Chapter 4

Engineers: A Special Case

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INTRODUCTION

Among the many thousands of workers displaced from defense jobs, one group of special concern is engineers. Their skills and education make them a national asset. An important public policy issue is how to put displaced defense engineers to good use on the civilian side of the economy.

Engineers are heavily represented in the defense sector. Military purchases are concentrated in manufacturing, especially durable goods, and these are engineering-intensive industries.[1] Moreover, the defense side of durable goods manufacturing industries (e.g., aircraft manufacture) is more engineering-intensive than the commercial side. Estimates of the number of engineers engaged in defense work differ, depending on definitions and method, but a reasonable estimate for 1990 (the latest year for which data are available) is 342,000, or 18 percent, of the Nation's 1.86 million engineers, including 73,000 employed directly by the Department of Defense (DoD) (table 4-l).

Recent layoffs reflect the concentration of engineers in defense industries and their vulnerability during downsizing. Roughly 30 percent of the 6,500 layoffs at the McDonnell Douglas facility in Long Beach, CA from July 1990 to June 1991 were engineers. About 30 percent of the 3,000 workers laid off at McDonnell Douglas in St. Louis in the summer of 1990 were engineers. Of the 3,000 workers laid off from the same facility immediately after the A-12 program was canceled in January 1991, nearly half were engineers, The General Dynamics facility in Fort Worth, TX, laid off 9,000 employees from July 1990 to July 1991; of these, 2,500 (27 percent) were engineers.

Reports from several places affected by defense cutbacks since 1988 indicate that many of the laid-off workers have had some difficulty finding new jobs, but engineers generally fared better than blue-collar workers. Eventually, most defense engineers have found jobs in their fields at good salaries. However, the job search is often long and arduous, and not infrequently the new job is with another defense firm and thus vulnerable to future layoff. Certain subgroups, chiefly older engineers and nondegree engineers, have had the most trouble finding new employment. By the end of 1991, defense layoffs were still accelerating.

PROSPECTS FOR DISPLACED DEFENSE ENGINEERS

Total engineering employment grew during the 1980s, rising from 1.6 million in 1984 to 1.86 million in 1990.[2] OTA's estimate of 342,000 engineers, or 18 percent of the total, in the defense sector is based on a National Science Foundation (NSF) survey in which engineers reported whether their jobs were funded by the Department of Defense (DoD). The percentage replying in the affirmative was then applied to total engineering employment, as reported by the Bureau of Labor Statistics.[3]

OTA estimates that from 1990 to 1995 as many as 127,000 defense engineering jobs could disappear with reductions in defense spending, the winding down of established weapons programs, and a scarcity of new programs.[4] This estimate assumes

[1] Sixty percent of all engineering jobs are in the manufacturing sector, 53 percent in durable goods. National Science Foundation Science *and Engineering Personnel: A National Overview, Special Report,* NSF 90-310 (Washington DC: The Foundation 1990), table B-18.

[2] U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings* (various issues), annual averages.

[3] This includes engineers employed as civilians by DoD, but not those whose jobs depended on non-DoD defense spending (see table 4-1 fOr further explanation).

[4] An often cited and substantially lower estimate is the forecast by the Institute of Electrical and Electronics Engineers, Inc., (IEEE) of a loss of 55,000 defense engineering jobs from 1989 to 1995. *(Engineering Manpower Newsletter,* vol. 2, No. 10A, Oct. 15, 1990, p. 1.) However, this estimate assumed a very modest decline in spending, smaller than is currently projected by DoD, and a base level of defense engineering employment of only 240,000. IEEE's base-level number for defense engineers rests on application of the DRI/NSF economic modeling system to the Bureau of Labor Statistics (BLS) estimate of the total number of U.S. engineers (based in turn on the Current Population Surveys conducted by the Bureau of the Census). OTA has concluded that this method produces an underestimate of defense engineers, because it assumes that defense manufacturing at the individual industry level is no more engineering-intensive than commercial manufacturing in the same industry. The IEEE estimate also assumed a 3 percent annual average reduction in defense spending. However, DoD now projects an annual average reduction of 4.1 percent from 1988 to 1995, and if DoD spending eventually declines to as low as $169 billion in 2001, the rate of reduction through 1995 would probably be slightly faster. In the case of the faster paced reduction, OTA estimates elimination of 127,000 defense-related engineering positions from 1990 to 1995.

Table 4-l-Engineering Occupations in Defense and the U.S. Economy

Specialty	Total engineers (thousands)	Nondefense engineers (thousands)	Nondefense engineers percent	Defense engineers (thousands)	Defense engineers percent	Percent of total in defense	Annual employment growth 1987-1990
Aerospaoe	109	62	4%	47	14%	43.2%	1.6?40
Chemical	71	67	4	4	1	5.3	4.1
civil	234	210	14	24	7	10.1	3.7
Electrical	581	428	28	153	45	26.4	2.2
Industrial	204	176	12	28	8	13.8	–2.6
Mechanical	316	266	17	50	15	15.9	4.5
Subtotal	1,515	1,209	80	306	89	20.2	2.2
Other	347	311	20	36	11	10.5	3.7
Total	1,862	1,520	100	342	100	18.4	2.5

[a]Includes defense industry engineers and DoD military and civilian engineers.
[b]Includes electrical and electronics engineers.

SOURCE: Total U.S. engineering employment from the Bureau of Labor Statistics (BLS), *Employment and Earnings,* various issues. Defense industry engineering basedon data from the National Science Foundation, U.S. *Scientists* and Engineers: *1986,* NSF87-322 (Washington, DC: 1987). The percentage of engineers in each occupational category reporting that their jabs were funded by DoD was applied to the total number of engineers reported in that category by BLS. This method was adapted from Ann Markusen and Scott Campbell, "The Occupational, Industrial and Regional Distribution of Defense-Related Economic Activity," draft paper for presentation at the Annual North American Meetings of the Regional Science Association, Boston, MA, Nov. 8-9, 1990. " .

that engineering positions would be reduced in proportion to the overall reduction in defense employment. On the other hand, if DoD decides in the future to develop new systems without putting them into production (one strategy proposed for an era of smaller defense budgets), the reduction in the defense engineering work force could be less than would otherwise be expected.

The timing of layoffs for engineers is often different from that of the defense work force generally. Engineering reductions tend to be front-loaded, preceding layoffs from production lines. This is because programs nearing the end of their production runs are less engineering-intensive; the engineers have completed their work and can be released before shop floor workers. Many of the biggest defense programs of the 1980s (e.g., General Dynamics's F-16 and McDonnell Douglas's F-15 fighter aircraft for the Air Force, Grumman's F-14 for the Navy, and General Dynamics's M1A2 tank) are coming to an end and few new programs are on the horizon to replace them, which means engineers can be let go while many production workers are still needed. Also, engineers are more heavily affected by the termination of new systems in their development stage. For example, the cancellation of the Navy's next generation attack jet, the A-12, caused the immediate dismissal of 7,000 workers, half of whom were engineers. In this case, the engineers were laid off before most of the production workers were even assigned to the program.

This suggests that yearly employment loss for defense engineers may have peaked. However, some individuals could go through a second or even a third wave of displacement, because considerable numbers of laid-off defense engineers have found new jobs with other defense companies. This is an old tradition among defense engineers, but it has new meaning in a period of long-sustained cutbacks.

During the 1980s defense buildup, there was a good deal of employment shuffling among defense companies, as one started work on a new contract and ramped up while another finished a program and shrank. Sometimes, as in the enormous Plant 42 complex in Palmdale, CA, these companies were next door to each other. Movement between firms was fairly easy in an environment of increasing or stable spending. But in 1990, when Lockheed closed its aircraft manufacturing facility at Burbank with a layoff of 9,500 employees, McDonnell Douglas in Long Beach reduced employment by 5,000, and other companies also cut back and laid off workers, this previously open regional job market suddenly shut down.

Early reports from outplacement centers that have tracked laid-off defense engineers indicate that many engineers (sometimes 40 percent or more) are still finding work in the defense sector. Most of these hirings are to replace workers lost to normal attrition. But as the number of total defense engineering positions continues to decline, this high rate of industry reemployment cannot be sustained.

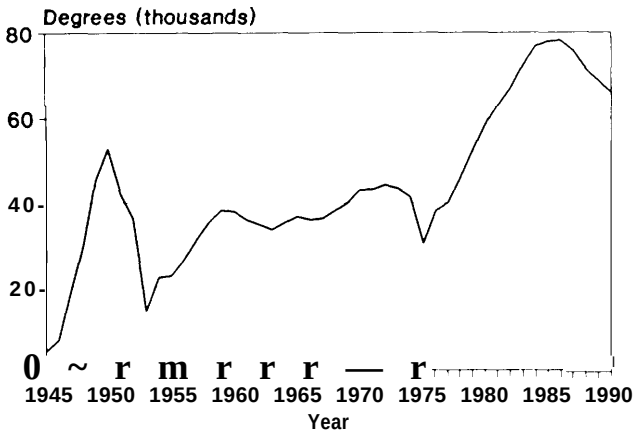
While engineers as a group have been successful thus far in avoiding overly long periods and high costs of displacement, many are still at risk.

None of this means that defense engineers are in a desperate position. For years, engineers have fared better than the work force in general. Throughout the 1980s, the average annual unemployment rate for engineers ranged from 1.4 to 3.0 percent while the overall rate varied from 5.2 to 9.5 percent. Nevertheless, unemployment rates that look small on the national scale can indicate hard times regionally for engineers; the peak unemployment rate for engineers in the 1970-73 period was 2.9 percent, in 1971. Yet unemployment among engineers was severe in some areas, especially in and around Seattle. With the current layoffs of engineers not only by defense contractors but also by computer companies and automobile manufacturers, the national unemployment rate for engineers rose from 1.4 percent in the first quarter of 1989 to 2.6 percent in the first quarter of 1991.5

Until recently, unemployment among engineers was low even among older, typically less employable, engineers. The Institute of Electrical and Electronics Engineers, Inc. (IEEE), which represents nearly 250,000 engineers in these specialties, found in early 1990 that only 1.9 percent of its members in the 50 to 59 age category were "involuntarily unemployed, compared with 1.4 percent for all member engineers. However, an indication of weakening demand was the finding that 20 percent of the engineers over 50 had been offered incentives to retire early in the previous 2 years (up from 16 percent in IEEE's 1989 survey) and 14 percent of the engineers over 50 had retired before they intended to (up from 6 percent in the 1989 survey).[6]

Forecasts from the late 1980s, before the end of the Cold War changed the outlook for defense

Figure 4-l—Bachelor's Degrees Awarded in Engineering, 1945-90



SOURCE: Engineering Manpower Commission, summer 1991.

employment, predicted a healthy market for engineers through the end of the century, with employment growth of 2 to 3 percent per year.[7] Whether those demand projections will prove out is open to question, but there is firmer evidence of a diminishing supply of engineers. Demographic trends suggest that the number of engineering school graduates will not increase. The source of potential students, the number of young adults in the U.S. population, peaked in 1982 and will decrease steadily until 1998.[8] The percentage of college freshmen selecting engineering over other majors might change direction and rise, but the recent trend has been down.[9] Figure 4-1 shows the number of bachelor's degrees granted in U.S. engineering schools each year since 1945. Degrees awarded peaked at 78,178 in 1986 and have fallen steadily since, to 65,967 in 1990.[10] To the extent that new engineering graduates are in short supply, engineers affected by the defense build-down could be a valuable resource to meet the demand.

[5]Unpublished data from the BLS, U.S. Department of Labor. These quarterly rates are not seasonally adjusted. The unemployment rate for engineers dropped later in 1991, falling to 2.1 percent in the third quarter; the average unemployment rate for the year ending Sept. 30, 1991 was 2.3 percent.

[6]Institute of Electrical and Electronics Engineers, Inc., *IEEE Member Opinion Survey, 1990* (New York NY: 1990), pp. 2-11, 2-18, and 3-16.

[7]George Silvestri and John Lukasiewicz, "Projections of Occupational Employment' *Month/y Labor Review, November* 1989, p. 45; U.S. National Science Board, *Science and Engineering Indicators—1989*, NSB-1 (Washington, DC: U.S. Government printing Office, 1989), p.235; Gary Stix, ' 'From Swords to Plowshares,' *IEEE Spectrum,* November 1989, p. 45; U.S. Department of Energy, "Energy-Related Scientists and Engineers, 1988 to 1994," internal working paper, December 1989, pp. 3-5.

[8]Nestor E. Terlechyi, *Employment of Natural Scientists and Engineers: Recent Trends* and *Prospects,* Report No. 224 (Washington DC: National Planning Association, 1986).

[9]OTA has previously documented a decline in interest of entering freshmen in natural science and engineering @Ors---fiom 27 percent, or about 286,000, in 1978, to 24 percent, or about 246,000, in 1986. U.S. Congress, Office of Technology Assessment, *Educating Scientists and Engineers; Grade School to Grad School, 0121-SET-377* (Washington, DC: U.S. Government printing Office, June 1988), p. 48.

[10]*Manpower Comments*, vo1. 27, No. 10, December 1990, p. 26.

ENGINEERS' EXPERIENCE AFTER THE VIETNAM WAR

Current decreases in the defense budget have aroused interest in examining previous reductions for indications of what to expect and lessons on how to cope. However, the previous reductions differed significantly from the present one. The sharp drop after World War II did not result in much unemployment for engineers because pent-up demand for automobiles and other consumer items supported a rapid conversion of companies (and engineers) from defense to commercial work. Layoffs at the end of the Korean War were minimal because the Cold War had begun. Defense spending (especially in aircraft) remained high compared to the peacetime levels just after World War II, including substantial spending for research and development (R&D) on sophisticated weapon systems.

The concern today is to avoid repeating the dislocations of the early 1970s, when the Vietnam War build-down coincided with detente between the United States and the Soviet Union. Inconstant 1991 dollars, defense outlays dropped from $342 to $235 billion from 1968 to 1973, with a further drop to $213 billion in 1976. NASA and its contractors watched their employment plummet from 410,000, including 86,000 scientists and engineers, to 135,000 from 1965 to 1973.[11] Civil aircraft sales fell sharply in the 1968-71 period, from $5.0 to $3.8 billion.[12] The result of these three simultaneous blows was a steep drop in aerospace industry employment, from 1.5 million in 1968 to 920,000 in 1972, and a further decline to 820,000 in 1977. Defense industry jobs plunged 900,000 in the 2 years 1969-71. A Department of Labor (DOL) program begun in 1972 to provide assistance to unemployed engineers, scientists, and technicians estimated that 75,000 to 100,000 of these professionals were out of work at the time.[13]

Current economic and employment conditions bear some resemblance to those in 1968. From 1968 to 1976, defense industry employment fell 47 percent; from 1987 to 1995, it could drop as much as 40 percent. In the early to mid-1970s, the U.S. economy moved in and out of recession; unemployment climbed from 3.4 percent in 1969 to 5.8 percent in 1971, and then, after a partial recovery in 1972-73, up to 8.3 percent in 1975. In 1990, the economy again moved into a recession, and unemployment rose from 5.1 percent in June 1990 to 6.7 percent in October 1991.

Other aspects of the economy and employment are quite different now. In 1968 defense spending was 9.2 percent of the gross national product (GNP); it was 6.5 percent in 1987 and had dropped further to 5.5 percent by 1991. Defense contracts are less important to many local economies now than they were in 1970.[14] Importantly, the defense and commercial aerospace businesses both fell sharply at the same time in 1970-73, while in the early 1990s commercia1 aircraft production remained fairly strong as military aircraft production declined. And where total employment in the space program fell by two-thirds between 1965 and 1973, it has been relatively stable ever since. The aerospace industry is more diverse now than in the past; in the 1960s, government spending was responsible for approximately 80 percent of aerospace sales, but it currently accounts for only about 55 percent.[15]

All in all, the stability of the nondefense segments of the aerospace business (commercial aircraft and space) has softened the impact of the engineering layoffs in the defense segment. In 1970-73, defense industry cutbacks and other layoffs resulted in a 13 percent reduction in total engineering employment.[16] From 1987 to 1990, while defense industry employment was declining 6 percent, total engineering employment continued to increase. Even if there were no overall growth in engineering employment between 1990 and 1995, and 127,000 defense

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[11] Trudy Bell, ''Back to the Future: A Perspective,' *IEEE Spectrum,* November 1989, p. 44; Aerospace Industries Association *Aerospace Facts and Figures 1990-91* (Washington, *DC:* 1990), p. 152.

[12] Aerospace Industries Association *Aerospace Facts and Figures 1983-84* (Washington, DC: 1983), p.15.

[13] Comptroller General of the United states, "Reemployment Assistance for Engineers, Scientists, and Technicians Unemployed Because of Aerospace and Defense Cutbacks, " Report to the Congress from the General Accounting Office, Accession Number 093372, Dec. 5, 1973, p. 1.

[14] As noted in ch.1, the defense purchases in California declined from 14.6 percent of gross State product in 1968 to approximately 7 percent in 1990.

[15] Aerospace Industries Association "Aerospace Employment Trends, 1961-90—The Impact of Defense and Commercial Spending and other Factors," March 1990.

16 National Academy of Engineering, Committee on Engineering Manpower Policy, *Engineering and Scientific Manpower—Recommendations for the Seventies* (Washington, DC: 1973), p. 8.

engineering positions were lost while no new jobs were created elsewhere-not a likely prospect-less than 7 percent of engineering positions would be lost. To reach a 13 percent loss, an additional 117,000 nondefense positions would have to disappear. This seems beyond the bounds of reasonable likelihood, given recent and long-term trends.

These comparisons indicate the employment situation for defense industry engineers *as a group* should not be as difficult in the early 1990s as it was 20 years earlier. The larger, less defense-dependent economy should more readily reabsorb the engineers. The lessons from the government programs of the earlier era will be discussed later in this chapter.

MOVING FROM DEFENSE TO CIVILIAN EMPLOYMENT

Defense engineers have several distinct demographic and professional characteristics that may affect their prospects for finding jobs in the civilian sector. First, they are somewhat older and have higher levels of education.[17] While they may possess educational advantages in seeking new jobs, the pool of equivalent commercial engineering jobs may be limited. It is possible that their extra education may even be a handicap; they could be rejected as overqualified.

Some people fear that the nature of defense work makes engineers too rigid and specialized for work in the commercial environment. Also, defense engineers are said to be slow to move to the civilian sector because they are overpaid in the defense sector and hold unreasonably high expectations for their earnings potential in commercial enterprises. The available evidence, discussed below, suggests that these fears are exaggerated.

Finally, defense engineers have different specialties from the general run of engineers, and moving to another specialty requires substantial retraining. The principal engineering specialties are electrical (including electronics), civil, mechanical, industrial, aerospace, and chemical. As table 4-1 shows, defense engineers are much more concentrated in aerospace and electrical specialties than engineers generally, and less in civil and chemical specialties. Displaced defense engineers whose specialties have a comparatively limited civilian market----especially if that market is not growing-are likely to encounter more than the usual difficulties moving into civilian jobs. But so far data on actual reemployment experience by specialty is too limited to allow any hard and fast conclusions.

Inter-Industry Mobility: The Record

Some civilian employers are predisposed against the defense industry and its employees—sometimes even when the employer and employee are in different divisions of the same fro-on the grounds that defense and civilian work environments differ too much for defense engineers to make the move.[18] Key differences are the time frames for product development (long in defense, short to medium in commercial); the balance between cost and performance (cost is often second to performance in defense, cost and reliability are more important in commercial); and the need to satisfy one customer in defense, versus many in commercial. In addition, the critics say that defense engineers put so much of their effort into pushing paper to meet burdensome DoD documentation requirements that their technical skills become obsolete from under-use.

These opinions can be tested against recent experience. Reports so far show that more than 60 percent of Lockheed's white-collar outplacement from its Burbank facility, 82 percent of Texas Instruments's white- and blue-collar outplacement from its Dallas defense plants, and 83 percent of laid-off McDonnell Douglas's engineering outplacement have been with nondefense firms. How many of the placements from Lockheed and Texas Instruments were engineers moving to new engineering positions is not clear, but officials at both companies believe it is a substantial number.[19]

[17] Joshua Lerner, ''The Mobility of Corporate Scientists and Engineers Between Civil and Defense Activities: Evidence from the SSE Database," Science, Technology, and Public Policy Program, Harvard University, Science, Technology and Public Policy Program, Discussion Paper 90-02, August 1990, p. 12.

[18] According to *Business Week* (July 2, 1990, p. 67), "Even highly skilled engineers sometimes have trouble finding jobs, tainted by the defense industry's reputation as being bureaucratic, late to market, and frequently over-cost. ' Seymour Melman, an advocate of defense-to-civilian industry conversions, states: "Engineers with long experience in the military industry are professionally incapacitated to various degrees from performing in the civilian economy. " (quoted in Stix, *IEEE Spectrum*, op. cit., p. 45.)

[19] Kathryn Griffiths, Lockheed (Burbank) Career Center, personal communication, June 3, 1991; Dan McMurtry, *Texas* Instruments Placement Center, personal communication% May 16, 1991.

Grumman reported that most of its engineers outplaced during 1989 ended up in engineering jobs, with slightly less than half outside of defense.[20] Many of the younger engineers left manufacturing and were working in financial services and computer systems. None of these company officials offered examples of moves by defense engineers into nondefense aerospace engineering. However, a representative of the engineers' union at Boeing, the Seattle Professional Engineering Employees Association, stated that the company frequently moves engineers between the defense and commercial sides of the company .21

The National Science Foundation's (NSF) Survey of Scientists and Engineers (SSE) shows more mobility between the two sectors than might have been expected. In a study for Harvard University's Science, Technology and Public Policy Program, Lerner used the SSE data to examine mobility between the defense and civilian sectors from 1982 to 1986, a time when employment in the defense sector was increasing rapidly.[22] He found that 24 percent of the scientists and engineers employed in the defense industry in 1982 had transferred to civilian industry jobs 4 years later. He also reported that much of this mobility apparently took place within firms.

Taken together, the SSE data and the more recent, though incomplete, company outplacement data show that many defense industry engineers do successfully move into civilian industry jobs. Individual defense engineers may fail to maintain up-to-date technical skills and thus limit their reemployment possibilities, but this failing is not unique to defense engineering. Many defense engineers are working on the leading edge of technology in materials, electronics, and communications, and are in a strong position to move into the civilian sector.

Salary Levels

Another factor said to limit mobility between the two sectors is differing pay levels; some employers generalize that defense industry engineers are overpaid compared to their counterparts in the commercial sector. Two sets of figures, comparative salaries in different industries and the salaries of engineers moving from one sector to the other, cast some doubt on this perception.

Table 4-2 shows median annual salaries in 1989 for engineers in six major industrial groups, by number of years since the engineers received their bachelor's degrees. The first three industry groups (aerospace; electrical machinery, electronics, and computers; and electronic equipment) have a significant defense industry component. But salaries for engineers in those groups trail those in two of the three commercial sector groups (electric utilities and chemicals, drugs, and plastics) and are only slightly ahead of the third (automotive). Table 4-3 shows the mean total compensation for all engineers in five manufacturing areas in 1989, without regard for years of experience. Defense industry engineers are concentrated in the third of the five areas listed, electronics and aerospace products. Engineers in this category have an advantage over those in the business equipment and wood products industries, but not over those in chemicals and primary metals.

The 1982 SSE compared average salaries for large numbers of defense and nondefense scientists and engineers. It showed that salaries were somewhat higher on the defense side: 32 percent of defense industry scientists and engineers made over $40,000 in that year, compared to 26 percent on the nondefense side. The survey also indicated, however, that the differences could be attributed to: 1) age differences between the two groups (61 percent of the defense scientists and engineers were over 40 years old vs. 45 percent of the nondefense); 2) the higher education level of defense engineers (53 percent with 5 or more years of post-high-school education vs. 48 percent of the nondefense); and 3) the longer tenure of scientists and engineers in defense companies with their current employers.[23]

Another indicator that defense industry engineers are not overpaid is their ability to maintain salary levels when they move into civilian jobs. In general, mobility-hanging occupations, changing employ-

[20] Richard Opsaul, Grumman Corp., Bethpage, NY, personal communication Nov. 7, 1991.

21 D. Mahoney, president, Seattle Professional Engineering Employees Association, personal communication, Dec. 10 1990.

[22] Lerner, op. cit. Interestingly, research on several defense layoffs in the early 1960s, a time when defense employment was also increasing, found that 35 percent of defense engineers transferred to nondefense work. (B. Curtis Eaton, "Defense Engineers: Do They Have Special Reemployment Problems?" *Monthly Labor Review*, vol. 94, No. 7, July 1971.)

[23] Lerner, ibid., p. 12.

Table 4-2—Median Annual Salaries of Engineers by Industry Group and Years Since Bachelor's Degree (In 1989)

Industry	Years since baccalaureate 0	9-11	18-20
Aerospace	$30,050	$41,500	$51,650
Electrical machinery, electronics, and computers	30,450	43,350	51,650
Electronic equipment	30,450	43,500	51,800
Chemicals, drugs, and plastics	31,700	49,100	59,800
Automotive	30,150	40,950	46,300
Electric utilities	31,600	47,100	56,750

SOURCE: *Salaries of Scientists, Engineers, and Technicians,* compiled by Commission on Professionals in Science and Technology, 14th cd., February 1990, adapted from table 126; data originally accumulated by Engineering Manpower Commission, American Association of Engineering societies, 1989.

Table 4-3-Total Mean Compensation of Engineers in Manufacturing, by Product Area (in 1989)

Type of product	Total compensation
Chemicals, pharmaceuticals, plastics, and rubber	$40,388
Primary metal products	39,411
Electrical, electronics, aerospace, and aircraft products	39,106
Business equipment	34,299
Furniture and wood products	33,257

SOURCE: *Salaries of Scientists, Engineers, and Technicians,* compiled by Commission on Professionals In Science and Technology, 14th cd., February 1990, adapted from table 156. Data originally accumulated by Abbott Langer and Associates, *Compensation in Manufacturing, April 1989.*

ers, or moving into a field that does not match the field of highest degree-has negative effects on an engineer's salary.[24] However, several defense industry outplacement officers reported to OTA that displaced engineers who had found new engineering jobs did not take salary cuts; a 1991 survey of defense workers displaced from McDonnell Douglas made a similar finding.[25] SSE data showed that scientists and engineers who moved from defense to nondefense jobs between 1982 and 1986 fared better in salary changes than those who moved in the opposite direction; 20 percent of the first group had salary increases of $15,000 or more during the 4-year period, against 14 percent of the second group.[26]

In short, experience before the current defense cutbacks provides little indication that the salaries of defense engineers were inflated compared to those of nondefense engineers or that their expectations of maintaining salary levels when they moved into nondefense jobs were unrealistic. However, finding a new job after layoff is a different proposition from a voluntary move, which was probably the situation in most of the moves between defense and nondefense jobs tracked by NSF in the period 1982-86. Even if they were laid off, displaced professionals had a far easier time finding new jobs without sacrificing pay levels than most blue-collar and less skilled white-collar workers in the prosperous mid- and late 1980s. This may no longer be the case. The stagnant or recessionary economy of the early 1990s makes this a less propitious time for finding a replacement job at equal pay, even for engineers. Moreover, as the discussion below suggests, engineers who have moved into management positions and have not kept up their technical skills, or who have become overspecialized or inflexible, or who do not have an engineering degree but are nevertheless classified by their company as engineers, may indeed have difficulty in moving to another job without a significant cut in salary.

CURRENT LAYOFF AND REEMPLOYMENT EXPERIENCE

Although no accurate count is available, it is clear that tens of thousands of engineers had been laid off from defense jobs since defense spending started to decline, with the biggest layoffs occurring in 1990 and 1991. Because sizable layoffs began so recently, few studies on engineers' experience have been completed. Most of the following discussion is based on interviews with company human resource staffs, State and local government personnel, and the engineers themselves, supplemented by reports in newspapers and magazines. This evidence indicates that engineers are by no means as distressed by displacement as they were in the cutback following the Vietnam War, but that the job search can be long and frustrating, and that older engineers and those without up-to-date skills face genuine difficulties.

[24] Robert C. Dauffenbach, ''Quali~ and Qualifications in the Market for Scientists and Engineers,'' Final Report to National Science Foundation, NSF-SRS-851 1331, 1990, p. 56. Changes in responsibility are an exception.

[25] Fifty-seven percent of the engineers laid off from McDonnell Douglas's defense facilities in St. Louis in 1990 and 1991 received the same salary at their new jobs as at their old, while 20 percent went up and 23 percent went down. E. Terrence Jones, "The Layoffs at McDonnell Douglas: A Survey Analysis," mimeo, September 1991.

[26] Lerner, op. cit., pp. 20 and 25.

Layoffs

Some plant closures or contract cancellations result in layoffs of all engineers, regardless of age, experience, or performance. For example, at UNC Nuclear in Montville, CT, termination of the plant's contract to build nuclear reactor powerplants for Navy submarines means that all of the facility's 300 engineers will have lost their jobs by the end of 1992. Similarly, Lockheed's decision to end its aircraft construction program at its Burbank, CA facility has meant layoffs for most of its engineers, regardless of their skills or experience.

In other cases, companies are picking and choosing. McDonnell Douglas's vice-president of human resources said of the company's 1990 elimination of 17,000 positions, primarily white-collar jobs, 'Generally, we thought, okay, what are the things we can eliminate and what are the things we must do? After we decided that, we asked, who are the people best suited to do the work that's left?"[27] General Dynamics, United Technologies Corp.'s Pratt and Whitney Division, and General Electric's Aerospace Division are among the major defense contractors who are selectively downsizing to reduce costs and increase efficiency and competitiveness. In addition to layoffs of engineers in technical positions, economic pressures are leading companies to thin out management layers and reduce the size of their central staffs.

State and local reemployment assistance agencies report that, in some companies that are laying off selectively, older engineers are being replaced with lower-salaried young engineers. Confirmation of these reports is difficult to come by. However, the IEEE survey noted previously indicates that more older engineers are being ''encouraged" to retire early than were in the recent past.[28]

Reemployment

Engineers' prospects of finding a satisfactory new job depend on a combination of factors, chiefly: 1) their age; 2) their credentials and special skills; 3) their willingness to relocate; and 4) the health of the local and national economies. The health of the national economy is an overriding determinant of employment opportunities, but each of the other factors has considerable impact on how engineers fare.

Table 4-4-involuntary Unemployment Rates for Electrical and Electronics Engineers, Early 1990

Region	All other ages	Over 55
Northeast	1.8%	1 .7%
East	1.3	1.7
Southeast	1.2	3.0
Central	2.2	3.7
Southwest	1.8	1.7
West	0.9	3.1
United States	1.5	2.4

SOURCE: Institute of Electrical and Electronics Engineers, Inc., "IEEE Member Opinion Survey, 1990" (New York, NY: 1990), pp. D-15 and D-67. Table is adapted from data on these two pages, with all retired respondents, voluntary and involuntary, excluded.

Engineers under 35 combine relatively low salaries, high mobility, and well-developed computer skills. Most young engineers with some experience are having little difficulty finding new jobs. In contrast, most outplacement and employment offices interviewed reported that older (over 50) engineers are having more trouble. The IEEE survey of electrical and electronics engineers in late 1989 indicated an involuntary unemployment rate of 2.4 percent for those over 55 years of age compared to a rate of 1.5 percent for those of all other ages combined.[29] Table 4-4 shows comparable unemployment rates in the two categories for six U.S. geographic regions. Since 40 percent of the respondents aged 55 or over were retired, and since 14 percent of those indicated they had been forced to retire prematurely, the actual involuntary unemployment rates among over-55 electrical and electronics engineers is likely to be 5 percent or more.

Outplacement officers reported that many mid-level engineering managers (aged 40 to 55) are having a hard time finding reemployment after the 1990-91 layoffs. Their difficulties often involve one or more of these factors: 1) high salary expectations; 2) unwillingness or inability to relocate; 3) technical obsolescence; and 4) corporate restructurings, which have reduced the number of management levels in many companies. Engineers who have been promoted into mid-level management positions may have let technical skills atrophy; they find reemployment as an engineer after layoff difficult.

[27] *Business Month*, October 1990, p. 78.

[28] IEEE, op. cit., pp. 2-18.

[29] Ibid., pp. D-15 and D-67.

Engineers without bachelor's degrees are also having a hard time getting new jobs. Many defense contractors have, over the years, promoted or hired non-degreed people for jobs classified as engineering, and now report them as having trouble finding new jobs. The 1982 SSE showed that 5.7 percent of people employed as engineers at that time lacked bachelor's degrees. Seventy-five percent of those classified as ''aeronautical engineers' possessed aeronautical or other engineering degrees, but 13 percent either lacked a degree in science or engineering or had no bachelor's degree at a11,[30] When members of these groups are laid off, they often suffer from the lack of broad-based technical skills developed in engineering degree programs. Personnel offices may add to the problem by being unwilling to take a chance on applicants without the proper paper credentials. During the hard times for engineers in the early 1970s, there were similar difficulties for non-degreed engineers: in mid-1971, the unemployment rate for engineers without a bachelor's degree stood at 4.4 percent, compared to 2.8 percent for those with the degree.[31]

Several outplacement centers report exceptional reemployment difficulties for engineers who have become very specialized, especially those engaged for years in engineering activities peculiar to defense contracting, e.g., reliability, documentation, and defense software. Staff members at the outplacement center for the General Electric Aerospace Division plant in Burlington, MA say that 15 to 20 percent of the engineers laid off there are niched in very narrow, defense-oriented fields and are having considerable difficulty finding new jobs.[32]

On the other hand, many outplacement offices reported little trouble in placing engineers who were in nonmanagerial jobs in high technology fields. UNC Naval Products, in Montville, CT, for example, reported few problems in placing its electrical and mechanical engineers, many of whom were actively involved with robotics. Engineers with sophisticated processing and manufacturing expertise often make employment transitions easily. Engineers at the M-1 tank production facility at General Dynamics Land Systems Division north of Detroit, for example, are frequently drawn away by the area's automobile manufacturers.

Finally, the willingness and ability to relocate can be important. With the New England economy having hard times, the UNC Naval Products plant reported that half of its engineers laid off in 1990 found new jobs outside of Connecticut. Earlier, exit interviews with 70 engineers laid off from Grumman's Aircraft Systems Division at Bethpage, Long Island, in 1989 indicated that almost all had stayed in engineering jobs but 53 percent had had to move out of New York State.[33] Some engineers, particularly those in two-career families, may be less willing to relocate, and hence may have a harder time getting reemployed.

Although aggregate data on engineers' reemployment experience are mostly lacking, a few companies have at least partial records, At Lockheed's company-operated outplacement service for white-collar workers in Burbank, CA, half of the people served were engineers, and about 70 percent of the total were in technically oriented professions. The office reported on 299 placements through May 10, 1991: 39 percent found jobs with other defense contractors and subcontractors; 12 percent with other commercial aerospace companies; and 49 percent with other commercial sector employers including some in computer services, entertainment, environmental services, health, insurance, and manufacturing.[34] The high percentage reemployed in other defense fins-a finding confirmed in less quantitative reports from some other companies—raises the concern that these engineers may go through additional rounds of displacement as defense spending continues to decline.

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[30]Dauffenbach, Op. cit.

[31]Kathleen Naughton, "Characteristics of Jobless Engineers," *Monthly Labor Review,* October 1972, pp. 16-21.

[32]Such difficulties are not new. A major study of the transferability of defense engineers by Stanford Research Institute in the mid-1960s (C.H. Rittenhouse, *The Transferability and Retraining of Defense Engineers,* Report No. ACDA/E-110, prepared for U.S. Arms Control and Disarmament Agency, November 1967) pointed out there were a substantially greater number of engineers in the defense industry engaged in documentation activities, e.g., in writing specifications> handbooks, and manuals, and in systems analysis and design, than there were in civilian industry. Although systems approaches are now widely used in commercial and nondefense government programs, in the mid- 1960s many of the engineers laid off from all of the aforementioned job areas had major problems because of the shortage of comparable jobs outside the defense industry.

[33]Richard Opsaul, Grumman Corp. representative to the American Institute of Aeronautics and Astronautics (AIAA), personal communication Jan. 2, 1991.

[34]KathrynGriffiths,Lockheed (Burbank) Career Center, personal communication June 3,1991.

An April 1991 survey of 1,000 salaried and hourly workers laid off by Texas Instruments in 1990 showed greater mobility from the defense to the commercial sector—possibly a characteristic of the electronics sector. Ninety percent of the respondents were from the company's defense sector, and roughly two-thirds were salaried, with a substantial (but unreported) number being engineers. Eighty-two percent of the reemployed workers found their new jobs in commercial sector firms, 16 percent were rehired by Texas Instruments, and only 3 percent went to other defense fins. The data also indicate the value of early warning. In this layoff, all the workers received 60 days' advance notice; 44 percent had found new jobs within 6 weeks, well before the actual layoff occured.[35]

MOBILITY AND CAREER-LONG EDUCATION

Adaptability is the key to mobility of engineers from defense to civilian jobs. Too many years in too narrow a specialty is the greatest handicap to an engineer seeking to move into the civilian sector. More broadly, flexibility is increasingly important to all engineers and their employers in a time of rapid technology change, intense global competition, and shifting national priorities.[36]

Companies, the government, engineering colleges and universities, and individual engineers all have responsibilities in maintaining a versatile engineering work force. Engineers need a lifelong commitment to continuing education to avoid technical obsolescence. Universities can offer courses, at convenient times and places, that meet a midcareer engineer's professional needs. Companies can structure engineers' careers to help them avoid obsolescence by providing both internal mobility and continuing education opportunities. Government has a part to play both in providing scholarship aid directly to engineers for continuing education, and in giving companies information, technical assistance, and incentives to provide their engineers with lifelong training.

As layoffs of longtime employees are increasingly a fact of life in many U.S. companies, engineers are having to look at their jobs as renewable, short-term contracts rather than lifetime positions. It is becoming common practice, for example, for companies to reduce engineering staff to a core group and hire contract engineers for one project at a time.[37] IEEE recently advised its members to become ''mature realists' and not to 'assume that your employer will take care of you or that your job has tenure. " It emphasized the importance of taking responsibility for one's career, and advised engineers to "recognize the need for lifelong learning to stay current and competent in your profession. '[38] The case of obsolescence may sometimes be overstated.[39] Nevertheless, engineers who continuously refresh their professional skills increase their value to their employers (and to society) and are less vulnerable to replacement by recent graduates who have less experience and cost less, but are trained in up-to-date skills.

Career-long learning for engineers includes on-the-job experience, professional development, and formal course work. Several surveys indicated that most engineers had taken part in formal training at some time in their careers; that in the early 1980s about half of all engineers were participating in some kind of continuing education every year; and that participation tended to decline with age.[40] The inconvenience of course offerings, especially long travel times and distances, and excessive time taken from family and personal life were the primary

[35]Dan McMurtry, Texas Instruments Placement Center, personal communication, May 16, 1991.

[36]National Research Council (NRC), Committee on the Education and Utilization of the Engineer, Panel on Continuing Education, *Continuing Education of Engineers* (Washington, DC: National Academy Press, 1985).

[37]U.S. Congress, Office of Technology Assessment, *Higher Education for Science and Engineering—A Background Paper,* OTA-BP-SET-52 (Springfield, VA: National Technical Information Service, March 1989), p. 220, note 69.

[38]IEEE, ''Professional practices for Engineers, Scientists, and Their Employers," Entity Position Statement, IEEE United States Activities Board, Aug. 13, 1990.

[39]See, for example, H.G. Kaufman, ''Continuing Professional Development at Mid-Career," *Proceedings, 1982 College-Industry-Education Conference of the American Society for Engineering Education (Washington DC: 1982), P.* 12S. Kaufman said: "It may be that, at least until midcareer, professional obsolescence may decrease with age, mostly as a result of accumulated experience and self-learning. Obsolescence may be used by employers as a convenient excuse for hiring younger and less-experienced professionals at salaries considerably lower than those which older professionals have attained."

[40]NRC, op. cit., pp. 19-27.

reasons engineers gave for not taking training courses.[41]

Help in overcoming these barriers might come from both universities and companies. Most universities, however, have other priorities. A few major ones (e.g., Stanford) have long taken an interest in continuing education to engineers and provide it in well-organized extension programs. But the large majority give it little attention, concentrating instead on what they see as their central tasks of undergraduate schooling, traditional graduate education, and research.[42] In its 1988 report on continuing education for engineers, a National Research Council (NRC) panel suggested that since industry has a direct interest in continuing education for engineers that accommodates diverse students, extends the boundaries of classes, responds to rapidly changing technology, and controls costs, industry itself should take on the primary responsibility .43 There are ways, however, of combining industry and university responsibilities. An example is the National Technological University, described in box 4-A, which brings high-quality engineering courses from 40 universities to thousands of engineers and scientists in private industry. Several States have also supported the formation of regional technology networks of a similar kind.

Companies have much more to offer in career-long training of engineers than support of formal courses offered by university engineering faculty. Possibilities include rotations within the company to avoid over-specialization; short courses (possibly computer-based and self-paced) on specific topics; and long-term guidance by supervisors on training needs and opportunities.[44] Some U.S. companies an excellent job of devising training programs that will keep their engineers versatile, flexible, and up-to-date. (See box 4-B for an example.) However, Japanese companies generally take this obligation more seriously. One study found that large Japanese firms are far more likely than U.S. companies to broaden engineers' experience by moving them around within the company .45 Another described the Japanese employer's obligation to train the employee as "a corollary of the traditional long-range outlook in Japan" and a complement to "the employee's sense of duty to the company. ' '[46] Young engineers are introduced to the company with a combination of formal classes at a company institute, assignment to a specific but off-line engineering project, rotation within the company, and most important, long-term guidance by a mentor who is responsible for the engineer's well-being and education. For older engineers, there are corporate technical schools, engineering seminars, internal l-year ''engineering crammin g" programs, Company - funded studies at Japanese or foreign universities, and for many mature engineers, a job as production manager, which draws on the engineer's years of on-the-job training and job rotation experience.

The Federal Government has not taken a very active part in supporting or encouraging continuing education for engineers. The National Science Foundation offers fellowships for graduate engineering study, but the grants are targeted to conventional graduate students who have recently completed BS degrees, not to midcareer engineers looking for support of continuing education. Federal tax law does provide some encouragement for engineers to use employer-provided tuition assistance, since employees do not have to treat this assistance as taxable income (if employers provide it in a manner that meets Federal requirements).

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[41] Ibid., p. 16.

[42] Ibid., pp. 49-55. The NRC report noted that neither the institutions nor the engineering faculty have much *incentive to* develop and take part in continuing education for engineers.

[43] Ibid.

[44] At the same time that it advised engineers to take charge of their career development, IEEE also recommended that employers establish policies for the continuing personal and professional growth of their employees. Top managers were advised to 'encourage internal job transfers to broaden career experience and minimize obsolescence as a result of over-specialization" through measures such as ''job posting, skills inventory, internal recruiting, counseling, internships, rotational assignments, support for personal risk, and liberal relocation benefits.' IEEE, 'Professional Practices for Engineers, Scientists, and Their Employers,' op. cit.

[45] Leonard H. Lynn, Henry R. Piehler, and W. Paul Zahray, ''En@eefig Graduates in the United States and Japan: A Comparison Of Their Numbers and an Empirical Study of the Careers and Methods of Information Transfer, ' Carnegie-Mellon University, Pittsburgh, PA, 1989. The study found that 62 percent of Japanese engineers had at least one job rotation assignment, 35 percent were assigned to production at some point, and 50 percent had one outside assignment in R&D. The comparable figures for American engineers were 35 percent with a job rotation assignment, 14 percent assigned to production and 14 percent with an outside assignment to R&D.

[46] Jeffrey Frey and William Finan, ''Engineering Education in Japan: A Career-long Process,'' *EngineeringEducation*, July/August 1991, pp.466-472. The authors were describing major Japanese companies that subscribe to the practice of career-long employment.

Box 4-A—The National Technological University: A Partnership for Continuing Engineering Education

The National Technological University (NTU) is a private nonprofit institution, governed by a board made up primarily of industry executives, that brings television courses via satellite network to engineers, i n g e n g i n e e r i n g schools, including 27 State universities and land grant colleges and several highly regarded private institutions (e.g., Cornell, Rensselaer Polytechnic Institute). Most of the clients are private firms, among them such industry leaders as AT&T, Du Pent, General Electric, Hewlett-Packard, IBM, Motorola, and Xerox. Clients also include universities, U.S. Government agencies, and several of the Department of Energy's contractor-operated national laboratories. All students are employees of client organizations.

Founded in 1984, NTU had 260 faculty members in the 1990-91 school year, delivering 370 courses to 4,155 students enrolled for graduate credit and 386 noncredit courses in advanced technology and management to about 85,000 participants. By 1990, 150 students had graduated from NTU with the M.S. degree.

The NTU network uses an advanced telecommunications system, operating day and night on the GSTAR-1 communications satellite, and providing four channels of instructional television. Many courses are broadcast live, and students can communicate with instructors in realtime by telephone or fax. However, most students view the programs on tape at times of their choosing, and get in touch with instructors by telephone, electronic mail, or fax during the instructors' office hours. These adult students seem to fare well enough without the instant two-way communication that children need for distance learning.[2] Students are encouraged to view the programs in groups, to gain from immediate face-to-face interaction and mutual reinforcement.

NTU is an outgrowth of the Association for Media-Based Continuing Education for Engineers (AMCEE), a consortium of a dozen colleges founded in 1976 to produce and distribute video programs for practicing engineers. From AMCEE's Board of Directors came the idea of a national degree-granting engineering college that would deliver its programs via satellite. The National Science Foundation gave startup support to AMCEE, and the Department of Defense put up seed money for NTU, but operations are now funded mostly by fees from clients. However, the Defense Advanced ResearchProjects Agency recently awarded NTU a $l.5-million grant in matching funds for installation of a state-of-the-art digital compressed video transmission system. Investments by NTU, its industrial customers, and its member schools, will bring the total funding for the new system to about $5 million. Chief advantages of the system will be improved video and audio quality and a many-fold increase in channel capacity.

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[1]Most of the material On NTU is drawn from Lionel V. Baldwin, "Higher-Education Partnerships in Engineering snd Science," *The Anna/s of the American Academy of Political and Social Science, March* 1991, pp. 76-92; and National Technical University, *Annual Report 1990-91,700* Centre Avenue, Fort Collins, CO 80526.

[2]A detailed examination of distance learning is in U.S. Congress, Office of Technology Assessment, *Linking for Learning: A New Course for Education,* OTA-SET-430 (Washington, DC: U.S. Government Printing Office, November 1989).

However, Congress has never made this tax exemption a permanent part of the law, but has repeatedly extended it for limited periods.

The U.S. Government does little to spur or help employers to provide training to their employees generally, including continuing education for engineers. Several other countries use a payroll-based levy to encourage employers to train workers; the levy can be forgiven if employers do sufficient training on their own. Moreover, the U.S. Government offers little in the way of technical assistance to employers or professional societies that might wish to develop training programs for their employees or members.[47] Because of the public interest in making use of the skills of all the Nation's engineers, especially since there are indications that the supply may shrink in the next few years, there is reason for the government to give special attention to policies

[47]For detailed examination of worker training issues in general, see U.S. Congress, Office of Technology Assessment, *Worker Training: Competing in the New International Economy,* OTA-ITE-457 (Washington, DC: U.S. Government Printing Office, September 1990).

Box 4-B--Continuing Education for Engineers at Texas Instruments

Several large defense contractors are strongly committed to continuing education of their engineers and other employees. An example comes from the Defense Systems and Electronics Group of Texas Instruments (TI). [1]

The TI program requires new employees to work with their supervisors to develop a personal 3- to 5-year training education plan, and then to update it regularly for the rest of their career with the company. TI has developed training profiles by job titles; the profiles list mandatory, recommended, and optional courses that serve as the starting point for each employee's personal training and education plan.

TI provides its engineers with opportunities both inside and outside the company to meet their training goals. The Group's Human Resources Development Department offers some 125 2-to 5-day courses, a few of which are computer-based and self-paced. Among the subjects covered are computer systems, including computer languages, operating systems, microprocessors, and software engineering; electrical, mechanical, and other engineering; and leadership and quality development.

For longer term educational courses, TI provides help with tuition through its Educational Assistance program, which is dedicated to helping individual employees better their job performance through career-long education. For employees taking an approved course, TI pays all the costs of tuition, books, and fees for the first $100 per semester hour, and 80 percent of all charges above that. Engineers are encouraged to pursue graduate degrees, especially in technical areas but also in business administration. Course work is generally done on the employee's own time.

The TAGER Television Network offers TI employees another way to receive advanced courses in engineering, computer science, mathematics, and management. Developed by a consortium of North Texas colleges and universities, TAGER uses one-way television and two-way telephone hookups to present credit and noncredit courses to 15 companies at 30 sites in the Dallas-Fort Worth area. Courses are offered primarily during working hours but also on week night evenings. M.S. degree programs in the TAGER network include electrical, mechanical, and computer engineering, computer science, operations research, and engineering management. TI also provides satellite-delivered courses in engineering and management from the National Technological University.

[1] Roughly one-quarter of Texas Instruments' business is in defense.

that would make career-long education and training for engineers more readily accessible.

REEMPLOYMENT AND RETRAINING ASSISTANCE FOR ENGINEERS

Engineers' Needs

Engineers laid off by defense industry employers typically need a range of outplacement services, many of them identical to the services that are useful to all displaced workers. These common services include skills assessment and job counseling, personal counseling, job search skills training, and job development, including company-sponsored job fairs. Engineers' needs do differ in some respects, however. For example, job banks and job fairs for the engineers are more useful if the potential employers come from all over the United States, while production workers are often interested mainly in local jobs.

Retraining needs can also be rather different. Many blue- and pink-collar workers can gain a good deal from relatively short-term skills courses, particularly those designed by local community colleges to meet the needs of displaced workers. Engineers who require retraining may need courses that are considerably longer and more expensive.

Moreover, engineers may need access to employment and training services for a relatively long time. Job searches for engineers average longer than those of blue-collar workers. A personnel officer for McDonnell-Douglas says, "For every $10,000 per year a person makes, it takes 4 to 6 weeks more to find a position."[48] At a General Electric plant in hard-hit Massachusetts, a personnel officer points out, "Even in good times, the average placement time for engineers was 3 to 6 months. ' '[49] Outplace-

[48] Personnel officer, McDonnell Douglas, personal communication, Oct. 19, 1990.

[49] Frederick T. Anderson, manager, professional staffing, GE Aerospace, Lynn, MA, personal communication, Mar. 11, 1991.

ment offices say that the 1990-91 recession has typically added another 1 to 2 months to the length of job searches for engineers.

Responses From 1970 to 1973: The Worst of Times

The employment situation for engineers was much worse in the early 1970s than in the early 1990s: total engineering employment then was considerably less (1.2 million in 1970 vs. 1.8 million in 1990); the defense aircraft, space, and commercial aircraft industries had all contracted signicantly at the same time; and the economy was much more defense-dependent. A national program for assistance to displaced workers did not exist in the 1970s, and in its absence several government and other reemployment and retraining efforts targeted to engineers were established. These may be applicable--and perhaps more effective-in an era when the engineers' situation is not so difficult.

The Federal Government's principal response was expansion of a small, trial assistance effort into a national program, the Technology Mobilization and Reemployment Program (TMRP). TMRP provided funds for job development, travel for job searches, relocation, and training for specific jobs. An estimated 75,000 to 100,000 engineers, scientists, and technicians were unemployed when the program began.[50] When the 2-year program ended in June 1973, some $28 million had been spent and 34,000 participants were known to be reemployed.[51] A 1973 General Accounting Office (GAO) report[52] criticized the program for falling short of its estimates of the number of people it would serve (35 percent of the goal) and the amount of financial aid it would disburse (19 percent), but otherwise regarded the program as reasonably successful.

One aspect of TMRP was a skills conversion study. Under a contract from the Department of Labor (DOL), the National Society of Professional Engineers (NSPE) organized research teams of unemployed aerospace/defense engineers in 14 cities with the highest unemployment rates for technical professionals. The teams examined potential employers' needs in 21 fields such as medical services, criminal justice, food products, and transportation, and identified some 55,000 job opportunities.[53]

Following the skills conversion study, DOL awarded NSPE a second contract, the Technology Utilization Project (TUP), to retrain aerospace/defense workers. Engineers and scientists were retrained for jobs in 11 industries with good job opportunities: food products, health care, transportation, wood products, power resources, pollution control, criminal justice, banking and finance, solid waste, educational technology, and occupational safety. Of 329 persons enrolled in the course, 302 found employment by early January 1973, and most in the occupations for which they had been trained. GAO recommended that skill conversion studies be given high priority for early implementation in future employment crises for technical professionals.[54]

The TUP's successes provided a counter to employer attitudes common in the early 1970s (and still prevalent in 1991). The attitude was that aerospace engineers were not good prospects for nonaerospace employment because they were overpaid, too specialized, and too old, and would return to aerospace as soon as they could. After the project ended, DOL reported the following:

- Employers mistakenly thought defense aerospace engineer salaries averaged $25,000; for those who participated in the training the average was $16,000.
- The technological spinoff from aerospace specialization convinced many employers that experience in defense aerospace was more an advantage than a disadvantage.
- The average age of the participants in training was 45.4, but these retrained engineers ap-

[50]Comptroller General Of the United States, "Reemployment Assistance for Engineers, Scientists, and Technicians Unemployed Because of Aerospace and Defense Cutbacks," op. cit., p. 1.

[51]President's Economic Adjustment Committee and Office of Economic Adjustment (DoD), *Economic Adjustment/Conversion*, July, 1985.

[52]Comptroller General of the United States, "Reemployment Assistance for Engineers, Scientists, and Technicians Unemployed Because of Aerospace and Defense Cutbacks," op. cit., p. 14.

[53]Naughton, op. Cit., p. 20; "Aerospace/Defense Job Skills Conversion Project Develops Action Responses to Engineering Employment" *Professional Engineer This Month*, vol. *42, No. 6*, June 1972, p. 17.

[54]Comptroller General, "Reemployment Assistance for Engineers, Scientists, and Technicians Unemployed Because of Aerospace and Defense Cutbacks," op. cit.

peared to take less time to become productive than new college graduates.

- Only one-third of the unemployed engineers returned to aerospace; many preferred the security of another industry .55

The Aerospace Employment Project was a small-scale, federally funded program, carried out by the National League of Cities and the U.S. Conference of Mayors, that retrained former aerospace and defense industry professionals for local government jobs. A total of 376 professionals were selected from some 7,000 applicants in the 10 highest unemployment areas in the United States. After attending 30-day courses at Massachusetts Institute of Technology (MIT) or the University of California at Berkeley, and after being organized into supportive self-help groups, the participants were made available to prospective employers. The program proved effective in giving the engineers new skills, and most participants found new jobs, but the job search was lengthy and most of the engineers took salary cuts. Roughly 8 of 10 participants were placed within 7 months of course completion, 65 percent in local government and the balance in private industry. Most participants reported that the new jobs did require substantially different skills from those involved in their old jobs so that retraining was appropriate.[56]

Professional societies (IEEE and the American Institute of Aeronautics and Astronautics (AIMA)) set up other programs to help engineers in the 1970-73 period. Both organizations worked with DOL to use both volunteers and paid, previously laid-off engineers in job and personal counseling programs and in self-help groups in areas where unemployment was high.[57] AIAA, for example, eventually provided 175 workshops in 43 cities, and served 14,600 out-of-work professionals.[58] Assistance from peers proved to be a key to success in these programs.[59]

Responses Today: Professional Associations

During the 1970-73 employment slump-the worst period for engineers since World War II-the professional associations were very active in helping their displaced members get back into the work force. During the current cutbacks, perhaps because of stronger outplacement efforts by many defense firms and the presence of the Economic Dislocation and Worker Adjustment Assistance (EDWAA) government programs, and because the slump for engineers is not as severe as that of two decades ago, the associations are not as heavily involved. They do, however, provide some services.

IEEE regularly tracks employment trends for its members, holds biennial Career Conferences, and has been actively promoting continuing education. (Electrical engineers represented 44 percent of defense-related engineering employment in 1990.) IEEE has taken a lead role in maintaining resume data banks for professional association members; developed and published a two-volume "employment guide" for scientists and engineers; helped build local consultant networks, which can support entrepreneurial efforts by displaced engineers; encouraged recruiting at IEEE conferences; and contracted with a private firm to present job fairs and job search seminars for local IEEE sections around the country.

AIAA (aeronautical and astronautical engineers represented 15 percent of defense-related engineering employment in 1990) has taken a very low-key role in the reemployment effort. It has revised and reprinted a popular 1970s job hunting guide and has provided free insertions of "Available for Employment" ads in the organization's monthly magazine.

Engineers are not heavily unionized, but those unions that exist have made some efforts at promoting conversion from defense to commercial production. One of the more creative union efforts was the Wichita Engineering Association's negotiations with Boeing, which resulted in the cross-training program described later in this chapter.

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55 Albert E. Berndt, "Government Efforts To Utilize Engineering Manpower," in S.S. Dubin, H. Shelton, and J. McConnell (eds.), *Maintaining Professional and Technical Competence of the Older Engineer—Engineering and Psychological Concepts*, op. cit.

56 H.G. Kaufman, *Professionals in Search of Work: Coping with the Stress of Job Loss and Unemployment* (New York, NY: John Wiley & Sons, 1982), p. 207.

57 Stix, Op. cit., p. 47; Berndt, op. cit., p. 140.

58 Kaufman, op. cit., p. 212.

59 Ibid., p. 138.

On Long Island, a group of engineers formed "The Center for Practical Solutions" in early 1990 to help each other with employment problems and opportunities and to develop jobs in the area. The group is trying to create new jobs through infusion of technology into existing companies and support of entrepreneurial efforts. The center includes people with expertise in marketing, sales, law, and accounting, to support development of businesses for the manufacture of commercial, environmental, transportation, and medical products.

Company Responses

A qualitative review of reemployment programs for engineers around the country indicates that many of the better ones are built around active company participation. When company programs are in place, government programs can be very effective complements, providing additional readjustment/reemployment services and staff. Partnerships between local EDWAA agencies and the companies can draw on the strengths of both and produce effective programs.

In the current downsizing, most large defense industry employers are providing engineers and other white-collar employees with a wide variety of outplacement services.[60] Companies may have more than one reason for taking on this responsibility. Besides feeling a duty to longtime employees, some are also concerned about maintaining morale among both the workers who have been given advance notice of layoff and those who will remain with the company.

Company outplacement services are a relatively new benefit. Before 1970, most defense industry firms took no responsibility for helping laid-off engineers find new jobs. In the San Francisco area during major defense industry layoffs in 1964-65, for example, only a quarter of the scientists and engineers laid off by 62 defense industry firms received outplacement services. The average time between layoff notice and end of employment for all 62 firms was only 7 days.[61]

Company outplacement services may be provided directly by the employer's human resources office or by an outplacement firm hired by the employer, and are often supplemented by some services provided by local and State EDWAA agencies. Although cooperation between companies and government dislocated worker assistance programs can work well, companies sometimes lose patience with the delays or inadequacies of government programs. Several companies reported that they sought help from the federally funded, State and locally operated EDWAA program when facing layoffs, but decided to provide the primary services themselves because the government agencies could not get projects set up quickly enough, did not have funds available, or declined to fund certain services (such as workshops by outside consultants).

Table 4-5 summarizes the services provided to engineers at 13 plants of large defense contractors after layoffs announced during 1990 or early 1991. Most of the large defense contractors make substantial efforts, with or without government assistance, to provide basic services (the second through seventh categories of "Benefits and Services Provided' in table 4-5). The aim is to help the employee find a new job as rapidly as possible, and to minimize the stress on employees from the time the layoff is announced until they find new jobs. Survey responses from 11 aerospace firms that had laid off scientists and engineers and provided outplacement services during 1989-90 indicated the average cost of the services provided ranged from $100 to almost $6,000 per employee; the median amount was $1,000.[62]

Reemployment programs for engineers and other white-collar workers typically start with a 2- or 3-day orientation, which includes topics such as skills assessment, resume preparation, interview techniques, importance of networking, and potential personal stresses. Such basic information may not seem necessary, especially in areas such as southern California where many aerospace workers have changed employers frequently and kept job-hunting skills honed. However, the layoffs of the 1990s are

[60] Some firms also provide services t. their blue-collar workers but tend to rely more on State and local government employment and training programs. Engineers and other white-collar workers frequently receive outplacement services at one office or location, blue-collar workers at another. See ch. 3.

[61] R.P. Loomba, "A Study of the Re-Employment and Unemployment Experiences of Scientists and Engineers Laid Off From 62 Aerospace and Electronics Firms in the San Francisco Bay Area During 1963-65," San Jose State College, San Jose, CA, Feb. 15, 1967.

[62] Aerospace Industries Association Survey, "Company Policies for Dealing with Economic Adjustment and Its Impact on Aerospace Workers," 1990.

Table 4-5—Benefits and Services Provided to Displaced Engineers

Company	Location	Number of engineers laid-off	Dates	Benefits and services provided: Severance pay	Job-search skills training	Office space	Job counseling	Personal counseling	Job banks[a]	Job fairs	On-site retraining courses	Funding for off-site training
Lockheed	Burbank, CA				c	c	c		C+G	C	—	—
McDonnell-Douglas	Long Beach, CA	1,990	7-90/6-91	—	C+G	C+G	C+G	C+G	G+G	C+G	—	G
Northrop	Los Angeles, CA (multiple sites)	1,200b	1-90/12-90	—	C+G	c	c	G	C+G	C	—	G
Rockwell-North American Aircraft	Los Angeles, CA	160	10-89/12-90	C	c	c	c	c	c			G
GD Electric Boat[c]	Groton, CT	75	10-90/1-91	—	c	c	c	c	G	:	=	G
UNC Naval Products	Montville, CT	240	2-90/12-90	C	CG	c	CG	c	G	CG	—	C+G
Boeing	Wichita, KS	60	1-90/12-90	—	c	c	c	—	—	—	C [d]	—
GE Aerospace	Burlington, MA	150	1-91/12-91	c	c	c	C+G	C+G	C+G	c	C+G	C+G
GE Aircraft Engines	Lynn, MA	350	10-90/2-91	C	c	c	c	c	c	c	c	c
McDonnell-Douglas	St. Louis, MO	1,900	7-90/6-91	—	C/G'	C/G	C/G	C/G	C/G	c		G
Grumman	Long Island, NY	230	1-90/12-90	c	c	—	c	—	—	c	:	G
Texas Instruments	Dallas, TX	700	1-90/5-91	c	c	c	c	c	c	c	c	C+G
GD Fort Worth[c]	Fort Worth, TX	2,500	6-90/ 6-91	—	c	c	c	c	c	C+G	—	G

KEY: C--company operated and funded.
G~government operated and funded.
C+ G-joint operation.
C/G-company operated, government funded.
— —not provided.

[a] Every State has an **Employment** Service **that maintains a** jobbank; displaced engineers may, however, rely primarily on job listings developed at **the company outplacement** center.
[b] Includes **engineers and other white-collar job holders.**
[c] Electric **Boat and Fort Worth are subsidiaries of** General Dynamics (G D).
[d] Company provided crosstraining **for 176 engineers to** change jobs within BOO@
[e] Programs designated C/G were company provided until November 1990, then turned over to government agency.

SOURCE: Office of Technology Assessment, 1991.

also displacing engineers who have been with the same employer for 15 or 20 years and have not had to look for a new position since they graduated from college.

After the orientation many of the engineers are ready to begin their job searches, while others take time to evaluate future career directions. Peers are often effective job counselors for engineers, and job clubs (peer support groups in which job-hunting experiences and job leads can be shared) are also popular and useful. Many companies provide laid-off engineers with office space for job search activities; this often includes a desk, photocopying and long-distance telephone privileges, and access to word-processing equipment or secretarial assistance.

Companies also assist their engineers by putting them in contact with potential employers through job fairs and job banks. In St. Louis, for example, McDonnell Douglas brought in more than 115 companies to job fairs for employees it laid off in mid-1990. Most outplacement offices maintain job banks (listings of available jobs), although these range widely in size and quality. Lockheed's Burbank, CA center for displaced salaried workers gathers job listings from some 800 potential employers and also distributes to employers a weekly newsletter describing the talents of specific Lockheed employees being laid off. Some companies, such as General Electric, maintain listings of professional opportunities available at the company's other locations.[63]

Personal counseling, usually in the form of group instruction on potential psychological, family, and financial problems, is an important service provided by many companies. Individual counseling on the same issues is frequently made available, sometimes through existing company employee assistance programs. Because unemployment periods for engineers are often relatively long, stresses can build up and the personal counseling programs become critical.

Although most large defense companies offer their laid-off employees substantial reemployment help, either by themselves or cooperatively with State and local agencies, others do less. After a large layoff in early 1989, one Long Island aerospace firm provided severance pay, job fairs, and informal counseling, but also: 1) informed most workers of layoffs on the day they were laid off, in some cases giving them less than 30 minutes to leave; 2) refused to permit local and State reemployment assistance programs to hold briefings at the affected plant to describe available services; and 3) refused to provide the assistance programs with the names of the laid-off workers.[64]

In addition to the tasks of finding a new job and managing the stresses of unemployment, laid-off engineers sometimes need training to fit the new job or to make them more appealing to potential employers. Interviews with laid-off engineers, outplacement office staff, and government employment agency directors indicate that retraining has not been a high priority for displaced engineers during the current cutbacks. Like blue-collar workers, many unemployed professionals are unwilling to risk retraining unless they are provided financial assistance and the promise of a job upon completion.[65]

The responses of the companies (and government agencies) to retraining needs at the 13 plants are shown in the last two columns of table 4-5. Retraining assistance is not provided by nearly as many companies as the more basic outplacement services. Training is expensive, and the companies have generally relied on government programs for this service. A few companies make tuition grants for training courses as part of severance packages. For example, General Electric's Aerospace Division will reimburse tuition costs up to $5,000 for each of the 2 years following an engineer's layoff. Hughes Aircraft reimburses each laid-off employee up to $5,000 for tuition for continuing education, improving technical skills, or completely changing profession.[66] Texas Instruments provides any worker who has been with the company for 15 years up to $6,000

[63] The seven largest aerospace employers in California joined the State in 1988 in forming the Aerospace Human Resources Network, with an office in Manhattan Beach, to help engineers and other white-collar employees transfer from one company to another as defense contracts ebbed and flowed. By late 1990, however, no one was doing much hiring. The network had essentially become an outplacement service for all of the employers. The members decided to end their joint effort and return to local (company- and State-run) employment offices.

[64] Linda Kravitz, "Wages of Peace: Community and Industry Experience with Military Cutbacks," contractor report prepared for the Office of Technology Assessment, July 1990.

[65] Kaufman, op. cit., p. 205.

[66] John Voelcker, "Reemployment Assistance Limited," *IEEE Spectrum,* November 1989, p, 54.

in tuition assistance during the 2 years following layoff. Other companies complete payment for any courses in which engineers are enrolled at the time of the layoff announcement.

When training needs are fairly narrow and shared by a number of clients, outplacement projects sometimes offer their own short courses. Typical subjects include computer-aided design and manufacturing (CAD/CAM) and specific computer programming languages. Classes in how to start a small business are popular offerings. These courses may be paid for either by the company or out of EDWAA funds.

Mass retraining of engineers for other jobs within the company is less common. An effort by Boeing's Wichita Division to retrain its defense engineers (described in box 4-C) is a successful but unusual example. In contrast, a company retraining program launched in a southern California aerospace plant was terminated when more than 60 percent of the class members dropped out. The keys to success in group retraining efforts appear to be careful selection of candidates and availability of jobs that will require engineering rather than technician or blue-collar skills.

Defense industry employers use several strategies to minimize layoffs. Normal attrition due to retirement or voluntary quits can reduce employment levels without layoffs. Some companies offer voluntary early retirement, although it appears that some recent early retirements have not been truly voluntary. An approach used in the past in single-fro cutbacks but less available now is the loan of engineers to other companies. In 1978-80, for example, Rockwell's North American Aircraft Division loaned engineers to Boeing and McDonnell Douglas with an option to call them back at any time with 30 days notice; Rockwell did so when B-lB bomber production began in the early 1980s.[67] Because the spending cutbacks have hit virtually all defense contractors, few are in a position to borrow engineers today. In the 1970s, several companies used shortened work weeks or work sharing, in which two employees alternate in a single job slot, to avoid dismissals;[68] they have not been used significantly in the current cutbacks, at least not by the large companies.

Government Programs

Federal programs of immediate importance to engineers facing layoffs because of defense retrenchments are the mandate for early notification of layoffs, under the Worker Adjustment and Retraining Act (WARN), and the EDWAA program as a source of funding or provider of retraining and reemployment services. These programs are discussed generally in chapter 3. The discussion here focuses on their effectiveness.

The early notification that WARN requires has proven very useful to local and State government agencies in getting programs into place for displaced engineers-in those cases where WARN has applied.[69] Like other workers, professionals who start their job search before they are laid off are likely to have a shorter period of unemployment than those who start looking after layoff.[70]

Federally funded EDWAA services are a major source of reemployment assistance for dislocated engineers. As described in chapter 3, EDWAA funds can be used for retraining, job search skills training, placement services, relocation assistance, and other specific support services for dislocated workers. Although most large defense contractors are currently providing readjustment and reemployment services other than retraining to their laid-off engineers, the EDWAA program still plays a very necessary role. State and local EDWAA agencies can provide reemployment services to engineers when companies are too small to afford them, when larger companies decline to provide them, and when companies that provide the services initially later want to turn the task over to someone else. EDWAA agencies can also provide technical assistance to

6? David Rowley, Vice-President, Human Resources, Rockwell International, Aircraft Division, El Segundo, CA, personal communication, Feb. 1, 1991.

[68]Kaufman, Op. cit., p. 259.

[69]The WARN legislation requires early notification whenever layoffs in a 30-day period involve either one-third Or more of a company's employees (minimum of 50) or 500 or more employees. The law also provides numerous exemptions, e.g., when a plant closing or layoff is the result of the ending of a project for which employment was understood to bc limited to the project's duration, or when it is the result of business circumstances that were not foreseeable. McDonnell Douglas and General Dynamics both took exemptions for large layoffs when the Navy abruptly canceled the A-12 program in January 1991.

[70]Kaufman, op. cit., p. 149.

Box 4-C—Retraining of Engineers: Boeing's Commercial Airplane Group

A model effort in retraining defense industry engineers for commercial engineering jobs within the company is in the Wichita (KS) Division of Boeing's Commercial Airplane Group. After a company reorganization in 1989, Boeing began to phase out military aircraft work at the Wichita facility, moving the work to other Boeing plants in Seattle and Philadelphia. At the same time, the Commercial Airplane Group at Wichita had a big backlog of work and faced a serious shortage of structural design engineers.

Expecting sizable layoffs from the cutback in military work the engineers' union, the Wichita Engineering Association, worked out a retraining agreement with the company in December 1989. Association members who were candidates for layoffs would be offered a chance at retrainingfor structural engineering positions.

Over the next 13 months, 176 engineers--mostly mechanical, civil, and aeronautical-entered the Cross Training Program. Their previous experience varied widely, and their ages ranged from 24 to 60. To be eligible, they must have completed basic engineering mechanics courses in statics, dynamics, and strength of materials. And they had to be committed to careers in airframe structural design.

The training course was on paid time and was taught in the plant by Boeing engineers. It included 6 weeks of classroom training, followed by 6 weeks of engineering liaison work on the plant floor. All but 8 of the original 176 engineers completed the 12-week program.

Afterwards, the trainees were assigned to structural engineering jobs as "apprentice engineers," a special cross-training category they are allowed to keep for 18 months, with no cut in salary from their previous positions. As apprentices, their progress is reviewed every 90 days. Additional training, such as advanced structural design courses, is available from Wichita State University. At the end of the apprentice period, the engineers become qualified structural engineers and move into the pool with others in the same category.

With most of the trainees still in the apprentice designer category at this writing, it is too soon to say whether the program has fully succeeded. If it does, the company and the engineers will both emerge as winners.

company projects, and they can provide services the company does not sponsor.

EDWAA agencies that are in partnership with companies often contribute by training company outplacement staff, conducting parts of workshops, preparing discretionary grant proposals, and providing specific services such as personal counseling to employees or operation of State job banks. At the General Electric Aerospace Division plant at Burlington, MA, for example, the State's EDWAA-funded contractor provided a job developer, a training coordinator, and a peer counselor, as well as training funds, to complement the staff, services, and facilities the company provided. It also counseled company officials on how best to set up an outplacement program. In St. Louis, McDonnell Douglas provided the basic outplacement services to engineers at company centers while the EDWAA agencies helped the company establish the centers, provided advanced CAD/CAM training to a group of engineers and funded individual courses for others, supported new business development by offering entrepreneurship training and incubator space, and took over operation of the company-established centers several months after the initial large layoff. Sometimes, it is possible for the defense company itself to become the EDWAA-funded service provider. At its Montville, CT plant (slated to close completely by the end of 1992), UNC Naval Products administers an EDWAA-funded contract to provide a full range of outplacement services to the dislocated employees.

In cases where companies do not provide outplacement help or have closed down their outplacement centers, engineers may turn to EDWAA-funded and operated centers. Some EDWAA projects are tailored to respond to a particular plant layoff, but many are open to all of a community's dislocated workers. Some of the centers are effective, giving individual attention to all workers, providing a range of readjustment and reemployment assistance services, and fitting retraining to each individual's background and abilities. In others, the EDWAA service providers are accustomed to working primarily with blue-collar workers and are not committed to serving dislocated white-collar

workers and professionals.[71] Moreover, during the recession and stagnant economic conditions of 1991, some EDWAA programs became so overstretched with demands for services that they provided only minimal help to those they considered most able to fend for themselves. This included most engineers.

Earlier, before demands for services became so insistent, some States had set up centers that were targeted specifically to professional employees. For example, the Commonwealth Career Center, located in Boston's southwest suburbs, was intended primarily to serve engineers and other professionals laid off by computer, defense, and financial fins. This center concentrated on job development and intensive, individual case management. In Texas, EDWAA agencies have contracted with the Center for Applied Technology, part of the University of Houston, to operate Career Resource Centers for professional and technical staff laid off in the Dallas, Austin, and Houston areas. The centers provide a range of readjustment and reemployment services as well as a considerable number of training courses. California's Employment Development Department is helping job-seeking engineers and other professional, managerial, and technical workers by supporting Experience Unlimited (EU) job clubs in its local offices. The EU clubs are voluntary self-help groups of the unemployed or underemployed, mostly mid- to upper-level executives. Members use the clubs to network and develop job search skills. They are expected to spend at least 4 hours per week in club activities designed to help them or fellow club members find jobs.

The costs of retraining usually fall on government sources, if not on the engineers themselves. Retraining or continuing education at the professional level is expensive. Some local service providers have virtually no EDWAA funds available for individualized courses for engineers; others consider advanced training for engineers an expensive luxury, and give priority to shorter term retraining of blue-collar workers without transferable job skills. Some are willing to support engineers' training but restrict their choices.

The Federal law that established EDWAA places few restrictions on training choices, but DOL's EDWAA regulations state: "Retraining services . . . should be limited to those individuals who can most benefit from and are in need of such services.' '[72] Many State and local agencies interpret this regulation to exclude dislocated workers with college degrees from EDWAA training. Most do not allow the use of EDWAA funds for pursuit of a full degree program, although they may fund a limited number of courses to complete a degree program already well underway. One agency (not atypically) interpreted the regulation to bar a laid-off defense industry mathematician from receiving EDWAA funds for retraining to become a high school mathematics teacher. The agency would not fund the retraining because the young woman ''already had a marketable degree in mathematics. As discussed in chapter 3, the same DOL regulation and policy usually disallows EDWAA training funds for skill upgrading. This could present a particular problem for engineers otherwise eligible for EDWAA retraining; jobs may be available in their specialty but only to those with the most up-to-date skills.

In principle, publicly financed training might appropriately be given to any displaced workers, including engineers, who need it to improve transferable skills. However, considering that training for engineers is expensive, and that EDWAA funds are limited--especially when recession is aggravating displacement and escalating demands for service service providers will face tough choices over how to spend their scarce resources. They may have to limit their help to engineers to outplacement services, which are relatively cheap, and save training for those who can benefit from shorter term, less costly courses. However, if a particular center serving engineers focuses too much on outplacement services, it runs the risk of coming up against the law's requirement that each EDWAA project must spend half its funds on training (unless the Governor reduces the portion to 30 percent). As noted in chapter 3, this requirement removes flexibility from projects primarily serving engineers, managers, and other professionals who may be job-ready and need no training. Considering the value to society of preserving and upgrading the skills of its engineers, there is good reason to consider options other than the EDWAA program for keeping midcareer engi-

[71] Some Service Delivery &~, concentrating on services to low-income and disadvantaged workers, have little experience or even interest in serving displaced workers in general, whether engineers, technicians, operatives, or clerical workers. See the discussion in ch. 3.

[72] 20 CFR 631.41(d)

neers in the profession. Chapter 2 discusses policy options for encouragement and support of continuing education of engineers-thus helping to avoid displacement and waste of this human resource. Two other options that seem particularly appropriate for engineers are described below.

Teacher Training

One creative approach to the reemployment of retired or unemployed engineers is to train them as certified math and science teachers for junior and senior high schools. Under one such program, started in September 1990 and funded jointly by Rockwell International and the State of California, 17 Los Angeles area Rockwell retirees aged 55 to 65 enrolled in a 9-month alternative credentials program. (Rockwell, like many defense industry firms, allows retirement as early as age 55 with 30 years company experience.) The engineers' practical experience was expected to add an extra dimension to their teaching. The company expected to see the program expanded to a number of other Los Angeles firms in 1991-92.[73] Several large nondefense companies, including Polaroid, IBM, and Kodak, have also established teaching as a second career programs.

Although the Rockwell project was not designed for laid-off employees, similar programs in other areas have been expanded to include both retired and laid-off engineers and scientists.[74] Such programs may be a good alternative for older engineers who often have the toughest time finding new jobs; at the same time, school systems would have a new supply of badly needed math and science teachers. In many districts, salaries for public school teachers are so low that the choice is not feasible for midcareer engineers with large financial responsibilities, although it can be attractive for retirees who are able to collect both a pension and a teacher's salary. However, in some school districts, where respectable salary increases were adopted during the 1980s, secondary and middle school teaching has become a viable alternative for laid-off engineers, especially perhaps for younger engineers and scientists with employed spouses.

The National Executive Service Corps (NESC), a New York City-based nonprofit group that provides retired businesspeople as consultants to other nonprofit organizations, has used Carnegie Foundation aid to train retired engineers (and other holders of relevant degrees) as high school math and science teachers. NESC works with businesses to recruit retirees and with local colleges to establish alternative pathways to teaching credentials. NESC has found that many engineers and scientists had thought seriously of teaching while they were in college, but decided not to because of the low salaries; the higher salary levels in some districts have allowed them to reconsider.[75] The program established 12 demonstration projects in 10 States from 1987 to 1990.

The NESC program is too new to allow full evaluation of its results, but it has chalked up some successes. For example, in a NESC-sponsored program at Texas Christian University (TCU) in Fort Worth, TX, retired, laid-off, and other individuals with undergraduate math or science degrees can receive interim teaching credentials after completing two courses at TCU and full credentials after finishing two more courses and 1 year as a paid, full-time, intern teacher in the Fort Worth system. Nineteen of the 20 men and women who completed the TCU training in the first 2 years of the program were teaching in the Fort Worth schools as of January 1991, and another 15 were enrolled in the current course program. Both TCU and the school district subsidize the second career teachers with tuition rebates.

State government agencies play an important role in such projects because they establish the requirements for certification for the prospective teachers; the route to credentials varies considerably from State to State. The New Jersey Board of Education's Provisional Teacher Program, established in 1985, is among the oldest alternative credentials programs. Although it is not limited to developing math and

[73] Tim Violette, Manager, Human Resources Planning, Rockwell International, Corporate Office, El Segundo, CA, personal communication Jan. 24, 1991.

[74] In 1988 OTA reported the existence of an estimated 26 such programs across the United States. US. Congress, office of Technology Assessment, *Elementary and Secondary School Education for Science and Engineering@ Technical Memorandum,* OTA-TM-SET-41 (Washington, DC: U.S. Government Printing Office, December 1988), p. 61.

[75] Dorothy Windhorst, Vice-President for Mathematics and Science Education, National Executive Service Corps, personal communication, Apr. 19, 1991.

science teachers, it is answering some basic questions about the effectiveness of teaching as a second career for engineers and others. Candidates for the program must have a college degree in the field they are going to teach and a passing grade in that field on the National Teacher Examination. After 200 clock hours of training during a year of "provisional" teaching, the candidate goes rapidly from observation, to practice teaching, to periodically observed, but otherwise unsupervised, teaching. At the end of the year, the new teachers are eligible for the State's standard formal certification. While some school districts give the new teachers credit for previous work experience, others do not.

The New Jersey program has found that: 1) alternative credentials teachers of mathematics and sciences know their subject matter significantly better than traditional credentials teachers; 2) the attrition rate during the frost year of teaching is much lower (5 percent in 1989-90) for alternative credentials teachers than for those with traditional credentials; 3) principals have been very satisfied with the performance of the "provisional teachers"-despite initial reluctance to accept them; and 4) minority participation is a side benefit of the program-23 percent of the teachers from the alternative credentials program are from ethnic/racial minority groups, versus 11 percent from traditional credentials programs.[76]

Entrepreneurial Assistance

Helping small businesses get started is a standard feature of economic development efforts by State and local government agencies; it is being widely employed in efforts to respond to defense spending cuts (see ch. 6). Several agencies providing help to displaced workers have made entrepreneurial assistance one of their approaches to finding new employment for laid-off workers, including engineers.

For example, the St. Louis (MO) County Economic Council is helping displaced McDonnell Douglas engineers and other employees start their own businesses. Typically, after a major blue- and white-collar layoff, 10 percent of the displaced employees will at least initially be interested in going into business for themselves. In the wake of the July 1990 McDonnell Douglas layoff, the County Economic Council obtained a $123,000 EDWAA grant to offer the laid-off workers short courses on starting small businesses. Some 500 people showed up at a l-day entrepreneurial training seminar, and 275 of them, mostly engineers, signed up for a lo-session course. Participants got instruction in how to start and operate a small business and were required to prepare a business plan for their proposed enterprises. The council also helped the prospective entrepreneurs get startup loans from the Small Business Administration and from a special, low-interest State fired. McDonnell Douglas donated building space for an incubator for some of the new enterprises.

There is no accurate count yet of how many participants in the entrepreneurial training program started up businesses or what fields they entered, but at least a few firms based on engineering skills did result from the entrepreneurial training program. Six months afterward, the McDonnell Douglas incubator housed three firms operated by the company's former employees, and a fourth was expected; the three firms specialized in computer repair and service, software and personal computer system installation, and contract management. A meeting of alumni of the program disclosed that seven more new businesses had started up, in such areas as desktop publishing, church sound system installation, and video production. However, it appears that most of those who took part in the entrepreneurial training program after the McDonnell Douglas layoff went into a service or retail business based on a personal hobby, not on technologies related to their former jobs.[77]

The DOL is supporting business startups by dislocated workers (not necessarily from defense industries) with demonstration projects in Washington State and Massachusetts. Patterned on large programs in France and Great Britain, the U.S. projects provide financial assistance or income support during business startups. In Washington State, workers who decide to start their own businesses may be granted lump-sum payments equal to the total amounts remaining in their unemployment insurance (UI) accounts to help with

[76]Ellen Schechter, Director of Teacher Education, New Jersey State Department of Education, personal communication, May 22, 1991. See New Jersey State Department of Education of the Provisional Teacher Program: "A Profile of Applicants to New Jersey's Alternate Route to Certification' "Second Year Report" (1986); "Third Year Report" (1987); and "Sixth Year Report" (1991).

[77]Gene Bosch, Director, St. Louis Technology Center, personal communication June 1991.

startup expenses. In Massachusetts the prospective entrepreneurs are allowed to draw their regular UI benefits while devoting full time to starting their businesses; standard UI job-search requirements are waived. In both States the participants receive a wide range of business development services, e.g., seminars and counseling on planning, marketing, and management.

In Washington State, 451 of 754 dislocated workers who showed strong interest in starting their own businesses were selected for the demonstration project. A surprising 14 percent of the resulting new businesses were small-scale manufacturing. In Massachusetts, 62 of 105 workers were selected for the demonstration project, and of these 42 reportedly established businesses; 62 percent of the participants were from professional, managerial, and technical occupations .[78]

Small business support programs apparently do provide some job opportunities, but the smattering of evidence so far suggests that few of the engineers being laid off from defense jobs have started spinoff high technology companies. According to one St. Louis service provider, those who want to start a high technology firm do so on their own, irrespective of layoff announcements.[79] Of the 32 businesses in the St. Louis Technology Center, a thriving high-tech incubator, none was organized by laid-off McDonnell Douglas employees; only one laid-off employee had approached the director. However, most of the center's entrepreneurs had at one time been engineers or scientists for McDonnell Douglas, Monsanto Chemical, Emerson Electric, or similar companies .[80]

It is possible that not many defense engineers have the combination of technical and managerial skills and entrepreneurial drive needed to succeed in starting up a high technology business. The temperament to work successfully as a member of a large defense industry team may differ from that required to start a new small business. Those that do have the requisite interest and drive to start a business may simply leave on their own, without being laid off.

[78] Stephen A. Wandner and Jon C. Messenger, ''The SeK-Employment Experience in the United States: Demonstration projects in Washington State and Massachusetts,' paper submitted to the Organization for Economic Cooperation and Development, April 1991.

[79] Bosch, op. cit.

[80] Ibid. Catherine Renault, Director of the Entrepreneurship Center at George Mason University in suburban Washington DC, says the same holds true for her high-tech incubator: only one or two people laid off from other jobs have become involved in the 60 companies that have developed in the incubator.