

SAI 9300249

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Foreign Conversion



DO NOT DESTROY
30 DAYS LOAN
RETURN TO AFSAA/SAMI
1777 NORTH KENT STREET, 7th FLOOR
ROSSLYN, VA 22209 (703) 588-6940

An Annex to
Adjusting to the Drawdown

Report of the
Defense Conversion Commission

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SAI 9300249

Foreign Conversion

Supporting Material For
Adjusting to the Drawdown

Report of the
Defense Conversion Commission

DO NOT DESTROY
30 DAYS LOAN
RETURN TO AFSA/SAI
PENTAGON, RM 1D363

February 1993

Prepared by: Peter Almquist

This paper was prepared as input to the Defense Conversion Commission in preparation of its December 1992 Report, *Adjusting to the Drawdown*. This paper does not necessarily reflect the findings, conclusions, or recommendations of the Defense Conversion Commission, the Department of Defense, or any Federal department or agency, nor does the Commission necessarily endorse the views expressed herein.

FOREIGN CONVERSION

INTRODUCTION

The United States is neither the first nor the only country to experience reductions in its defense spending. Several western European countries have also reduced their defense spending, as have countries with planned economies such as the (former) Soviet Union and the Peoples Republic of China (PRC).

As many as 100,000 of the 1.5 million defense industrial jobs were lost in western Europe from 1987-1990, and another 350,000-500,000 could be lost by 1995.¹ Starting in the late 1970s, China undertook to shift the emphasis of its defense industry from military to civilian production. Ten years later, the Soviet Union also attempted an ambitious conversion program that was to be centrally planned, but responsibilities for conversion fell mainly on the plant managers and local governments as the country collapsed. Japan's defense production is relatively small, and benefits from being embedded in the civilian sector.

While the economic structures and degree of government intervention in the economy may vary, the experiences of these countries in minimizing the negative impacts of "downsizing" the armed forces and/or reducing procurement are useful in identifying common and particular problems as well as approaches that have succeeded and failed. It is the purpose of the paper to summarize these foreign experiences and distill lessons for the U.S. from them. It focusses on four main responses to contracting defense spending: physical conversion (that is, changing the actual output product of a plant or factory), diversification, concentration or rationalization, and exports.

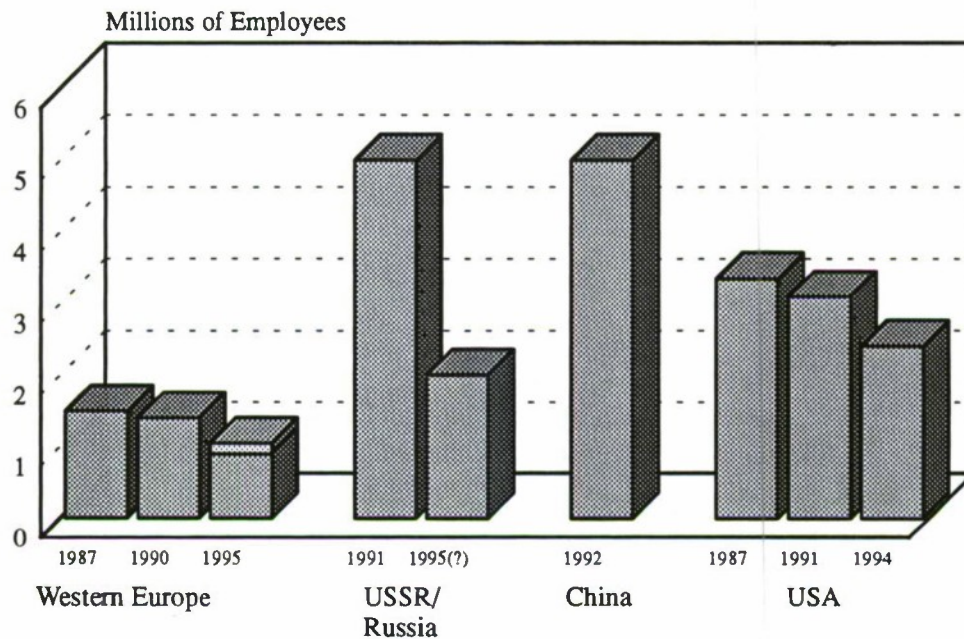
CONTRACTING DEFENSE INDUSTRY

In general, defense industries around the world are contracting, and expect to do so for the next few years. (See Figure 1.) A general trend of reductions of from 25 to 30 percent appears to be the case in Europe in general, as well specifically the United Kingdom (UK) and France. The Russian government has indicated a desire to reduce the defense industry

¹*SIPRI Yearbook 1991: World Armaments and Disarmament*, Oxford: Oxford University Press, 1991, p. 296.

to some 40 percent of its current size. Data on "layoffs" does not exist for China, and because layoffs are considered only as a last resort in Japan, there appear to be no expected losses for full-time employees there.

Figure 1.
Reductions in Defense Industry Employment
Western Europe, USSR/Russia, China, and the U.S.



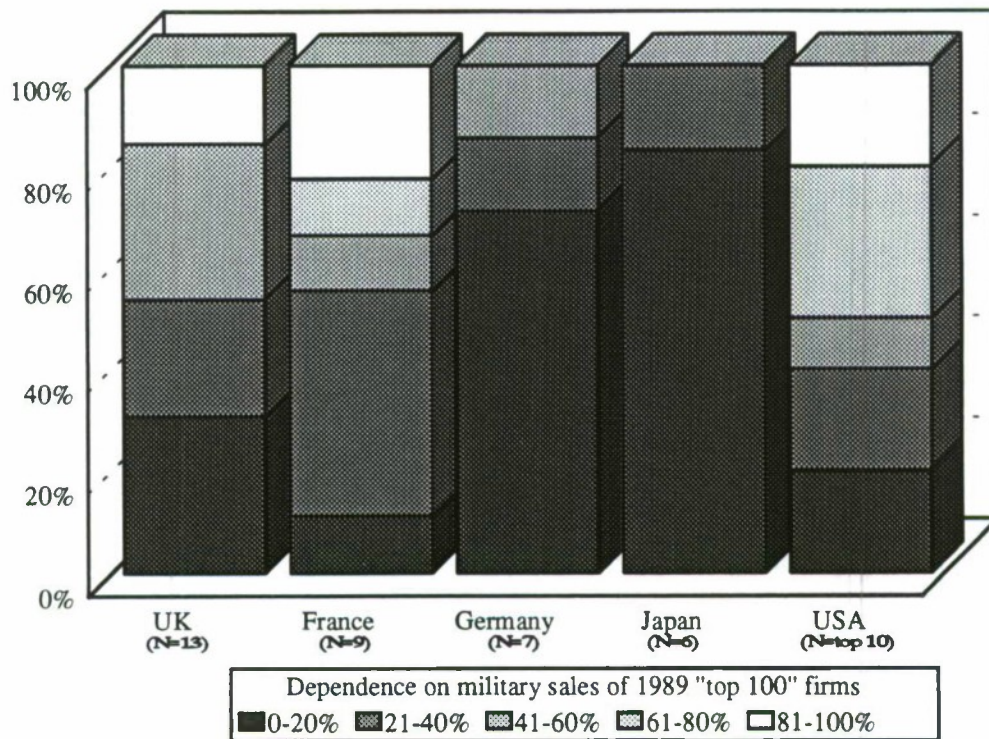
DIVERSIFICATION OF INDUSTRY

Based on a survey of the world's 100 leading defense industrial firms (ranked by military sales)², it is possible to determine, in general terms, the degree of diversification of the major defense industries in each country

²*SIPRI Yearbook 1991: World Armaments and Disarmament*, Oxford: Oxford University Press, 1991, pp. 310-316. See also the updated rankings in "Top 100 Worldwide Defense Firms," *Defense News*, July 10-26, 1992, p. 16.

(see Figure 2). This data shows that the leading defense firms of the U.S., France, and the UK are the least diversified, while those in Japan and Germany are the most. In other words, the firms receiving most of the military contract work in the U.S., France, and the UK tend to produce mainly for the military market, while those companies in Germany and Japan with the largest contracts for military production tend to have the majority of their business in the civilian market. (There are, of course, significant exceptions in most of these countries.)

Figure 2.
Defense Industry Diversification
UK, France, Germany, Japan, U.S.



GOVERNMENT OWNERSHIP

A final potentially significant difference between the six countries examined is the degree of government ownership of the defense industries. Specifically, there is little or no public ownership of the defense industries in the UK or Japan, some state ownership in Germany (as will be

discussed in greater detail below), and complete state ownership in Russia and the PRC. In France, about 80 percent of the defense industry is owned by the state.

THE UNITED KINGDOM

The defense industry of the United Kingdom is the second largest of the market economies. Defense accounts for 11 percent of British manufacturing and three to six percent of the manufacturing exports.³ Fourteen of the "top 100" arms producers are based there.⁴ Defense spending in the UK provided an estimated 310,000 industrial jobs and another 255,000 indirect jobs in the early 1990s.⁵

However, the defense sector has been contracting since the mid-1980s, losing an estimated 100,000 jobs over the last five years, with losses expected to continue.⁶ For example, total employment in the British aerospace industry is expected to fall from 194,000 in 1989 to about 150,000 by end of 1992.⁷

The contraction in the defense sector was accompanied by the withdrawal of the British government from direct participation in the

³"Tough Battle for UK Defense Companies," *Defense Week*, September 8, 1992, p. 15.

⁴According to *SIPRI Yearbook 1991*, in 1989 these were: British Aerospace (42%), GEC (20%), Lucas Industries (45%), Rolls Royce (25%), VSEL Consortium (99%), Hunting Associated Industries (53%), Smiths Industries (51%), Thorn EMI (9%), Racal (15%), Ferranti-International Signal (36%), Devonport Management (98%), Dowty Group (33%), Siemens Plessey Electronic Systems (na), and Hawker Siddeley (10%). Listed in order of military sales. Percentages in parentheses indicate proportion of arms sales to total sales.

⁵Susan Willett, "Conversion Policy in the UK," *Cambridge Journal of Economics*, vol. 14, no. 4, December, 1990, p. 470. Lovering gives total industrial employment generated by defense spending as 966,000 in 1963; 713,000 in 1978; 740,000 in 1980; 565,000 in 1986, and an estimated 620,000 in 1987. See John Lovering, "Military Expenditure and the Restructuring of Capitalism: The Military Industry in Britain," *Cambridge Journal of Economics*, vol. 14, no. 4, December, 1990, p. 457.

⁶Francis Tusa, "France's Go-It-Alone Policy Undergoing Radical Change" Tusa, *Armed Forces Journal International*, June, 1992, pp. 21-22.

⁷*Financial Times*, September 2, 1992, Aerospace Survey, p. 1.

defense industry during the 1980s: British Aerospace and Rolls Royce were denationalized, while Royal Ordnance, Shorts Brothers Aircraft, several shipbuilding yards, and government-held shares in Ferranti and Fairey Engineering were sold.⁸ In addition, the free-market stance of the British government under Prime Ministers Margaret Thatcher and John Major has limited any government support for conversion or diversification efforts.

The withdrawal of the state was followed by a concentration and streamlining by the British defense industry. Several firms attempted to ensure their position by seeking monopoly status in particular niches or specialties.⁹ In part as a result, many British firms are heavily dependent on defense contracts. For example, 25 percent of Rolls Royce sales are for military use, 42 percent of British Aerospace (BAe), 51 percent of Smiths Industries, 98 percent of Devonport Management, and 99 percent of VSEL Consortium.¹⁰

HISTORICAL AND CONTEMPORARY EXPERIENCE

British experience grappling with "conversion" (in many forms) over the years has been, at best, mixed.

PHYSICAL CONVERSION

Conversion at the plant level has been explored at various times in Britain, principally due to active interest by labor unions and the peace movement. The best-known example is the case of Lucas Aerospace in the early 1970s. In the Lucas case, an alternative "corporate plan" was developed mainly by the Combined Shop Stewards Committee. The plan, which identified non-military products that might be developed by Lucas facilities, was rejected by the company's management, in part because of

⁸See Lovering, p. 460.

⁹Willett, "Conversion Policy in the UK," pp. 473-474. Various specialties include BAe combat aircraft and missiles (BAe); helicopters (Westlands); radar and torpedoes (GEC-Marconi); nuclear submarines (Vickers Shipbuilding and Engineering); frigates (Yarrow Warshipyard); tanks (Vickers (Leeds)); small arms, ammunition, and explosives (Royal Ordnance).

¹⁰Figures are for 1989. See *SIPRI Yearbook, 1991*, p. 286.

disagreement with the marketability of many of the products and in part because of concern over the precedent of increased worker participation in a management task.

Other attempts at conversion similar to the Lucas Plan were attempted elsewhere in the UK. Such programs or proposals have generally been based on identifying alternative and, preferably, "socially useful" products for the plant or facility that could be produced with existing skills and equipment, rather than focussing on market demand. In addition, as one analyst observed of such an effort at the Vickers facility in Barrow, "many of the [proposed] products required a guarantee of public procurement"¹¹ at a time when such guarantees were unlikely.

In general, the physical conversion efforts have often been late attempts to protect jobs, rather than long-term programs of conversion. Local governments have often become involved, specifically because of the emphasis on job-protection. But studies of British conversion have been unable to identify any significant successes for such conversion efforts.

DIVERSIFICATION

Several companies have attempted various forms of diversification in an effort to weather reductions in defense spending.¹²

INTO CIVILIAN MARKETS

Rather than attempting to convert their existing facilities, many British companies have attempted to "manage" their way into the civilian market. They have in general had limited success. British Aerospace (BAe) created a small division, Spectrum Technologies, to adapt missile-related technology for the civilian sector. GEC has tried to use its Marconi Electronics Devices Company to develop civilian applications for military technology, but the effort has not been successful.¹³

Lucas Aerospace provides one of the few successes as a result of its acquisition of Tracor Aviation in 1991. The California-based company is

¹¹Willett, p. 49.

¹²This paragraph is drawn from Willett, ILO, pp. 33-34.

¹³Lovering.

reportedly "thriving as airlines seek to refurbish older aircraft rather than buy new ones."¹⁴ In another example, Racal was able to enter the civilian mobile telephone market successfully, based on its extensive background in military electronics.¹⁵

Diversification might also consist of finding a civilian market for a previously military product, although in general this, too, has proven difficult. The only successful example identified in a 1991 British Parliament study was the sale of thermal imagers, developed for use in battlefield smoke, to fire departments.¹⁶

Another recent British study of the country's defense industries identified five major (and familiar) impediments to companies seeking to diversify into the civilian sector: scarce financial resources, lack of marketing skills, incompatible management skills, corporate culture, and the short-term pressure of the stock market. The study also noted that most companies are spending little on R&D, and most of that is on enhancing customer products, not new technology.¹⁷

Diversification into the civilian sector has received little, if any, support from the British Conservative government, which is committed to free-market principles. However, the opposition Labour Party (with the support of some local city governments) has promised, if elected, to create a National Diversification Unit within the Ministry of Defense.¹⁸

¹⁴*Aviation Week and Space Technology*, September 7, 1992, pp. 54+.

¹⁵Racal's main work is in electronics. In 1989, it had total sales of \$3.2 billion, 15 percent of which were military.

¹⁶Jane Bird, "UK Cold Warriors: Out in Cold?", *Science*, July 5, 1991, pp. 26-27.

¹⁷"Tough Battle for UK Defense Companies," *Defense Week*, September 8, 1992, p. 15.

¹⁸Willett, CJE, p. 474, 476.

INTO DEFENSE MARKETS

Several companies have attempted to diversify into other defense markets. GEC, for example, has tried to expand into other areas of defense, both on its own and in cooperation with the German industrial giant Siemens. Dowty has attempted to move into the aerospace and electronics industries, as well as expanding its defense work in cooperative efforts with one of its rivals (Smiths Industries) and with foreign firms. BAe has also pursued cooperative ventures and is increasing its emphasis on R&D over production. Plessey is stressing exports and has acquired key foreign firms in the defense electronics area.

Such efforts depend on the company's ability to identify areas of likely growth in the defense sector in which it can compete.

CONCENTRATION/RATIONALIZATION

Rather than running the risks of diversification or physical conversion, many British firms heavily dependent on defense contracts have attempted to *increase* their emphasis on defense, striving to attain a monopoly position in a particular technology or to establish cooperative efforts with other British or, more often, foreign defense firms. At times, this has also meant "rationalization," that is, reducing excess capacity through various types of cooperation and consolidation. As one analyst noted, "the aspiring world-players are shedding non-defense work from their defense divisions, and concentrating more narrowly on military niches."¹⁹

A good example of this sort of concentration is the experience of BAe, which attempted to diversify into (among other things) automobiles and property development, but found these markets also weakened by the recession in Britain. As a result, BAe is "refocusing its activities on its core aerospace and defense business." It is also seeking a buyer for its corporate jet business and has decided not to develop new commercial aircraft on its own.²⁰ BAe recently reported that the losses in its commercial sector offset the profits of its military business, and that it was undertaking further restructuring that would mean the closure of one

¹⁹Lovering, p. 459.

²⁰See *Financial Times*, September 2, 1992, Aerospace Survey, p. 1; and *Aviation Week and Space Technology*, September 7, 1992, pp. 54+.

factory and 3000 layoffs (bringing the 1992 BAe layoff total to 7500). In addition, BAe would pursue a proposed joint venture with Taiwan to produce commercial regional aircraft.²¹

It should also be noted that a small number of companies have also attempted to *leave* the defense market by selling their defense subsidiaries. Racal and Thorn EMI have, however, been unable to find buyers for their military products divisions.²² Such an approach would be much more difficult for firms more heavily decedent on defense contracts: defense business accounts for less than 15 percent of Racal's and Thorn EMI's total sales.²³

EXPORTS

The British defense industry has become increasingly dependent on exports as a source of revenue: in 1963, exports accounted for about 9 percent of the defense industry's revenues. By 1980, it was 22 percent, and in 1987 24 percent.²⁴

British industry has fared relatively well in the export market, with its total exports generally growing over the last several years. This is mainly because of long-standing British relations with stable clients in the Middle East. Whether the country's producers will be able to increase their sales or expand their markets at a time when competition will certainly be increasing is uncertain. Even if they are able to do so, it is unlikely to be sufficient to offset the reductions anticipated in defense acquisition.

TECHNOLOGY TRANSFER

There have been two notable attempts in the UK to exploit military research and development in the civilian sector. The first was the creation of Defence Technology Enterprises (DTE) by a group of British venture

²¹*Financial Times*, September 24, 1992, p. 1.

²²Willett, p. 474; Lovering, p. 460-461.

²³*SIPRI Yearbook*.

²⁴Lovering, p. 459.

capitalists in 1985.²⁵ DTE's objective was to identify and license commercially viable projects of the defense research laboratories. Examples included using explosives developed for destroying bridges to decommission oil rigs and using active sonar to create "fences" for fish farms at sea. DTE closed, however, after the resignation of its managing director in December 1991. Although he estimated that more than \$119 million in sales and \$12.7 million in royalties could have been generated by the late 1990s, his investors sought a more rapid return on their money.

A second effort to build on the capabilities of military research has been undertaken more recently by the British government. In 1991, it announced the merging of the four main non-nuclear research establishments into the "Defense Research Agency (DRA)," with a mission of providing cost-effective science and technology advice to the government and civil customers.²⁶ While it is too early to gauge the success of the DRA, a study prepared for Parliament suggested that it would be impossible to serve both the Ministry of Defense (MoD) and commerce, while the government's science and technology advisory panel suggested converting the research establishments into National Technology Centers. At the same time, some critics are concerned that the creation of a DRA is likely to limit so-called "blue-sky" research, as projects are increasingly determined by the likelihood of their having an exploitable outcome.²⁷

LESSONS FOR THE U.S.

British experience reinforces the widely-held view that conversion as a means of maintaining a combination of skills and capital at the plant level is very difficult. Efforts to do so have generally foundered on the problem of identifying and entering a market. "Socially-useful products" or products determined by existing capabilities are only able to sustain a firm if a market exists and if the new products are competitive.

²⁵The discussion of DTE is based on Jane Bird, "British Ferrets Go Hungry," *Science*, July 5, 1991, p. 27.

²⁶See Jane Bird, "British Ferrets Go Hungry," *Science*, July 5, 1991, p. 27.

²⁷Lovering, p. 462.

At the same time, entry by defense firms into new civilian markets has proven very difficult, in part because some civilian markets are also contracting (such as that for large ships) and in part because of the culture that tends to dominate defense production. This culture, in Britain and elsewhere, tends to emphasize products that are capital intensive, costly, and complex.²⁸

British experience also suggests that many defense firms tend to "hunker down," focussing on and even expanding their defense work, rather than trying to leave the defense market or shift to other (commercial) markets. This is likely to be contingent on a firm's degree of dependence on defense contracting.

In addition, the British experience with technology transfer efforts highlights one limit of venture capital: the desire for relatively quick returns. Even when transferable technology exists and is identified, its commercial application may require several years of further development.

²⁸See also Willett, p. 476.

FRANCE

More than most European countries, France has consistently attempted to maintain a broad defense industrial capability. As a result of the French government's efforts to maintain its "independence," the French defense industry is perhaps the broadest in Europe and most capable of independently developing advanced weapons systems. However, the French defense industry, like that of the U.S., UK or Germany, has encountered decreasing demand at home. And perhaps more significantly, France has also suffered from a deep decline in its military exports.

The French defense industry has suffered the same sort of reductions that have affected other countries. The French defense industry directly employs an estimated 200,000 people, down from a 1989 level of about 261,000 people; when indirect employment is included, the total is more than 400,000.²⁹ Since that time, however, employment in the defense industry has been dropping. The aerospace industry, which currently employs 102,000 workers, is expecting layoffs of 32,000 over the next two years. Employment in aerospace, defense, and aviation-related electronics companies in general is expected to fall by 45,000 - 100,000 workers.³⁰ The president of the French Defense Industries Council estimates that by 1994 30,000 to 45,000 direct jobs will be lost in the aerospace industry (from a 1991 total of 118,700), and 15,000 in both the electronics industry (from 50,700), and the ground forces materiel industry (from 50,000).³¹

These reductions are taking place even though the French state controls (through full or significant ownership) almost 80 percent of the French defense industry.³² For example, the government holds 97.11 percent of the shares of SNECMA, the leading French aircraft engine firm; 59 percent

²⁹ See "Case for Fortress Europe," *Jane's Defence Weekly*, September 26, 1992, pp. 27-28 and Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 18.

³⁰ Pierre Sparaco, "French Aerospace Industry to Slash 32,000 Jobs," *Aviation Week & Space Technology*, August 24, 1992, pp. 20-21.

³¹ See "Case for Fortress Europe," *Jane's Defence Weekly*, September 26, 1992, pp. 27-28.

³² Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, pp. 6-7.

of the defense-electronics firm Thomson-CSF; and 49 percent of Dassault Aviation, producer of Mirage and Jaguar aircraft.³³ In addition, the government controls most of GIAT Industries, formerly the army arsenal and now Europe's largest military land-systems company³⁴, and the shipyards of the Directorate of Naval Construction (DCN), responsible for all France's naval ship production.³⁵

Procurement is the responsibility of a centralized procurement agency, the General Delegation for Armaments (DGA). The DGA manages R&D and acquisition for both the French armed forces and for export purposes, as well as certifying performance and cost standards. In addition, it also plays a major role in shaping the French defense industry. The DGA supervises government arsenals, guides government participation in industry, strives to ensure the industry's health, and works to adapt the defense industry to France's overall industrial needs.³⁶ Because defense industrial policy and procurement are so closely tied, the DGA is often willing to spend more in acquisition to accomplish a broader *industrial* objective.

HISTORICAL AND CONTEMPORARY EXPERIENCES

The French are dealing with the contraction of their defense industry in many of the same ways that other countries and companies are dealing with: diversification, concentration, cooperative ventures, and an emphasis on exports. And while in general their experiences mirror that of other countries, some French experience is particularly interesting.³⁷

³³Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 8.

³⁴ Francis Tusa, "France's Go-It-Alone Policy Undergoing Radical Change." *Armed Forces Journal International*, June, 1992, pp. 21-22.

³⁵Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 20.

³⁶Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, pp. 11-12.

³⁷While the French government has not developed a "conversion plan" per se, a "Restructuring Committee" within the MoD was established in mid-1991.

DIVERSIFICATION

The DGA has encouraged firms to diversify into non-military efforts while shedding their marginal military work. While this has proven difficult for some companies, others have been relatively successful. Matra, for example, was totally dependent on defense contracts in the 1960s, but by 1979 had equal shares of sales to civilian and defense customers. In 1989, Matra's defense sales were just 24 percent of its total business, and its civilian ventures included subway cars and a van marketed by Renault. Other firms that have also been successful in their efforts to enter the civilian market include Aerospatiale, SNECMA, Dassault.³⁸

A valuable study of the French defense industry by the U.S. Office of Technology Assessment (OTA), *Lessons in Restructuring Defense Industry: The French Experience*, does not explicitly address the question of why these firms were successful in their diversification efforts. The study does suggest, however, that one reason may be that regulation of industry by the French MoD is minimal; there are few special management or administrative requirements placed on defense contractors for reasons other than security. As a result, the well-known peculiarities of defense acquisition are somewhat ameliorated in the French case.

DGA also apparently shapes its acquisition policies with the firm's diversification in mind. That is, DGA may well be willing to act as a *de facto* "deep pocket" upon which a firm can draw through its defense sales (both domestic and foreign) to subsidize its expansion into the civilian sector. At the same time, the French government can act to support, through government procurement, the civilian production of a diversifying firm. In other words, DGA is able to support a broad industrial policy through its impact on defense acquisition, while government acquisition in general can provide a market for new civilian output.

CONCENTRATION/RATIONALIZATION

The French defense industry, like that of other European countries, has been "rationalizing" over the last several years, that is, collapsing from many competing companies into fewer and fewer large companies. For

³⁸Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 21.

example, while there were 14 major aerospace companies in 1966, there were only six by 1990.³⁹

DGA's role in rationalization has been to encourage firms to identify their "core competencies," and to focus on those. As a result, these firms become "national champions," that is, virtual monopolies in specific defense production areas. Larger firms can turn over less-essential work to subcontractors.⁴⁰

In addition, some firms have been shedding their non-defense components. Thomson-CSF, one of the largest French firms, has sold off some of its civilian enterprises as it pursues acquisition of foreign defense firms.⁴¹

While French tradition has been one of independence in weapons development, DGA has increasingly encouraged French contractors to cooperate, both internally and with foreign firms, as a way to reduce duplication and excess capacity. Thomson-CSF, for example, agreed in 1991 to transfer production of its VT1 missile to the Euromissile consortium, made up of its competitor Aerospatiale and Deutsche Aerospace. The goal was to integrate the missile into both Thomson's

³⁹Kelly Campbell. "Current State of Defence Cooperation and the United States' Role," in Jane Davis Drown, Clifford Drown, and Kelly Campbell, eds., *A Single European Arms Industry?* London: Brassey's (UK), 1990, p. 49.

⁴⁰Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 21, and Kelly Campbell. "Current State of Defence Cooperation and the United States' Role," in Jane Davis Drown, Clifford Drown, and Kelly Campbell, eds., *A Single European Arms Industry?* London: Brassey's (UK), 1990, p. 49-52.

⁴¹Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 27. The best-known example is Thomson's unsuccessful effort to acquire the missile division of LTV.

Crotal and Euromissile's Roland anti-aircraft systems, saving development money for Euromissile and expanding the market for Thomson.⁴²

According to the Office of Technology Assessment (OTA), Aerospatiale collaborates with foreign firms on two-thirds of its products, including 97 percent of its aircraft and 62 percent of its tactical missiles. Thomson and Britain's GEC-Marconi are cooperating on the development of radars for fighter aircraft through a jointly owned company, GTAR.⁴³

The French are currently working most closely with German companies.⁴⁴ For example, Eurocopter was formed by Aerospatiale and Germany's MBB, while the latter's missile division also worked with Matra and Aerospatiale on different missile systems.⁴⁵

EXPORTS

Over the years, the French system became increasingly dependent on arms exports, and France is often ranked third among countries in foreign military sales.⁴⁶ Arms sales accounted for 18 percent of defense production in 1970, 42 percent in 1985, and 33 percent in 1988. Nine out of ten Aerospatiale helicopters were sold abroad, as were 60 percent of the Dassault combat aircraft.⁴⁷ Such sales provided important revenues to the

⁴²Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, pp. 26-27.

⁴³Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 29.

⁴⁴Francis Tusa, "France's Go-It-Alone Policy Undergoing Radical Change," *Armed Forces Journal International*, June, 1992, pp. 21-22.

⁴⁵Francis Tusa, "France's Go-It-Alone Policy Undergoing Radical Change," *Armed Forces Journal International*, June, 1992, pp. 21-22.

⁴⁶In sales to the Third World, the UK overtook France in arms sales agreements in 1991. See Richard F. Grimmett, *Conventional Arms Transfers to the Third World, 1984-1991*, Washington, DC: Congressional Research Service, 1992, p. 50.

⁴⁷Although Dassault "has not clinched an export deal for combat aircraft since 1988, and that deal -- with Jordan -- has since been

companies, and, because exports help keep costs down, it is not surprising that a weapon's potential for export plays a significant role in DGA acquisition decisions.⁴⁸

With the contraction of the export market, however, the French arms industry has been hit especially hard. Not only have total sales been declining, but the percent of these sales accomplished through exports has declined as well. For example, 64 percent of the French aerospace industry's sales were from exports in 1983, but only 54 percent in 1991.⁴⁹ The value of French export agreements to the Third World fell to \$400 million in 1991, after having been between about \$1.5 billion and \$4 billion per year from 1985 to 1990.⁵⁰

EMPHASIS ON R&D

One other approach the French are taking to dealing with reduced defense demand is an emphasis on research and development over production. The DGA has chosen to retain French competitiveness in defense industry by investing in R&D at the expense of production. Dassault, for example, intends to retain a "big brain and a small body," concentrating on aircraft design, software, aerodynamic analysis, project management, and assembly, with less manufacturing.⁵¹

In general, firms are increasing the proportion of engineers and reducing the number of production workers. While the number of Dassault

suspended." *Financial Times*, September 2, 1992, Aerospace Supplement, p. 6.

⁴⁸Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 8.

⁴⁹Pierre Sparaco, "French Aerospace Industry to Slash 32,000 Jobs," *Aviation Week & Space Technology*, August 24, 1992, pp. 20-21.

⁵⁰Richard F. Grimmett, *Conventional Arms Transfers to the Third World, 1984-1991*, Washington, DC: Congressional Research Service, 1992.

⁵¹Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 23.

employees fell from 15,843 in 1980 to 12,390 in 1990, the proportion of engineers increased from 26 to 38 percent and production workers decreased from 29 to 11 percent. In 1986, Thomson-CSF had 10,000 production employees and 2,000 software developers; in 1991, production employment had fallen to 5,000 and the number of software developers had increased to 7,000.⁵²

There is also increased interest in focussing on prototyping and the development of technology demonstrators, rather than striving to get a design into production.⁵³

It is too early to assess the success or failure of this approach.

DUAL-USE TECHNOLOGIES

Finally, the French are interested in the potential for dual-use technologies, that is, technologies that are cost-effective and for which there is both a civilian and military market. DGA provides financial support for research on such technologies, while at least one industrial leader, Thomson-CSF, argues that future defense requirements will be served by dual-use technologies mostly rooted in the civilian sector.⁵⁴

As noted earlier, one of the important advantages of French firms in working on dual technologies is that "the French government imposes no legal, regulatory, or accounting barriers to combining civil and military activities in the same facilities (other than security restrictions and military specifications.)"⁵⁵ As a result, there is constant cross-fertilization between the civilian and military production lines in a firm.

⁵²Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, pp. 22-23.

⁵³Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, pp. 23-24.

⁵⁴Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 25.

⁵⁵Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 25.

SNECMA, for example, is using the M88 engine developed for fighter aircraft as the basis for its new civil aero-engine. At Matra, there is considerable mobility of personnel between the company's military and civilian divisions, while Dassault's engineers use the same design software for civilian and military products.⁵⁶ And there are few, if any, regulatory or legal restrictions on such internal cooperation; the barriers that often exist between defense and civilian production within a U.S. firm are largely absent in a French firm.

LESSONS FOR THE U.S.

Despite the significant differences between the U.S. and the French defense industries in terms of ownership and procurement practices, there are several lessons for the U.S. that can be drawn from French experience.

One of the most important lessons is the danger of export-dependency. The export market is seen by many firms -- both U.S. and foreign -- as perhaps the main solution to reduced domestic demand. Unfortunately, as French experience shows, exports can become "the tail that wags the dog," that is, the export market can increasingly determine domestic acquisition. Exports also are problematic in the efforts to provide offsets: not all the economic benefits of arms sales accrue to the seller.⁵⁷ At the same time, the export market is contracting and perhaps even more volatile and competitive than the domestic market.

In other words, exports are likely to provide, at best, a stop-gap measure before greater industrial restructuring is required if domestic demand does not increase.

A second lesson for the U.S. appears to be the utility of minimizing the "legal, regulatory, or accounting barriers" that isolate defense production from civilian production. These barriers serve to reinforce the differences between defense and civilian research, design, production, and marketing,

⁵⁶Office of Technology Assessment, *Lessons in Restructuring Defense Industry: The French Experience*, Washington, DC: OTA, 1992, p. 26.

⁵⁷For example, McDonnell Douglas recently concluded a deal with Finland valued at \$2-3 billion, but which, according to *The Financial Times*, included industrial offsets for the full value of the deal. See *The Financial Times*, September 2, 1992, Aerospace Supplement, p. 6.

making it difficult for firms or divisions in one type of market to shift or expand into another.

However, such an approach would be more difficult in the U.S. than in France because of the greater emphasis here in accounting for expenditures of tax money; in France, monitoring by the government and legislature is much less rigorous than in the U.S.⁵⁸ This, in turn, may be related to the French government's partial or total ownership of many of the major defense firms and the active participation of the DGA in what would, in the United States, often be corporate decisions.

Finally, French experience drives home the difficulties of shifting from military to civilian production. Many French firms -- even those afforded considerable protection by the French government -- are concentrating on their defense production and pursuing domestic and foreign acquisition in defense, rather than attempting to move into new civilian markets. Those that have succeeded in some degree, such as Matra and SNECMA, have required years to do so and apparently moved into areas of significant government procurement of civilian products. In other words, there is some convergence in the French system: defense production is less isolated from civilian, and civilian production by defense firms is often for the government.

⁵⁸This was pointed out by an OTA specialist in a telephone discussion September 8, 1992.

GERMANY

With 265,000 employees, the German defense industry is about the same size as that of France and only about 10 percent smaller than that of the UK.⁵⁹ The German defense industry includes a number of diversified firms and holding companies, such as Siemens (the largest industrial employer in Germany), Daimler Benz (which owns 85 percent of Deutsche Aerospace [DASA]), Diehl, Krupp, and Krauss-Maffei. Like those in other European countries, the German defense industry has been trying to cope with reductions in demand. And, again like other European defense industries, it has attempted to do so through a combination of techniques.

HISTORICAL AND CONTEMPORARY EXPERIENCES

THE GERMAN SHIPYARD EXPERIENCE

The German shipbuilding industry provides several case studies indicative of a range of conversion programs and efforts, and six case studies by Werner Voss are summarized in the next few paragraphs.⁶⁰ Voss, arguing that the experience of industrial decline in the shipbuilding industry provides insights applicable for reduced defense demand, examined six cases at different shipyards: AG Weser, Bremer Vulkan, Thyssen (TNSW), HDW, Blohm und Voss, and Ross Industrie GmbH. As demand for new ship construction fell from the mid-1970s, these yards, which produced both military and civilian vessels, faced mounting difficulties; employment at these yards fell from more than 36,000 in 1975 to 15,340 in 1988.⁶¹ Their responses included efforts at physical conversion, diversification, concentration, retraining, and the obtaining of state financial assistance, and thus provide a useful comparative study.

⁵⁹Interestingly, according to OTA the German procurement budget is less than a third that of either country. See OTA, *Building Future Security: Strategies for Restructuring the Defense Technology and Industrial Base* (Washington, DC: OTA, 1992), p. 157.

⁶⁰Werner Voss, "Reduction In Armaments Production: Lessons to be Drawn from Adjustment to Structural Change in the Shipbuilding Industry in the Federal Republic of Germany," World Employment Programme Research Working Paper No. 12 (ILO, 1989).

⁶¹Voss, "Reduction In Armaments Production," p. 5.

The AG Weser yard in Bremen did not survive. It had specialized in large tanker production, and as that market collapsed, so did the yard. Its management, optimistic that the market would return, delayed restructuring efforts until it was too late, and then absorbed DM200 million in company investment and state subsidies. No efforts were made to diversify to products other than vessels because the yard's owners (Krupp) had focussed its diversification efforts at another yard and closed the AG Weser R&D department.

Krupp did not offer alternative employment to the 2300 employees and trainees who were "made redundant" by the yard's closure. Most white collar workers were able to find employment immediately, and almost 80 percent of those still in the labor force had jobs within two years. But although former yard workers had a better chance to find work than other unemployed, most of the jobs they found were inferior to those lost at the yard.⁶²

With the closure of AG Weser, the remaining yards in the area formed an association under the leadership of Bremer Vulkan AG, a producer of sophisticated vessels. Bremer Vulkan was on the brink of bankruptcy at the start of the 1980s, but was saved by subsidies from the federal government and by the acquisition of control of the yard by the Bremen state government.⁶³ This ownership gave the local government greater influence on the shipbuilding industry than subsidies alone provided.

The restructuring under Bremer Vulkan involved coordination of, and specialization by, various shipyards; reductions and modernization of capacity; and an effort to diversify. It was planned to spend DM400 million, of which about 40 percent would be government subsidy. Diversification took place only slowly, however, as funds were invested mainly in shipbuilding and because of the limited flexibility of shipyard manufacture.

⁶²Interestingly, Daimler-Benz offered to hire 1000 retrained workers, but only a few met the company's criteria.

⁶³By 1989, Bremen had sold a large part of its shares to private shareholders.

The Thyssen Nordseewerke yard (TNSW), owned by one of the largest West German corporations,⁶⁴ had decided in the early 1970s not to enter the tanker market, preferring to pursue "limited product flexibility." This led to production of specialized ships (such as frigates, submarines, and gas tankers) as well as an apparently successful effort to diversify into components for off-shore oil production soon after oil prices increased in 1973.

Thyssen AG's ownership of TSNW was both beneficial and problematic for the yard's diversification efforts. On the one hand, it was barred by company policy from diversifying into products that other Thyssen subsidiaries produced or intended to produce. On the other hand, Thyssen was able to provide more and longer-term financing than a smaller or independent yard could obtain, as well as offering alternative employment for some laid-off workers.

The HDW yard was created by merging two smaller yards in Hamburg in the early 1970s at the instigation of the federal government. At the time, it created the largest shipyard in Europe. By the late 1980s, the main shareholder was a federal-government-owned steel company, while the state government also held partial ownership.

In 1978, a restructuring effort that would have entailed significant layoffs was blocked by Hamburg's representative on the HDW board. Instead, the emphasis was to be put on diversification efforts. The plan failed, however, because it undercut the management restructuring and because of the difficulties encountered with diversification. The limited diversification successes were not sufficient to compensate for significant losses. The Hamburg yard was sold to Blohm und Voss, and HDW diversification and consolidation efforts were concentrated in the HDW yard at Kiel.

The emphasis at the Kiel yard was increasingly on submarine production, while diversification efforts included the acquisition by HDW of an existing engineering and electronics firm and the creation of another from the yard's division of ship automation and cable measuring technology. The spin-off firm was so successful that employment in the region rose rapidly, new facilities were built, and production was expanded to include marine and environmental technology and system engineering.

⁶⁴In the late 1980s, 14,000 of Thyssen's 35,000 employees were engaged in defense work.

The DM120 million investment required for this expansion came from the state of Schleswig-Holstein and, again, the federal government-owned steel company.

Blohm und Voss, like TNSW, had decided in the early 1970s not to enter the tanker market.⁶⁵ Blohm und Voss had started to diversify in the early 1970s, before the oil crisis, into off-shore technology produced first under license, and later based on its own designs. At the same time, the company intensified its ship repair and maintenance work and diversified into mechanical engineering, using funds invested from company reserves, the parent company, and government subsidies. It also placed an emphasis on having employees whose skills were broad enough that they could move between the three general areas with relative ease. In addition, the company shifted from a functional organization to one emphasizing "profit centers," in which each center was responsible for research, design, production, and marketing.

In 1986, however, the shipbuilding crisis intensified, and Blohm und Voss was faced with laying off 1500 workers in Hamburg. As a result, the local government created a program involving subsidies for the local yards, support for new technologies, promotion of creation of new firms, establishment of a diversification fund for the shipbuilding industry, and assistance and retraining for workers threatened with dismissal. The retraining program was aimed at preparing workers for new ventures resulting from diversification. Because it was funded by the government, it relieved the yard of considerable labor costs during diversification (the government financed retraining and contributed significantly to the income of the trainees).

In addition, a "Committee on Alternative Production" was established. This was done with the support of the trade unions to undercut the demand from some workers for increased military exports. The Committee initially failed to mobilize much worker support because it was seen as just another R&D unit. The proposals it eventually made in shipbuilding and mechanical engineering were rejected by management because, in part, the market was small or non-existent, the product could not be integrated into the Blohm und Voss program, management had other diversification plans, and management was concerned about expanded worker participation in company decisions.

⁶⁵This may not have been a coincidence, as Blohm und Voss is chiefly owned by Thyssen AG, also the owner of TSNW.

The final case study examined by Voss is that of Ross Industrie GmbH, taken over by Blohm und Voss in 1986. Workers made redundant or who chose to leave as a result of the take-over could take financial compensation or choose retraining. After retraining, if employment was not available at Blohm und Voss, an option would be to join an "employment company." This is a non-profit company with local government, trade-union, and management representatives on its board of directors. Such a company, Oko-tech, was formed by former Ross workers with a site provided by the government and facilities from Blohm und Voss; most workers are paid by the Federal Labor Office. Its work will be in the field of experimental and prototype production in maritime technology, environmental R&D, infrastructure issues, and consulting on employment initiatives, although it is too early to evaluate how successful it has been.

Voss concludes that only Blohm und Voss was generally successful in partial conversion from shipbuilding, and attributes this to its decision not to enter super-tanker production and its willingness to undertake restructuring relatively early. He also considers the acquisition by HDW of the Kiel electronics firm as a successful example of diversification.

PLANT-LEVEL

In the shipyard cases, plant-level conversion efforts proved very difficult. As in the UK, there have been a number of "alternative production working groups" at various plants calling for diversification of product lines to include more "socially desirable and ecologically adapted products."⁶⁶ However, the Federation of West German Shipbuilding Industry (as well as several other organizations) concluded that diversification at the plant level would have to be selective and would have only limited job effects.⁶⁷

As noted above, the search for alternative products at the Blohm und Voss yard proved of little value for several notable reasons, including a lack of worker support and the opposition of the management.

⁶⁶Burkhardt J. Huck, "The Regional and Occupational Dependence on Defence Contracting in the Greater Munich Area," in Liba Paukert and Peter Richards, *Defence Expenditure, Industrial Conversion, and Local Employment*, Geneva: International Labour Office, 1991, p. 70.

⁶⁷Voss, *Reduction in Armaments Production*, p. 7.

DIVERSIFICATION

INTO CIVILIAN MARKETS

Diversification proved very difficult for many of the shipyards. The Bremer Vulkan yards were apparently pushed towards greater diversification mainly due to investment by the state government, while TNSW's parent company both hampered and promoted diversification efforts. HDW was forced by Hamburg's partial control to pursue diversification, but the effort failed because of the inherent difficulties of diversification and the weakening of the management's restructuring plan.

Only Blohm und Voss was successful, due to early management decisions to enter the off-shore drilling equipment and repair markets, first through licensing, then through its own products. By the end of the 1980s, Blohm und Voss was pursuing three broad categories of production: energy and environmental technology, production technology, and shipbuilding.

INTO DEFENSE MARKETS

German defense firms, perhaps more than any other, have also diversified into other major defense firms through a variety of holding companies. For example, before it was absorbed into Deutsche Aerospace (DASA), the aircraft firm MBB acquired a major stake in Kraus-Maffei, the armor manufacturer.⁶⁸

And German companies have been very active in international mergers and cooperative efforts in the defense field. For example, in 1990, MBB formed Eurodrone with Matra, Eurocopter with Aerospatiale, and DEFTEC with Spain's Santa Barbara company, while BMW and Rolls Royce are also cooperating.⁶⁹

⁶⁸See the discussion in Burkhardt J. Huck, "The Regional and Occupational Dependence on Defence Contracting in the Greater Munich Area," in Liba Paukert and Peter Richards, *Defence Expenditure, Industrial Conversion, and Local Employment*, Geneva: International Labour Office, 1991, pp. 64-65.

⁶⁹*SIPRI Yearbook 1991*, p. 290.

CONCENTRATION/RATIONALIZATION

The German defense industry has undergone considerable concentration or rationalization over the last several years in an effort to retain its competitiveness by eliminating over-capacity. This is especially apparent in the aerospace industry, where the federal government asked Daimler-Benz to lead the creation of Deutsche Aerospace AG (DASA) through the consolidation of Dornier, MBB, MTU, and Telefunken Systemtechnik. In a reorganization that was completed in 1992, a new parent company was formed in which 85 percent of the shares are held by Daimler-Benz, eight percent by the state of Bavaria, and six percent by the city of Hamburg.⁷⁰

ROLE OF EXPORTS

Exports have had an interesting impact on the German defense industry, serving as a double-edged sword. Germany was limited in its arms exports by legislation, and, in fact, the West German government indicated that it believed these limits encouraged companies to diversify. When the ship market collapsed, however, the laws were relaxed to allow the export of naval vessels. In addition, German participation in cooperative and joint programs allows its companies to reap some benefits of exports without actually being the exporter.

OTHER EFFORTS

One other interesting case study is the experience of Krauss Maffei in the mid-1980s. The company, 25 percent owned by the state of Bavaria, suffered a 36 percent decline in sales from 1985 to 1987, although declines in military sales reached 47 percent. Through what one author calls "remarkable" steps, the company was able to mitigate the impact on its workforce, reducing it by only seven percent. The company developed an early retirement scheme and focused on eliminating office and other service workers in the belief that these were the most versatile and could

⁷⁰*Aerospace Daily*, August 21, 1992, p. 303. DASA is also looking for civilian ventures, and is working in areas such as airport guidance systems, traffic management technology, "black boxes" for cars, photovoltaic systems and other electricity generation systems, and civilian aircraft technology. See *R&D Magazine*, May, 1992, p. 42.

be most easily replaced when business picks up. There were also reductions in quality control units, but there was an effort to find alternative work for production employees, and many of those in units with insufficient sales were transferred to other units. Those for whom work could not be found were paid a lump-sum redundancy compensation.⁷¹

GOVERNMENT PARTICIPATION

A distinguishing feature of German experience is the degree of local and national government involvement in shaping adjustments to declining defense orders. Several examples have already been noted in the case studies of shipyards and the ownership of Krauss Maffei. The government has also sought specific activities by private firms in helping the defense sector. For example, in the late 1980s Daimler-Benz was asked by the federal government to oversee the creation of Deutsche Aerospace (DASA), consolidating the aerospace and defense firms MBB, Dornier, MTU, and Telefunken Systemtechnik. The rationalization effort was intended to make the industry more competitive within Europe and internationally and to make the aerospace industry independent from government financing and intervention.⁷²

Such local partial control or ownership has not been uncommon at times of crisis or difficulty. Bavaria acquired its 25 percent of Krauss Maffei in 1986, when the company was experiencing the deep reductions noted earlier.⁷³ And the state government of Bremen first subsidized and

⁷¹ Burkhardt J. Huck, "The Regional and Occupational Dependence on Defence Contracting in the Greater Munich Area," in Liba Paukert and Peter Richards, *Defence Expenditure, Industrial Conversion, and Local Employment*, Geneva: International Labour Office, 1991, pp. 65-66.

⁷² Burkhardt J. Huck, "The Regional and Occupational Dependence on Defence Contracting in the Greater Munich Area," in Liba Paukert and Peter Richards, *Defence Expenditure, Industrial Conversion, and Local Employment*, Geneva: International Labour Office, 1991, p. 61; *Aerospace Daily*, August 21, 1992, p. 303; *R&D Magazine*, May, 1992, p. 42.

⁷³ From early 1990, the company has been owned by two other defense firms, Diehl and Mannesmann. See Burkhardt J. Huck, "The Regional and Occupational Dependence on Defence Contracting in the Greater Munich Area," in Liba Paukert and Peter Richards, *Defence Expenditure*,

then bought shares of several shipyards in its efforts to reduce the impact of the collapsing shipbuilding industry of the late 1970s and 1980s.⁷⁴

LESSONS FOR THE U.S.

German experience with shipyard diversification and defense industry in general suggest a number of lessons for the U.S.⁷⁵

First, conversion efforts should focus on regional problems and strengthen the regional economy, not focus exclusively on the defense firms located there.

Second, diversification into high technology markets and competition with existing producers requires extensive research and marketing preparation. "Alternative product" efforts based more on existing capabilities than on new or existing commercial demand are seldom successful.

Third, the more improbable a reversal in military demand, the more likely management will seek alternative products. The opportunity to export military equipment creates special problems and jeopardizes the conversion process. Industries need to recognize that there will not be a swing back to defense spending. The awareness of permanently changed demand conditions stimulate defense company managers to adopt more flexible attitudes and to take greater risks.

Fourth, state ownership may provide a temporary bridge, but it is not a solution to the conversion problems.

Finally, skilled workers expand their qualifications with diversification

Industrial Conversion, and Local Employment, Geneva: International Labour Office, 1991, p. 65.

⁷⁴Voss, *Reduction in Armaments Production*, p. 10.

⁷⁵Some of these conclusions are drawn from Voss.

[REDACTED]

THE FORMER SOVIET UNION AND RUSSIA

In the past, it was suggested that the most capitalist sector of the Soviet economy and the most communist sector of the U.S. were their defense industries. While there are significant political and economic differences between the two countries, their conversion experiences and concerns have been remarkably similar.

The Soviet defense industry employed one in four industrial workers, and approximately 60 percent of its output went to the military.⁷⁶ The industry probably included 1500-2000 major factories and design organizations, with 70-80 percent of these located in Russia, 15 percent in Ukraine, and 2-3 percent in Belarus and Kazakhstan. The major factories tended to be enormous by western standards: the tank plant in Nizhniy Tagil had 40,000 workers, the missile-building plant in Dnepropetrovsk had 50,000, and an aeroengine association (similar to a western corporation) in Perm had 70,000.⁷⁷

But beginning in 1989, demand was shifted in the defense industry from defense production to civilian production. The defense industry was already producing a wide range of civilian products, from commercial aircraft to most of the country's refrigerators, washing machines, and consumer electronics.⁷⁸ The objective of the 1989 policy decision was to reverse the 60-40 military to civilian ratio. Originally, this was to be done through a centrally directed plan, but as the Soviet state began to come apart, increased responsibilities fell to (and were demanded by) the republics, local governments, and the firms themselves.

At the same time, prices for weapons were skyrocketing and procurement allocations were falling: allocations were cut 25 percent in 1991 and a reported 65.2 percent in 1992, while prices for weapons systems have been doubling, trebling, and more. This combination of reduced allocations and increased costs led to reported cuts in production

⁷⁶See Julian Cooper, "Defence Industry Conversion in the East: The Relevance of Western Experience," NATO, April, 1992.

⁷⁷See Cooper, p. 7.

⁷⁸Cooper, *The Soviet Defence Industry: Conversion and Reform*, p. 38-39.

of from 40 percent for "strategic missiles" to 80 percent for infantry combat vehicles (ICVs) by late 1991.⁷⁹

It is not surprising that one in five Russian defense plants are bankrupt and another 43 percent are on its verge.⁸⁰

HISTORICAL AND CONTEMPORARY EXPERIENCES

PHYSICAL CONVERSION

Soviet (and now successor) military factories have been hard-hit by the cuts in allocations due to the cuts' depth and abruptness. And as a result, many are scrambling to identify products that can be built with their existing personnel and hardware. In a country where prices have been artificially set for decades, this situation has led to a number of peculiar anomalies, such as the use of composite materials developed for the military to make commercial wheel-barrows. And the result is a wide range of attempts at physical conversion. Many of these are desperate efforts, undertaken when there is no other choice. The efforts are marred by a wide range of problems, from the collapse of the supply system, high inflation, and inexperience with operating in a market system.

The gap between marketing and production has led to considerable inefficiency. The highly skilled engineers and production personnel who formerly produced the SS-20 missile were "converted" to producing baby-carriages, for which there is substantial demand. The shift from an emphasis on quality to emphasis on cost has also proven difficult for engineers and designers, as indicated by the over-engineering evident in a washing machine with two dozen cycles and a price-tag ten times that of the most expensive alternative.

Physical conversion in the former Soviet Union would have been possible under the conditions of a centralized plan, with resources, funding, and prices controlled by the state. But with the introduction of a new market, it has proven extremely difficult at the same time it is necessary. There have been, however, a few successful (and not surprising)

⁷⁹See *Ekonomika i Zhizn'*, no. 34, August, 1991, p. 2-3; *BBC Summary of World Broadcasts*, October 14, 1991, p. A1/1; and *Ekonomika i zhizn'*, no. 52, December, 1991, p. 9.

⁸⁰*Krasnaya zvezda*, March 27, 1992.

exceptions. Some shipyards, for example, have been able to find customers for civilian ships, ranging from floating hotels (built in Russia or Ukraine, but often outfitted by another country). Some of the aircraft factories and design organizations have increased their emphasis on civilian aircraft.⁸¹ And the Yuzhnoye missile plant *may* be successful in its efforts to design and produce new trolleybuses for Ukraine, but (western) experience suggests that there will be a significant period of trial and error.

And there are many cases of skilled workers in relatively high-technology firms shifting production to low-technology products to keep working and because there is a demand for such relatively simple products. While this approach draws on the capital (both human and otherwise) of the original organization, it tends to be extremely inefficient.

DIVERSIFICATION

The initial motive for the Soviet conversion program was to help salvage the moribund civilian economy by utilizing the capabilities of the defense sector. First, Gorbachev transferred leading defense industry officials to the civilian sector. He then established civilian analogs to the coordinating and quality control organizations that oversaw military production (perhaps similar to proposals to create a "civilian Defense Advanced Research Projects Agency (DARPA)").⁸² When these efforts proved insufficient, Gorbachev transferred more than 200 civilian plants and facilities to the defense industries.⁸³

Such large-scale and involuntary diversification collapsed with the centralized ministry structure, and the lack of capital has probably hampered much other such diversification. Companies are diversifying,

⁸¹One of the most successful has been the Sukhoi Design Bureau's Su-26 aerobatic airplane, currently being exported to the west.

⁸²For example, the Council of Ministers Machine Building Bureau was supposed to coordinate civilian industry, just as the Military Industrial Commission (VPK) coordinates the defense sector. The State Acceptance Service was clearly patterned after the military's voyenpred system of independent quality control.

⁸³For example, several factories from the dairy industry were placed under the authority of the Ministry of Medium Machine Building, mainly responsible for production of nuclear weapons.

but it is a haphazard effort to move into markets that are unclear, poorly understood, or determined by non-market factors (such as local politics).

Diversification in the former Soviet Union offers few of the advantages of diversification in an established market economy. The existing commercial producers in the country generally had a poor reputation for quality, the supply and marketing networks of *all* industry, not just defense, have been shattered, and the marginal difference between marketing weapons to the state and civilian products to the state was probably so little that the corporate "culture" of the civil producers is unlikely to be significantly different from those producing for the military. The only significant advantage in diversification through acquisition is obtaining expertise in a particular technical area, requiring acknowledgment that the firm's existing core (that the management would like to preserve) is inadequate--hardly a desirable message to send.

Where the firms of the former Soviet Union have an advantage is in the extent of unmet demand. A U.S. company seeking to diversify is likely to find a number of existing firms already operating in a market; a company in the former Soviet Union is more likely to encounter significant unsatisfied demand.

CONCENTRATION/RATIONALIZATION

With the collapse of military acquisition, few firms are trying to concentrate on defense production. Those firms with civilian divisions are trying to keep these going as an important additional source of revenues.

There are, of course, firms that will continue to have a mainly defense orientation for some years to come, such as the MiG aircraft design bureau (the Sukhoi Bureau, competing with MiG for design contracts, has been much more aggressive about moving into commercial fields). But it is highly unlikely that firms are dropping their non-defense work (where there is significant potential for growth) to concentrate on the volatile and contracting defense market--except in the area of exports.

EXPORTS

Military exports have become the mechanism of choice for the Russian leadership in its efforts to preserve key parts of the collapsing defense industry and to earn foreign currency to support conversion. The officials responsible for conversion in Russia have clearly concluded that it makes

greater economic sense to continue defense production for export, using the profits generated to fund the long-term "physical conversion" of the industry's plants and facilities. Yeltsin's Counselor for Conversion estimates the process will require \$150 billion over ten years, and is working hard to promote exports for hard currency.

And there have been some significant successes: aircraft are being exported to China, aircraft and submarines have been sold to Iran, and the United Arab Emirates is buying several infantry vehicles. The defense industries are participating in international military trade shows and advertising (in both English and Russian) in Russian military newspapers.

While the Soviet and Russian market share declined significantly from 1990, the political leadership has put its weight behind exports to customers able to pay cash. And while the overall export market is declining, it seems likely that the Russians will continue to expand their participation in arms sales.

TECHNOLOGY TRANSFER

For many years, the walls between military and civilian production were extremely rigid, even within the same ministry. Gorbachev referred to this as the "internal COCOM," referring to the western effort to restrict the transfer of technology to the Soviet Union. While there does not yet appear to be a significant, coordinated "technology transfer" effort to shift technology from the military sector to civilian, the "free-for-all" currently taking place in the former Soviet Union, in which defense plants are scrambling to find anything they can market, has meant much defense technology is fair game for whomever possesses it. Thus, factories and labs are marketing unique technologies developed for the military with only limited controls at present, and much of it is likely to be going to foreigners. The situation has become so uncontrolled that the military is increasingly concerned about the involvement of serving military officers in companies created to market current and former military equipment and technology.

EMPHASIS ON R&D

The military leadership of the Commonwealth (many of whom are now the military leadership of Russia) have said in the past that emphasis would be placed on R&D over production, with resources from the latter allocated to improving the living conditions of the troops. The CIS

Commander in Chief argued that "there are some areas where we lag behind our partners. There is the Stealth program, there is a program of high precision weapons, and here we should not be second best as far as our partners are concerned."⁸⁴

The result has been that research and development funding has not been cut as significantly as procurement.

LESSONS FOR THE U.S.

The experiences of the Soviet Union and its successor states indicate the difficulties with product or physical conversion, that is, attempting to use existing people and capital for new purposes. In Russia, the approach is often extremely wasteful of talent, if not resources, in part because of the mismatch between the declining demand for technically complex products and the high skills of many of the production people. However, in many cases it is seen as the only alternative for workers and firms.

A second point of interest for U.S. industry is the likelihood that Russian export competition will be increasing for a shrinking market. U.S. defense firms hoping to survive through reliance on the export market should be aware that they are now facing a very highly motivated competitor with flexible (indeed, often unreal) prices and good equipment.

⁸⁴Russia's Radio, September 18, 1991, in *Summary of World Broadcasts*, September 20, 1991, p. B17-B21.

CHINA

The Chinese military industry is believed to employ up to five million people. Its core comprises three ministries and a State Shipbuilding Corporation, responsible for thousands of factories and design bureaus.⁸⁵ The ministries, in turn, are overseen and coordinated by the Commission on Science, Technology, and Industry for National Defense (COSTIND), established in 1982.

The Chinese experience with conversion is, in many ways, similar to that of the Soviet Union, but ten years earlier and without the political and economic collapse that took place in the Soviet Union. The Chinese reduced their defense spending and required defense industry to shift to civilian production, as the Soviets attempted a decade later. A 1979 Chinese Communist Party directive stipulated that defense industries should "combine military with civilian [products], combine peacetime with wartime [production], give priority to military products, and use civilian [sales] to foster military [R&D]." An additional provision was added soon afterwards: to "utilize the military [sales] to foster the military [R&D]."⁸⁶ In the course of the 1980s, industrial management was decentralized and defense industrial managers were given increased responsibilities and independence for profits and losses.⁸⁷

The Chinese conversion experience has proven difficult in part because of the decision in the late 1960s to relocate or build thousands of defense factories in the "Third Front (or Line) Regions," that is, in the country's less vulnerable central areas. Although the region became responsible for most of the defense production in China, many of these factories were isolated from important industrial infrastructure such as transportation and energy supplies. When defense spending was reduced, they were hit particularly hard.

⁸⁵The Chinese defense industrial structure closely resembles that of the former Soviet Union.

⁸⁶John Wilson Lewis and Hua Di, "China's Ballistic Missile Programs: Technologies, Strategies, Goals," *International Security*, Fall, 1992, vol. 17, no. 2, pp. 5-40, at p. 33.

⁸⁷Paul Humes Folta, *From Swords to Plowshares? Defense Industry Reform in the PRC* (Boulder, Colo: Westview, 1992), pp. 56-57.

Despite these difficulties, as defense production has declined, the civilian output of the defense industries has increased significantly. The civilian proportion of the defense industry's output increased by one estimate from 10 percent in 1978 to 80 percent in 1990⁸⁸ while another gives the 1992 level as 65 percent, with 80 percent as a target for 1999.⁸⁹ This has been accomplished through a combination of reforms giving greater responsibility to managers for contracts and profits; production above plan could be sold, and the profits reinvested in the factory.⁹⁰

HISTORICAL AND CONTEMPORARY EXPERIENCE

PLANT LEVEL AND DIVERSIFICATION

It has been reported that fewer than half of China's defense-related firms "have found viable commercial goods to manufacture or commercial services to offer. Most have been able to find only a single product to assemble."⁹¹ However, there have been a few apparent successful efforts, and Folta discusses several cases in his study.

As defense orders were cut, there was considerable overcapacity within the industry, and new civilian product lines had to be found. For example, motorcycle production was increased dramatically at a factory of the Ministry of Aeronautics and Astronautics in Zhuzhou (from 2000 motorcycles in 1979 to 250,000 in 1986) and one of the Ministry of Machine Building and Electronics Industry in Jialing (from 2500 in 1980 to 350,000 in 1986). Microcircuit production for civilian use was also expanded at two electronics plants that had formerly specialized in defense electronics.

⁸⁸Paul Humes Folta, *From Swords to Plowshares? Defense Industry Reform in the PRC*, Boulder, Colo.: Westview, 1992, pp. 119, 122. In absolute terms, Folta estimates that defense output fell between 1979 and 1990 from 9 billion yuan to 4.5 billion yuan, while civilian output grew from 1 billion to 18.1 billion yuan.

⁸⁹"On Civvy Street," *Far Eastern Economic Review*, February 6, 1992, pp. 40+.

⁹⁰Folta, pp. 81-109.

⁹¹Tai Ming Cheung, "On Civvy Street", *Far East Economic Review*, February 6, 1992, pp. 40.

Giving management greater responsibility for contracts and the right to keep and reinvest profits was a significant step in increasing the civilian output of these enterprises. The Zhuzhou factory chose to invest in and expand its internal motorcycle production capabilities, while the factory in Jialing entered into cooperative arrangements with a range of other producers.

Military and civilian production were kept almost completely separate at the factories, and both received significant support from their ministries and the national government as motorcycle production increased; over time, however, central government intervention declined.

Where successful, conversion in China was predicated on greater authority and responsibility being given to the factory managers. In addition, defense plants diversifying into civilian production were given preferential treatment on loans from local banks. The converting firms also benefitted from easier access to foreign products that could be duplicated, and, because of their more qualified workforce and higher technical levels, these firms were also more attractive to foreign investors.⁹²

But these firms were also frequently burdened with significant overcapacity, as new civilian production was often *added to* defense capabilities, rather than replacing it.

EXPORTS

Many enterprises in the Chinese defense industry, when confronted with the cutbacks of the late 1970s and 1980s, turned to exports: Third-Front enterprises found themselves forced to choose between finding civilian products or exporting weapons, and, as the growth in Chinese participation in the international arms market indicates, many chose the latter.⁹³ The value of Chinese exports to the Third World peaked in 1987

⁹²For example, the China North Industries Corporation (NORINCO) bought millions of dollars of equipment to establish civilian production at its tank plant in Inner Mongolia in a joint venture with Mercedes. "On Civvy Street," *Far Eastern Economic Review*, February 6, 1992, p. 42.

⁹³See John W. Lewis, Hua Di, and Xue Litai, "Beijing's Defense Establishment: Solving the Arms Export Enigma," *International Security*, Spring, 1991, vol. 15, no. 4, pp. 87-109; and John Wilson Lewis and Hua

at \$5.5 billion, falling to less than half that in 1990 and a meager \$300 million in 1991.⁹⁴

LESSONS FOR THE U.S.

As was the case with the former Soviet Union, the direct lessons for the U.S. of Chinese experience in conversion are limited.

First, Chinese experience suggests that even in a planned economy, conversion need not be successful. Even in cases where conversion takes years and is crafted by both the center and industrial managers, many plants have found only a single product or remain grossly overmanned and underutilized. Conversion is more than simply expanding the civilian sector; it must be accompanied by a willingness to reduce capacity in the defense sector.

Second, the Chinese experience reinforces the importance of demand. While demand is difficult to document in a non-market economy, it seems apparent from the success of the motorcycle ventures, for example, that there is significant "pent-up" demand in the economy for relatively low technology products. In addition, the Chinese relied in part on existing domestic and foreign experience in the technologies, rather than attempting to start from scratch. As a result, the motorcycles appear to have avoided the "over-engineering" problem common in Soviet and other conversion efforts.

The Chinese experience also highlights the importance of local and regional efforts at conversion, as well as the peculiar problems of concentration and isolation of the Third Front factories. While the central government was the source of many of the directives about conversion, the local governments were often active participants in encouraging a local defense industry to produce civilian goods.

One of Folta's case studies also noted the success of an electronics firm that promoted technology transfer through an extension-type service with

Di, "China's Ballistic Missile Programs: Technologies, Strategies, Goals," *International Security*, Fall, 1992, vol. 17, no. 2, pp. 5-40.

⁹⁴Richard F. Grimmett, *Conventional Arms Transfers to the Third World, 1984-1991*, Washington, DC: Congressional Research Service, 1992.

other industries and a series of exhibitions and fairs.⁹⁵ In addition, the electronics firms studied by Folta indicated that there was little underutilization of capacity, in part because of the dual-use nature of many of their products.

Finally, the Chinese defense industry benefitted from being targeted for assistance. This meant that these industries had easier access to capital from banks than existing civilian enterprises seeking to expand or modernize.

⁹⁵Folta, p. 175.

JAPAN

The Japanese defense industry is extensively integrated with the industrial economy as a whole: the major suppliers of the Japanese Defense Agency are generally large Japanese corporations for whom defense production plays a relatively small part. This is a result of the small size of the Japanese defense forces, their limited spending on material, a reliance on U.S. technology, and a ban on military exports. In other words, demand for military hardware in Japan has been, and continues to be, significantly constrained. Defense manufacturing accounted for only .5% of the country's industrial output in 1990.⁹⁶

While Japanese acquisition spending grew through much of the 1980s, it contracted in the 1990s. Compared to 1990, allocations in 1992 for defense products were down 19 percent; 36 percent for missiles; 24 percent for aircraft; 10 percent for naval ships; 10 percent for ammunition; and 15 percent for tanks.⁹⁷

The impact of these reductions is difficult to assess, given the embedded nature of Japanese defense industry in the civilian sector. But when Japanese industry has been confronted with declining demand, it has generally fallen back on--and emphasized--diversification in order to maintain its workforce. While hiring may be reduced and early retirement may be encouraged, layoffs of full-time workers is an avenue of last resort in dealing with reductions.⁹⁸

In part, this is due to the belief in Japan that its industry in general, and defense industry in particular, serve a role beyond simple production. An alternative to production as a measure of success for Japanese industry

⁹⁶Tai Ming Cheung, "Yen for Arms," *Far Eastern Economic Review*, February 24, 1990, pp. 58-59.

⁹⁷Tai Ming Cheung, "Defence Contraction," *Far Eastern Economic Review*, April 30, 1992, pp. 52-53.

⁹⁸See Arthur Alexander, "Conversion Lessons from Declining Industries in Japan," Paper prepared for the Council on Economic Priorities-USSR Academy of Sciences Conference on Economic Demilitarization, Moscow, November, 1990.

is the ability to obtain new technology, "indigenize" it, and then disseminate it throughout the Japanese economy.⁹⁹

HISTORICAL EXPERIENCE

PHYSICAL CONVERSION

The potential trauma of physical conversion is mitigated in the Japanese economy by the flexibility built into industry as a whole. Military production is often integrated into a civilian facility, and there is an emphasis on dual-use production and transferability of skills that makes it possible for production to switch, with relative ease, from military to civilian products and back again, responding quickly to changes in markets. As a result, the extent of specialized production equipment or personnel that contributes to the difficulties of physical conversion is unlikely to be significant. In addition, the firms, other private organizations (such as banks), and the government have demonstrated a willingness to invest heavily to keep a plant in operation or, if the industry is deemed unsaveable, ease it from the market.

This does not mean, however, that physical conversion does not take place. For example, Kawasaki Heavy Industries is attempting to convert an aircraft plant to the production of bullet trains.¹⁰⁰ But it appears that such conversion takes place in Japan in a context of significant economic flexibility, with the investment of considerable resources in personnel and production equipment and a willingness to build from the ground up.

DIVERSIFICATION

One of the cornerstones of the Japanese economy is the diversification of its firms. The same large corporations produce a wide range of commodities, from personal electronics to tanks. When a corporation finds

⁹⁹See David B. Friedman and Richard J. Samuels, "How to Succeed Without Really Flying: The Japanese Aircraft Industry and Japan's Technology Ideology," Paper prepared for the National Bureau of Economic Research conference on "Japan and the U.S. in Pacific Asia," April 1-3, 1992, San Diego, CA.

¹⁰⁰Tai Ming Cheung, "Defence Contraction," *Far Eastern Economic Review*, April 30, 1992, p. 52.

itself in some sort of trouble in one area, its first line of defense is to diversify into another.

At the same time, much of this diversification is based on the existence of numerous--and very flexible--much smaller firms: 87 percent of all manufacturing firms employ fewer than 20 people, accounting for 29 percent of manufacturing employment, while the figures for the U.S. are 65 percent and 7.4 percent respectively.¹⁰¹

Diversification is likely to be a Japanese firm's initial solution to most problems of contraction in a market, not just defense, and it is an approach with which the companies are well-acquainted.

CONCENTRATION/RATIONALIZATION

Reducing excess capacity in a planned or guided manner is also a apparent hallmark of Japanese firms. But given the relatively small size of the Japanese defense industry, this seems unlikely to be a major issue there. In addition, concentration and rationalization generally take place when an overcapacity for production exists. If the Japanese do indeed, value obtaining and diffusing technology as an important goal of their corporations, then such overcapacity becomes less likely and less important.

EXPORTS

The Japanese are, by Cabinet decision, barred from exporting weapons. However, there is growing interest in exporting dual-use technologies, that is, technologies that can be used in military or civilian applications.

LESSONS FOR THE U.S.

The first lesson that might be drawn from the Japanese experience is the importance of varied and broad training of the workforce. The more flexible a workforce, the easier transitions from one product line to another should be. But even in Japan, it should be noted, reductions in military

¹⁰¹See Arthur Alexander, "Conversion Lessons from Declining Industries in Japan," Paper prepared for Council of Economic Priorities-USSR Academy of Sciences Conference on Economic Demilitarization, Moscow, 1990, p. 2.

acquisitions have forced defense contractors to lay off temporary workers, reduce overtime, and cut back on subcontracting.¹⁰²

A second lesson is that close cooperation between financial institutions and industry has significant benefits, not only in funding but in the availability of a flexible and capable source of alternative management advice.

Interestingly, the Japanese experience also suggests that it *may* be difficult and/or expensive for companies not concentrating on defense to produce military hardware. Identical military products produced in the U.S. and Japan cost significantly more in Japan.¹⁰³ And, in general, Japanese defense products are considered inferior to those developed in the U.S.

On the other hand, Japanese experience with "spin-ons" suggests an important advantage of diversified companies in a country where civilian R&D vastly outweighs military R&D. Dual-use technologies are generally born in the competitive, commercial market, and moved to defense. The development of such dual-use technologies also meant that production did not have to convert when the defense market contracted.

Technology transfer is facilitated through sanctioned and even encouraged cooperation between competitors as well as between customers and suppliers.

Finally, the Japanese experience indicates the value of acquiring capabilities through licensing, rather than products through purchases. While such licensing may be more complicated and more expensive, it is also an investment.

¹⁰²Tai Ming Cheung, "Defence Contraction," *Far Eastern Economic Review*, April 30, 1992, p. 53.

¹⁰³For example, a McDonnell Douglas F4 reportedly costs more than twice as much to produce in Japan as in the U.S. See Tai Ming Cheung, "Defence Contraction," *Far Eastern Economic Review*, April 30, 1992, p. 53.

CONCLUSIONS:

COMMON PROBLEMS, COMMON SOLUTIONS

This overview has examined the impact of declining military acquisition on the defense industries of six countries. Despite the differences in the economic and political systems of the countries, there are a number of similar problems, attempted solutions, sources of success and causes of failures.

The common problem confronted by the defense industries in each of the countries was a reduction in spending, either across the board or in a particular sector. Most cases involved reductions in defense spending for acquisition; in the German case the focus was on the decline in the shipbuilding market.

Such reductions forced firms to explore various methods of survival. There were four basic options or approaches:

- physical conversion of plants or facilities;
- diversification by a firm;
- concentration and/or rationalization ;
- exports.

One of the most interesting aspects of these steps is that they are common to communist and free market systems, countries in which the government plays an active role in defense industry management and countries in which the role is relatively minor.

In addition, there are lessons in foreign experience in technology transfer and dual-use technology.

PHYSICAL CONVERSION

When reductions in defense spending are relatively sudden or a firm is poorly prepared for some other reason, "physical" or "product" conversion is an almost universal first step, undertaken in countries as different as Britain and Russia. As the defense market declines, the firm is left with both workers and machinery. The objective is to find an

alternative product that uses these skills and technology, and redirect production. There is often considerable local pressure or interest in such conversion because it implies stability for employees and the community.

But such efforts almost always fail, apparently for several reasons:

First, they are often last-ditch efforts in the market economies. As a result, time and money are not available for a gradual or planned (whether by government or firm) shift to new products. In China, where the effort was undertaken over several years, the result appears to have been an underutilization of defense industrial resources, rather than their actual shift to civilian production.

Second, product conversion is driven by the existing accumulation and/or combination of technology and workforce. Both tend to be highly specialized, limiting the potential for moving into other areas without changing equipment and/or retraining or replacing workers. Failing to do so risks being wasteful of existing capabilities or relying on designers, engineers, and workers who are capable, but inexperienced in particular areas. An exception to this appears to be Japan, where both machinery and personnel seem more flexible in their application.

A related problem is that the identification of new products is often driven by the technology and workforce on hand, not by the market. The result is products seeking markets (supply seeking demand), rather than capabilities responding to demands (supply *responding to* demand). Such an approach might be acceptable if and when the government is willing to intervene to create demand (in a planned economy, for example), but fail in most market economies. Consequently, products are produced for which there is little or no market, or that are inappropriate for an existing market because of cost and/or complexity.

Fourth, the production "culture" for defense often differs from that for civil products, especially at the management level. For many years, defense production emphasized performance over cost, while production for the civilian market tolerates a much wider range of cost and quality. The defense market concentrated on effectiveness of its output, while the civilian market places a greater premium on efficiency of its production.

Finally, it is almost always difficult to change product lines; there does not appear to be a successful way to do so without starting from virtual scratch. The exceptions are cases in which the civilian and defense products are very similar (for example, aircraft components) or in which

production of military and civilian products is already highly integrated (for example, in France or Japan).

In sum, while there are cases of successful physical conversion, they are the exception rather than the rule. The degree to which they are attempted depends on the commitment of the company, the national government, and/or the local government to providing support during often long and difficult periods of transition, and to invest in changing the qualifications of the personnel or the capital involved. But, of course, the more the workforce or production equipment is changed, the more we are moving away from physical conversion and into investment in a new product line--diversification.

DIVERSIFICATION

Diversification is the broadening of a firm's markets, rather than the replacement of the defense market with commercial ones; new markets or products are added to existing ones, rather than replacing them. Firms attempt to diversify for a number of reasons, including spreading risks and shifting away from declining industries into those that promise growth. These two motives in particular suggest why defense firms may attempt to diversify both when the defense market is threatened and when the firms are doing especially well. Successful diversification provides a buffer against declines in the defense business, provided the civilian business is successful.

One of the important bases for diversification is resources. The diversifying firm must have sufficient funds to buy an existing firm, sufficient resources to support a merger, or the assets to sustain a new product until it becomes profitable, possibly requiring several years. As a result, it appears that defense industrial firms pursue diversification at a time when their business is going well. The available resources give them a bit of flexibility and a cushion for protecting them in the new market.

Diversification is easiest when it consists of taking over an existing firm or factory with an established market. For example, the acquisition of an electronics firm by German shipyard or the acquisition by Lucas Aerospace of Tracor Aviation.

In addition, defense firms have successfully entered various civilian markets. These include, for example, the British firm Racor's entry into

the mobile telephone market and various efforts by the French companies Aerospatiale, SNECMA, Dassault.

Finally, a few companies have been able to directly apply their defense outputs to the civilian markets, but these are relatively unusual cases.

Foreign diversification experience suggests that diversification is possible, especially when the defense market is booming, and perhaps valuable as an initial source of experience with the civilian market. However, much of the foreign experience must be tempered by recognizing the diversification that often exists already in many of the firms.

In addition, diversification is far from easy, and many firms have attempted it unsuccessfully. Entry into an existing market is almost always difficult for a number of reasons, including customer satisfaction with existing firms, economies of scale in the existing firms, and control or familiarity with resources or technology by those firms in the market already. Identification or creation of a completely new market is also very difficult, one of the greatest tests of entrepreneurial skill.

Diversification by a domestic firm into a market dominated by foreign firms is one area of potential government policy through protection or willingness to favor new domestic producers by a willingness to pay more. The French, for example, have apparently undertaken this sort of approach.

The lessons for diversification, regrettably, sound like platitudes. The most obvious is to diversify early, when a firm has resources and can learn from its new acquisitions or markets. As the defense market contracts, lending institutions and investors are likely to become increasingly cautious about defense companies.

Second, learn from the newly acquired or created firm, rather than imposing lessons from defense onto the new firm. Those firms diversifying into other defense areas are unlikely to benefit from significant differences in marketing and management skills.

Third, diversification is easier into areas similar to a firm's defense production, as exemplified by the efforts of many aerospace companies to diversify into the civilian markets and the efforts of various German shipyards to expand into other nautical efforts such as deep-sea mining and drilling. But these efforts appear most successful when undertaken with a significant financial commitment and allowance for the length of time involved.

Fourth, diversification with products, that is, the attempt to sell defense-based products on the civilian market, is highly dependent on the firm's ability to correctly identify appropriate markets.

Finally, one of the potential values of diversification is the opportunity for cross-pollination between firms. It would seem to make sense to rotate personnel from the defense firm into the new commercial venture for a period of time as a way of acculturating the defense producer to the commercial markets.

CONCENTRATION/RATIONALIZATION

Foreign firms experiencing reduced defense spending over the last several years have not only attempted to convert or diversify. Many firms have taken the opposite approach to diversification, increasing their concentration on specific defense products and reducing overcapacity in attempts to "rationalize" their production. Such rationalization generally involves divestiture of parts or components that are considered ancillary to the firm's "core" businesses in defense, and might include factories producing civilian products or even those producing defense products that are outside the firm's core interests.

Closely related to concentration are the efforts by many companies to develop cooperative ventures or teaming within one's own country or internationally. Some of these have been sketched out above.

EXPORTS

A final way to cope with a contracting domestic defense market is to replace it with an export market. But each of the countries examined has found that while the export market is attractive, it is also highly competitive and, because of reduced demand abroad, also contracting.

TECHNOLOGY TRANSFER

While not specifically a conversion issue, the question of technology transfer from the military to civilian market is of interest to the Defense Conversion Commission for several reasons, including the potential for DoD laboratories and research organizations to contribute to the economy and the opportunity to share both costs and benefits of research in key and/or very expensive areas.

The experiences of the defense industries of other countries emphasizes how difficult such transfers can be. The case of the UK's Defence Technology Enterprises (DTE) is the most clear-cut: an effort to extract technology from defense labs and "commercialize" it was unsuccessful after six years of effort, apparently because the venture capital investors were dissatisfied with the pace or prospects of return on their investment. Apparently, identification, commercialization, and marketing of technology in these labs took more time than the available capital was willing to provide.

In contrast to the DTE case, in which defense labs exist as separate entities from commercial firms, technology transfer in Japan and, apparently, France takes place because defense and commercial work are generally intertwined. As a result, there is an on-going exchange between the commercial and defense sectors in France and an even wider circulation of technology in Japan. In the Japanese case, there are a number of mechanisms specifically designed to promote the rapid diffusion of technology, regardless of whether it originates in civilian or defense work.

Two points might be noted about recent Soviet and Russian experience in technology transfer. Until the early 1990s, there was very little technology transfer between military and civilian production (the "internal COCOM"), although it would be interesting to have more information on whether this occurred at specific firms involved in both civilian and military production. A second point is that with the collapse of many defense orders and desperate efforts to find commercial products, internal restrictions on technology transfer have probably been overwhelmed.

DUAL-USE TECHNOLOGIES

Both France and Japan are placing a premium on the development of dual-use technologies, although each is approaching the problem from opposite sides. In the French case, it appears that the French DGA hopes to reduce the costs of weapons programs by identifying additional uses for defense technology. The "dual-use" is driven mainly from the defense side. Such an approach might be characterized as emphasizing "spin-offs."

The Japanese approach appears to be the reverse. Japanese work on dual-use emphasizes the enormous civilian R&D effort, and attempts to identify products or components that have a defense application as well as

a civilian one. Such an approach makes the military the beneficiary of civilian R&D, and might be characterized as emphasizing "spin-ons."

NO MAGIC BULLETS

The experiences of the six different countries discussed in this overview lead to many findings, but one stands out: there is no easy solution to the problem of defense conversion. Indeed, countries with widely differing political and economic systems have, in general, trod the same paths when trying to convert, and the results have, with few exceptions, been painful. At best, their experiences suggest that government policies can mitigate some of the trauma of economic dislocation, but not eliminate it.

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