure 8 contains a pie chart showing the relative importance of the 10 major budget categories in 1994. This shows that the two largest categories, Military Personnel and Operations and Maintenance, comprise over 60% of total spending, weighing in at 73.8 billion and 99.4 billion dollars, respectively. All procurement categories combined make up less than a quarter of the total, or 62.5 billion dollars. Within procurement, other procurement is the largest (19.9 billion), followed by aircraft procurement (19.3 billion) and missiles procurement (10.9 billion). Other procurement includes a wide variety of products and services, including economic models and consulting. The other category in the chart is Military construction and family housing, which came to 7.5 billion dollars in 1994.

Figure 8. Shares of Ten Major Procurement Categories in Total Defense Expenditures in 1994



RDEIMS: The State-Level Module

The purpose of RDEIMS is to determine the impact of defense expenditures by major procurement category on each state, at the 85 industry (LIFT) level. There are 17 major concepts that are forecast by RDEIMS, listed in Table 6 below. For each concept, forecasts are made by 50 states plus the District of Columbia, as well as a U.S. total, at the 85 industry level. Therefore, each major array in RDEIMS is 52 by 85.

The first 11 categories in Table 7 correspond to the first 11 budget categories of IDEIMS. A certain percentage of total pay is split out from the Military Personnel category as retired pay, and this is then shared out to the state level using current state shares. Category 12, total direct demand, is just the sum of the first 11 categories. Indirect impacts of defense arising from purchases are derived from IDEIMS, and shared out to the state level using the assumption that services are purchased locally, and manufactured goods nationally. Manufactured goods are assumed to have the same state distribution as overall production. Indirect purchases arising from pay are calculated by applying the shares of each industry in total personal consumption expenditures from the LIFT model to the total compensation paid out in each state. Total defense impacts are then calculated as the sum of total directs, indirect impacts arising from purchases, and indirect impacts from pay. Total output is taken from the LIFT model, and shared out to the states using current data on production by state. Total nondefense expenditures are calculated by subtracting total defense impacts from total output by state.

Most of the state shares used to estimate procurement, research and development, military personnel and military construction are estimated up to the current year using a large database

Table 6. Arrays used in RDEIMS

Array Name	*Description*
milper	Military Personnel
retper	Retirement
o&m	Operations and Maintenance
aircraft	Aircraft Procurement
missiles	Missiles Procurement
wtcv	Weapons and Tracked Vehicles Procurement
ammo	Ammunition Procurement
ships	Ships Procurement
other	Other Procurement
rdt&e	Research, Development, Test and Evaluation
milcon	Military Construction and Family Housing
totdir	Total Direct Expenditures
indpur	Indirect Impacts of Defense Arising from Purchases
indpay	Indirect Impacts of Defense Arising from Pay
totdef	Total Defense Impacts on Production
totndf	Total Nondefense Expenditures
sttotal	Total Output, Including Non-Defense

of defense contracts called the Contract Awards database. These share vectors have been compiled for us by the Institute for Defense Analysis..

Figure 9

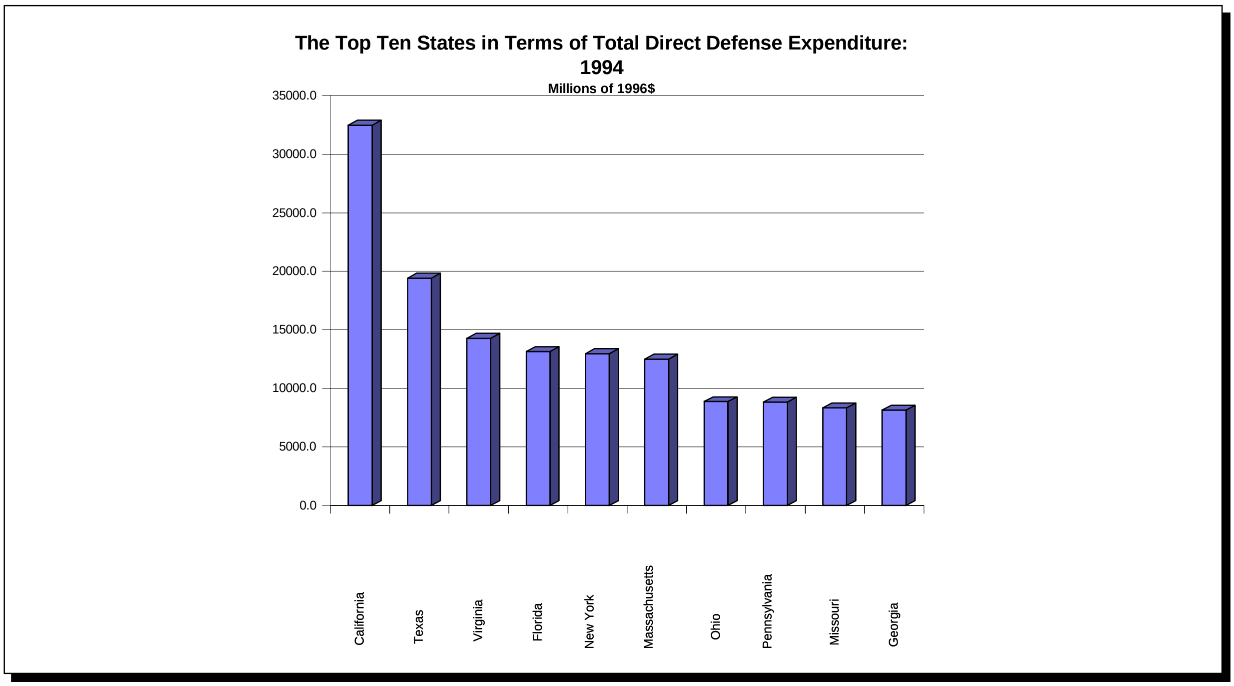
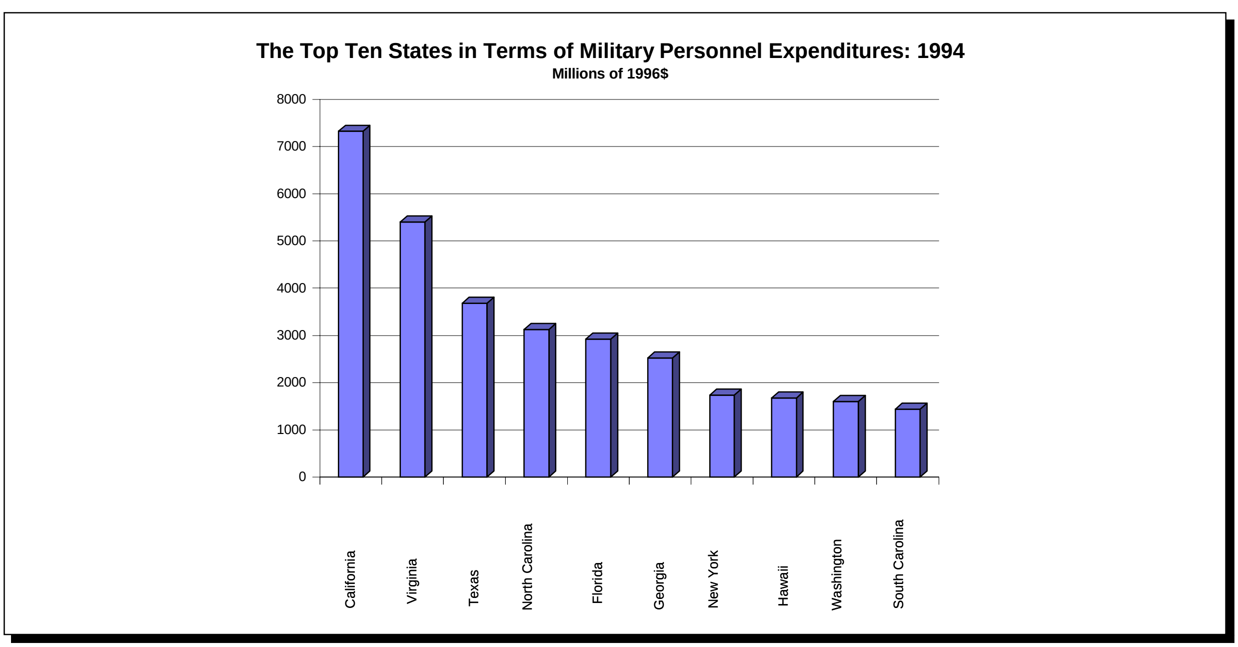


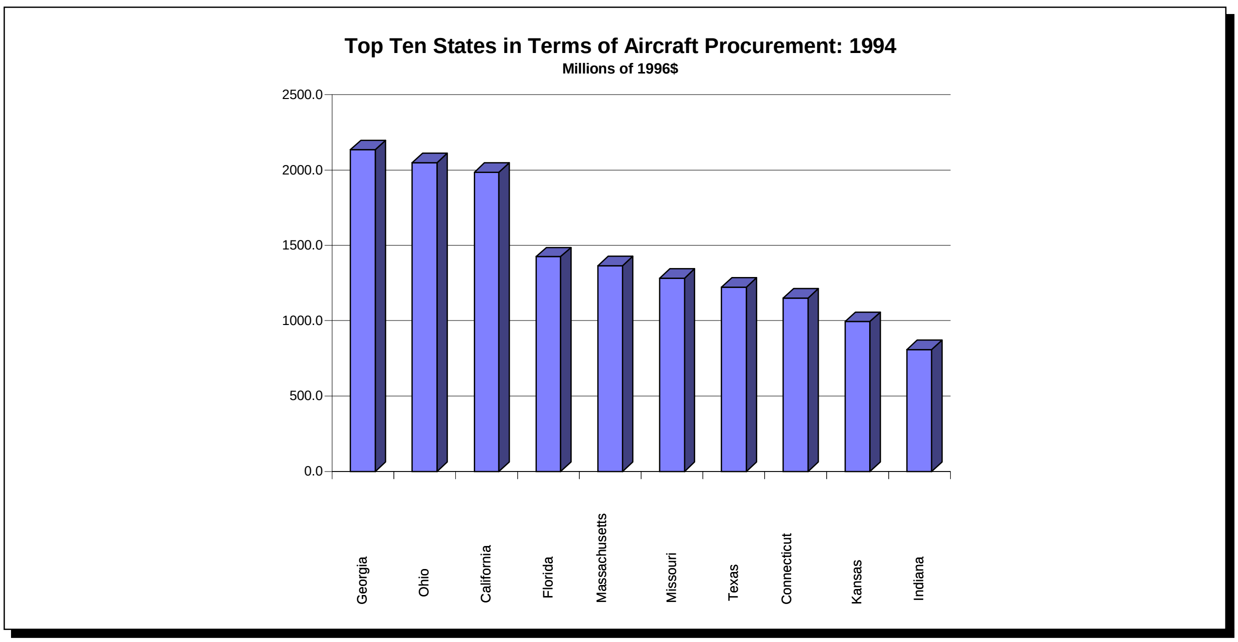
Figure 10



The RDEIMS results are quite detailed, and the forecast can be viewed from either the state, industry or budget category perspective. The following figures summarize the aggregate shares of expenditure for certain categories.

Figure 9 shows the top 10 states in 1994 in terms of total direct defense expenditures. This chart confirms the general knowledge that California is the largest state in terms of total defense spending, receiving almost twice as much as Texas, the second highest state. Other states which receive a large share of total spending are Massachussetts, New York, Florida and Ohio[6]. Figure 10 focuses on one category of spending, military personnel. The distribution of this category is determined in large part by the distribution of military bases. Navy bases tend to be located along the East and West coasts, and in Hawaii. Army bases tend to get located in warm-weather states. Thus, while California still takes first place overall, southern states such as Virginia, Florida, Georgia and the Carolinas receive a high proportion of military personnel expenditures.

Figure 11

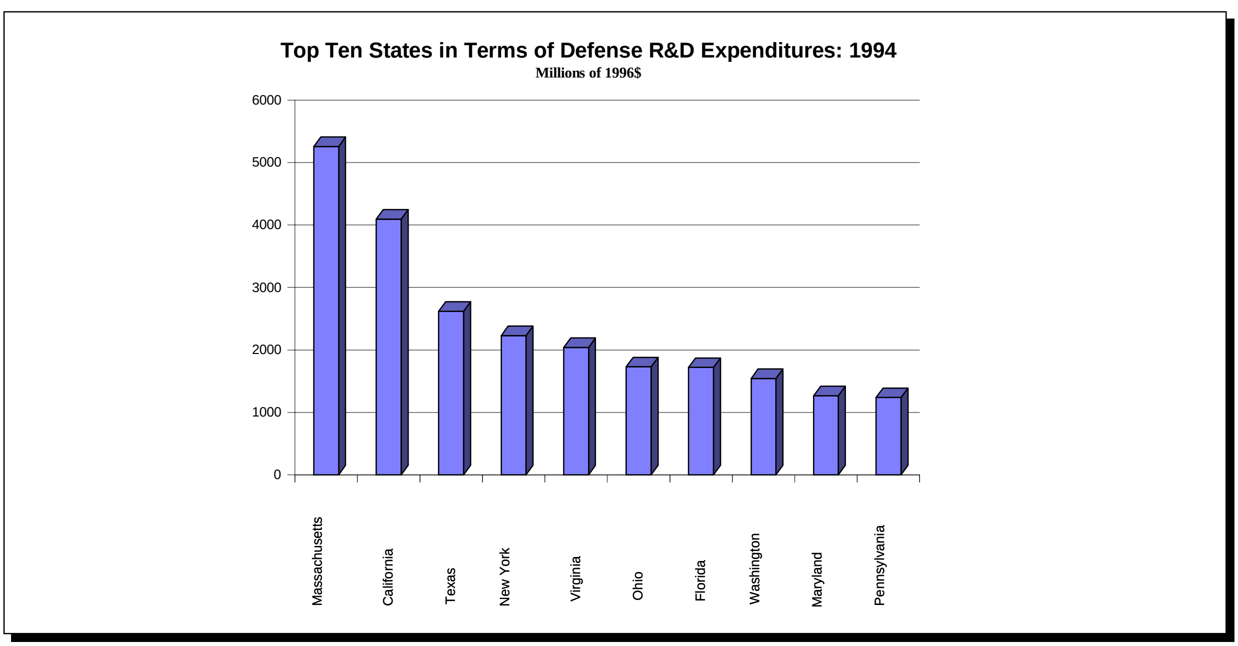


6 Some have taken to calling these states the "Gunbelt", although they are not geographically contiguous.

Aircraft Procurement, as we saw in Figure 8, is a relatively small share of total defense spending, roughly 7 per cent. However, it is a very important and visible part, and cuts in aircraft procurement items are vigorously contested in Congress. Figure 11 shows the distribution in 1994 of aircraft procurement in the top ranking states. Although California is among the top three, it is actually lower than both Georgia and Ohio. Other states strongly affected by the spending on aircraft procurement are Florida, Massachussetts and Missouri.

In this era of high-tech weaponry, an ever higher percentage of expenditures is being devoted to R&D. The broader category called Research, Development, Test and Evaluation (RDT&E) also includes expenditures for prototyping and testing of new systems and products. From Figure 8 one can see that RDT&E is larger than any single procurement category, and comprises nearly 13 percent of the total budget. RDT&E tends to be concentrated in areas where high-tech production is taking place, but is also generally located close to good universities and technology corridors such as silicon valley in California, route 128 in Massachussetts, and also in the Washington metropolitan area. Figure 12 shows the top ten states in terms of RDT&E. With respect to this important category, Massachussetts has the lead, followed by California, Texas and New York.

Figure 12



The distribution of any given category by industry is exogenous to RDEIMS, and constant over the period of the forecast. The resulting impacts on an industry in any given state are a function of the state distributions of each spending category, and the relative growth rates of that category and industry within a given budget projection.

Table 7 shows the resulting impacts from the current projection on two arbitrarily chosen states. The numbers in these tables are summed across industries, so that one can determine the total impacts of a given budget item, such as Operations and Maintenance, on the given state. Since the state shares for a given budget category and industry are taken as constant throughout the projection, differences in growth rates of the same category between two states are the result of differences in state distributions of the industrial categories within any given budget category, and differences in the growth rates of these industrial categories in the

Table 7. State Summary Tables for Alabama and Ohio
Millions of 1996$

1 Alabama
State Summary Table

	1994	1995	1996	1997	1998	1999	2000	2001
1 Military Personnel	774.5	709.6	637.8	610.3	611.6	608.4	617.3	566.0
2 Retired Pay	473.5	484.4	493.5	503.1	513.0	522.1	530.5	550.5
3 Operations and Maintenance	2915.4	2834.0	2736.2	2643.7	2564.8	2533.0	2501.4	2500.8
4 Aircraft Procurement	176.1	150.3	126.5	114.9	117.1	124.3	134.6	142.1
5 Missiles Procurement	92.3	77.3	64.0	55.1	52.7	52.9	55.7	58.2
6 Weapons & Tracked Vehicles Procurement	13.5	11.6	10.9	10.4	10.2	10.1	10.7	11.1
7 Ammunition Procurement	19.7	17.6	15.0	13.9	13.2	12.4	10.5	9.6
8 Ships Procurement	18.8	15.1	14.9	12.8	11.8	10.4	10.3	11.3
9 Other Procurement	178.6	161.4	147.6	139.5	138.2	137.7	139.7	141.5
10 Research, Development, Test and Evaluation	915.4	898.1	855.4	796.2	767.7	730.8	703.3	684.6
11 Military Construction and Family Housing	131.2	130.0	129.0	119.4	121.4	122.1	121.9	122.3
12 Total Direct Expenditures	5709.1	5489.4	5230.7	5019.3	4921.7	4864.2	4836.0	4798.1
13 Indirect Impacts of Defense Arising from Purcha	2482.3	2295.7	2140.6	2057.3	1967.3	1980.8	2000.6	1950.2
14 Indirect Impacts of Defense Arising from Pay	1016.1	968.4	917.5	871.5	878.6	864.5	863.0	862.9
15 Total Defense Impacts on Production	9207.5	8753.5	8288.7	7948.0	7767.5	7709.5	7699.6	7611.1
16 Total Nondefense Expenditures	230222.1	238172.2	242903.7	249387.1	255966.6	261378.1	266375.4	272823.2
17 Total Output	239429.6	246925.7	251192.4	257335.2	263734.2	269087.7	274075.0	280434.4

36 Ohio
State Summary Table

	1994	1995	1996	1997	1998	1999	2000	2001
1 Military Personnel	816.0	714.1	606.4	586.6	573.3	577.6	590.2	430.0
2 Retired Pay	345.2	353.1	359.7	366.8	374.0	380.6	386.7	401.3
3 Operations and Maintenance	2411.5	2339.7	2270.9	2254.9	2046.9	2048.2	2010.0	2061.5
4 Aircraft Procurement	2048.0	1740.6	1453.4	1304.2	1308.3	1374.7	1487.4	1575.1
5 Missiles Procurement	429.1	360.4	300.7	261.2	251.3	252.1	265.0	276.3
6 Weapons & Tracked Vehicles Procurement	81.4	69.9	65.0	60.7	57.9	57.5	60.8	62.9
7 Ammunition Procurement	211.7	191.6	167.6	150.7	137.4	119.7	87.3	70.0
8 Ships Procurement	55.6	40.2	35.4	30.3	24.4	17.1	15.4	17.1
9 Other Procurement	541.6	484.5	437.8	410.0	404.7	402.9	411.0	417.3
10 Research, Development, Test and Evaluation	1730.3	1696.9	1617.1	1507.7	1458.9	1387.8	1340.3	1313.4
11 Military Construction and Family Housing	193.6	203.9	210.3	199.5	200.9	199.5	200.4	201.3
12 Total Direct Expenditures	8864.1	8194.8	7524.3	7132.7	6838.1	6817.8	6854.4	6826.1
13 Indirect Impacts of Defense Arising from Purcha	7516.9	6947.6	6497.9	6265.9	5993.3	6039.6	6102.4	6031.6
14 Indirect Impacts of Defense Arising from Pay	3340.3	3186.0	3025.2	2877.9	2903.0	2853.9	2848.4	2854.9
15 Total Defense Impacts on Production	19721.2	18328.4	17047.4	16276.4	15734.4	15711.3	15805.1	15712.6
16 Total Nondefense Expenditures	498814.7	516610.2	527198.8	543969.7	559858.7	571528.8	582321.1	597728.1
17 Total Output	518535.8	534938.6	544246.3	560246.2	575593.2	587240.4	598126.1	613440.6

projected defense translator vectors. For example, the decline in Military Personnel expenditures from 1994 to 1995 is 12.5 percent in Ohio, but only 8.4 percent in Alabama. This is because the industrial mix within the Military Personnel category is different in the two states, and each of the 85 industries within that category are growing or declining at a different rate. More detailed tables can be made for each state that show total direct impacts at the industry level, or that show industry impacts by category.

LDEIMS: The Defense Skilled Labor Module

The Skilled Labor Module provides a convenient way of summarizing the requirements generated for various occupational classifications of employment in each industry. INFORUM maintains the most recently published BLS occupational matrix, aggregated to the LIFT level of employment by 85 industries.[7] The total number of rows of this matrix is 628, although some of these rows are aggregates of more detailed groupings. The matrix used in LDEIMS is comprised of 100 occupational categories, chosen in a way to provide more detail on categories that are heavily employed either directly or indirectly by the Department of Defense.

The Skilled Labor Module starts with estimates of DOD direct hires, direct defense employment, defense induced employment, and total employment, and then multiplies the occupational matrix in coefficient form by these employment by industry estimates, to obtain employment by occupation by industry.

As with RDEIMS, the detailed set of data projected by LDEIMS is huge, and difficult to absorb. In the following pages, we will look at some "radar" graphs, that analyze occupational employment patterns at the broader 10 category level.

Figure 13 shows such a graph for the civilian employees of the Department of Defense, which amounted to about 835 thousand persons in 1994, which is more than a third of total

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[7] The 85 sectors in LIFT have been extended to include State and Local and Federal categories of employment, so that the total number of "industries" is actually 90.

Figure 13. Distribution of DoD Direct Hire by 10 Major Occupational Groups in 1994
Thousands of Persons

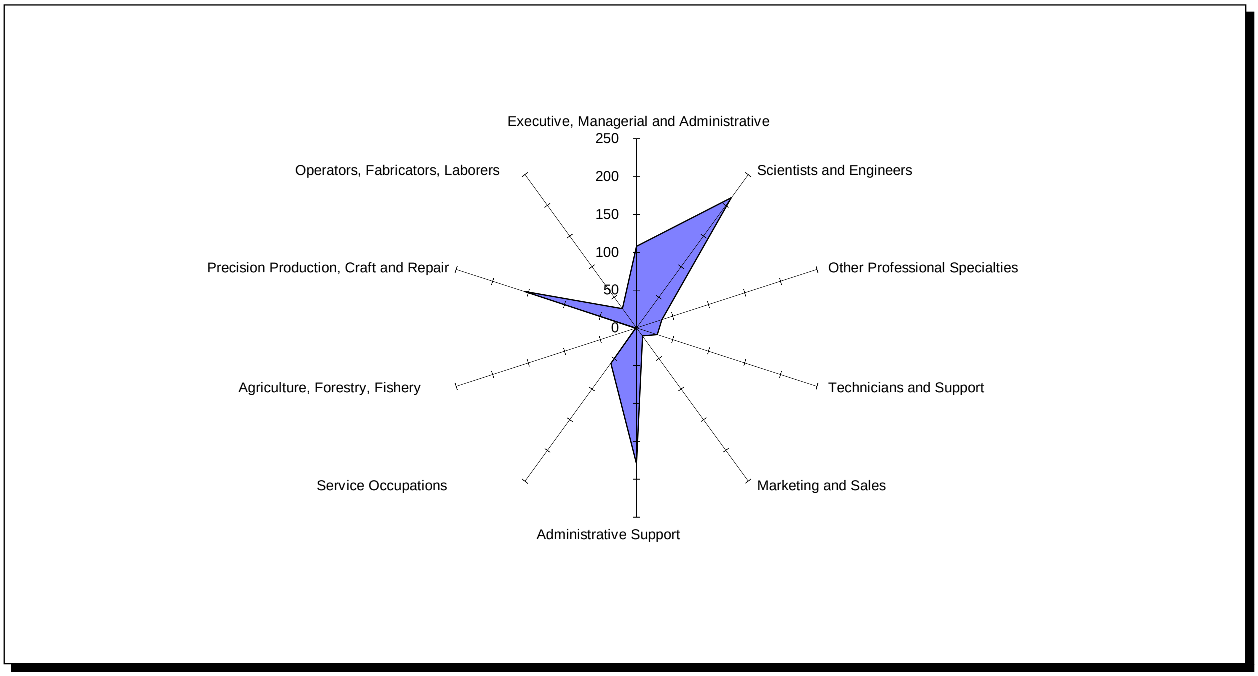
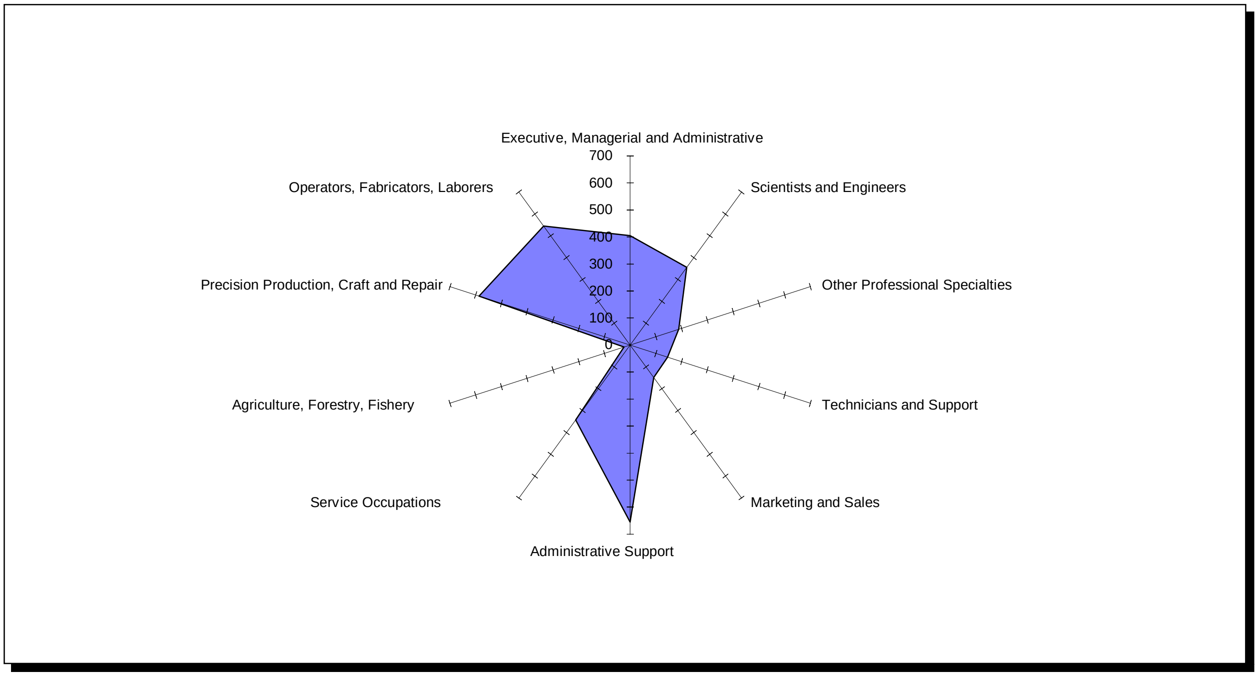


Figure 14. Distribution of Employment in Defense Direct plus Indirect Demand by 10 Major Occupational Groups in 1994
Thousands of Persons

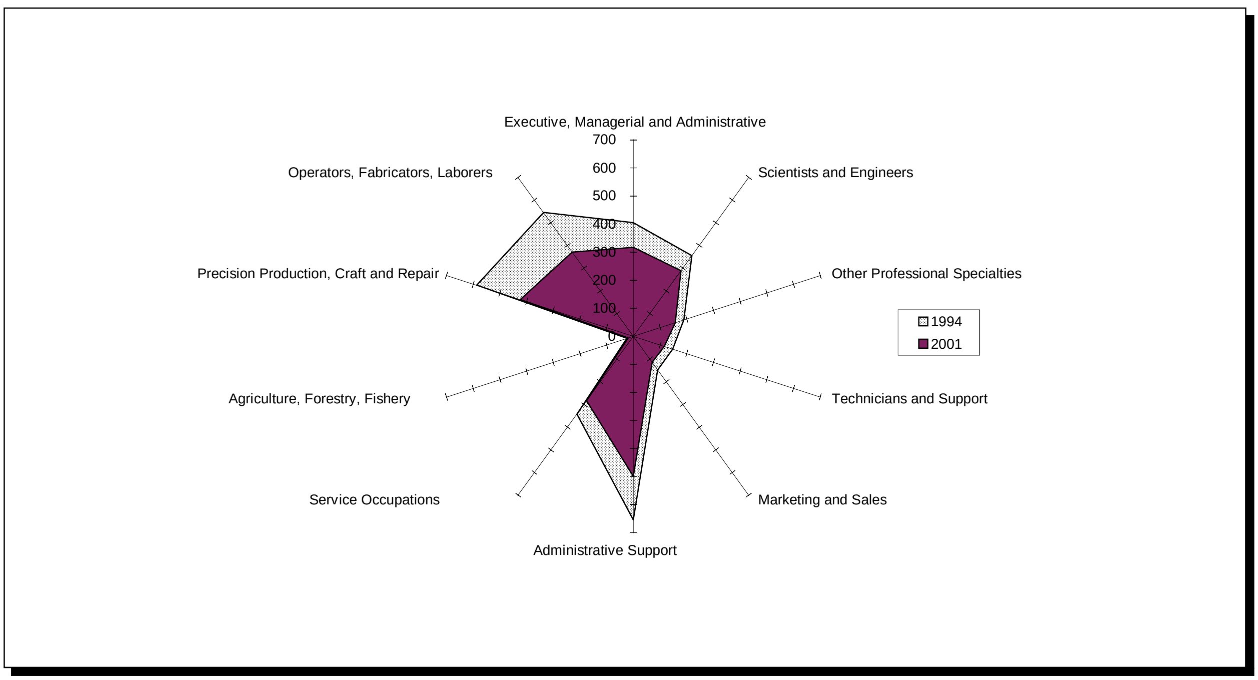


federal civilian employment. The largest category is that of Scientists and Engineers (212 thousand), but there were also a large number of Administrative support (179 thousand) and Precision production, crafts and repair (155 thousand).

Figure 14 shows the distribution of occupational employment requirements for direct plus indirect defense demand. Out of a total of about 3.2 million persons, the largest category is Administrative support (653 thousand), followed by Precision production, craft and repair (586 thousand), and Operators, fabricators and laborers (543 thousand).

This type of graph is also useful for summarizing changes in the employment distribution over time. Figure 15 summarizes the changes in occupational employment in defense direct plus indirect demand between 1994 and 2001. The outer figure represents employment in 1994, as in the previous figure, and the inner figure represents employment in 2001. Employment by all categories is shrinking (by 811 thousand), but the largest declines are to be found in the categories of Operators, fabricators and laborers (-173 thousand), and

Figure 15. Comparison of Occupational Employment for Defense Direct plus Indirect Demand: 1994 and 2001
Thousands of Persons



Precision production, craft and repair (-163 thousand). The category of Administrative support, which is larger than the other two, actually loses less employment (-154 thousand).

Since the assumed occupational shares by industry are based on an interpolation of the BLS projection, they change gradually over time. The major factor in the change of the aggregate occupational distribution shown in Figure 15 is the change in purchases by industry. Since procurement items such as aircraft and missiles are suffering the largest relative declines, occupational categories that are needed to produce these items will be more strongly affected.

Figure 16 shows the change in overall U.S. occupational employment over the corresponding period. Over this period, total employment grows by about 12 million persons. Employment increases in every category except for Agriculture, forestry and fisheries (-166 thousand). The occupations showing the largest overall increases are the Service occupations (+ 3.4 million), which is not surprising, since the service industries are also experiencing the largest growth in employment. Skilled labor categories such as Operators, fabricators and laborers

Figure 16. Comparison of Total U.S. Occupational Employment: 1994 and 2001
Thousands of Persons

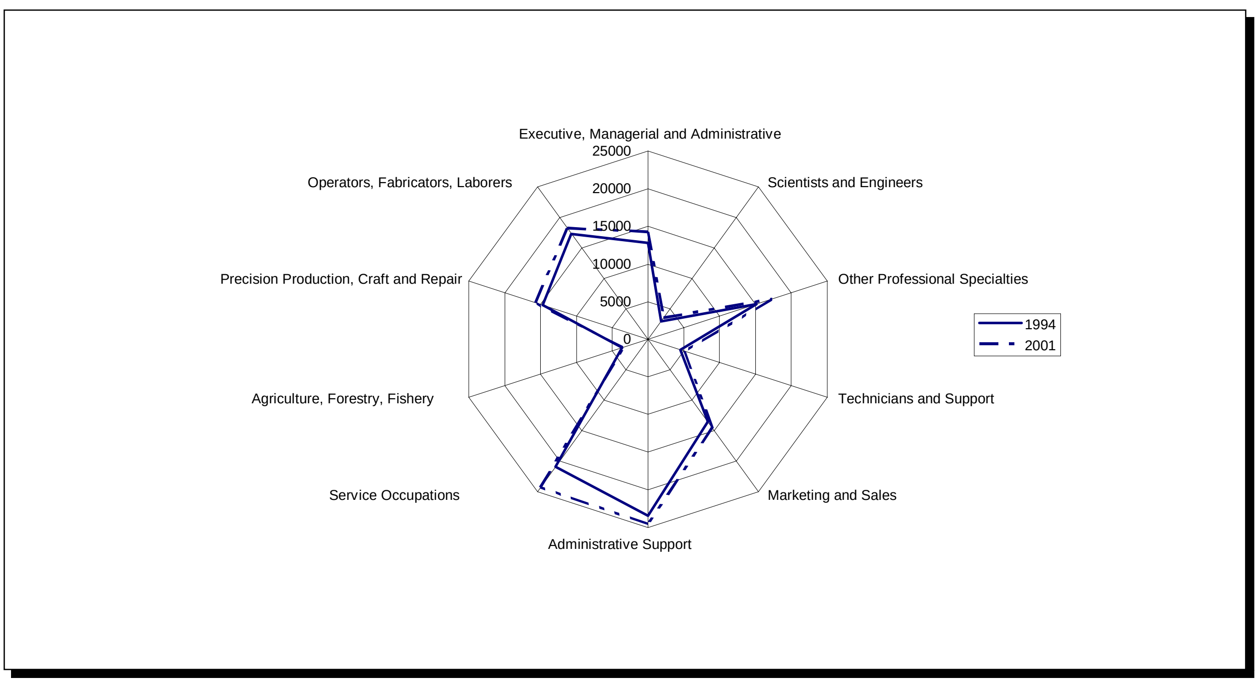


Table 8. Top 20 Occupations Ranked by Share in Defense Direct Plus Direct

Rank	*Occupational Category*	*U.S. Emp.*	*Defemp*	*Percent*
	TOTAL EMPLOYMENT	129089.1	3418.0	2.65%
1	74 Shipfitters	15.8	10.0	63.29%
2	64 Aircraft assemblers, precision	19.5	8.9	45.64%
3	3 Aeronautical and astronautical engineers	65.2	23.7	36.35%
4	60 Aircraft mechanics and engine specialists	146.0	38.8	26.58%
5	15 Operations research analysts	55.2	10.0	18.12%
6	6 Electrical and electronics engineers	422.3	76.0	18.00%
7	19 All other physical scientists	39.2	7.0	17.86%
8	8 Mechanical engineers	255.6	40.9	16.00%
9	5 Civil engineers, including traffic engineers	193.7	27.8	14.35%
10	13 Computer systems analysts, engineers, and scientists	830.2	110.8	13.35%
11	73 Sheet metal workers and duct installers	250.2	31.2	12.47%
12	7 Industrial engineers, except safety engineers	124.2	15.1	12.16%
13	37 Programmers, numerical, tool, and process control	7.4	0.8	10.81%
14	71 Boilermakers	28.9	3.1	10.73%
15	14 Mathematicians and all other mathematical scientists	50.0	5.0	10.00%
16	69 All other precision assemblers	42.6	4.2	9.86%
17	97 Water transportation and related workers	131.2	12.9	9.83%
18	10 All other engineers	329.6	32.1	9.74%
19	72 Machinists	379.4	35.4	9.33%
20	9 Metallurgists and metallurgical, ceramic, and materials en	20.5	1.7	8.29%

and Precision production, craft and repair would have grown about 10 percent more were it not for declining defense expenditures.

Table 8 provides some perspective on how important defense spending is to certain occupational categories. This table shows total U.S. employment, employment due to defense direct plus indirect expenditures, and the percentage of employment attributable to defense, for 1994. While defense related employment is only 2.65 percent of total employment, it accounts for upwards of 10 percent in many of these categories. In fact, for many types of scientists and engineers, the current status of defense spending is crucial for their job outlook.

Summary

The Defense Economic Impact Modeling System (DEIMS) is an integrated system for the analysis of the impacts of defense spending on industries, states and occupational categories. The system can be used to project the impacts of a given baseline projection, or to compare the impacts of two or more alternative scenarios. The database on which DEIMS is based is rich in detail, and based on data developed both at DOD and at the Bureau of Economic Analysis.

The information from DEIMS might be used by a corporate planner trying to predict demand for various industries in which his corporation produces. It could be used by a state government trying to project the flow of federal revenues into the state, or to predict tax revenues arising from defense production. The skilled labor component (LDEIMS) would be of interest to a federal agency such as the National Science Foundation, in determining demand for occupations such as scientists and engineers due to defense. DEIMS could be used in conjunction with other tools to locate production bottlenecks or capacity constraints in a mobilization scenario. Finally, these tools may be of interest to academic researchers studying defense economics.

In our next meeting we plan to present detailed simulation results of a baseline projection constructed using DEIMS, and perhaps to contrast this simulation with an alternate spending projection.