Employment in high-tech defense industries in a post cold war era

Defense high-technology manufacturing industries attempt to redefine their markets, and join partnerships, as employment and technological innovation suffer from decreasing defense budgets

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Defense spending cuts in the United States are largely attributable to the end of the cold war era and the disintegration of the Soviet Union. Private sector defense contractors reacted to those cuts by dismissing large numbers of workers and expanding sales into civilian markets. Industries that had relied heavily on defense spending for both research funds and sales have been forced to reevaluate and redefine their roles in the global economy.

This article explores recent employment trends in high-tech defense industries and implications that current efforts might have for jobs in the future.

What is high-tech defense?

There are four manufacturing industries most often referred to as "high-tech defense."[1] The first two, aircraft and parts and guided missiles and space vehicles, are collectively known as the aerospace industry, which designs and constructs both the bodies and complex integrated electronics and guidance systems in aircraft, missiles and rockets.[2] Next is the ordnance and accessories industry which designs and assembles many of our "smart" bombs and weaponry bodies. Finally, there is search and navigation equipment manufacturing in which radar, sonar, infrared homing, and many other tracking and locating systems are designed and built. High-tech defense industries have been defined by (1) the number of technology workers employed as a proportion of total employment and/or (2) the ratio of research and development expenditures to sales.[3] As a group, these four industries had nearly 20 percent of their employment in high-tech occupations in 1993, as compared with 8 percent in all manufacturing industries.[4] Also, while research and development spending as a percentage of sales averages a little more than 4 percent for all of manufacturing, these defense high-tech industries average 11.2 percent.[5]

All four of the high-tech defense industries manufactured at least 50 percent of their output for defense purchases in 1987, the peak year for U.S. Department of Defense expenditures. However, all four, especially aircraft, have private sector demand that is critical to their employment as well. As time has passed, all four industries have experienced large declines in the proportion of their products that go to defense purchases.[6] The decline in defense spending along with the private sector recession in 1990–91 have been the dominant factors in the employment losses experienced since 1987.

Recent history of industry employment

The Inter-Continental Ballistic Missile contract in the 1950s caused the defense manufacturing industries to turn their attention toward cutting-edge technologies more broadly than before.[7] Subsequent Department of Defense demands for space-based warfare systems, via missiles and radar, continued from the Trident Missile to the most expensive program ever, the Strategic Defense Initiative (SDI, or Star Wars) in the mid-

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1980s.[8] Defense spending on major physical capital and research and development increased 90 percent in constant dollars from 1980 to 1987, as the push for the cutting edge reached its peak.[9]

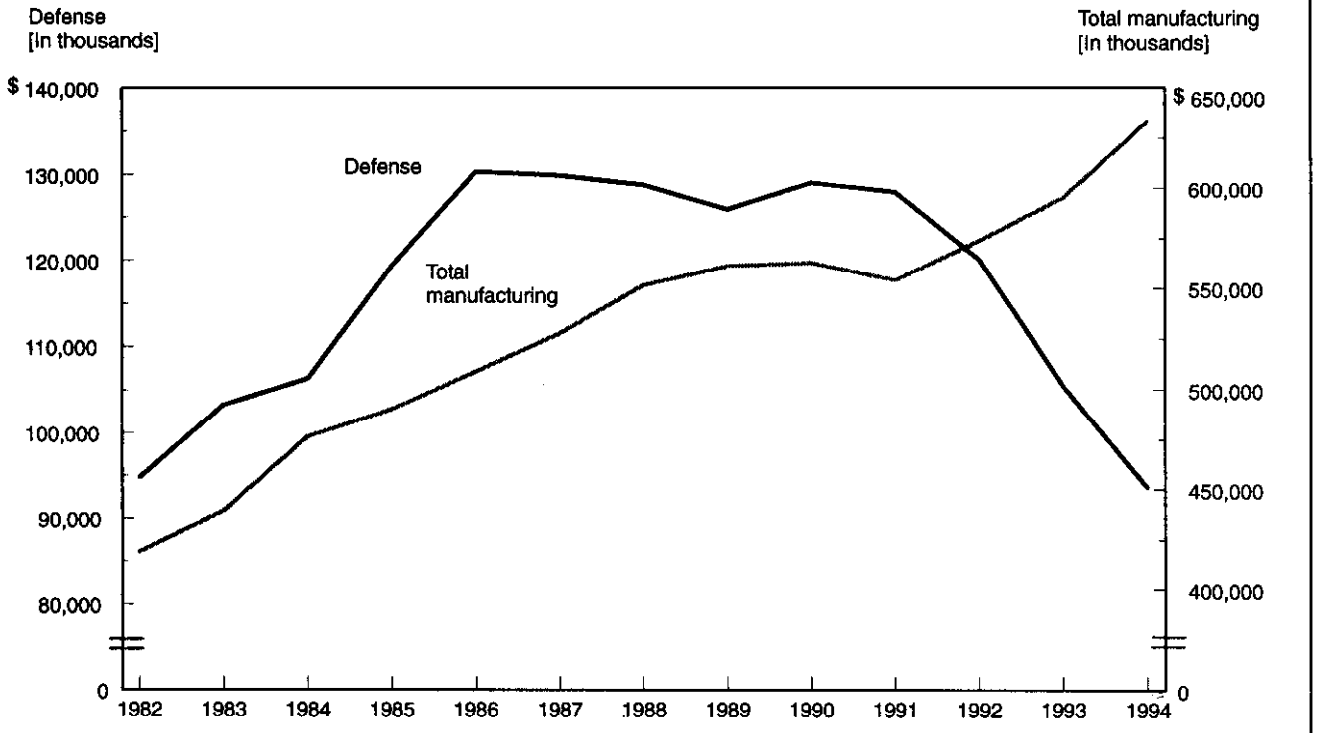
Expansion of the Strategic Defense Initiative was followed by a post cold war era contraction in defense spending. By 1994, spending was at a level 36 percent below that of 1987. Total shipments from the four industries to defense and civilian markets dwindled in the mid-1990s, while the economy as a whole expanded. (See chart 1.)

Exports for high-tech defense industries, which are highly dominated by the aerospace industry, have likewise seen a trend inversely related to the business cycle in recent years. Military aerospace exports had its most recent peak in 1991, the heart of the last recession. (See chart 2.) This rise is mostly attributable to Saudi Arabia, which increased its military orders to more than 10 times its 1989 level during Operation Desert Shield/Storm.[10]

The United States, as explained later in the article, has increasingly depended on exports to keep defense production lines open. Recent contract victories for the United States have come at the expense of European Economic Community joint ventures. For example, two recent contracts for fighter helicopters came up for bid in Great Britain and the Netherlands. The U. S.-made *Apache* won over the *Eurocopter Tiger* in both contracts, because of the proven track record and cost-benefit factors of the *Apache*. Due to each country's pressure to support its own defense industry, U. S. defense manufacturer's products must be far superior to other countries' "home-grown" alternatives before other countries will purchase U.S. goods. As the products of the European Economic Community mature, their replacements will create greater competition in the European arms markets.

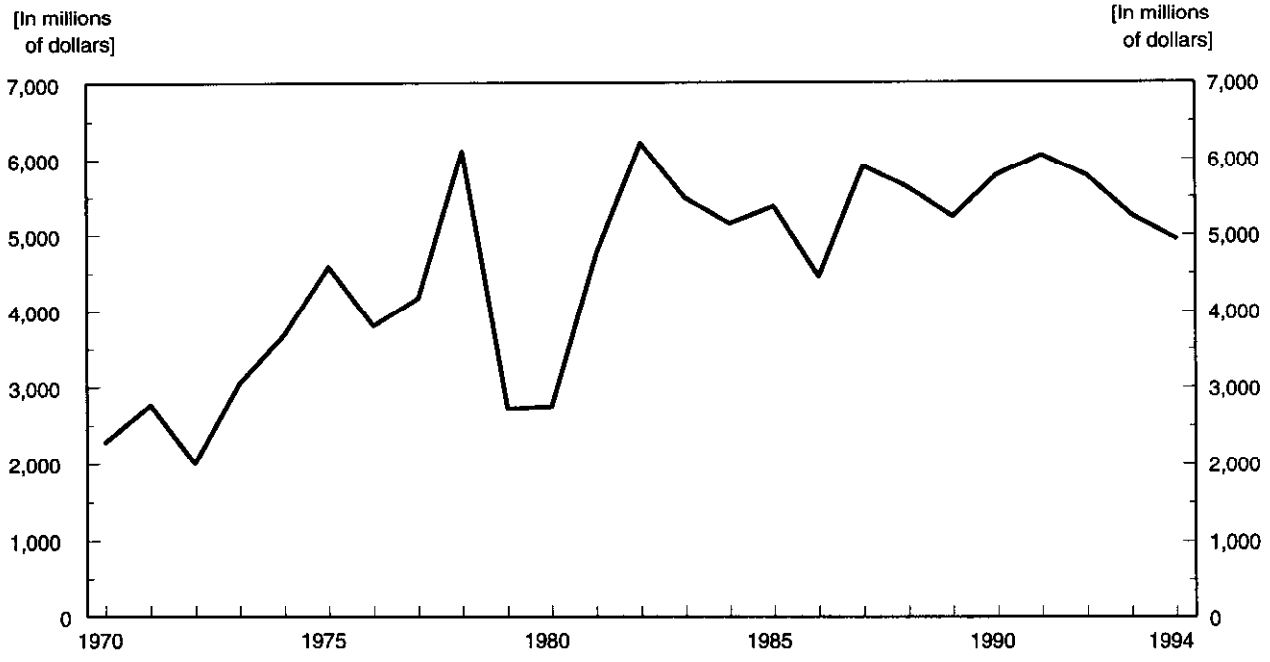
The trend in defense spending in the 1980s has been reflected by employment trends in the four high-tech defense industries. (See table 1.) In terms of numbers of jobs, the aerospace industry led the decline as aircraft and guided missiles together shed more than 300,000 workers between 1986 and 1995. The other two high-tech industries combined lost more than 200,000 jobs after the spending peak in 1986. This was the result of mergers and of smaller companies getting out of the defense business. (See chart 3.) The most rapid rates of decline were in guided missiles and in search

Chart 1. Shipments in high-tech defense industries, versus total manufacturing and trade, constant dollars, 1982–94



SOURCE: Economics and Statistics Administration and Bureau of Economic Analysis, U.S. Department of Commerce.

Chart 2. Exports of military aerospace products in constant dollars, 1970–94



SOURCE: Aerospace Industries Association, based on data from the U.S. Department of Commerce, International Trade Administration.

Chart 3. Indexes of employment in the four defense high-tech industries, 1986–95, not seasonally adjusted

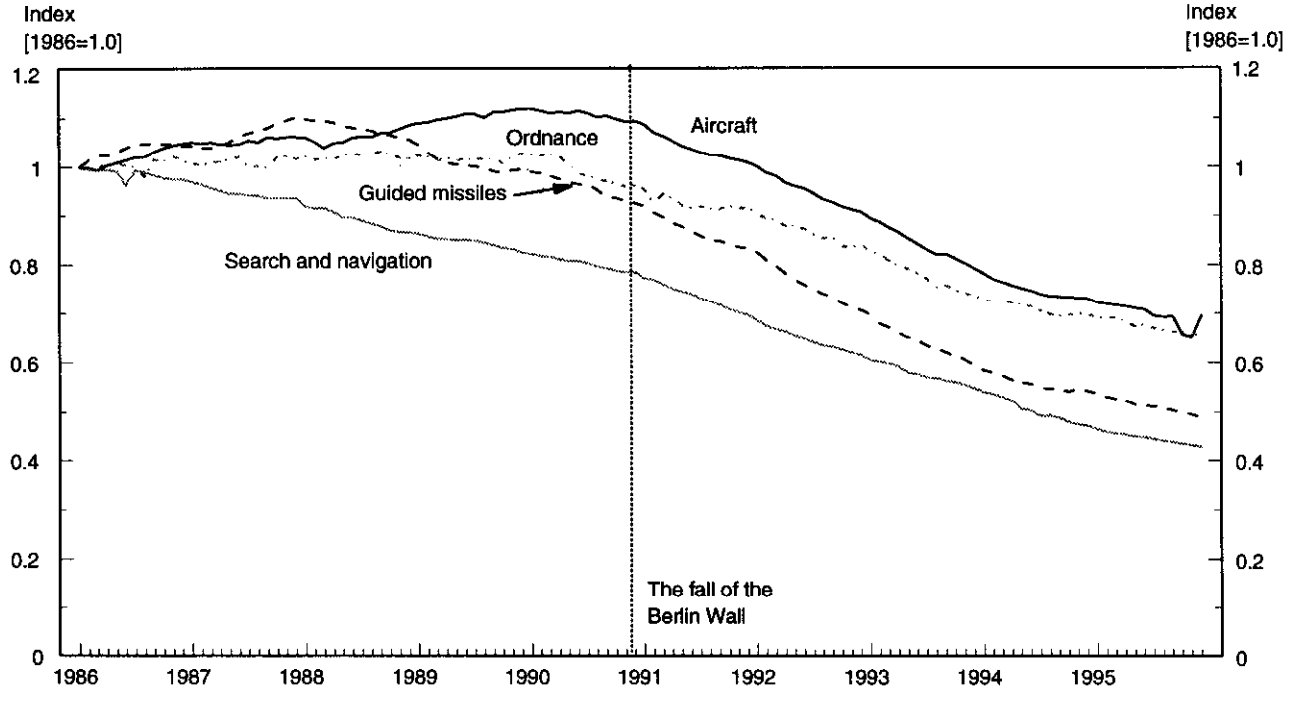


Table 1. Employment in high-tech defense goods-producing industries, selected years 1986–95

Period	Aircraft	Guided missiles	Search and navigation	Ordnance
Employment (thousands):				
1986	655.8	199.5	349.1	75.9
1990	712.3	185.1	284.3	74.9
1995	449.1	98.9	157.9	50.8
Percent change:				
1986–90	8.6	–7.2	–18.6	–1.3
1990–95	–37.0	–46.6	–44.5	–32.2
1986–95	–31.5	–50.4	–54.8	–33.1

and navigation equipment, which both cut nearly half of their work force since 1986.

Aircraft was the last of the four high-tech defense industries to start losing employment. It was not until the civilian aircraft market softened, between 1989 and 1990, that declines in employment for military purchases of aircraft more than offset increases due to civilian purchases. (See chart 4.) Job losses were particularly steep, starting in 1991 when both military and civilian demand for aircraft fell off. As a result, nearly 2 in 5 jobs in aircraft were lost in a 5-year period.

These job losses also are a focus of the recent debate on the loss of "good" jobs from the American economy.[11] As a group, production workers in these four highly unionized industries have average hourly earnings that are 53 percent above the average for all total private industries, and 41 percent above the manufacturing average. These high wages reflect, in part, the superior technical skills required to manufacture these high-tech products.

Present strategies

The current lag in some areas of technological innovation in high-tech defense industries compared with their nondefense private sector counterparts has prompted a reexamination of the protocols and standards used to regulate the invention, production, and procurement of defense products. Three areas often recognized as solutions to the current problem of technological decline are: (1) promoting dual-use (civilian/military) technology sharing and development, (2) reforming the armed services acquisition process, and (3) expanding global partnerships.[12]

Promoting dual-use technology. Toward the end of the 1980s, a government program was established to encourage defense industries to spread into more commercial end-uses so that fluctuations in defense spending would not have such profound employment shocks. The result of this program was the creation of the Technical Reinvestment Project (reinvestment project, hereinafter), a Department of Defense initiative managed by the Advanced Research Projects Agency and initially funded with nearly a half-billion dollars. Funds from the reinvestment project provide start-up money for joint ventures between defense and commercial companies, encouraging the participants to share technological development while creating dual-use products. Backers of the reinvestment project point out many possible advantages to dual-use technologies. They claim that high-tech defense contractors who pair their research and development facilities with those in companies dedicated to commercial products could lower investment costs and reduce time spent bringing products to the market. In addition, defense contractors could take advantage of the higher productivity assembly lines of the commercial sector and gain experience designing goods with broader demand bases. These advantages would, ideally, maintain a group of independent and financially healthy defense contractors who would be even better suppliers to the Department of Defense, if needed. This could lead to stable or relatively smaller employment declines even during spending slowdowns. The goal of the Advanced Research Project Agency is to develop the reinvestment project's technology into a commercialized business so that in 5 years, it can function without further governmental backing.[13]

Proponents of dual-use technologies point toward existing accomplishments like the Navstar Global Positioning System, a satellite-based, multi-chip module that is technology-controlled by the Department of Defense. The military uses the system for guiding aircraft and troop movement, while the private sector finds it useful to guide just about everything; from private airplanes to luxury automobiles to golf carts.[14] It has been a success and a marketable technology worldwide. Other reinvestment project awards have been issued for power generation, computer simulations for medical and training purposes, rescue equipment, plastic packaging, sensors, and various other endeavors.[15]

Not everyone is convinced of the reinvestment project's worth, and opponents have expressed desires to terminate further funding. Their arguments consist of two basic principles: that the reinvestment project is similar to corporate welfare, and that the defense companies, because of outdated technology and a history of adhering to strict military specifications which guide their processes, are no longer able to make worthwhile commercial technologies.[16] This second argument is crucial when discussing employment by defense goods providers. Although the intended outcome of the reinvestment project is to foster stable or growing defense industries that will be around when Department of Defense spending returns, opponents question whether the defense side of the partnership in the reinvestment project would receive any of the benefits from joint projects. Any monetary benefit would have to overcome the costs associated with retraining employees, as well as the reengineering and re-

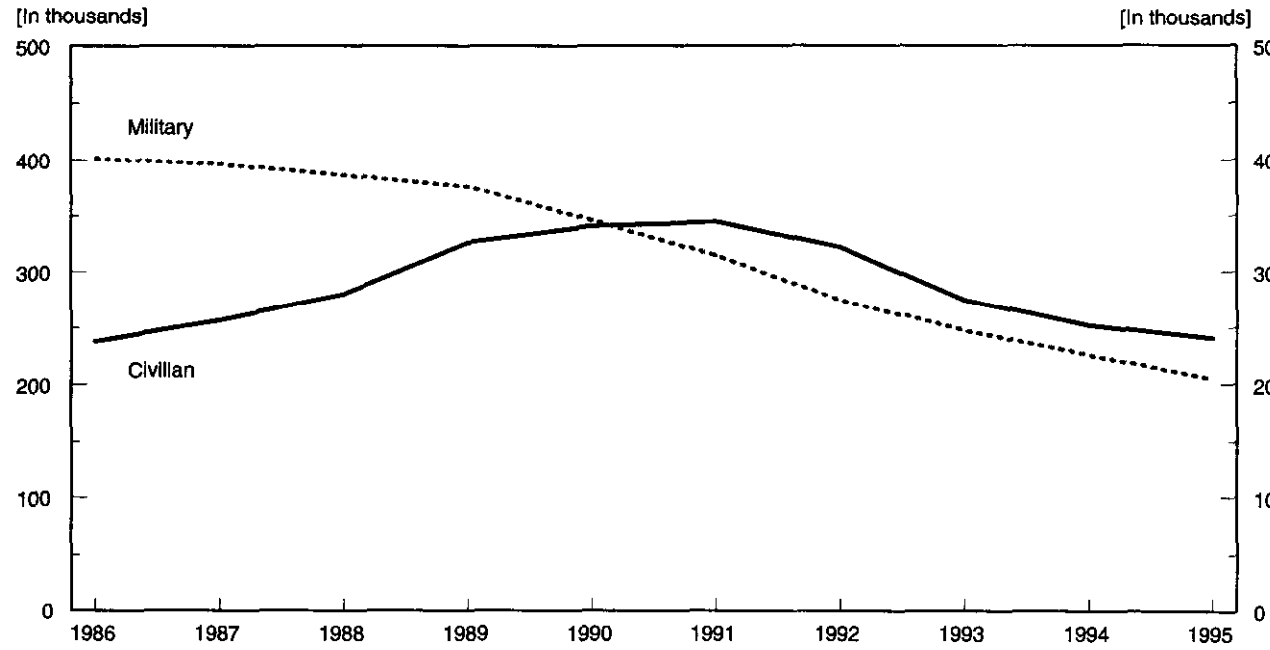
tooling of production facilities, that would have to occur for successful conversion.

Another area of concern is the repositioning of defense from a leader in technology to a follower. Critics argue that most of today's defense technology was designed over a decade ago and technological capabilities have advanced over that time, making many systems archaic and uninteresting to the civilian economy.[17] For example, the grand Inter-Continental Ballistic Missiles built in the 1950s, still contain, and are operated by 1950s' technologies.[18] Attempts to upgrade the missile seem to compound the problem because the military contract/bid process can take anywhere from 90 to 300 days. With the frequency of turnover in technology, long delays in getting parts mean that they are often out of date before they are delivered.[19]

Procurement reform. Many observers believe that one of the key reasons for the recent decline in technical pioneering has been the cumbersome acquisition process. Regulations effective years ago have become a major obstacle in today's creative processes in which new technologies have shorter useful life spans before they are superseded. The largest constraint is on the ability of both the Defense Department and private-sector providers of defense goods to buy commercial products or crucial technologies in time to use them efficiently.[20] Even if these technologies are bought, the costs of transforming them to meet military specifications would drive their price skyward because of, perhaps, strict performance requirements and rigid test designs. Strict military specifications made sense when military products were the cutting edge of technology and no other standards had been set. Now, that cutting-edge innovations are increasingly derived from nonmilitary producers, the Defense Department is willing to adopt their specifications.[21] It is believed that any chance that dual-use technology will succeed, lies in the removal of unnecessary regulations or an adoption of commercial practices, when appropriate.[22] The military has already gone to great lengths to provide solutions to these problems. So far, specifications on some existing projects have been slashed by up to 80 percent, and nearly half of the 105 most costly military standards have been canceled altogether.[23]

Although reform of specifications and standards would improve the efficiency of defense purchasing, the impact on employment in companies that provide defense goods is unclear. If the government looks elsewhere for capital goods, traditional defense suppliers would have to redesign their business practices to survive against companies who have had years of experience in minimizing costs in the commercial market. On the other hand, those defense goods suppliers that must rely on purchasing other defense goods to produce their products could greatly benefit from the loosening

Chart 4. **Employment distribution in aircraft, civilian versus military, 1986–95**



SOURCE: Aerospace Industries Association.

of detailed standards and testing requirements that make up a large part of their costs of production. This could create a system of financially stronger defense companies who could stabilize payrolls.

New allies: expanding global partnerships. The last area of improvement is to obtain a successful partnership with non-U. S. companies or governments. The United States provides many military products to other countries, but those countries do not contribute to substantial start-up investment costs. In the past, not sharing costs was more acceptable, as foreign orders allowed American defense suppliers to continue production runs. With defense budgets tightening and the U. S. government decreasingly willing to pay for start-up costs, high-tech defense manufacturers need to share those costs with foreign partners or risk heavy debt burdens or bankruptcy. In addition to the benefits of cost sharing, U. S. defense firms would gain access to the most sophisticated technologies available, wherever they may be currently produced.

Partnerships also are a way to win foreign contracts, as was recently illustrated in the British Army's tactical helicopter contract award. All three bids included the promise of jobs for Britain, a practice called offsetting. (Britain's defense industry employment declines have mirrored those in the United States since the late 1980s.[24]) The winning bid was a joint venture by Britain's Westland Helicopters and America's McDonnell Douglas. They were chosen for the $3.2 billion contract, not only because of their craft's reputation, but on the promise by McDonnell Douglas and its other American partners to buy $352 million worth of British components and indirectly invest $1.6 billion in British industry.[25]

Globalization may offer new opportunities for defense contractors to stay at the forefront of high technology. However, as with the earlier proposals, the employment effect of this global trend could have mixed results for U. S. workers. Although every contract awarded to a foreign-allied American firm will help keep the firm stable, most of the employment gains could go to the country purchasing the goods.

The three-fold approach to keep defense industries on the cutting edge of high-tech—dual-use, procurement reform, and partnership—are intertwined. For example, successful dual-use technologies will require a reduction of specifications and quicker product development, and global partners may be ideal for joint dual-use projects. A simultaneous attack on all three fronts could create a more technically advanced climate in the defense industries.

Implications for employment

Technical progress is no longer a guarantee of employment strength. This has been frequently illustrated in the wave of mergers set in motion in the 1990s. As merging firms seek to cut costs, they often combine research and development laboratories. Scientists and engineers, working together under one roof hope to establish quicker product development cycles. By combining brain power, defense stands a greater chance of retaining technical dominance. On the other hand, combined labs need fewer technicians. So, while defense could be regaining technical clout, this alone will probably do little to change the trend of declining employment.

THE MILITARY MIGHT CONTINUE its recent downsizing. According to projections, the employment outlook for the four high-tech defense industries is dismal. Search and navigation equipment is facing predicted annual job losses of 2.8 percent through 2005, while aerospace and ordnance are expected to ease their annual losses, but shrink nonetheless.[26] The ability of companies in these industries to shift products to commercial markets, and adopt commercial practices, could temper the losses. However, total manufacturing employment is predicted to fall 0.7 percent annually through 2005, so even the commercial markets do not promise employment stability.[27] □

Footnotes

[1] Richard W. Riche, Daniel E. Hecker, and John U. Burgan, "High technology today and tomorrow: a small slice of the employment pie," *Monthly Labor Review*, November 1983, pp. 50–58.

[2] The aircraft and parts industry constitutes SIC 372, while guided missiles makes up SIC 376 in the Standard Industrial Classification system. See *Standard Industrial Classification Manual, 1987* (Washington, DC, Office of Management and Budget, 1987).

[3] Riche and others, "High technology," pp. 52–53.

[4] High-tech occupations are defined as: engineers and related technicians, physical scientists and related technicians, computer scientists and related occupations, and mathematical scientists and related occupations. Data are from the Bureau of Labor Statistics, Office of Occupational Employment Statistics.

[5] Data exclude ordnance and accessories because of the unavailability of that data. Data are from the National Science Foundation/SRS, Survey of Industrial Research and Development, 1992.

[6] Analysis done by the Bureau of Labor Statistics, Office of Projections.

[7] Ann Markusen, Peter Hall, Scott Campbell, and Sabina Deitrick, *The Rise of the Gun Belt* (New York, NY, Oxford University Press, 1991), p. 30.

[8] Christopher Maura, "What's behind the high cost of defense?" *Scholastic Update*, Feb. 23, 1987.

[9] Data are from the *U. S. Budget for 1996* (Washington, DC, Executive Office of the President, Office of Management and Budget), table 9.1. Data are in constant fiscal year 1987 dollars.

[10] *Foreign Military Sales, Foreign Military Construction Sales and Military Assistance Facts* (Washington, DC, Department of Defense, Security Assistance Agency, September, 1994).

[11] See Randy E. Ilg, "The nature of employment growth," *Monthly Labor Review*, June 1996, pp. 29–36.

[12] Although these three points were specifically mentioned in the *Clinton Technology Report, Letter from the President* (Washington, DC, Nov. 4, 1994), other evidence shows that these were military proposals made over several

other presidential administrations, see "The Administration Agenda for Acquisition Reform," Volume 10 Number 39, and "DOD Must Re-engineer Its Procurement System," Volume 10, Number 24, *Defense Issues*, 1995.

[13] *Federal Document Clearing House Congressional Testimony*, Federal Document Clearing House Inc., May 17, 1995.

[14] *Second to None: Preserving America's Military Advantage Through Dual-Use Technology* (National Economic Council, National Security Council, Office of Science and Technology Policy, February 1995), p. 17 and Don Fuqua, "GPS: U.S. Technology Made Available for World Benefit," *Aerospace Industries Association Newsletter*, May 1995, p. 3.

[15] See *Federal Document Clearing House Testimony* and "IPAC Eyes Low-Cost Chip Packaging Via ARPA Award," *Semiconductor Industry and Business Survey*, May 8, 1995. Also see, "Lockheed Martin hopes air bag technology will bomb," *Orlando Business Journal*, Apr. 7, 1995, p. 5.

[16] P. Lessard, "Battered in House, TRP Endures Harsh Reception in Senate, Too," *Federal Technology Report*, July 6, 1995, p. 1.

[17] Andrew Pollack, "In U.S. Technology, a Gap Between Arms and VCRS," *The New York Times*, Mar. 4, 1991, section A, p. 1. Also see, David F. Noble, "Command Performance: A Perspective on the Social and Economic Consequences of Military Enterprise", *Military Enterprise and Technological Change, Perspectives on the Human Experience* (MIT Press, Cambridge, Mass., 1985), pp. 329–43.

[18] William Scott, "Shrinking ICBM Fleet Gets Needed Upgrade, *Aviation Week and Space Technology*, July 10, 1995, pp. 58–60.

[19] Most of this information comes from "*The Administration Agenda for Acquisition Reform*," a prepared statement by Colleen A. Preston, deputy undersecretary of defense for acquisition reform, to the Acquisition and Technology Subcommittee, Senate Armed Services Committee, Apr. 6, 1995.

[20] Text of the *Clinton Technology Report*, p. 38.

[21] Defense Department Briefing, *Federal News Service*, June 29, 1994.

[22] See, *The Administration Agenda for Acquisition Reform*. There are several commonly proposed solutions to the regulation and commercial practice problem. First, the Defense Department needs to be able to buy goods (commonly available products such as light bulbs and stationery) from commercial, nondefense-specific suppliers. Second, the Defense Department needs to be able to make small purchases (those under $100,000) without going through endless forms and testing procedures. Finally, the Defense Department and its private sector counterparts need to reengineer the purchasing process, adopting commercial practices whenever appropriate.

[23] The Urge to Purge: Standards Reform Approaches a Milestone, *Defense Week*, Oct. 30, 1995.

[24] Anthony Velocci, Jr., "Boeing, Labor Talks Ripple Industry wide," *Aviation Week and Space Technology*, Aug. 14, 1995, pp. 20–21.

[25] "News Breaks," *Aviation Week and Space Technology*, July 17, 1995, p. 21.

[26] James C. Franklin, "Industry output and employment projections to 2005," *Monthly Labor Review*, November 1996, pp. 45–59.

[27] Ibid.