THE U.S. HELICOPTER INDUSTRY

Its Development, World Market and Foreign Competition

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.

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Its Development, World Market and Foreign Competition

An Ad Hoc Study Project
of the
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Study Participants:
Bell Helicopter Textron, Inc.
Boeing Vertol Company
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and
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The mission of the Aerospace Research Center is to engage in research, analyses and advanced studies designed to bring perspective to the issues, problems and policies which affect the industry and, due to its broad involvement in our society, affect the nation itself. The objectives of the Center's studies are to improve understanding of complex subject matter, to contribute to the search for more effective government-industry relationships and to expand knowledge of aerospace capabilities that contribute to the social, technological and economic well being of the nation.

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INTRODUCTION

World helicopter production has been growing steadily, and at a healthy rate, over the last two decades with civil sales playing an increasingly larger role. Forecasts indicate that following recovery from the current recession-related slump, helicopter sales should again assume an upward growth trend.

While both U.S. and foreign manufacturers have felt the effects of the recession, U.S. manufacturers, long dominant in the marketplace, have been hardest hit. U.S. share of the turbine-powered helicopter market—the largest source of sales dollars—slipped from 60 to 41 percent between 1979 and 1982. In 1982, for the first time, total deliveries of foreign manufacturers exceeded those of the U.S. industry. Perhaps most significant, market share at home has dropped substantially for U.S. rotorcraft producers. The success of foreign manufacturers—primarily the European firms Aerospatiale, Agusta, Messerschmitt-Boelkow-Blohm, and Westland—is attributable largely to strong foreign government promotion and subsidization of both rotorcraft development and exports.

In December 1981, AIA published a report titled "The Challenge of Foreign Competition to the U.S. Jet Transport Manufacturing Industry." If anything, the threat of foreign competition is even greater with rotorcraft when one considers the market achievements of foreign rotorcraft manufacturers.

Like other sectors of the aerospace industry, and in contrast to many other U.S. manufacturing exporters, the helicopter industry has maintained a positive balance of trade over the years; this may be in danger. Further, the helicopter's unique role in military operations has made helicopters an important component of U.S. defense preparedness and the industrial base. Thus, a weakening of the industry has serious national security implications.

A third report on the subject of foreign competition will soon be forthcoming as AIA is currently engaged in a study of the private, business and light transport market. There are obvious differences between the three segments of the aircraft industry: transports, helicopters and private, business and light transport craft. Nonetheless, all three segments have been buffeted by world economic recession and the growing success of foreign manufacturers, much of it made possible by practices and policies instituted by foreign governments to help their aircraft industries establish themselves in world markets.

The two reports concluded to date have a common thread: that the United States must soon and effectively address the issues raised.

There have been encouraging signs of high-level awareness of the aircraft industry's problems. The Reagan Administration policy statement on aeronautical research and technology—an outgrowth of an Office of Science and Technology Policy study—recognizes the importance of the aircraft industry and acknowledges the government's responsibility to participate in maintaining its R&T base. The Federal Aviation Administration's recent streamlining of its organization and establishment of a Rotorcraft Task Force and Program Office is also commendable and encouraging.

It is critical that these policy directions be backed by strong and continuing commitment to implementation. Without that commitment, there may be irreversible damage to the market position of the aerospace industry, the United States' leading manufacturing exporter.

CONCLUSIONS

1. The U.S. helicopter industry is relatively young and is facing increasing competition in the world market. European manufacturers and their licensees account for virtually all of the foreign free world helicopter production; by the early eighties, France's Aerospatiale was producing about half of foreign-delivered rotorcraft. The trend is toward an increase in foreign manufacturer production as new rotorcraft models are introduced. On the basis of aircraft deliveries, 1982 was the first year in which sales of foreign manufacturers exceeded those of U.S. manufacturers. U.S. manufacturers must be assured competitive opportunities in the marketplace equal to those of foreign producers, or they will continue to lose major market share.

2. European subsidies of helicopter manufacturers are based on conscious decisions to create and support their domestic defense/aerospace industries. These countries are recognizing that high subsidies of both military and commercial development are the price for national defense autonomy, and then proceeding to minimize the burden to the extent possible through: (1) targeting the U.S. domestic market, (2) cross-border collaboration with government to government participation, and (3) government-subsidized exports to the Third World. U.S. manufacturers must find ways to counter the advantage that subsidies play in the free market environment.

3. The world market is becoming more diversified, and more sophisticated equipment is needed to satisfy customers. To develop a new helicopter, a company must commit large sums of capital for many years in a complex cycle of design, testing and certification. Aviation technology changes quickly and manufacturers must also invest to stay abreast of the state of the art. Technology development *and* the application of that technology in production is essential for a company to stay competitive.

4. The U.S. helicopter industry is maintaining its historical technological advantage over foreign producers, particularly with respect to military helicopters. However, due to the ability of foreign producers to incorporate technical advances quickly in design and production, the commercial helicopter models of both domestic and foreign manufacturers appear to be close to parity. Foreign manufacturers have concentrated their R&D efforts in a few key technologies, e.g., fiberglass blades and rotor heads. In these areas, they have on occasion been able to lead U.S. industry for a time.

5. U.S. industry and the U.S. government generally have been very open about sharing technical data of a nonstrategic military nature with foreign manufacturers. This assistance has often enabled European producers to field technology quickly and freed them to concentrate R&D funds, and make rapid advances, in some specific technical disciplines.

6. (a) Both European and American governments directly fund helicopter development programs designed to satisfy domestic military requirements. However, in Europe, projects targeted for the commercial and foreign military markets also benefit from foreign government subsidization, thereby reducing the financial risks to which the manufacturers are exposed. In the United States, the undertaking of such projects requires the acquisition and commitment of privately held risk capital. This disparity in financial exposure enables the European manufacturers to initiate programs entailing higher levels of marketing and technical related risk.
   (b) For aerospace firms, R&D is a necessary cost involved in maintaining a competitive position. Aircraft manufacturers are more constrained than manufacturers in many other industrial sectors from reducing R&D expenditures during periods of adverse economic conditions. However, these funds represent an increasingly greater cost for U.S. aircraft firms as interest rates rise. In government-controlled companies, the cost of capital is either independent of financial markets or is highly influenced by the implied state backing.

7. Civil helicopter production will continue to grow in importance as new uses arise and existing markets continue to develop. However, the military services will continue to be an important market for helicopter manufacturers.

8. In the United States, civil and military helicopter technology will undoubtedly continue to diverge with military systems emphasizing technological advances in such areas as maneuverability and survivability. By contrast, civilian technology will emphasize features such as economy and comfort. As a result, both the applicability of military R&D to the civil sector and opportunities for the direct transfer of hardware between the two sectors are likely to diminish, thus putting a greater burden on other sources of funding to support civilian helicopter advances.

9. The declining utility of military R&D in the civilian area could be a serious problem for U.S. industry. The U.S. military will press for state of the art improvements, regardless of their applicability to potential civilian needs. Funding for American civilian helicopter development will have to come increasingly from the market, placing new strains on parent firms. Given the highly competitive military market, it is likely that in some cases military R&D will also be "subsidized" by parent firms in hopes of winning production contracts that are critical to the helicopter manufacturer's existence, diverting funds from civil-oriented R&D. In other countries, there is more cooperation and planning between military and civil sectors to assure that new military rotorcraft programs have potential commercial value, even if this requires compromising domestic requirements. A prime example is the EH-101, a medium-sized helicopter being developed by Westland and Agusta, taking into account both commercial and military requirements. Such dual-purpose programs allow foreign manufacturers to be more effective in their use of R&D funds.

10. Foreign governments have been selective and perceptive concerning new research facilities in the rotorcraft field. The Europeans have excellent wind tunnels and facilities for two critical areas of research: noise and rotor icing. In the United States, government research management has tended to develop larger and more elaborate replacements or extensions of existing facilities rather than new, imaginative facilities to address new problems.

11. The United States must address an array of trade-related issues in an effort to enhance the competitiveness of its industries in the world market. Attention should focus on creating incentives and eliminating disincentives to export. Among the key issues:

    - *Trade Restrictions*—U.S. trade restrictions are inconsistent and poorly administered. This causes long-lasting problems for U.S. equipment manufacturers and is particularly difficult for aerospace companies which count on considerable follow-on sales (e.g. spare parts) resulting from the initial sale of an aircraft.

    - *Financing*—Government backing of foreign manufacturers often permits them to secure more favorable financing for commercial customers than is available to U.S. manufacturers. The Export-Import Bank, whose financing is available only for commercial sales, has been helpful to U.S. producers but, in many cases, the rates have not been competitive. In the case of direct military sales, U.S. firms face tough competition when foreign manufacturers offer state-subsidized financing.

    - *Collaborative Arrangements*—The increasingly prevalent phenomenon of collaborative arrangements in the development of new helicopter models between manufacturers in several countries enhances the market position of the partners. American manufacturers have considerably more difficulty than foreign firms in participating in such arrangements both among themselves—where antitrust strictures may apply—and with foreign partners—where government financial support often enhances the attractiveness of joint ventures.

    - *Tax and Other Subsidy Incentives*—Comparisons of tax and other subsidy practices in the United States and in other countries have shown that, generally, other nations provide greater incentives to exporters than does the United States.

12. While the foreign challenge to the U.S. helicopter industry is great, sound industry leadership and appropriate U.S. government policy will enable the industry to compete effectively. The U.S. industry is not without market power as the United States forms, by itself, the largest helicopter market—both civil and military—in the free world. The U.S. helicopter industry still leads in important technology areas and has strong support advantages in the area of systems integration.

RECOMMENDATIONS

MARKET ENVIRONMENT

1. Government and industry must work together more closely to create a business environment supportive of exporters, yet in accord with free-market principles.

2. The United States Government should specifically repudiate protectionist actions to insulate the domestic market from foreign manufacturers. U.S. helicopter manufacturers can maintain an effective competitive position if the issue of government subsidization is resolved.

3. A sound and consistent policy framework should limit the application of export restrictions to cases where absolutely necessary. Export policies and procedures should be reviewed and, where possible, simplified. Foreign policy-related restrictions should be weighed in light of alternative sources of supply, trade consequences for U.S. manufacturers, and the impact on the U.S. economy. The United States government should establish strong, consistent and long-term national policies to promote U.S. exports, as well as the technological base that makes exports possible. Obstacles to the sale of U.S. products in world markets should be removed. Efforts should focus on incentives both to market abroad and to expand industry research and development.

TECHNOLOGY

4. The technological leadership of the U.S. helicopter industry must be increased or at least maintained relative to foreign competitors' capabilities in order to maximize U.S. opportunity in the international marketplace. The United States must also act to make the flow of technical information between U.S. and foreign manufacturers more nearly a two-way street. Specifically, U.S. capability can be enhanced by:

   - *Increasing the rate of technical progress*—A strong government-funded program of aeronautical research and technology, through NASA and the military services, should be maintained. Government facilities for rotorcraft testing should be expanded and new facilities developed as required to counter deficiencies in research and testing capabilities. Industry must commit itself to continuing strong investment in research, technology and development.

   - *Increasing the time lag on release of technology advances to competitors*—The transfer of technology to U.S. foreign competition should be reviewed. New technology developed by U.S. firms under contract to the U.S. government should be disseminated first to U.S. domestic users. However, open and active communications in the technical community on an international basis must be maintained.

   - *Emphasizing the reciprocal exchange of basic aeronautical R&D with other nations*—The United States should concentrate on better collection, translation and distribution of technical information from abroad. This should be a NASA function and given high priority. The U.S. might explore establishment of long-term Memoranda of Understanding (MOU) by which foreign rotorcraft research facilities will be available to the U.S. rotorcraft R&D community on an economical, consistent basis.

FINANCING

5. Until all forms of export subsidy assistance can be eliminated through international negotiations, the Export-Import Bank direct loan and guarantee authority should be strengthened to assist U.S. manufacturers to be more competitive against foreign-supported firms. In addition, where feasible, government and industry should pursue alternatives to Eximbank for the financing of exports.

6. The government should support and strengthen U.S. trade representatives in their efforts to broaden the "Commonline" Agreement on aircraft export financing to include general aviation and rotorcraft.

INCENTIVES/DISINCENTIVES

7. The government should maximize export incentives to U.S. companies through an alternative to the Domestic International Sales Corporation (DISC), and through promotion and implementation of the export trading companies concept recently enacted into law.

8. U.S. antitrust laws should be revised to encourage U.S. industry research and development collaboration in areas that will permit manufacturers to be more efficient and to compete more effectively.

9. The U.S. government should continue to encourage other nations to adopt standardized aircraft certification criteria. All manufacturers can then sell their aircraft anywhere in the world without the additional costs of recertifying aircraft to different standards.

FOREIGN SALES OF MILITARY EQUIPMENT

10. The United States should explore ways to utilize more effectively arms sales in the nation's foreign policy. The government should:

    - Increase assistance by U.S. trade and embassy representatives overseas in the promotion of sales by American firms.
    - Seek new ways to assist debt-burdened nations in the purchasing of weapons necessary for their security.
    - Encourage improved industry participation in Security Assistance programs, strengthening the role of the private sector in marketing campaigns.
    - Streamline existing Foreign Military Sales contracting procedures that create delay and enhance the competitive positions of foreign manufacturers.
    - Remove restrictions on allocation of FMS sales costs to domestic DOD contracts.
    - Recognize risk factor of FMS sales in negotiating profit levels.
    - Increase progress payments to 100 percent on FMS sales as well as other DOD sales, similar to the current policy for small business.

EXECUTIVE SUMMARY

The helicopter market today is very different from that of thirty, twenty, even ten years ago—both in terms of the industry's market and the manufacturers that comprise the industry. The major change is the growth of the civilian market in terms of both absolute volume and market share. Indeed, the number of civilian helicopters produced now exceeds military production.

Even more striking than the change in the market is the makeup of the industry itself. Fifteen years ago, U.S. firms were clearly dominant. Foreign manufacturing primarily consisted of U.S.-designed helicopters produced under license. Today, European manufacturers account for over 50 percent of free world production and France's Aerospatiale accounts for about half of the European market presence. Licensed production has been largely replaced by production of indigenous designs.

MARKET PARTICIPANTS

The key American helicopter manufacturers today are Bell Helicopter Textron, Inc., Boeing Vertol Company, Hughes Helicopters, Inc., and Sikorsky Aircraft. The four major foreign (non-communist) producers are Societe Nationale Industrielle Aerospatiale (France), Messerschmitt-Boelkow-Blohm (West Germany), the Agusta Group (Italy), and Westland Helicopters (United Kingdom). In addition, several foreign manufacturers are predominantly involved in licensed production of helicopters designed by one or more of the major competitors. These include Nurtanio of Indonesia; Helibras of Brazil; and Kawasaki, Fuji, and Mitsubishi of Japan. Kawasaki has undertaken some developmental activity in its participation with MBB on the BK-117 project.

Although each of the four leading European manufacturers today produces one or more models of its own design, these companies owe much of their technical expertise, if not their existence, to past associations with U.S. manufacturers. Aside from the various licensing and co-production agreements through which design and manufacturing technology has flowed, foreign manufacturers have gained additional know-how from the fairly free and open dissemination of basic U.S. technology. This has allowed these foreign firms to concentrate and move ahead rapidly in more specialized areas.

Hughes Apache

SIZE AND COMPOSITION OF THE WORLD HELICOPTER INDUSTRY

The helicopter industry has been growing at an annual rate of 10 to 12 percent in yearly sales over the last two decades. It has been only in the last ten years that significant numbers of helicopters have been produced for civil use. In 1981, civil use accounted for 82 percent of the U.S. industry's unit shipments, and 48 percent of the total value (a difference reflecting the typically higher value of military models). In 1982, helicopter deliveries declined substantially because of sluggish national economies and the high cost of financing. With the recovery of the world economy, however, the civil market is expected to take delivery of 63 percent of a total of 24,000 helicopters forecasted to be produced through the next decade in the free world.

As civil sales declined, U.S. manufacturers have been harder hit than foreign manufacturers, an indication that the competition of foreign firms is strong. U.S. world marketshare for turbine-powered helicopters slipped from 60 percent to 41 percent between 1979 and 1982. Deliveries to the United States, as a percent of their total deliveries, have increased substantially for foreign manufacturers from under 7 percent in 1973 to 20-26 percent during the last three years.

U.S. AND FOREIGN APPROACHES TO TECHNOLOGY DEVELOPMENT

The strong sales momentum of European helicopter manufacturers would not have been possible were they not offering products of demonstrated capability. A technical review of foreign and U.S. commercial helicopters presently in production shows a complex picture of differences due to technology and design features. For military models, the United States maintains a substantial but narrowing lead over foreign competitors; in the commercial sector there is more nearly parity.

An assessment of actual relative levels of technology, however, requires both an understanding of the development process and of U.S. and foreign approaches to technology development and exploitation in the marketplace.

Largely because of the military market, government funding plays a role in the U.S. helicopter industry as well as in the European industries. American and European governments alike provide some funding for basic aeronautics R&T through scientific research institutes. In the United States this basic R&T assistance is provided through the National Aeronautics and Space Administration. The level of spending on aeronautical research through scientific research institutes is estimated to be quite similar in the United States and in Europe in dollar terms. If a fairly substantial share of U.S. funded technology is also flowing overseas, there may, in fact, be an imbalance, to the detriment of the United States. For that reason, it is critical that subsequent U.S. budget priorities reflect the commitment to support that is expressed in the Reagan Administration's policy pronouncement on aeronautics R&T. If they do not, U.S. technology leadership could shift in part to Europe where intense research is currently being performed in such commercially sensitive areas as fuel efficiency and maintenance reduction.

In the military market, where government R&D funding is relatively assured, U.S. firms function in a competitive environment quite different from that of their European counterparts. In Europe, industry/government teamwork (and sole source procurement) is commonplace. In the United States, rotorcraft producers engage in lengthy and intense competitions for government contracts. These competitions force producers to advance the leading edge of technology, but the structured competitive phases of U.S. programs result in lengthy delays before final fielding of advanced systems; often military programs may take 10 or more years to reach fruition. While these programs are underway, the technology being developed is made available to competitive manufacturers through the liberal policies of U.S. government agencies and through widely

Bell 222B

encouraged dissemination of technical papers concerning both military and commercial applications.

Technology advances are also transferred through co-production programs between governments. Combined with the already established capabilities of other countries, this assistance has often enabled foreign manufacturers to field technology more quickly than in the United States where the technology originated. The technology gleaned from the United States has freed foreign producers as well to concentrate R&D on specific portions of technology. Technology transfer, in other words, has enabled them to concentrate and to move ahead rapidly in such key areas as composite structures. Foreign manufacturers have been able to fund work in these areas with low-risk capital because of government support.

In addressing the problem of technology transfer, a distinction must be made between technology that is presently existent and has been incorporated into a saleable product and that which is still in the research phase. Controls on the former are impractical and can limit the competitiveness of American industry. Controls are more appropriately placed on basic research, where the release of information will allow foreign competitors early access to technology.

An early, strong lead and commitment to aeronautical funding has kept the United States ahead in technology development, but increasing European commitments to basic R&D have narrowed the U.S. lead. If present trends and policies continue, the U.S. helicopter industry's technological advantages (or even technological parity) could disappear.

MANUFACTURER/GOVERNMENT RELATIONSHIPS: THEIR IMPACT IN THE INTERNATIONAL HELICOPTER MARKETPLACE

In the United States and in other countries, the helicopter industry's national security role has created a special relationship between manufacturers and their governments. There are, however, major differences in the kinds and levels of support given the industry in the United States and in other countries. These begin with a philosophical divergence: the United States' emphasis is on private enterprise while, in many countries, firms are either directly owned or largely guided and financed by their national governments.

In the United States, helicopter manufacturers make decisions on product offering, investments and pricing based on the need to balance two objectives: (1) To provide an offering sufficiently attractive to the customer in terms of performance and price for him to choose that product over another and (2) to obtain reimbursement that will cover all costs—both direct and indirect—and allow for a profit.

In contrast, for government-owned or controlled companies, the factors that make aircraft a critical industry weigh more heavily in business decisions. These factors include the industry's key roles in the national transportation system and defense preparedness as well as its potential to support foreign policy initiatives, advance the national technological base, increase employment opportunities, and contribute to the balance of trade.

The introduction of a new helicopter to the market is a highly expensive and risky venture. In the United States, the commitment to such an undertaking is heavily influenced by the need to obtain an adequate return on investment. As each of the U.S. helicopter manufacturers is part of a larger industrial entity, a rotorcraft project must offer a combination of risks and rewards superior to that of a project in one of the diverse sectors represented by the other divisions of the parent company. Equally important, the returns offered by such ventures must be in excess of the corporation's cost of capital (weighted average of the costs of debt and equity funding) which, during recent years, has risen to as high as 20 to 25 percent.

In government-controlled companies, the cost of capital is either independent of financial markets or highly influenced by implied state backing. The government can also provide loans or loan guarantees which allocate to the government a share of future revenues if the venture has a favorable financial outcome. Government-controlled firms can carry heavier debt loads at interest rates comparable to the rate charged on the national government's debt, backed by the "full faith" and credit of the nation. Government-owned firms have a cost of capital close to zero since the government stockholder may forego a financial return as long as it achieves political and social objectives. The result is that government-owned and controlled firms in the aircraft industry can more easily undertake projects involving higher initial outlays and risk than can privately capitalized firms.

In the United States, as in Europe, sizeable sums have been provided to the helicopter industry through military R&D. Two important distinctions between U.S. and foreign military programs should be noted, however: (1) the U.S. Department of Defense is concerned solely with developing products which meet military requirements and has no direct intent to develop products or technology for commercial application. In the case of foreign manufacturers, projects with commercial potential do receive direct government funding; and (2) U.S. military procurement policy is primarily concerned with meeting a threat to national security and funding of military projects varies widely over time in reflection of the political-military environment. Foreign governments, particularly the French and Japanese, fund their aircraft industries as part of a long-term national industrial strategy, often with planning horizons up to 20 years into the future.

In most countries, arms-producing industries are backed by well-organized government bureaucracies that assist in marketing the country's military exports. In European countries, the sale of arms involves politicians at the highest level and is supported by coordination of civil and military requirements. The United States on the other hand, has had a vacillating and, at times, restrictive approach to arms sales. In the Ford Administration, there were severe

reductions of Military Assistance Advisory groups (MAAGs) and restrictions on their involvement in activities that would stimulate overseas requests for U.S.-supplied arms. In the Carter Administration, the so-called "leprosy letter" curtailed the promotion of arms sales by both government officials and private manufacturers. The Reagan Administration has outlined a more realistic approach whereby arms export decisions will be focused on the security interests of the United States. The Administration has also sought to rebuild the MAAG program, but much damage has been done that will not easily be reversed. U.S. inconsistency is in itself a deterrent to arms sales, which revolve about the development of long term, stable relationships between supplier and recipient nations.

Both U.S. and foreign governments provide assistance in the marketing of commercial aircraft overseas. The most common form of aid is assistance in financing. Foreign government leaders actively participate in marketing aircraft industry products and each European nation has a well-coordinated agency to assist its industries in exporting. In the United States, however, export responsibilities are scattered over several agencies in the Departments of State, Commerce, Agriculture, Defense and Justice. While many other departments of the Government are involved in setting trade policy, responsibility for policy coordination is split between the Department of Commerce and the Office of the U.S. Trade Representative in the Executive Office of the President.

INTERNATIONAL SALES PRACTICES AND INCENTIVES

The government/industrial teamwork in other nations has created serious competitive problems for U.S. helicopter manufacturers. These broad differences in business environment are reflected in very specific practices and incentives—from export financing to procurement packages—that can spell the difference in the export sales market.

Financing, for example, has been a pivotal item in sales in recent years and high interest rates have made it difficult for U.S. financing programs to compete with those of other nations. U.S. private lending institutions will not risk making loans to foreign customers at rates that would make the sale attractive. Foreign governments are more willing to assist with financing to make sales and expand the markets of their national firms. For U.S. firms, the alternatives to the private financial market are funding through the corporate structure or through the U.S. Export-Import Bank. The first choice is often unacceptable at current market rates, and the last has been weakened as an option as Eximbank loan restrictions have increased and loan and guarantee authority has decreased. Helicopter firms have not generally made use of Eximbank, but this may change as a result of a recent Eximbank initiative in providing a medium-term loan program for civil helicopters and general aviation aircraft. Eximbank's charter does not provide for financing of military exports, however, and these form a substantial portion of the helicopter industry's foreign sales.

The pricing of helicopters also reflects the differing situations of U.S. and foreign manufacturers. Without the same profit constraints as U.S. firms, foreign producers have a great deal of flexibility in pricing. Even if interest rates are equal, they can lower the price of their products until they are strategically placed in the market, or offer long-term service/spares packages as incentives.

The establishment of national partnerships has been an industry trend in recent years. These international collaborative arrangements permit the merging of complementary strengths, the establishment of broader markets, and risk reduction. Existing partnerships in the helicopter field include Germany's MBB and Japan's Kawasaki (to produce the BK-117 utility helicopter) and the United Kingdom's Westland and Italy's Agusta (to produce the EH-101 anti-submarine warfare helicopter). While other nations move readily into these relationships, U.S. manufacturers are at a disadvantage in initiating or participating in such collaborative arrangements among themselves because of U.S. antitrust laws and the uncertainty created by their interpretation. In addition, unlike U.S. manufacturers, foreign producers can generally offer potential partners the inducement of government financial support.

The ease of creating sales packages of aircraft, arms and related equipment and material is yet another reason why other nations have been able to rapidly expand military exports. In the United States, sales packages are not easily put together because the government cannot dictate terms of sale and must negotiate with each manufacturer separately for the requisite items. Also, more restrictions are made in the United States on sales of military hardware associated with rotorcraft sales. With relatively few restrictions and freedom of negotiation, foreign governments are able to put together highly attractive sales packages.

It is time for the United States to ask whether it is providing sufficient incentives to foster a strong, competitive international market position. If not, the nation must evaluate the risks: long-term damage to the economy from loss of exports and eventual deterioration of the industrial base.

The United States must take steps to enhance its market position with a more supportive environment for exporters, yet one that is non-protectionist and consistent with a free and fair world trade environment.

THE WORLD HELICOPTER INDUSTRY —AN OVERVIEW

DEVELOPMENT OF THE INDUSTRY

The helicopter industry is very new by most measures, having come into being at the end of World War II, just under 40 years ago. Even then, it had rather modest beginnings and it took some time before the helicopter—an idea as old as Leonardo Da Vinci—was seen as more than a flying enthusiast's dream.

Because of the complexity of the physical laws associated with rotorcraft—and the dual flight modes of hovering and high speed flight—the technology lagged behind that of fixed wing aircraft by decades in aerodynamics, structures, and flight controls.

The first major use of the helicopter was in the Korean War where it served as an air ambulance and rescue vehicle. The early sixties saw an increase in the commercial use of helicopters by the petroleum industry in the Gulf of Mexico and other areas of the world. Innovative people began to realize how useful the helicopter could be; any location that was difficult to get to by conventional means, such as an offshore oil platform, was a prime candidate for helicopter transportation. Still, the market grew slowly until the Vietnam War created a need for bigger, faster helicopters that could deliver troops and supplies and, later, fire power. High volume production of military aircraft allowed manufacturers to grow quickly and mature as international forces in the aviation market. The war years gave the industry the ability to develop new products designed for both military and civilian use, and the commercial marketplace was seeing an unprecedented growth period with demand outstripping supply. By the end of the Vietnam period, it was a seller's market commercially. When the war ended and government purchases essentially stopped, manufacturers around the world began positioning their products more evenly across the various market segments. Competition among U.S. manufacturers became more intense and foreign helicopter producers began to target markets outside of their own countries for exploration.

THE SEVENTIES—A CHANGING MARKET

U.S. manufacturers continued to dominate the market in the seventies through the process of product improvements of military helicopters. The total market was strong and non-military customers accepted versions of military aircraft not developed to their specific requirements. As the user industries developed, a market and industry environment evolved in which commercial customers were becoming the major buyers. Manufacturers responded by developing new models specifically for civil use.

New models, however, come off production lines only after huge capital investments by manufacturers. With technology the key sales point in this new market, manufacturers worldwide pursued technological advances; each had sources for funding in varying degrees from their own governments. U.S. manufacturers had an early lead in rotorcraft technology; however, there was a flow of technical knowledge from the United States to foreign manufacturers through licensing agreements, coproduction, and the open dissemination of basic technical information fostered by government agencies such as the National Aeronautics and Space Administration. This technology transfer, along with their own efforts, made it possible for foreign manufacturers to heavily fund development of key technologies and new products. For the most part, their efforts were fostered and subsidized by their governments, enabling them to put new designs into production more quickly than could the U.S. manufacturers who were funding developments out of their profits.

While American companies were more slowly introducing new materials and technologies, and gaining experience with them through company-sponsored testing, foreign firms rushed advanced new designs into production. As a result, U.S. helicopter manufacturers found themselves working during the late seventies to overcome a perceived technology gap in their products, as compared to foreign products. An assessment of the reality of the situation (next Chapter) is that the United States—far from lagging—continued to be innovative and highly competent technically and, in fact, contributed significantly to the development and success of European manufacturers.

THE MARKET TODAY

In the early eighties, the sagging economy and uncertainty in financial markets have caused helicopter sales to decline considerably; they are now much lower than projected a few years ago both in the United States and around the world. It is expected that the economic recession is only a temporary situation. However, the market itself has

changed in some important ways which may have an impact on the market position of U.S. manufacturers.

The helicopter industry is presently going through a transition period, which began approximately five years ago, and relates to a significant potential for growth in lesser developed countries. In these countries, most major industry is owned and controlled by the government. Industries that do offshore oil drilling, for example, and have need for rotorcraft, are heavily subsidized and are often controlled by the government. These developing countries share a commonality of needs and goals regarding investment and technological development. Lesser developed countries are encouraged to make industrial investment conducive to private companies, creating an attractive environment for development of a technology base, through, for example, coproduction programs.

In this growing Third World market, there is less and less likelihood of major direct helicopter sales without technical cooperation and participation by the customer. The policy of many nations today is either to manufacture the purchased product under collaborative agreements with major seller nations and/or require that the seller establish an offset procurement program. The purpose of these offset requirements is to establish new areas of product development and production that will help the nation expand its industrial base.

In addition to coproduction, offsets may involve direct licensed production, subcontract production, investment, technology transfer or countertrade—a situation in which the seller agrees to purchase goods and services from the purchasing country as a condition of the offset agreement. Examples of countertrade run the gamut from agreements to purchase raw materials in exchange for finished products (Russia is buying construction machinery from Japan's Komatsu and Mitsubishi in exchange for the purchase of Siberian lumber) to the establishment of manufacturing facilities in exchange for long term aircraft procurement (General Electric has built a turbine blade factory in Canada in exchange for a Canadian contract to purchase F-18 aircraft from McDonnell Douglas). The value and depth of these offset agreements is considerable when the total impact on the aircraft company and the participating countries is taken into account. Offset is now commonplace in the world aircraft market and companies are forced to make such agreements in order to survive. Unfortunately, large aircraft sales to other countries are generally made at the government-to-government level through Memoranda of Understanding and Memoranda of Agreement, and manufacturers must accept the results. U.S. manufacturers must accept significantly lower profit margins because of offset requirements if they win the program and they do not have the resources that a government-supported manufacturer would have to compensate them for those lost profits.

Other significant aspects of the market today have considerably affected U.S. helicopter manufacturers. As a result of the world's economic situation, high interest rates and other factors, the U.S. dollar is now much stronger than at any time in recent history. The strength of the dollar and the implied relative weaknesses of competitive currencies provide strong advantages to the foreign competitors of U.S. helicopter manufacturers. The change in relationship between the Dollar and the Franc over a period of 18 months from late 1981 through March 1983 was the equivalent of a 28 percent reduction in the price of French helicopters in comparison to U.S. helicopters, continuing the trend that has been seen in the currency exchange rates since 1979.

The U.S. helicopter industry is functioning in an international marketplace characterized by economic and competitive pressures that have little to do with the physical and performance differences of products. The challenge is to be competitive and still make the profit required for survival in a free enterprise market system.

CIVIL MARKET

The civil helicopter market was slow to develop but came into its own during the early seventies for many helicopter manufacturers. As helicopters became more commonplace and new models proved what they could provide in the way of convenience and economic payoff, more corporations, small businesses and individuals began to operate them. The result was a rapid increase in market share for the civil sector, from 13 to 64 percent of the world turbine market between 1970 and 1981 and an even more dramatic increase, from 10 to 82 percent, of the U.S. turbine market during the same period. Even though the civil market is cyclical, and reflects national and international economic developments such as the 1981-82 recession, the overall growth trend is positive and long-term demand looks strong.

The major U.S. helicopter manufacturers spend as much time and effort on the civil market as on larger customers such as the U.S. government. They do so because government demand and spending are also cyclical, though they do not necessarily follow the same cycle as the private sector. Government demands are controlled by changes in politics, by wars or international crises, changes in tactical thinking and obsolescence of existing equipment. These factors tend to create a unique demand curve, but one which is relatively long-term and somewhat predictable once a program is launched and funded. When this market segment is included with the civil sector, it creates a more stable and growing demand for new helicopters.

To place the civil segment of the world helicopter market in perspective, civil deliveries accounted for only about 19 percent of total helicopters produced in the free world during the sixties. In the seventies, this proportion doubled to approximately 40 percent. Through the next decade, the civil market is projected to take delivery of 63 percent of a total of 24,000 helicopters to be produced in the free world.

The primary use of helicopters in the civil sector is in support of petroleum drilling and production platforms offshore. Commercial operators use rotorcraft for everything from hauling people to hauling materials and equipment,

Sikorsky S-76

and supporting work crews in a variety of remote locations. Helicopters serve corporations for executive transportation, logistics support, and surveillance missions over corporate property and equipment. Civil governments use them for VIP transportation and, increasingly, to improve the quality of community life through air ambulance service, and police and traffic surveillance. Helicopters are also frequently employed in reporting for the electronic news media. The civil market, as we know it today, is growing rapidly and, undoubtedly, helicopters will find many more uses in the next decade as the versatility of the helicopter increases.

MILITARY MARKET

National support for the aircraft industry is an important factor in the military helicopter market. All governments with an indigenous helicopter industry provide some level of support largely because it is important to maintain, even in peacetime, the capability to produce equipment which has become so important in almost every nation's military inventory. As evidence of this, 41 percent of the active U.S. Department of Defense inventory of aircraft in the continental United States are helicopters. The helicopter has matured to a point where it now constitutes the air vehicle component of major defense systems for tactical troop lift, logistics transport, battlefield reconnaissance and surveillance, attack, and combat aircrew recovery. The DOD budget confirms the continuing importance of rotorcraft to the military. In FY 1983, $3.5 billion were requested for 232 helicopters and related systems (engines, avionics and weapons systems). DOD is seeking $4.2 billion in FY 1984 for 273 helicopters and $4.7 billion in FY 1985 for 340 helicopters.[1]

Both commercial and foreign military sales of helicopters are pertinent to national security because they allow manufacturers to sustain a greater and more stable production capability. The greater the number of aircraft being produced at any time, the faster manufacturers will move along the production learning curve, allowing costs to drop with each successive unit—and permitting a nation to more easily afford a given level of national security. The sustained production capability provides an additional element of "surge" capacity that can be critical in a national emergency.

The importance of maintaining high and consistent levels of production has led many nations to actively pursue foreign military sales and has added a strong element of governmental competition to the international marketplace.

Clearly, military programs provide a certain amount of long-term sales security to helicopter manufacturers. Beyond that, they also provide much needed funds for research and development. Without the military spending that has occurred over the last 20 years, the helicopter industry in the United States and Europe would not be as advanced or as large as it is now. Even today, the amount of investment necessary to launch a new product is so large that most companies are unable to finance such a development or they are unable to accept the risk associated with devoting such a large portion of corporate funds to such a venture. This is especially true if the product incorporates new technology. Manufacturers of high technology products must rely on the backing of their governments to help carry the financial burden of research and the high risk development, and/or on the establishment of joint ventures with potential competitors. This latter possibility places American manufacturers in jeopardy of antitrust action. Simply the perception of potential antitrust violation is a deterrent to collaboration.

Even with military R&D support, U.S. manufacturers face the necessity of recouping their investment in R&D as well as the extremely high costs of program start-up—the expense of bringing new technology to the marketplace.

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[1]Department of Defense Budget, various years.

U.S. Military Sales—Military sales play an important role in the helicopter industry and some aspects of the military sales market, and its changing characteristics, should be noted. Over time, the U.S. military has been the major customer for U.S. helicopter manufacturers. In the United States, as in most other industrial countries, the nation's military branches buy their aviation equipment largely from their own manufacturers. This had nearly always been the case in the United States until the last few years when the U.S. Navy ordered the British-designed Harrier, a single-engined jet, capable of taking off and landing vertically, and the U.S. Coast Guard purchased French-made Dauphin helicopters and Falcon jets.

The U.S. military sales market, in recent years, has also reflected a serious attempt by NATO members to develop common types of warfare equipment through a rationalization, standardization and interoperability (RSI) program. The goal of RSI is to encourage commonality of equipment, ammunition, fuel, tools, and so forth, in order to reduce logistics problems associated with combined armies in time of war.

The U.S. military sales market is changing in another way: the manner of contract awards. The trend is toward fixed price contracts for development and for production of new products. When applied to a complex machine like a helicopter, this contractual approach is a high-risk venture for a publicly-owned company which must make a profit to survive and grow. It is an even more risky enterprise for an American manufacturer when foreign competitors can bid on the same program knowing that their government is providing them with funding; this funding may or may not be repaid to their government, depending on the success of the program.

Finally, the demand for military products is cyclical, the market being sensitive to the pressures of politics, budgets and world events. In the space of a decade, only three or four major new helicopter programs may be started and if a manufacturer is not positioned to bid on one of these few large programs, it could be years before another opportunity comes along. In order to be ready for new programs, manufacturers must continue to advance their technology bases in areas of military application, whether or not they have an ongoing program that can use the technology.

Foreign Sales of Military Aircraft by U.S. Manufacturers—The key to successful foreign sales of military aircraft is support of the sale by a manufacturer's own government either in principle and/or financially and, increasingly, to tie the sale into a package of goods that another government wants or needs. Three different types of foreign military sales are available to U.S. manufacturers. These are the Military Assistance Program (MAP) Sales, Foreign Military Sales (FMS) and Direct Sales. The MAP-financed aircraft sale goes directly from the manufacturer to the U.S. Government which then gives the aircraft to a foreign government based on its needs, with the U.S. Government retaining title to the aircraft. Any subsequent transfer of the aircraft to another country must be with the permission of the U.S. Government.

The FMS sale differs in that foreign governments "buy" aircraft from U.S. manufacturers, using the U.S. Government as sales broker and by using U.S.-issued trade credits. In FMS sales, title to the aircraft passes to the foreign owner, and the U.S. agency which handles the sale receives a management fee from the purchaser for overseeing the transaction.

Boeing Vertol CH47D

The direct sale is a sale directly from the manufacturer to a foreign government in exchange for money or credits. It requires an export license as a minimum and, if the aircraft has the capability to be armed, additional government approval may be necessary before the sale is final.

Programs in each of these categories can range anywhere from five to six aircraft to numbers in the hundreds. Typically, these programs require many months to develop and many more months to finalize.

Overall, the foreign military market is growing steadily and there is good potential for the sale of smaller and less expensive helicopters. In this arena, the reputation of the company, or the country, or possibly even the salesperson can make a difference. So, too, can government support. Foreign governments often put together substantial sales packages that U.S. manufacturers would have difficulty assembling. Just one example of this common practice is the French package of ships, helicopters, ground vehicles and arms sold to Saudi Arabia in 1980. A deal of this magnitude would probably have taken years to put together in the United States.

But most often the deciding factor in international military sales is pricing and financing. Here again, U.S. manufacturers cannot be as creative and aggressive as their international competitors, being constrained by their business structure and practices and the need to make a profit.

Foreign Sales of Military Aircraft by Foreign Manufacturers—The foreign competitors of U.S. helicopter manufacturers must also work through their governments in making military sales. They, too, face the problems of making sales in an arena where political differences, and the reputation of a company or country, play a vital role. European countries have tended to pool markets as well as resources, in effect, by codeveloping machinery where there is a common need. This has not always been successful, however, with respect to military programs. It has been more successful with commercial programs such as the Concorde (a technical success) and the Airbus (a technical success with prospects for marketing success as well). One of the aims of the European Community is to have member countries buy products from one another. If this were realized as fully as envisioned, it could provide European helicopter manufacturers with considerable market advantage within the Community over U.S. manufacturers.

Because of government financial and marketing support, foreign helicopter manufacturers have an edge over U.S. manufacturers in their ability to effect coproduction and licensing agreements in areas of the world where the profit potential may be only marginal. Examples of this are Aerospatiale's programs in Brazil, India, China, Rumania, Yugoslavia, and Indonesia where the first goal is to assure themselves of sales in key areas of the world. These programs are possible because of government backing in the interest of achieving national objectives such as market expansion and worldwide recognition for aviation products.

MARKET PARTICIPANTS

To understand the helicopter industry today, it is important to identify the key manufacturers who produce most of the world's helicopters. (Descriptions of both the American and foreign firms, including information on their origins and product lines are included in Appendix A.)

Looking first at the American manufacturers who produce both civil and military products, there are four major companies which have produced over two-thirds of the free world's helicopters over the last 20 years. They are: Bell Helicopter Textron Inc., a subsidiary of Textron, Inc.; Boeing Vertol Company, a division of The Boeing Company; Hughes Helicopters, Inc.; and Sikorsky Aircraft, a division of United Technologies Corporation. Other U.S. helicopter manufacturers include Hynes Helicopters, Inc., The Enstrom Corporation; Hiller Aviation, Inc.; Kaman Corporation; and Robinson Helicopter Company, Inc.

Four major aviation organizations have produced most of the free world's helicopters manufactured outside of the United States. They are: Societe Nationale Industrielle Aerospatiale (France), Messerschmitt-Boelkow-Blohm (West Germany), the Agusta Group (Italy), and Westland Helicopters, Ltd. (United Kingdom). There are, in addition, several foreign manufacturers predominantly involved in licensed production of helicopters designed by one or more of the major competitors. These include firms such as Nurtanio of Indonesia; Helibras of Brazil; and Kawasaki, Fuji, and Mitsubishi of Japan. (Kawasaki has undertaken some developmental activity in its participation with MBB on the BK-117 project).

Although each of the four leading European helicopter manufacturers today produces one or more models of its own design, these companies owe much of their technical expertise, if not their existence, to past associations with U.S. sponsors. The extent to which today's European industry is built on a foundation of U.S. technology can be illustrated by a brief review of the early histories of the leaders.

Agusta is perhaps the clearest example of U.S. technology put to work by European industry. Starting in the mid-fifties with a license from Bell for production of the Model 47, Agusta took on more and more license work until in 1972 it was producing no fewer than seven U.S. designs from three different manufacturers—Bell, Boeing Vertol and Sikorsky. These ranged in size from the 2,700-pound Bell Model 47 to the 50,000-pound Boeing CH-47C, and were sold in a variety of configurations to hundreds of military and civil customers worldwide.

Since the early sixties, Agusta had also been designing and testing its own helicopter models. Several of them, notably the A-106 light anti-submarine helicopter and the A-101G three-engine transport, were built in prototype form and flown in evaluation programs by the Italian military forces, but none entered production. Not until 1976, did an Agusta-designed helicopter, the A-109 Hirundo light-twin business helicopter, enter production. As re-

Aerospatiale Dauphin

cently as 1980, with A-109 production proceeding satisfactorily and development of the A-129 Mangusta underway, over 60 percent of Agusta's production output continued to be of U.S. design origin.

Westland Aircraft in the United Kingdom entered the helicopter field in 1947 with a license to produce the Sikorsky S-5l, which it named the Dragonfly. The company has held Sikorsky production licenses ever since; the S-61 Sea King still represents some 20 percent of its production output in 1980. In addition to U.S. technology, Westland received infusions of domestic design capability in 1960 through its government-enforced merger with other British helicopter firms. Two of these, Bristol and Saunders-Roe, brought with them indigenous programs which were already in production, and all brought engineering departments which combined to develop Westland's own first domestic model to enter production, the WG-13 Lynx. (Two earlier British-designed models, the Wasp and the Scout, had been produced by Saunders-Roe prior to the merger.) This aircraft was later included as part of a collaborative program with Aerospatiale, which also covered that company's SA-341 Gazelle and SA-330 Puma models.

Today, Westland is in production on its own Lynx and W-30 programs, and is developing jointly with Agusta the EH-101, an ASW helicopter which is based on Westland's WG-34 design. But even after 33 years in the business of manufacturing helicopters, a large percentage of Westland's all-time helicopter deliveries have been of U.S. design origin.

Like Westland, France's Aerospatiale Helicopter Division is the result of an amalgamation of separate domestic helicopter interests during the fifties and early sixties. Unlike Westland, each of the components of Aerospatiale was already owned by the government. Two of the elements, known under the acronyms SNCASE AND SNCASO, brought to the partnership ongoing production programs, the SE-3130 Alouette II and the SO-1221 Djinn respectively, and these two models are the technological forebears for today's Aerospatiale light helicopters, the Gazelle and AStar/Ecureuil. However, the company's first exposure to helicopters larger than 2500 pounds gross weight was the late fifties license production, by Sud Aviation, of Sikorsky S-58's. In the early sixties, when Sud sought to capitalize on this experience and develop its own large, three-engine SA-321 Super Frelon, it turned again to Sikorsky which contracted to design the rotor head and its controls. A further Sikorsky license for design of the main rotor head was used for the SA-330 Puma. Thus, to a larger extent, Aerospatiale's designs in the medium and heavy markets were dependent on the infusion of technology from American licensers.

The fourth European helicopter industry leader, MBB in Germany, also has past associations with the U.S. industry in its only production model, the BO-105. In this case, the connection is with Boeing, a minority stockholder in MBB since the foundation of the corporation. MBB has conducted a number of cooperative development efforts with Boeing Vertol, including technical assistance in the development of the BO-105. This relationship also includes one of the few examples of helicopter technology transfer in a Europe-to-U.S. direction when Boeing Vertol based the rotor head design for their YUH-61A UTTAS candidate on that developed in the BO-105.

It is true that in the eighties, each of the European manufacturers is producing its own designs to fill worldwide markets. While these countries would most certainly have been able to develop their own indigenous capabilities, achievement of their present level of competitiveness would have been substantially delayed were it not for the assistance, both in design and manufacturing technology, provided by the leading U.S. manufacturers with whom they now compete.

It is important to note that while each foreign helicopter manufacturer is the sole producer of rotorcraft in its own country, the U.S. industry is composed of a number of individual, autonomous firms. In competition with each

MBB BO 105

other for market share and, ultimately, for survival—these U.S. companies over the years initiated licensing and production relationships with foreign manufacturers. In retrospect, it seems that relationships made on sound business judgment at the time contributed to the establishment of strong foreign competitors for American firms. This evolution of affiliates into strong competitors is certainly not unique to the helicopter industry, nor is it anathema to U.S. manufacturers. Their primary point of concern has been the added element of foreign government support as the European nations particularly have fostered their aircraft industries, significantly altering the course of events. Foreign helicopter manufacturers have thus been given the opportunity to move ahead more quickly than might otherwise have occurred. At the same time it must be said that, as discussed in the next Chapter, U.S. policies and practices relating to technology dissemination have given foreign rotorcraft manufacturers an added advantage.

SIZE AND COMPOSITION OF THE WORLD HELICOPTER INDUSTRY

The U.S. helicopter industry is small relative to the total aerospace industry in the United States. Deliveries of U.S. built helicopters in 1981 exceeded $1.6 billion dollars compared with the $9.7 billion of U.S. civil transport sales and $2.9 billion of general aviation aircraft.[2] In 1982, helicopter manufacturers' deliveries totaled $1.3 billion.

Although rotorcraft manufacturing is the smallest segment of the aircraft industry, helicopter sales have been growing steadily at a yearly rate of 10-12 percent over the last two decades. Helicopters have been in production for only forty years in the United States and it is only during the last 10 years that the civil market has represented a significant proportion of the total (Figure 1). In 1980 and 1981, about 80 percent of *unit* shipments of U.S.-made turbine helicopters were for civil use. Value of new civil turbine helicopters accounted for a much lower proportion of the total, however (60 percent in 1980 and 48 percent in 1981), indicating the typically higher value of military models. By 1982, civil deliveries had dropped to 63 percent of unit shipments and 37 percent of value, reflecting both the impact of world economic recession on the civil aircraft market, and increasing foreign competition in the civil sector. The number of 1983 civil deliveries is expected to be below the 1982 level.

For helicopter manufacturers, 1980 was a very successful year. It was the best production year since 1973, when large numbers of rotorcraft were still being delivered for military use (Figure 2). Since 1980, deliveries have steadily declined as a result of sluggish economies and related factors such as the unusually high cost of borrowing money, and a low level of military procurement.

Sales have been unstable for U.S. turbine helicopter manufacturers over the last five years. In terms of current-year dollar sales, 1983 could be a five-year low. But if inflation is removed from these numbers, the result is a 20-year low in terms of either sales dollars or delivery units. Taking an optimistic outlook, one could assume that once interest rates stabilize at a lower level the economy will continue recovering and sales will increase. Assuming the growth will be comparable to previous annual rates of 10-12 percent, it will take at least several years until the industry returns to 1981 delivery levels and it could be many years until the unit production level once again returns to the 1980 mark.

Although both U.S. and foreign manufacturers are feeling the effects of the current sales slump, the former have been hit hardest (Figure 3). Looking at turbine-powered helicopters, which account for the vast majority of the sales dollars, in 1979 U.S. manufacturers held a world market-share of 60 percent of units delivered (Figure 2). By 1982 this share had slipped to 41 percent. This is the first time

[2]Aerospace Industries Association, *Aerospace Facts & Figures, 1983/84*, (Washington, D. C.).

FIGURE 1.

DELIVERIES OF TURBINE HELICOPTERS BY U.S. MANUFACTURERS, 1970-1982

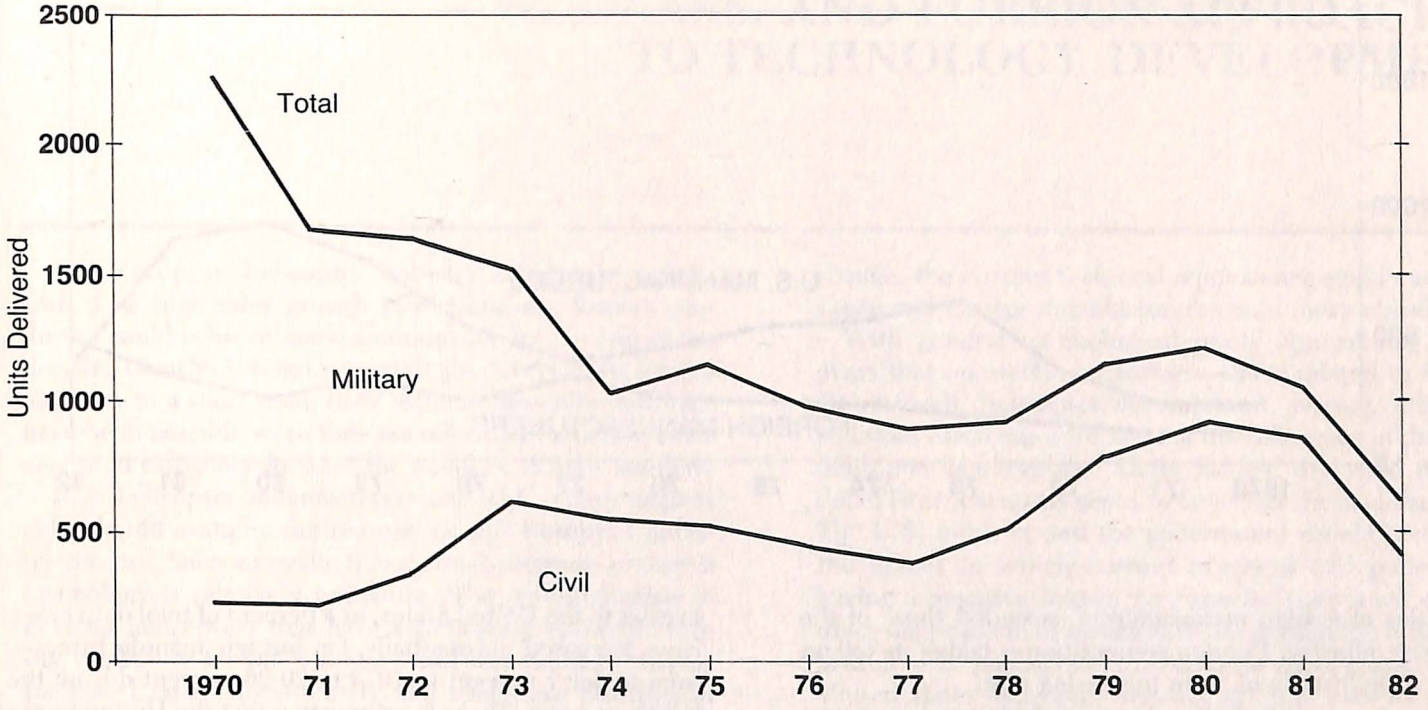


FIGURE 2.

WORLD TURBINE HELICOPTER DELIVERIES, 1970-1982

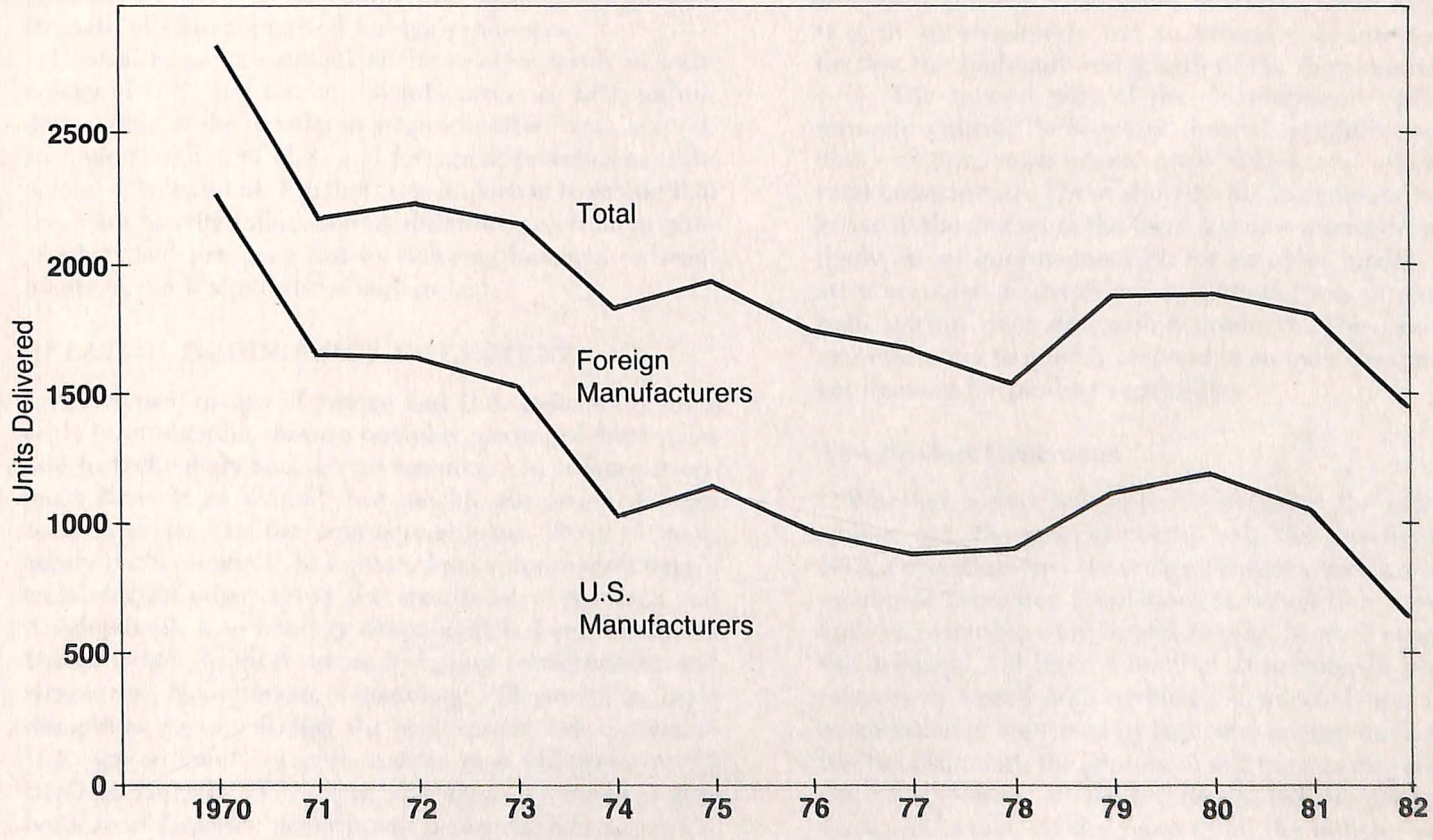
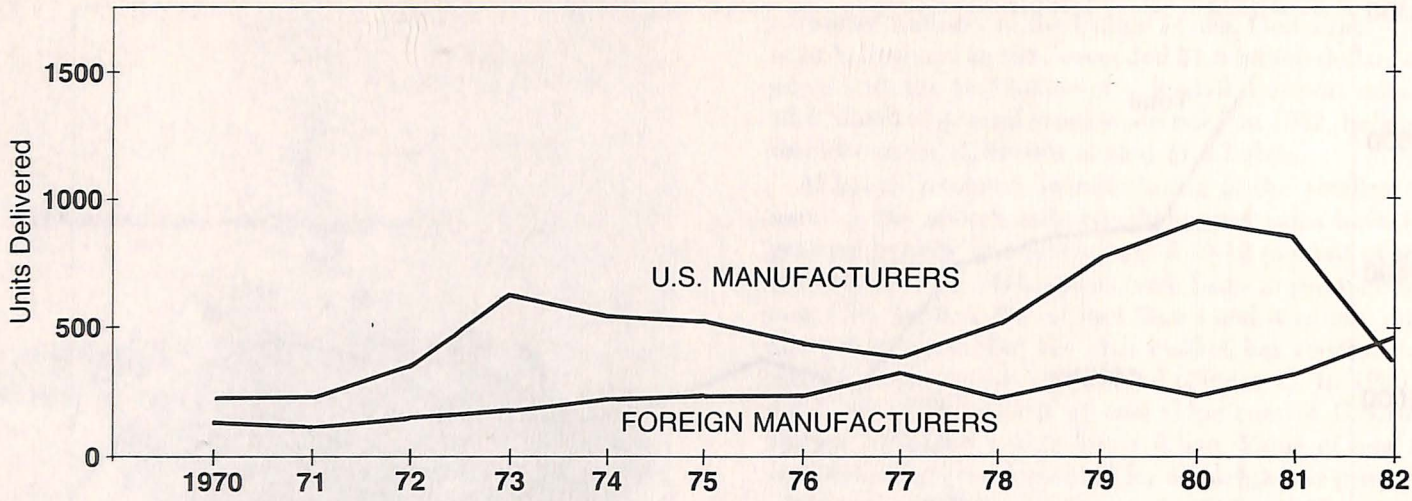


FIGURE 3.

U.S. AND FOREIGN MANUFACTURED CIVIL HELICOPTER DELIVERIES, 1970-1982



that sales of foreign manufacturers exceeded those of the domestic industry. Foreign competition is taking its toll on the U.S. industry and at an increasing rate.

Not only are U.S. helicopter manufacturers losing predominance in the world marketplace, they are also losing market share at home. The growth rate of foreign helicopter imports into the United States has accelerated. Deliveries to the United States, as a percent of total deliveries, have increased substantially for foreign manufacturers—from under 7 percent in 1973 to 20-26 percent during the last three years. There is no question that the United States is facing strong competition in yet another segment of the aircraft industry, an industry which has repeatedly made a strong positive contribution to the nation's trade balance.

U.S. AND FOREIGN APPROACHES TO TECHNOLOGY DEVELOPMENT

The European helicopter industry has grown rapidly and, if its high sales growth rate continues, foreign producers could achieve market dominance by the end of the decade. Clearly, foreign rotorcraft producers have come a long way in a short time; their sales momentum would not have been possible were they not offering products of demonstrated capability to meet the needs of various markets.

U.S. helicopter manufacturers and U.S. policy makers alike should examine the reasons for this European industry success. Such an evaluation is timely because rotorcraft technology is relatively immature. The potential exists to develop helicopters that have significantly improved mission capability for both military and commercial vehicles. Increased range, productivity and speed are possible, as well as improvements in comfort level, noise, life cycle cost, and safety. Emerging technology supports the development of advanced rotorcraft, narrowing the gap between the performance of helicopters and fixed-wing aircraft. U.S. manufacturers must remain in the technological forefront in order to be competitive against the growing strength of state-supported foreign producers.

Central to an assessment of the relative levels of technology of U.S. and foreign manufacturers is, first, an understanding of the development process itself and, second, an understanding of U.S. and foreign approaches to technology development. Further, it is important to realize that these are heavily influenced by different government philosophies and practices and by differing business environments in the United States and abroad.

RELATIVE TECHNOLOGY ASSESSMENT

A technical review of foreign and U.S. helicopters presently in production shows a complex picture of differences due to technology and design features. On balance it appears there is an overall, but quickly narrowing, foreign technology lag. In the commercial areas, there is more nearly parity, while U.S. military helicopter models have a technological edge. From the standpoint of research and development, a technology assessment is favorable to the United States in most areas, including aerodynamics and structures. Nonetheless, technology differences in basic disciplines are small and the widespread distribution of U.S. government research results may eliminate initial R&D advantages. The clear and alarming signal is that because of disparate government policy on information exchange, the current technical equivalence could easily dissipate and foreign manufacturers could move ahead.

With general technological parity approaching, it appears that non-technical factors—those related to funding for research, helicopter development, pricing, marketing and sales financing—are making the difference in the world helicopter marketplace. These factors, discussed in more detail later, currently seem to favor foreign manufacturers. The U.S. industry and the government should investigate the extent to which current practices and policies are having a negative impact on exports. They must also address the problem of significantly increasing the technology lead of U.S. producers. Unless these steps are taken, the United States helicopter industry will likely see its share of the world marketplace diminish still more sharply.

THE DEVELOPMENT PROCESS

The development of a new helicopter generation is a long and costly process. Companies introduce these new products in approximately ten to fifteen-year intervals, reflecting the high cost and length of the development process. The second part of the development cycle is to improve existing helicopters through modifications in a craft's engine, rotor heads, rotor blades, and other structural components. These short-term, incremental changes arrive in the market in the form of a new model or, alternatively, as an improvement kit for an older model. Derivative versions of aircraft are an essential way of recouping high startup costs of existing products. They also allow manufacturers to quickly respond to an ever changing market demand for product capabilities.

New Product Generation

Whether a new helicopter is designed for military or civilian use, the process begins with the development of design specifications; these specifications then go through numerous computer simulations at which time a model is built for extensive wind tunnel testing. As work progresses, the company will build a number of prototypes which are extensively tested and modified. If selected in a military competition or approved by company management for civilian development, the prototype will then go into engineering development, where the design will be prepared for mass production. At the same time, the military will con-

tinue testing a prototype destined for their use. For civilian craft in the United States, the Federal Aviation Administration (FAA) approves company test plans and tests of the model's mechanical reliability, flying abilities, and responsiveness under different weather conditions. All civil models must be certified by the FAA before any sales can be made. After the model passes all tests the company can begin production.

In general, military helicopters are more expensive to develop and require a longer development period than civilian craft. The increased cost arises from the greater sophistication of newly developed military systems and the greater stringency of military specifications. These two factors also stretch out the test and evaluation period. Because of the complexity of military helicopters and the need to evaluate a helicopter's performance in battlefield simulations, more frequent, complex, and sophisticated testing procedures are required.

The difference between industry and Government-funded programs is illustrated in Figure 1, comparing development lead time of a commercial model and a military model. As shown, first production deliveries of each type occurred at the end of 1978 or start of 1979. But the commercial model was developed over a four-and-a-half year period, while the military helicopter required nine years through completion of the maturity phase.

Delays are also introduced by the Government approval and testing cycle. In the case of the commercial program described in Figure 4, the development decision coincided with the production decision. Release of drawings for production occurred less than 12 months after program go-ahead, enabling first delivery approximately 36 months later. In the case of the military model, release for development fabrication was dependent on the Critical Design Review, nearly two years after program go-ahead, and five years before production delivery. Another difference between the programs is the length of the test cycle. This is required both as a result of new technology introduced in the military model and the demanding performance requirements specified by the military. FAA certification of the commercial helicopter for IFR operation occurred a little over two years after first flight, with production proceeding concurrently. The time interval between first flight and production deliveries of the military rotorcraft stretched to four years.

Product Improvement

Product improvement occurs regularly over the ten to fifteen year production run of a helicopter generation. Changes to an initial design can be quite major, e.g., transmission and airframe changes to improve fuel consumption and increase payload, or rotor blade change (from metal to composite, for example). Over time, changes improve performance by smaller increments as a model approaches the limits of a design's potential.

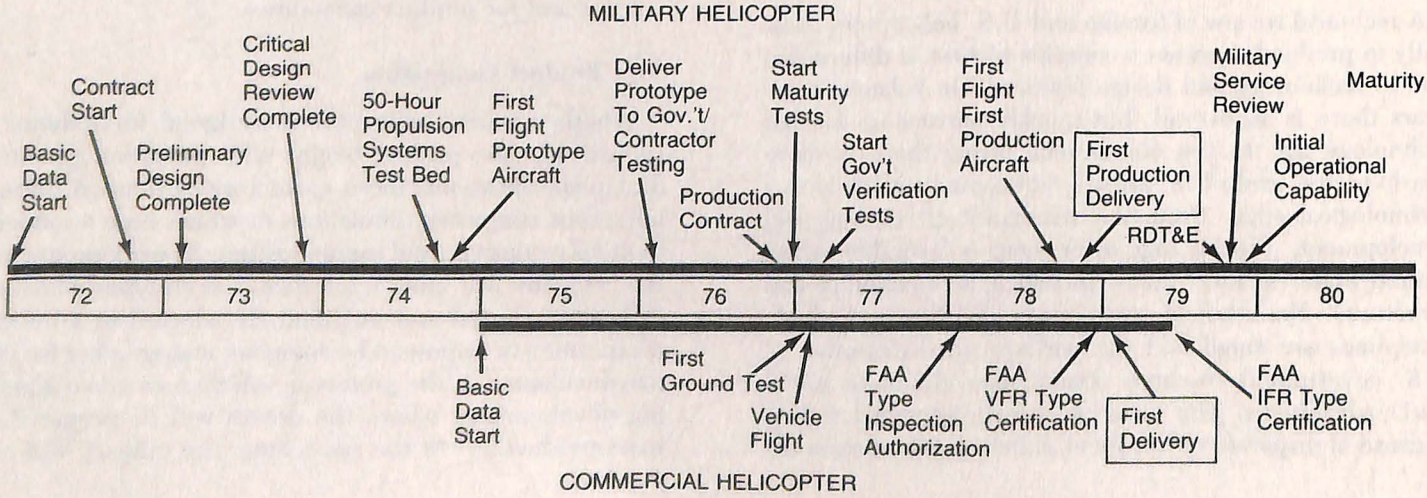
The evolution of a large army transport produced by one U.S. firm illustrates the importance of product improvement to helicopter manufacturers, as well as the cost. The first model of this transport was delivered more than 20 years ago and was itself based on an earlier, smaller helicopter. The most recent modification, of which first delivery was made in May 1982, took place over a four-year period and cost $75 million for research, development, test and evaluation.[1] This particular program shows that the large investment required to produce improved models can pay off, however, as it enables the helicopter to remain competitive for years.

It has been said that U.S. helicopter manufacturers use "old" technology. In fact, all producers use a "building block," evolutionary approach to product development, based on proven technology. The requisite time and cost

[1]Department of Defense, *Program Acquisition Cost by Weapon System*, various years.

FIGURE 1

COMPARISON OF DEVELOPMENT SCHEDULES MILITARY AND COMMERCIAL HELICOPTER MODELS



involved in bringing out either totally new designs, or making modifications, must be carefully factored into program decisions.

EUROPEAN VERSUS U.S. APPROACH TO TECHNOLOGY DEVELOPMENT

Helicopter manufacturing is a very technology-intensive industry in that large sums are expended in research and development in order to push the state-of-the-art forward. Market demands, both for civil and military helicopters, are such that continual and rapid improvements in performance are required to maintain a given manufacturer's market position. Historically, new technological advances were derived through military programs and thus funded from government sources. Once such technology was developed and proven on the military programs, it was then, at a later date, incorporated into the manufacturers' commercial models.

This procedure has worked well in the past for U.S. rotorcraft manufacturers. In the sixties, the U.S. Army and Navy's requirements for larger, faster, and more maneuverable helicopters stimulated the production of models suitable for these needs. Derivatives of these aircraft were adapted to the emerging civilian markets of the period. In the seventies, manufacturers became sufficiently confident of the stability and future growth of commercial markets to initiate development programs specifically directed to this sector. However, while the development programs were funded by internal corporate sources, they incorporated technology that had been developed and funded in previous military programs.

The rationale for not attempting to introduce anything more than incremental technological advances into commercial models is due to considerations of maintaining acceptable levels of program risk and the striving for a sufficient level of return to justify the investment. For commercial programs a company is faced with initiating an expensive development program on the basis of a relatively uncertain market outlook extending twenty years into the future. To couple this market uncertainty with the added risks involved with the introduction of new technology would lead to overall program risks that would be unacceptable for privately-funded efforts. As a result, industry-funded commercial programs are driven to shorter development lead times and use of concurrent rather than advanced technology. In general, it might be stated that the objective of Government-funded programs is to advance the state-of-the-art, while the objective of commercial programs is to reduce these advances into economical practice and achieve rapid introduction to the competitive marketplace.

Because of this important connection between civil and military R&D, the military cycle itself has an important impact on civil helicopter development programs. In the United States, rotorcraft producers engage in lengthy and intense competition for U.S. government contracts such as the Army's new utility helicopter, the UH-60A Blackhawk; their new gunship, the AH-64 Apache; and their latest scout helicopter, a modified version of the OH-58A, known as the Model 406 AHIP (Army Helicopter Improvement Program).* Firms are driven to move forward the leading edge of rotorcraft technology but the structured competitive phases of U.S. defense programs delay the final fielding of these advanced systems. Required competitive prototyping can consume as much as three years before full scale development for production can begin, and operational testing of pre-production prototypes must be completed *before* release for production. The last requirement can add as much as two years to the development cycle. The lag between development and utilization of technology is especially important where civil application proceeds from a prior military introduction of a new design or technology. In contrast, European nations tend to address civil applications in their military programs (as previously discussed for the EH-101), and enjoy shorter development cycle times as well.

While protracted competitive military programs are underway in the United States, the technology on which individual companies have based their models is also available to European helicopter manufacturers. Over the years, the liberal dissemination of research results by the National Aeronautics and Space Administration and the generally open discussion of research by the U.S. technical community, has provided foreign firms with valuable technology assistance. Combined with the already established capabilities of these countries and their government's support, this assistance has often enabled European manufacturers to field technology more quickly than in the United States where much of the technology may have originated. The technology gleaned from the United States has freed foreign producers to concentrate R&D on specific portions of technology. Technology transfer, in other words, has enabled them to move ahead rapidly in key areas such as composite structures.

With the above background an understanding can be achieved of the following risks facing the American helicopter industry in the future.

Specialization of U.S. military market—In the past technology, and even entire vehicle designs, were easily transferred from the military sectors to the commercial marketplace. However, in recent years military requirements have become so specialized that they are diverging considerably from the attributes required for success in commercial markets. As an example, Army aircraft generally are designed to maintain operational capability at pressure altitudes and temperatures far more extreme than those which commercial models will face. Military markets are placing emphasis on survivability, low life-cycle cost, de-

*This program is unusual in that corporate funds were spent to develop new components of this aircraft before the Army decided to fund the program.

tectability and maneuverability, whereas the growing sophistication of the commercial markets is demanding improvements in reliability, safety, comfort, acquisition costs and productivity. These differences lead increasingly to divergences in the designs appropriate to each of the individual markets. As a result, models optimized to specialized U.S. military criteria may now present potentially weak competition vis-a-vis foreign Government-funded designs directed to the commercial market.

Flexibility of foreign military design specifications— Foreign military establishments, particularly the French and British, have shown greater willingness to relax their specifications to improve the export potential of their resident industry's products and/or to allow easier adaptation of the model to the commercial market. To a large extent this policy is necessary to maintain economical production, since domestic demand is relatively small. In France, for example, exports comprise more than 75 percent of total aerospace military production. As an example of this trend, the EH-101 project, being funded jointly by the governments of Italy and the United Kingdom, involves the development of a 30,000-pound helicopter intended initially for military markets but later changed to make it commercially attractive as well.

As indicated earlier, the U.S. manufacturers have greater difficulty in incorporating major technological advances in commercial programs because of the unacceptability of incurring additional risks on top of the already substantial market uncertainty. Foreign manufacturers, backed by government funding, have less motivation to avoid these risks; the penalties for failure are less severe in that national goverments seldom require paybacks on unprofitable programs. As a result, while lagging behind the United States in over-all technology development, European manufacturers may incorporate advanced technology in their commercial designs and, indeed, even obtain government funding to pursue such advances as part of a commercial program. For example, the British government has provided 71.7 million dollars to "cover the development and production" of an improved Westland 30, a purely commercial helicopter.[2]

FUNDING HELICOPTER DEVELOPMENT

The high level of investment and the requirement for U.S. manufacturers to be competitive in the civil as well as the military market poses substantial R&D investment requirements. While foreign governments will fund both commercial and military projects directly, the U.S. government directly funds only military development programs. There is an opportunity for U.S. manufacturers to recoup some of their investment in R&D expenses on commercial programs if the R&D has potential military applicability. A manufacturer will present its program of self-initiated and funded independent research and development (IR&D) in a yearly review with government officials. The government may allocate a certain percentage of the company's costs to products and services sold to the Defense Department in that year by that manufacturer. The amount of allocation will be a negotiated percentage of the firm's approved IR&D, with a maximum ceiling. If the company had no ongoing program with DOD in that year, then no IR&D cost allocation is possible.

From 1974 to 1979, there was a downward trend in the portion of IR&D costs allocated to all DOD contracts—from 40 percent in 1974 to 30 percent in 1979. The allocation of IR&D costs to DOD contracts has increased over the last three years to nearly 38 percent of costs incurred.[3] Nonetheless, this means that, in 1982, $2.65 worth of contractor IR&D was accomplished for each dollar charged to DOD contracts. Whatever their recovery from DOD of costs incurred, defense contractors must continue to invest in R&D out of profits or commercial sales to maintain their readiness for new programs, and the government benefits from their investment.

American and European governments alike provide some funding for basic aeronautics R&T through scientific research institutes to increase the technology data pool available to manufacturers. Although U.S. aerospace research institutions have historically taken the lead, they have been followed quite closely by research organizations

TABLE 1

CIVIL AERONAUTICS RESEARCH FUNDING THROUGH PUBLIC RESEARCH INSTITUTIONS EUROPEAN NATIONS AND UNITED STATES 1980 (Millions of Dollars)

Belgium	$ 6.1
France	92.3
Germany	83.8
Italy	6.9
Netherlands	NA
United Kingdom	89.2
Subtotal	278.3
United States	308.0

Source: Commission of the European Communities, *The European Aerospace Industry Trading Position and Figures*, (Brussels, Belgium), 1980, p. 80.
Budget of the U.S. Government, Fiscal Year 1981, U.S. Government Printing Office, Washington, D.C.

[2]*Air International*, November 1982, p. 210.

[3]Defense Contract Audit Agency, *Summary of Independent Research and Development and Bid and Proposal Costs Incurred by Major Defense Contractors*, various years.

TABLE 2

NASA RESEARCH AND DEVELOPMENT BUDGET AUTHORITY AND THE AERONAUTICAL COMPONENT (Millions of Dollars)

	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83[a]	FY 84[a]
				CURRENT DOLLARS			
Total NASA R&D	3,102	3,477	4,088	4,336	4,738	5,543	5,709
Aeronautics R&T[b]	228	264	308	271	265	280	300
Rotorcraft R&T[b]	17	21	32	31	42	45	51
				CONSTANT DOLLARS[c]			
Total NASA R&D	2,064	2,127	2,298	2,220	2,266	2,525	2,469
Aeronautics R&T	152	161	173	139	127	128	130
Rotorcraft R&T[b]	11	13	18	16	20	20	22

[a]Estimate as reported in the Budget of the *United States Government-Fiscal Year, 1984,* U.S. Government Printing Office, Washington, D.C.
[b]Aeronautics Budget, National Aeronautics and Space Administration, various years.
[c]Based on FY GNP deflators.

in the major European nations. Today, the level of spending on aeronautical research is estimated to be quite similar in the United States and in Europe, as shown in Table 1. The primary government agency performing aeronautics research in the United States is the National Aeronautics and Space Administration (NASA). Even though NASA's budget is larger than the other aeronautical research groups individually, it can be seen that the Europeans together maintain a comparable, if not somewhat larger government funded research effort. If a fairly substantial share of U.S. funded technology is also flowing overseas, there may, in fact, be an imbalance, to the detriment of the United States. It is critical that subsequent U.S. budget priorities reflect the commitment to aeronautics R&T that is expressed in the Reagan Administration's policy pronouncement. If they do not, U.S. technology leadership could shift in part to Europe where intense research is currently being performed in such commercially sensitive areas as fuel efficiency and maintenance reduction. The European and particularly the French research institutes may be of greater assistance to their industries, not due to higher levels of funding, but because of the performance of more highly focused industry-specific research than NASA performs. In addition, national research institutions abroad generally support a single helicopter manufacturer while U.S. producers compete against each other, in effect, both for research results and research facilities.

Foreign governments have been very selective and perceptive concerning new research facilities in the rotorcraft field. The Europeans have excellent wind tunnels and facilities for noise and rotor icing research. In the United States, helicopter research facilities have had significant financial support in recent years, particularly by NASA, but these improvements have tended to focus on very large and elaborate facilities which extend existing capabilities rather than address new problems. The 40 x 80 x 120 full-scale testing facility at NASA/Ames Research Center will be an extremely valuable tool for U.S. manufacturers, if sufficient funds can be found to support tests at the scale that this facility addresses. Similarly, the NASA Vertical Motion Simulator is undoubtedly the best facility in the world for vertical takeoff and landing (VTOL) simulation; but it is also an extremely expensive facility to use. On the other hand, facilities for noise and icing testing, two new areas of growing concern, have been virtually neglected in the United States.

The NASA Budget

Substantially all of NASA's budget is devoted to research and development although aeronautics (aerodynamics, propulsion, avionics and similar disciplines plus selected demonstration projects) is only one of four major areas of research, the others being related to space.

NASA's research and development budget since 1978 and the share of that budget going to aeronautics and rotorcraft R&T are shown in Table 2.

In real terms, aeronautics R&T funding increased between 1978 and 1980 and then showed a decrease in FY 1981 and 1982; FY 1983 and 1984 funding represents some improvement.

NASA rotorcraft R&T, as can be seen in Table 3, represents a small, though increasing, share of that agency's total aeronautical R&T funding, amounting to seven percent in FY 1978 and rising to 17 percent in the proposed FY 1984 budget. Budgeted rotorcraft R&T funding for FY 1984 is, in constant dollars, double the level of FY 1978, resulting from joint funding with the military and emphasis on advanced concepts such as the Tilt Rotor, X-Wing and the Rotor Systems Research Aircraft program. Nonetheless,

TABLE 3

AERONAUTICS R&T AS PERCENT OF TOTAL NASA R&D AND ROTORCRAFT R&T AS PERCENT OF AERONAUTICS R&T

	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84
Aeronautics R&T as Percent of Total NASA R&D	7.4	7.5	7.5	6.3	5.6	5.0	5.3
Rotorcraft R&T as Percent of NASA Aeronautics R&T	7.4	7.5	10.4	11.4	15.8	16.0	17.0
Rotorcraft R&T as percent of Total NASA R&D	.5	.6	.8	.7	.9	.8	.9

NASA rotorcraft R&T funding accounts for less than one percent of total NASA R&T funding, and actual levels are expected to decline somewhat in Fiscal Year 1985-86 as some of the joint military projects and advanced concepts are developed and move into the application phase.

When the FY 1983 budget was submitted, the Office of the President and the Office of Management and Budget commented about NASA aeronautics research: ". . . federal support for technology development with relatively near term commercial application represents an inappropriate subsidy to industry and is being curtailed.[4]

Since then, the Administration has completed an in-depth study of Aeronautics Research and Technology policy, rejected threatened cuts in funds, and concluded that strong support for research promises large advances in both civil and military aviation.[5] The Administration concluded that potential improvement gains to be made in aviation warrant aggressive research investments in the future, and that a continued strong government-budgeted program of aeronautical R&T is consistent with overall government priorities.

[4]Executive Office of the President, *Budget of the U.S. Government—1983*, p. 162.

[5]Executive Office of the President, Office of Science and Technology Policy, *Aeronautical Research and Technology Policy*, Vol. 1: Summary Report, Nov. 1982.

TABLE 4

U.S. ARMY AND NAVY RDT&E—HELICOPTERS (Millions of Dollars)

	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83
			CURRENT DOLLARS			
Army Rotorcraft RDT&E	308.1	293.3	291.6	298.1	290.2	327.7
Navy Rotorcraft RDT&E	4.0	113.0	224.0	154.0	95.0	50.0
			CONSTANT DOLLARS[a]			
Army Rotorcraft RDT&E	205.0	179.4	163.9	152.6	138.8	149.3
Navy Rotorcraft RDT&E	2.7	69.1	125.9	78.8	45.4	22.8

Source: Department of the Army, Department of the Navy

[a]Fiscal year GNP Deflator

TABLE 5

SIZE AND OWNERSHIP OF MANUFACTURING FACILITIES
1981
(Thousand Square Feet)

Company	Owned	Leased	Gov't Owned	Total	Percent Gov't Owned
Boeing	38,400	6,800	200	45,400	0.4%
Textron	18,401	3,637	220	22,558	0.9%
United Technologies	45,287	5,067	none reported	50,354	0

Source: SEC Form 10K—1981 Properties Report, Summary of Data

Two other important sources of government R&D dollars for the helicopter industry are the U.S. Army and Navy, each of which has provided more direct dollars for rotorcraft technology development over a 6-year period than has NASA (Table 4).

In a minor way, the U.S. government also provides support to companies which are performing manufacturing operations under a defense procurement contract by allowing them to use government owned facilities without paying rent. However, for the major, publicly-owned parents of helicopter manufacturers, this form of assistance is miniscule. (See Table 5).

U.S. TECHNOLOGY DISSEMINATION

Since the primary rationale for government sponsorship of aeronautics R&D through NASA is to provide the United States with a technical edge for military supremacy and foreign commercial trade, it becomes important to address the degree to which U.S. firms have preferred access to government-sponsored research results. The Office of Science and Technology Policy study of aeronautical research and technology concluded that an in-depth evaluation of NASA dissemination policies and procedures should be made.[6] It would appear that constraints are needed to assure that it is the U.S. industry that first benefits from publicly-funded research. NASA's For Early Domestic Dissemination (FEDD) guidelines need to be strengthened. In addition, some differentiation needs to be made between basic R&D information released for widespread circulation, and engineering/applied technology that may merit more careful release.

This concern with technology dissemination is not to say that it can or should be totally eliminated. Nor is it the main reason why European manufacturers have fielded new technology more quickly. Nonetheless, the broad and timely dissemination of the majority of U.S. government research results—occasionally to foreign audiences before publication in the United States—clearly dilutes any technological advantage the United States might have relative to the foreign research community. The United States should also concentrate, as the OSTP study has pointed out, on better collection, translation and distribution of technical information gathered from abroad; this should be a function of NASA and given high priority. Much new technology in the rotorcraft area was first developed abroad—the use of fiberglass for the hub and blades, are examples—and yet this technical data is, for the most part, not disseminated by the foreign research community. The United States would benefit from a more concerted attempt to "trade" information, as opposed to broad dissemination.

The timely transfer of technical information and the implicit cross-fertilization of ideas that it supports has always been strongly encouraged in the United States through professional societies and forums. This is not in itself objectionable because much of the interchange is controlled by industry. A much more intimate dissemination takes place as a result of Memoranda of Understanding (MOUs) between the United States and foreign governments. These MOU's are designed to eliminate duplication in the development of NATO weapons systems with the attendant waste of technological and financial resources, to foster logistical commonality among the weapons systems of the alliance, and to equitably distribute employment related to weapons production. Under this concept, all NATO weapons requirements (U.S. and other) will be equitably competed through the industrial base of the alliance as a whole. The MOUs provide for government-to-government technology exchange agreements to place European companies on the same footing as those in the United States and vice versa (i.e., share the common *military* technology base). Such government to government agreements originated to facilitate the exchange of information in very specialized technical areas but have often been vaguely defined and broadly interpreted. This point is critical since

[6]Ibid.

data in Department of Defense development centers on rotorcraft airframe technology is applicable to both military and commercial products. European helicopter development centers are contained largely within nationalized companies. Thus, technology applicable to commercial helicopters is passed directly to European competitors via Reciprocal Defense Production MOUs. There has been much concern about transferring military technology via dual use of commercial transactions. There is little or no concern about passing commercial technology to foreign competitors via military technology exchange agreements under the MOUs. This dissemination of information has permitted the Europeans, and the Soviets, to concentrate research efforts in key areas where they see large payoffs, while relying on the United States to provide the broad spectrum of engineering research results required to make advances on all fronts. This is particularly true in the systems research areas, and especially advanced configurations. In several areas of helicopter technology, for example, the only advanced concept work is being conducted in the United States.

In summary, with comparable resources and levels of effort, the European industry generally has adapted U.S. technology except in those specialized areas where their effort has been concentrated. The length of the foreign lag in technology has been gradually reduced as the European industry has matured. Today, the lag depends on:

- The rate of progress of U.S. technology;
- The time lag for release of U.S. technology overseas; and
- The relative response time for new helicopter development or modification of U.S. versus European aircraft.

In addressing the problem of technology transfer, a distinction must be made between technology that is presently existent and has been incorporated into a saleable product and that which is still in the research phase. Controls on the former are usually impractical and can limit the competitiveness of American industry. Often comparable products are available from foreign competitors and, in any event, reverse engineering can duplicate existing technology. Controls on developed technology can also inhibit the potential for coproduction programs, which are increasingly a requirement for overseas sales.

The appropriate placing of controls is on basic research, where the release of such information will allow foreign competition early access to technology. Obviously, release of such information could be harmful to the competitiveness of the industry and/or to the security of the nation. At the same time, there are problems with controls in this area as well. They can inhibit the valuable flow of information even within a company and, certainly, within the U.S. technical community.

MANUFACTURER/GOVERNMENT RELATIONSHIPS: THEIR IMPACT ON THE INTERNATIONAL HELICOPTER MARKETPLACE

The nature of the aircraft industry and its helicopter component, and the importance of both to national security, places them in a unique relationship to the national government. This holds true worldwide, whether a government owns or controls the industry, as in many European nations, or whether it is simply the major purchaser of privately produced aircraft and related weapons systems, as in the United States. Despite this necessarily close relationship between aircraft manufacturers and the government, there are nonetheless very real differences between the support provided industry by the United States and that provided their aircraft industries by many other countries.

DIFFERENCES BETWEEN GOVERNMENT-CONTROLLED ENTERPRISES AND PRIVATE COMPANIES

The foreign competition facing the American helicopter industry is, for the most part, composed of firms either directly owned, or strongly influenced, by their respective national governments. As such, these firms bring to the market a unique set of objectives and characteristics that places privately-owned U.S. firms at a distinct competitive disadvantage.

A discussion of the differences between government-controlled and privately owned enterprises can be divided broadly into three aspects of the problem:

- Goals and objectives,
- Costs and risks, and
- Support of product marketing.

These issues are discussed below.

GOALS AND OBJECTIVES

The aircraft industry, including the helicopter component, is a key industrial sector in that it has the potential to affect the development of the rest of the economy and can also be used to accomplish non-economic and social objectives. First and foremost, it is of critical importance to national security. Indigenous military production capability makes a nation less dependent and vulnerable in time of national emergency.

For nations seeking to pursue independent foreign policies, such as France, reliance on imported military equipment may potentially act as a constraint to their freedom of action. Successful production of military products can be used to support national foreign policy initiatives and to extend a nation's influence over less developed countries. Second, Government purchases from the industry often represent a sizeable portion of the national budget, thus consuming a considerable amount of the taxpayers' funds. Third, a successful aircraft industry can be a major factor in favorably altering a nation's balance of payments. This is an important consideration to France, for example, where over 85 percent of the helicopters produced are exported. These countries have certainly been influenced by the experience of the United States where the aerospace industry is the largest manufacturing contributor to the balance of trade, and in 1982 had an $11.2 billion trade surplus. In 1981, before the full impact of the recession, aerospace had an even higher trade balance of $13.1 billion. Finally, being a high-technology industry, aerospace—with heavy reliance on its aircraft component—can act as a stimulant to the development of associated technologies. This stimulus is provided both directly as a result of servicing the aerospace sector and indirectly through the application of aerospace technology to other industrial sectors.

In the United States, the aeronautical industry was initially developed, and has subsequently remained, primarily within the private sector. Decisions on product offerings, investments and pricing are based on the need to balance two objectives:

- To provide an offering that will be sufficiently attractive to the customer, both in performance capabilities and in price, for him to choose that product over those offered by the competition.
- To obtain a price that will cover all of the manufacturer's costs—both the direct costs of making the product, and the overhead costs of maintaining and operating the business.

The second of these objectives is so important that in many cases it will be the basis for a "no-bid" decision, i.e., a decision not to go after business because it could only be won at a price that would not cover costs and provide the profit necessary to stay in business.

In the U.S. commercial arena, it is the general belief that the "check and balance" nature of these two goals will result in the most cost-effective product and competition,

therefore, has been encouraged. This philosophy has also been extended to the military sector where contracts are usually awarded only after fierce competition.

In government-owned or controlled companies as in Europe, however, the factors that act to make aircraft a critical industry are taken more directly into consideration. As a result, both military and commercial investments are influenced not only by projected profits, but also by the following objectives:

- Support of foreign policy initiatives
- Contribution to the balance of trade
- Advancement of the national technological base
- Enhancement of national prestige
- Increased employment opportunities for professionals and skilled labor

When the government-owned or supported company approaches new business, it makes its crucial bid and pricing decisions based upon the national social accounting system rather than the much narrower accounting of commercial enterprise. For example, a contract which provides work for the labor force but does not completely cover labor costs may be preferable in a national accounting sense than the alternative of supporting those same workers as unemployed. Similarly, obtaining an inflow of foreign currency or influence with a foreign nation will also have a value which can be offset against the purely internal concept of commercial profit.

Indicative of the European attitude toward the aeronautical industry was the following statement by Marcel Cavaille, former French Minister of Transport, concerning development of a medium-range 160-seat airliner: ". . . the Government must also assess the effects of the launch of a new program on jobs for the highly-skilled, of which there are many in the aircraft industry, and on the balance of payments, in which this advanced activity plays an important part."[1]

DEVELOPMENT COSTS AND RISKS

The introduction of a new helicopter to the market entails a development period of six to eight years and the expenditure of hundreds of millions of dollars. Returns on investment, particularly for commercial models, are not easily predictable in advance, being dependent on sales forecasts as far as fifteen years into the future. In fact, the magnitude of the investment required and the riskiness of such ventures are often cited as major rationales for government support.

Funding Sources and Cost of Capital

Helicopter related research and development and capital investment in plant and equipment is funded from: equity, debt, retained earnings, government funds provided under contract and, in the case where R&D is directly charged against current earnings, from operating income. These sources of funds are used by both European and American companies although the importance of each source varies from company to company.

The ability to attract funds from the three external sources is strongly affected by the real risks inherent in the business as well as the risks perceived by the investing public. U.S. helicopter manufacturers, like most large U.S. corporations, raise much of their funds in the equity and debt markets where each company's capital structure and return to equity and debt holders is examined. It is at this point that the assessment of the risks of producing for the military and civilian markets is important, for the amount of risk perceived by the public is directly related to the returns they demand.

In privately-owned firms, the cost of investment funds is usually expressed as the rate of return required by the source of funding for having taken on the financial risks involved in the program. This rate of return is normally risk-adjusted, i.e., the returns must appear sufficiently lucrative to counter-balance the inherent risks of such development programs. In an environment where risk-free U.S. Government Treasury Bills were recently yielding over 14 percent, the cost of debt financing on ventures as risky as new helicopter programs may rise to as much as 20-25 percent.

R&D is particularly sensitive to the cost of capital (See Appendix C). Discounting returns in later years to reflect these costs can have a strong negative impact on the present value of R&D efforts. Combining this effect with the higher return on investment required for risky projects makes R&D financing particularly expensive.

Further, since the four major U.S. helicopter manufacturers are all part of larger industrial concerns, obtaining development funds for helicopter programs involves demonstrating a combination of risks and rewards superior to that which can be achieved in the diverse industrial sectors represented by other divisions of the parent company. (For example, the parent companies of U.S. helicopter manufacturers also own companies involved in such activities as elevator and air-conditioning installation, commercial aircraft and engine production, and machine tooling.) Once such a demonstration is made, procurement of funding usually involves considerable and often repeated justification to corporate officers, the board of directors and stockholders.

The implications of the costs of funding helicopter development are not as straightforward as they might seem because aerospace, in common with other high-technology industries, is somewhat more constrained in its ability to reduce R&D expenditures during periods of adverse economic conditions than most manufacturing sectors. Technology is vital for competitive success, especially when companies are faced with foreign competitors whose government sponsors are continuing to escalate the provision of R&D funds to their resident industries. Although at a decreasing rate, aerospace continues to pour funds into

[1] "Cavaille Speaks to 'Flight,'" *International*, November 19, 1977, p. 1510.

technology and product development; to do otherwise would be a form of corporate suicide. These funds represent an increasingly greater cost as the interest rates rise. Again, independent of the economic environment, the cost of the government-furnished funds that the foreign competition receives is essentially zero. Thus, particularly during periods of high interest rates, American high technology is conducted at a major financial disadvantage vis-a-vis its foreign competition. As many economic forecasters foresee an extended period of high interest rates during the eighties, this disadvantage can be expected to exist throughout the coming decade, and America's technology leadership will face further erosion.

In government-controlled companies, the cost of capital is either entirely independent of financial markets or is highly influenced by state backing. There are several mechanisms by which foreign governments can contribute to the funding of state-controlled firms. First, acting in its role as a stockholder, the government can provide continual infusions of equity funds to either increase the capital stock or to compensate for losses incurred during the performance of "uneconomic" activities. Such funding was provided Aerospatiale in the period from 1970 to 1978, during which it suffered a continuing series of losses. The French government provided Aerospatiale with $70 million when it was first formed in 1970 and, subsequently, provided additional capital in the following amounts: $14 million in 1973, $108 million in 1974, and $124 million in 1976.[2]

Debt Financing

Firms that are either partially owned by the national government, such as Germany's MBB and Italy's Agusta, or highly dependent on governmental support as is Britain's Westland, may have difficulty in attracting private equity investors since they are often seen as being less profitable than private firms. However, since there is an implied government protection against default, such firms are able to finance themselves with a higher proportion of debt, at interest rates only slightly in excess of that of the national government's. By being able to rely on higher debt burdens rather than more expensive equity funds, these firms can further reduce their overall cost of capital.

The most common form of subsidy is the government loan or loan guarantee which allocates to the government a share of the future revenues generated from the specific program being funded. These loans are repayable only if the venture has a favorable financial outcome, the usual practice being that payment does not begin until a break-even point is achieved. France's aircraft industry has been a major recipient of government-provided loans. In addition to direct budgetary allocations, which supported the Mercure 100, the CFM-56 engine and the Airbus programs, Aerospatiale has obtained funding from "Article 90" aid whereby the government participates (up to 50 percent) in the development program and shares in the subsequent revenue. Such a program was used for the development of the Puma helicopter.[3] Aerospatiale also has access to "Chapitre 52-90" aid, which is directed toward promoting exports and is repayable from future sales. In addition, the government provides FDES loans (Fond de Development Economique et Social) to implement programs displaying economic or social value.[4]

Risks in Military Programs

While it is true that sizeable sums are provided by the government for military research and development, two important distinctions relative to the financing practices of foreign governments should be emphasized. First, the U.S. Department of Defense is concerned solely with developing products to meet anticipated military requirements. There is no direct intent to develop either products or technology for commercial application. Contrary to this, as discussed in the previous chapter, developmental aid is often provided to foreign manufacturers for the funding of commercial programs. In addition to the earlier-cited example of the British/Italian EH-101, the Japanese Ministry of International Trade and Industry has made a substantial loan to back the development of the BK-117, an intermediate-sized utility helicopter, and can be expected to fund additional programs in the future.[5]

A second important distinction between U.S. and foreign financing practices is that U.S. military procurement policy is strictly concerned with preparing to meet a threat to the national security. The extent of military funding varies over time as a function of both the internal and external political environments and funds are often provided on a stop-and-go, year-by-year basis with no direct relation to a long-term funding plan. In recent years, the Defense Department has used multi-year procurement to inject some stability into the funding process, and several helicopter programs have been funded on this basis. However, this funding approach could be more widely utilized.

Foreign governments, particularly the French and Japanese, fund their aircraft programs as part of a long-term industrial policy, which often involves planning horizons up to 20 years into the future. U.S. policy, concerned primarily with the short-term outlook, is often an inhibiting rather than a contributing factor to commercial helicopter development. The cyclical nature of military spending introduces added risks in that capacity additions required to

[2]"The Helicopter Industry of Western Europe," a private study commissioned by Sikorsky Aircraft and prepared by EcoPlan International, September, 1977.

[3]Report by M. Jacques Limouzy to the French National Assembly, "Commission D'Enquete Sur L'Utilisation Des Fonds Publics Alloues Aux Enterprises Privees ou Publiques de Construction Aeronautique," April 21, 1979.

[4]Ibid.

[5]"The MBB/Kawasaki BK-117," *Interavia*, April 1979, p. 325.

meet near-term requirements may be underutilized in the long-term as military requirements ease.

The high volume of military sales flowing to U.S. helicopter manufacturers is often cited as evidence that the business risks faced by these firms always have been and will continue to be relatively low. Inherent in this idea are two fallacies: the first and most obvious is that the military market clearly dominates. While it is true that sales to the U.S. military were once the dominant market for U.S. helicopters, the military's role has diminished. Deliveries to the U.S. military in 1970 accounted for 82 percent of total U.S. turbine helicopter unit production, or 88 percent of total dollar volume, but the military's share was just 13 percent of unit production and 32 percent of dollar volume in 1980. Military sales are expected to remain at a relatively stable level for the next few years.

The second and more pervasive fallacy is that U.S. defense contractors consistently earn high profits at low risk. Helicopter companies do benefit from their relationship with the government. However, typically, aerospace profits as a percent of sales and assets are lower than those for all manufacturing. In 1982, for example, profits as a percentage of sales were 3.2 percent for aerospace and 3.5 percent for all manufacturing corporations.[6]

Further, a number of disadvantages stem from the government's position as the only buyer in the competitive military helicopter market. First, depending on the type of contract, helicopter manufacturers must devote a significant share of funds and company resources to win the competition and develop a prototype; the cost may be partially reimbursed by the government if the company wins the contract. Conceivably, foreign military sales of a helicopter model can help spread development costs over a broader production base, yet they generally cannot substitute for the large volume procurement of a U.S. military program. A company does not usually launch a military helicopter without a Department of Defense buy so, in effect, helicopter companies have one military sales customer and, thus, limited sales opportunities. A second disadvantage is that changes in U.S. government policy create a built-in instability in year to year operations and can therefore play havoc with companies' strategic planning.

The most important contribution to business risk for manufacturers was discussed in the previous Chapter and that is the often unpredictable length of the development period for military rotorcraft. For the loser of a military procurement competition, there is obviously the loss of manpower and internal resources committed during the competition phase. However, even the winner may suffer as a result of extended development programs. The longer the development period, the longer the company must wait to begin earning profits on production and sales of the new helicopter. The average development period for eight military helicopters introduced from 1960 to 1982 was almost eight years.[7]

In addition to the lengthy development schedules, military procurements are characterized by uncertainties as to rate of production and length of the ultimate production runs.

Risks in Civil Programs

The risks involved in moving a civilian helicopter project from the drawing board to the production line and finally to the market place share much in common with those relating to a military vehicle. Helicopter and other aerospace projects involve a major investment of time in research and development. Both civilian and military helicopter programs suffer the risks inherent in a long term undertaking—changing supplier costs, changing technologies, high capital requirements combined with lengthy payback periods and reliance upon forecasts which could stretch out over a decade.

In addition, civilian craft must be designed to fit commercial requirements and consumer tastes projected years in the future. Yet unpredicted events can radically alter even the most careful market projections. For example, the rapid price rise of petroleum in 1973-74 created a need for more fuel efficient civil helicopters. In a parallel repercussion, oil shortages spurred oil exploration in remote areas such as the North Sea creating a demand for large, long range helicopters to carry oil rig personnel. The long development period involved in helicopter production makes it difficult to radically alter the product in response to changing demand. Manufacturers did develop craft suitable for oil industry use in the seventies. Today, however, much of the present softness in the civil market reflects falling activity in the oil industry.

So while civilian model production may not be so vulnerable to political forces as military programs, it shares many of the risks other industries face in anticipating the design requirements and volume that the civilian market will demand years in the future.

Another problem that the U.S. industry faces is in the area of obtaining certification in other countries. Each country has its own government agency to grant airworthiness certification, which enables an aircraft to be legally operated in that country. For foreign helicopters coming into the United States, the Federal Aviation Administration (FAA) has historically accepted the test data from the home country's certifying agency and, without cost to the manufacturer, has granted reciprocal certification in the United States. However, when a U.S. product goes overseas, there is sometimes additional data and/or

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[6]Aerospace Industries Association, *Aerospace Facts & Figures*, various years.

[7]The eight helicopters included in the average are the Bell OH-58 (9 years), the Bell UH-1 (5 years), the Sikorsky CH-53 (6 years), the Sikorsky SH-60B (13 years), the Sikorsky SH-3 (4 years), the Hughes OH-6/500 M (6 years), the Sikorsky UH-60A (10 years), and the Hughes AH-64 (10 years). SOURCE: Defense Marketing Service.

testing required; and the manufacturer not only pays for the use of its aircraft for the testing but, in Great Britain, must also pay the cost of the certifying agency's manpower involved in monitoring and evaluation of test results.

When the FAA sends a test group into a foreign country, it is at no cost to the manufacturer or its country because of the laws under which the FAA is established. There needs to be a fair and equitable arrangement accepted by all nations so that no cost disadvantages accrue to any manufacturer or country through the certification process.

SUPPORT OF PRODUCT MARKETING

Recognizing the role played by exports in maintaining a viable and cost-competitive aircraft industry and the impact that such exports can have on a nation's overall trade balance, all nations with resident industries have established government agencies to support the marketing efforts of their countries' firms. In military competitions particularly, but also in commercial markets, the assistance provided by the Government, in terms of both financing and the dissemination of expert guidance, can be crucial in the winning of an international competition. In addition, governments can bring to bear resources and provide trade-offs that are beyond the capabilities of any individual company.

Marketing Support/Military

As discussed earlier, military-weapons exports are important to supplier countries not only in terms of their impact on the balance of trade but also as a means of strengthening political ties to recipient nations. In most countries, arms-producing industries are backed by well-organized government bureaucracies that lend considerable assistance in marketing that country's military exports.

In France, the Delegation Generale pour L'Armement (DGA) has overall responsibility for the production and sale of French weapons. A specific group within this agency, the Direction des Affairs Internationales, is charged with maintaining a steady growth in weapons exports. Another aspect of DGA's activities is the organization of semi-annual armament fairs to demonstrate the performance of French weapons systems. The efforts undertaken by the French in selling arms also involve the highest levels of the government. Arms deals have often supported major foreign policy initiatives. It is no accident, for example, that more than half of the French arms exports in recent years have been directed to the Middle East, upon which the French are so dependent for their future oil supply. Reportedly, Mitterand's lifting of the arms embargo to Libya, imposed by the previous administration, "cleared the way for renewed oil exploration by the French government-owned company Elf-Aquitaine."[8] In the words of one observer: "The state has . . . become *the* purveyor of French arms."[9]

[8]Andrew J. Pierre, *The Global Politics of Arms Sales* (Princeton: Princeton University Press, 1982) pp. 95-96 (paperback).

[9]Ibid., p. 89

The British, like the French, have also set up a highly capable organization—the Defense Sales Organization (DSO) unit of the Ministry of Defense—to stimulate their exports of armaments. DSO has a staff of 400 with representatives stationed at specific overseas embassies. Like the French organization, the DSO also conducts arms shows and has even used a Royal Navy ship, the Lyness, to provide a floating display of British arms. In addition to assisting British manufacturers in their foreign sales efforts, the DSO has taken on a further role in advising the Defense Ministry of overseas requirements during the initial design period of a product. As a result, Britain's own internal requirements can be modified, when necessary, to fit the criteria imposed by overseas markets. At times, overseas customers have been provided with equipment superior to that supplied to the British military.

In contrast to the aggressive efforts being carried out by European governments in support of their armaments industries, the United States has had a vacillating and, at times, restrictive approach to arms sales. Notable in this regard was the International Security Assistance and Arms Export Control Act enacted on June 30, 1976. Among other things, this act severely reduced the number and size of military assistance advisory groups (MAAGs) in foreign countries and instructed government personnel to refrain from any activities that would act to stimulate overseas requests for U.S.-supplied arms. The act, passed during the Ford Administration, was expanded early in the Carter Administration by Presidential Directive 13, the so-called "leprosy letter." A major intent of the letter was to curtail if not eliminate the promotion of arms sales by both government officials and private manufacturers. Such activities would henceforth require clearance by the State Department, and President Carter himself reviewed many of the larger proposed transactions. The Directive forbade manufacturers from making any significant modification to U.S. arms in order to enhance their appeal in the export market. Further, the Directive restricted the initiation of co-production arrangements with foreign manufacturers for any major weapon system or for major components. Finally, the Directive reaffirmed and strengthened the restrictions on sales to countries which evidenced a consistent pattern of human rights violations. As a result of this policy, "614 requests from 92 countries totaling more than $1 billion were turned down in the first fifteen months of the new Carter arms transfer policy.[10] An unknown amount of additional sales were lost from countries which went to other sources rather than risk the embarrassment of a publicized U.S. rejection.

Early in the Reagan Administration, announcement was made of an intent to reverse the policies detailed above. This reversal was most clearly enunciated in the administration's statement on "Conventional Arms Transfer Policy" issued July 9, 1981. The statement outlined a more

[10]Ibid., pp 55-56.

realistic approach to future arms sales and should allow American industry to be placed on a more even footing with the foreign competition. In general, the new policy puts less emphasis on attempting to unilaterally restrict the growth in military sales and, instead, develops a format in which security interests of both the United States and its allies will be the predominant guiding force. It recognizes that despite the previous administration's attempt to restrict weapon sales there has been "little or no interest in arms transfer limitations manifested by the Soviet Union or the majority of other arms producing nations." As a consequence of this lack of interest "the United States will not jeopardize its own security needs through a program of unilateral restraint."

While the reversal in policy is welcome it must be noted that this does little to correct the damage already done to American producers. Rather, it will take years to return government support to the level of effectiveness evidenced in the early seventies. In the past, great assistance had been provided to industry by MAAGs personnel, but with the reduction in number and funding of these missions, a large force of highly qualified and experienced people was removed from these assignments. While the new administration has sought to rebuild the MAAG program, it is presently unable to provide the support or breadth of knowledge attained only through years of experience in the field.

Inconsistency in the United States' arms export policies is, by itself, a deterrent to arms sales, which revolve around long-term, unfettered relationships between supplier and recipient nations. An arms purchaser needs to be assured of some stability in policy since the acquisition of major weapons or weapons systems may require a stream of deliveries over several years. Further, arms purchases require the surety of the continuing provision of spare parts over the length of time that the weapon system is retained in the user's inventory, possibly as much as twenty years. The continuing reversals of American policy can only inhibit all but the United States' staunchest allies from seeking to purchase its arms. While the present policy of the Reagan Administration may be favorable to arms sales, it is well-known that strong sentiment exists within Congress to revert to the Carter arms-export policy and there is a high probability that a subsequent administration will do so in the future.

One reason for the rapid growth of French military exports is that they are widely perceived as purely commercial transactions and less dependent on the recipient nations meeting some ill-defined "moral" standard; other nations expect that their contracts will be fully consummated and be unhindered by subsequent changes in the French political environment. An example of the French attitude is indicated by the speed with which France resumed shipments of arms to Argentina after the Falkland Islands War despite the danger this action posed to one of its closest allies.

The question of what level of inducements and restrictions should apply to military exports is a difficult and complex issue. Certainly, political limitations must be applied to nations that have demonstrated an entirely irresponsible attitude in their conduct of foreign policy. It is difficult to argue against the application of sanctions to nations such as Uganda, for example, under Idi Amin. However, the question of arms shipments to most nations of the world is not as clear-cut. It is a sad fact that few nations outside of North America and Europe practice a democratic form of government and fewer yet have the same built-in safeguards for human rights as does the United States. Is it wise to withhold the flow of arms to such nations when the supply of weapons is a means of influencing the political leanings of Third World countries? To withhold arms, in today's environment, means only that the potential recipient will seek an alternative supplier.

Despite its frequent use in the last decade, there is no evidence that a unilateral American arms embargo has been influential in favorably altering the internal political environment within any country. Instead, such moves have succeeded in raising resentments that affect not only military but commercial relationships as well. In particular, U.S. ties with several Latin American governments have been considerably strained by their having been singled out for human rights violations. These nations have turned elsewhere for arms: Argentina to France, Germany and Britain; Peru to France and the Soviet Union; Chile to Israel; and Brazil to France, Germany and Italy. Additionally, in both Argentina and Brazil, U.S. restrictions on arms sales acted to speed the development of in-country arms production facilities. There is, finally, no evidence that any major weapons requirements have remained unsatisfied as a result of U.S. restrictions.

Marketing Support/Commercial

In the commercial arena, both the U.S. and foreign governments provide assistance to their national industries in the marketing of products to overseas customers. The most important support is in the form of financial incentives, particularly financing assistance, which are detailed elsewhere in this report. However, governments can also provide marketing assistance in many forms. One of the most effective aids is for government leaders to actively participate in the marketing of its aircraft industry's products.

European companies utilize government marketing assistance quite adeptly and have enlisted the assistance of both heads of states and members of royalty in pressing their sales campaigns. Each of the European nations has also developed a well-coordinated agency to assist their resident industries in the export of their products.

In the United States, the encouragement of exports has been performed in a rather haphazard manner. Presently, export responsibilities are scattered throughout several agencies in the Departments of State, Commerce, Agriculture, Defense and Justice. While many other departments

of the Government are involved in setting trade policy, overall responsibility for trade policy coordination is split between the Department of Commerce and the Office of the U.S. Trade Representative in the Executive Office of the President. The United States should take steps to achieve a clearer and more coherent definition of trade policy and to provide more timely response to industry requests for assistance.

THE ROLE OF MILITARY SALES IN U.S. MANUFACTURER/GOVERNMENT RELATIONSHIPS

While a number of foreign nations provide aggressive support to military sales programs, obviously, the United States government also has an interest in and is involved in the foreign sales of U.S. manufacturers. A deeper understanding of this relationship requires a look at how military helicopter sales relate to national security and how the U.S. employs military assistance programs to advance foreign policy objectives.

PRODUCTION BASE/NATIONAL SECURITY

The helicopter has, since its introduction to the battlefield, taken on an ever-expanding role to the point where it is now an indispensable component of almost every nation's military inventory. For the U.S. military, with its continued emphasis on quick reaction and rapid deployment, the requirement for helicopters is especially critical. Thus, the capability to produce large numbers of aircraft at economic costs is important to the maintenance of the national security. Of equal importance is the ability to rapidly expand production in the event of a deterioration of relations with potential adversaries.

Helicopter per unit costs are greatly influenced by the length of the production run and the over-all quantity produced. First, start-up of new programs requires large sums for initial design and development and for the acquisition of production tooling. The longer the likely production run, the more units over which such costs can be spread and, consequently, the lower the cost allocated to each unit. Second, helicopter production entails a highly sloping "learning curve." That is, production costs continue to drop with each successive model produced. As the production run is lengthened, both the marginal production costs of the last units and the average costs of the whole program decrease.

It can be seen that overseas sales can have a major impact on the affordability of a given level of national security. Denial of foreign military markets, either through loss to overseas competitors or through restrictions placed by the U.S. government to achieve foreign policy objectives, tends to raise the costs of domestic military sales.

A second aspect of the national security question involves the availability of both trained manpower and facilities should "surge" military production be required. Foreign military sales, by retaining an in-place production capability over and above that required to satisfy immediate U.S. defense needs, provide a "surge margin." Tooling, facilities, and manpower required to produce commercial aircraft can quickly be converted to military production should events warrant. Capacity is also determined by management, engineering staff, and marketing and service organizations. To the extent that this additional capacity is already in place to meet commercial requirements, it acts as a "cushion" if military production must be rapidly accelerated. Indirectly, the loss of commercial markets to overseas competition will lower the nation's defense preparedness and its ability to respond to future military crises.

U.S. GOVERNMENT SECURITY ASSISTANCE PROGRAMS

Historically, the United States has employed Security Assistance Programs as vital instruments of its foreign policy, rationalized on the basis that by "assisting friendly and allied nations to acquire and maintain the capability to defend themselves, we serve our worldwide interests in collective security and peace."[11]

In general, Security Assistance Programs have been successful, at times extraordinarily so, in achieving their basic purposes: the encouragement of other nations to resist adversaries and the solidification of the relations of these nations with the United States. The programs have helped many nations rebuild their war-ravaged economies, and provided them with a measure of security while they created new political and economic institutions.

Security assistance is predominantly, but not exclusively, associated with military sales and services and is composed of four programs:

The Military Assistance Program (MAP), which provides defense articles and defense services to selected foreign governments. This program is now being phased out and replaced by an expansion of the FMS Program detailed below.

The International Military Education and Training Program (IMET), which provides grants for personnel training in the United States, in the Canal Zone and overseas United States military facilities, as well as for mobile training teams for selected foreign military and related civilian personnel.

The Security Supporting Assistance Program (SSA), which provides economic assistance on a loan or grant basis to those countries of special political and security interest to the United States.

The Foreign Military Sales Program (FMS), which provides credits and loan repayment guarantees to selected foreign governments to purchase defense articles, defense services and training. Financing is extended by the

[11]Congressional Presentation: Security Assistance Programs, FY 1980, Washington, D.C., U.S. Government Printing Office, p.1.

Federal Financing Bank, an arm of the Treasury Department, with repayment guarantees issued by the Department of Defense.

Traditionally, arms sales have been used by developed nations as a major, if not the only, instrument of influence over recipient countries. Old style alliances no longer seem to convey the necessary reassurance of allegiance, and intervention by a superpower into a conflict situation is generally conceded to be fraught with the danger of escalation to uncontrollable dimensions.[12] Hence, the supplying of arms is seen to be a practical and effective means to gain political leverage as well as to impose some restraints on the recipients.

To minimize external political influence in their affairs, arms-purchasing nations today often "shop around" for the best deal, financial or otherwise, diversifying their equipment, obtaining weapons from other than the previous exclusive supplier, and even using several suppliers as sources for their military needs. In the past, arms sales often involved the transfer of old or outdated materiel, particularly to less-developed countries. Many countries began demanding quality equipment for "prestige" reasons, rather than to meet real and substantive needs. In recent years, more advanced weapons are being shared with favored countries, particularly by the major Western suppliers to Free World customers. In part, the competition among arms suppliers in terms of quality, as well as pricing, is a factor in the upgrading of the weapons inventories of these nations.

Until the mid-seventies, the U.S. foreign aid programs involved the gifting of surplus military equipment to developing countries, but as a consequence of increased United States budget deficits and large aid programs, Congress was impelled to establish a loan program to keep American arms flowing. Under the new arrangements, the U.S. Treasury provided the credits for arms, the Department of Defense guaranteed the loan, and recipient countries were encumbered with paying principal plus interest at the current commercial interest rate. This remains the primary form of U.S. military aid today.

The recent phenomenon of exceedingly high interest rates within a depressed world economy, and the concomitant financial problems in less-developed countries, have substantially weakened the ability of many countries to pay for goods received. In mid-1982, for example, thirteen countries fell behind in their interest payments to the United States for arms purchases with several more expected to default:[13]

When client governments fail to meet payments for defense articles, the United States Department of Defense, as guarantor of the loan, pays both the principal and the accrued interest to the Federal Financing Bank and then attempts to collect from the borrower. If the loan is overdue for one year, no further loans are arranged, a condition which often generates considerable ill-feeling. In light of the current level of defaults, it is estimated that the Department of Defense's reserve funds covering such contingencies, which totaled $1.1 billion at the beginning of FY 1982, will drop to $788 million in FY 1983 and $624 million by the close of FY 1984. This projected closing balance is below the $750 million threshold established by Congress as a point of review of the fund's adequacy. In two years time, outstanding guarantied loans will have increased by $7 billion and the reserve fund will protect fewer than 3 percent of outstanding loans as against nearly 6 percent in FY 1982.[14]

Given present and recurring problems, new solutions need to be provided to guarantee the continued effective utilization of sales in the nation's foreign policy.

Industry participation in security assistance programs should be improved as well. The development of effective military aid programs is not simply in the interest of the companies that manufacture aircraft and related weapons systems but is of importance in furthering U.S. objectives.

In general, the FMS program is well-structured and is of great benefit to the recipient nations, the U.S. Government, and the involved industrial companies. The major value is in providing potential customers with funding of their military procurements. The program also provides the major vehicle with which U.S. military representatives can assist companies in the marketing of military hardware.

The participation of the Defense Department in the FMS process tends to lengthen and complicate the already complex negotiation process with potential customers. Provision of the various approvals and supporting documentation creates delays that enhance the competitive positions of foreign producers. In addition, with the Government acting as a middleman in such negotiations, the company whose products are being marketed loses much of its control of the marketing activities. A particular problem area in the helicopter industry is that of sales of primarily commercial products to foreign military services. In such sales, the company is required to justify prices being charged long after the buyer has agreed to contract terms. Further, in at least one instance, a company that initiated a potential procurement and did much of the work in uncovering an aircraft requirement, eventually lost the sale to a competitor during the open competition required under the FMS program. The marketing effort had been initiated as a direct sale.

A speeding up of the FMS negotiation process and greater participation by industry in price negotiations would solve many of the problems that have been created for helicopter manufacturers. The government should re-

[12]"Review of the Global Politics of Arms Sales," *The Economist*, June 16, 1982.

[13]Dan Morgan, "Thirteen Countries in Default of Arms Sales," *The Washington Post*, July 7, 1982.

[14]Department of Defense, Defense Security Assistance Agency, *Congressional Presentation on Security Assistance Programs, FY 1984*, pp. 46-47.

examine other aspects of its policy on FMS sales, especially where allocation of costs, profit levels and progress payments are concerned. The Government does not now recognise the risk factor of FMS sales in negotiating profit levels, nor allow progress payments to 100 percent on FMS sales as it does with DOD domestic sales. Finally, the Government places restrictions on the allocation of FMS sales costs to domestic DOD contracts. These policies fail to recognize the added risk associated with FMS sales and reflect a failure by the government to accept ordinary, necessary and reasonable costs of doing business.

In summary, the relationship of helicopter manufacturers and government grows out of critical production base and national security requirements. At the same time that the relationship provides a certain built-in sales base and continuing support (e.g., R&D) it also imposes restrictions and controls and subjects the manufacturers to the vicissitudes of government funding and budget cycles. Nor does it shield the industry from the strictures of the private enterprise system.

A broader view of the industry's role is taken in other countries where planning horizons are longer and decisions more often take into consideration jobs, balance of trade, advancement of a technical base, and foreign policy objectives including national prestige.

While the United States' philosophical orientation has been toward a less structured and planned approach to economic decision-making, and as nearly as possible toward a "free market," it should be recognized that the European/Japanese approach makes formidable competitors for United States free enterprise firms. More consistent, focused policies aimed at promoting and facilitating exports would serve individual industries and be of broader benefit to the U.S. economy as well. It is important, too, that positive efforts be taken to improve the competitive stance of U.S. exporters and defuse protectionist sentiment which, in the end, will damage industry more than serve it.

INTERNATIONAL SALES PRACTICES AND INCENTIVES

Earlier chapters have established that the international sales arena has changed considerably in the past several years, posing serious competitive problems for U.S. helicopter manufacturers. These changes have come about largely because foreign governments have provided their aircraft industries with strong support.

Given that world economic recession is playing a critical role in sluggish helicopter sales today, U.S. manufacturers are also feeling the impact of foreign sales practices and incentives that, in many instances, they cannot match.

FINANCING

The greatest impact on U.S. sales in both the domestic and international marketplace has been felt in the area of new aircraft financing. In recent years, high interest rates have made sales financing a pivotal item in the helicopter marketplace. Unfortunately, U.S. helicopter manufacturers have found it increasingly difficult to make sales because available financing programs have not been as competitive, especially in the U.S. export market, as those of other nations. U.S. private lending institutions simply will not make loans on aviation products to foreign customers at rates that would make the sale attractive to purchasers. Foreign governments, on the other hand, are often more than willing to make loans that a U.S. financial firm would turn down. These loans are in line with national goals of developing industrial capability, promoting domestic goods and services in world markets, and creating jobs. For many nations, entering into high risk loan agreements is an acceptable expense for realizing their objectives.

For a U.S. helicopter manufacturer, available alternatives—if private bank financing is unavailable—are to finance a five to seven year loan through its own corporate structure, or to work through the Export-Import Bank (Eximbank). The former approach is usually as unacceptable to corporate officers as to a private bank; the interest rates required to be competitive in the world market are too low relative to the risks entailed with lending to a foreign commercial customer. Further, U.S. helicopter manufacturers do not have sufficient resources to allow large amounts of cash to be tied up for several years.

The Eximbank, on the other hand, has financed few helicopter sales over the years. Funding generally has been directed to higher value products which contribute more substantially to the U.S. balance of trade. For example, Eximbank has been used widely by large commercial jet transport manufacturers. Unfortunately, this has left the helicopter and general aviation components of the aircraft industry vulnerable to market encroachments of foreign manufacturers. Eximbank, in a report to Congress, concluded that its medium-term credit support in 1981 "did little good for U.S. exporters facing subsidized competition, except that it gave them a fixed-base from which to reduce the rate further."[1]

Table 1 compares medium-term fixed export credit effective interest rates in 1979 and 1981 for the United States and other major exporting nations. In 1981, interest rates varied from 8.60 percent to 18.30 percent, with a general upward trend from 1979. U.S. rates continued well above

TABLE 1

MEDIUM-TERM FIXED EXPORT CREDIT EFFECTIVE INTEREST RATES (Percent)

	1979	1981
France	8.00	8.75
Germany	8.30	10.05
Japan	7.85	9.85
United Kingdom	a)11.33	8.60
United States	b)12.58	17.05
		18.30

a Face rates are adjusted upward to effective rate by accounting for insurance, guarantee, and commitment fees in the following amounts: France (.75), Germany (.80), Japan (.60), and the United Kingdom (.60).

b Line a) represents the effective rates assuming only a 0.25 percent discount loan commitment fee. Line b) assumes a 0.25 percent discount loan commitment fee plus a 1.25 percent fee for the optional insurance.

Source: Export-Import Bank of the United States, *Report to the U.S. Congress on Export Credit Competition and the Export-Import Bank of the United States—For the Period January 1, 1981 through December 31, 1981*, Washington, D.C., December 1982, p. 14.

[1]Export-Import Bank of the United States, *Report to the U.S. Congress on Export Credit Competition and the Export-Import Bank of the United States—For the Period January 1, 1981 through December 31, 1981*, Washington, D.C., December 1982, pp. 13-18.

TABLE 2

COMPARATIVE GOVERNMENT SUBSIDY OR PREMIUM PER BILLION TO SUPPORT MEDIUM-TERM EXPORT FINANCE (Millions of Dollars)

	1979	1981
France	$(56.8)[a]	(173.4)
Germany	2.7	(29.0)
Japan		
a) Yen	(11.6)	15.4
b) U.S. $	(57.7)	(113.4)
United Kingdom	(136.2)	(155.4)
United States	40.5	47.5

Source: Export-Import Bank of the United States, *Report to the U.S. Congress on Export Credit Competition and the Export-Import Bank of the United States—For the Period January 1, 1981 through December 31, 1981,* Washington, D.C., December 1982, p. 14.

a ( ) = subsidy

those of competitors and were roughly double those of France and the United Kingdom. Table 2 illustrates the estimated rate of subsidy offered by the major countries to support their medium-term exports. Only the U.S. program operated "profitably" or without subsidy. Again, Eximbank characterized its medium-term export support program in 1981 as "basically uncompetitive."[2] A growing awareness of this problem led Eximbank to announce, in the fall of 1982, a new medium-term loan program for aircraft costing less than commercial jet transports. Helicopters and other general aviation aircraft, which compete with government subsidized foreign firms for export sales with credit terms of 1-5 years, may now be financed with the aid of Eximbank loan guarantees to financial institutions. These institutions, in turn, can arrange fixed rate financing with the foreign buyer. It remains to be seen if this is sufficient to assist manufacturers in meeting competition from abroad. Such financing through Eximbank is limited by the bank's charter to commercial sales.

International Agreements on Financing

Many, although not all, of the countries with which U.S. helicopter manufacturers are competitive have signed the General Agreement on Tariffs and Trade (GATT), which prohibits signatories from offering low cost, below-market loans or other subsidies in order to make a sale. An Agreement on Trade in Civil Aircraft, which specifically addresses fairness in trade in the aircraft marketplace, was also made at the 1979 Tokyo Round of international trade negotiations. The Agreement went into effect in January of 1980. The impact of GATT and the Aircraft Agreement have been weakened, however, since interest rates in other countries have frequently been below interest rates in the United States.

As a result of an earlier, near "war" on export credits centering on sales of commercial jet transports, the major industrial nations, through the Organization for Economic Cooperation and Development (OECD), concluded a "Standstill Agreement" in 1976 on terms of aircraft export financing. This Agreement involved a "Commonline"—a minimum export financing rate and maximum loan term. The rate has been revised upward several times to reflect financial market conditions. Negotiations to revise the Commonline Agreement to more nearly reflect market conditions are ongoing; however, as interest rates fall in the United States, they have become of less immediate concern than has market "term." The United States is working to see that the Commonline Agreement sets realistic loan terms that reflect the useful life of most aircraft—15 to 20 years in the case of commercial jet transports. Currently, the Commonline sets market term at 10 years. Helicopters and other general aviation aircraft have not been covered by the Commonline, although U.S. trade representatives will negotiate for their inclusion in coming meetings.

Without inclusion of rotorcraft in the Commonline on export financing, U.S. manufacturers must continue to compete, at a disadvantage, against the low-cost packages offered by foreign firms. The GATT Agreements do not, moreover, involve trade in military aircraft and in this area U.S. manufacturers meet tough competition when foreign manufacturers can offer prices or financing subsidized by state support. U.S. manufacturers, who must recover costs in sales, cannot compete against offers that feature very low initial downpayment and/or interest rates that are far under market.

U.S. aircraft manufacturers, hindered by lack of support from Eximbank and by the high cost of funds in financial markets, have explored alternative means of financing, among them leasing arrangements. Nonetheless, a greater level of government commitment through the Eximbank loan and guarantee authority is essential to industry export competitiveness.

PRICING

A major factor in any sale is the price and, for U.S. manufacturers who must produce a profit to remain in business, the price of a helicopter must include a proportionate share of the cost of development in addition to production and administrative costs. Foreign manufacturers that are government owned and/or supported, are not so constrained by the need to recover costs and make a profit, and have a great deal of flexibility in pricing. Even if interest rates are equal, foreign producers can lower the price of their products—disregarding the actual cost of production and associated costs—to strategically place them in the market.

[2]Ibid.

NATIONAL PARTNERSHIPS

Helicopter manufacturers in other nations, bolstered by government support, may make business decisions that U.S. firms would find untenable. Such decisions are rooted in an approach to manufacturer/government relationships that, as we have seen, differs from that of the United States. A different kind of business environment and outlook also affects the relationships of foreign rotorcraft producers with each other. It is reflected in the increasingly prevalent phenomenon of collaborative arrangements between manufacturers in several countries in the development of new helicopter models.

A number of motivations exist for establishing international collaborative arrangements but in all cases they enhance the partners' effectiveness by the merging of complementary strengths, eliminate major home markets from open competition and, through sharing, reduce the risk involved in product introduction. Recognizing these advantages, European manufacturers have made various attempts to pool resources and establish a jointly-owned entity to counter the American industry. It is, thus, not unlikely that in the near future American helicopter manufacturers will be faced with a multinational challenge similar to that presented by Airbus Industries to the U.S. commercial jet transport industry.

It should be noted that American manufacturers are at a disadvantage in initiating or participating in such collaborative arrangements among themselves. First, uncertainties with respect to the interpretation of the antitrust statutes would, in many cases, inhibit most American companies from collaborating in development of a new commercial helicopter model. Second, a major attraction in such arrangements is the support provided by the respective national governments in terms of both funding of the development program and assistance in marketing of the aircraft. U.S. government policies offer few such inducements, thus penalizing the attractions of joint ventures between foreign and domestic manufacturers.

As examples of the trends toward national partnerships, the following programs may be cited:

MBB/Kawasaki BK-117—The BK-117 is an intermediate-sized utility helicopter jointly developed by Messerschmitt-Boelkow-Blohm of Germany and Kawasaki Heavy Industries of Japan. Development funds were largely provided by agencies of the governments involved. It is understood that the Economics Ministry provided a loan amounting to 70 percent of the German contribution, while for the Japanese, an unspecified portion was obtained from the Ministry of International Trade and Industry (MITI).[3] The latter is a reflection of MITI's having targeted aerospace as an industry qualifying for special financial assistance as part of a broader program of industrial restructuring. MITI loans are generally repaid only after the project has achieved profitability.

EH-101—The EH-101 is a collaborative effort between the English and Italian industries originally set up to develop a medium-sized helicopter to replace the existing Anti-Submarine Warfare (ASW) helicopters in both nations' navies. Development work on the aircraft will be performed by EH Industries (EHI), jointly-owned by Westland and Agusta, with equal funding provided by the English and Italian governments.

While the initial impetus to this effort was to satisfy a military requirement, EHI has concluded that the commercial market for such an aircraft may be even more attractive than at first assumed. In fact, of the approximately 700 sales, it is expected that only 100 would come from the British and Italian navies. EHI has apparently redirected the program and intends to introduce a commercial model first, in 1987, directed toward the offshore oil market. Military derivatives will appear somewhat later. While, for now, the program is limited to the two partners, future collaboration with both the Germans and the French is not unlikely. Invitations have been extended to both countries and it is conceivable that Aerospatiale and MBB will join either as full partners or as major subcontractors. Thus the EH-101 offers the potential for the accomplishment of a long-desired goal, a joint program involving all of the four major European manufacturers.

TAX AND OTHER SUBSIDY INCENTIVES

In 1971, the U.S. government adopted a program based on tax deferment, to promote export sales and help the U.S. balance of trade. Corporations could set up Domestic International Sales Corporations (DISCs), which permitted them to defer payment of U.S. taxes on up to 50 percent of net earnings from exports until such time as earnings were distributed to shareholders or until disposition of DISC stock to shareholders. Over the years, however, DISC has been revised and its advantages are now less than they had been. DISC benefits (deferral of tax on one-half of profits) are limited to income attributable to gross receipts in excess of 67 percent of average export gross receipts in a 4-year base period. Also, military exports are restricted to a ceiling equal to 50 percent of a company's non-military exports. Since a DISC must be a separate corporation, a firm must establish a separate subsidiary for the sole purpose of conducting export business. This corporation is exempt from federal income tax, but its shareholders are taxable on dividends distributed, or deemed to have been distributed, by a DISC. It is also subject to state tax laws. Beginning in DISC year 1981, the export incentive effect of DISC is reduced by the Accelerated Cost Recovery System (ACRS), introduced in the Economic Recovery Tax Act of 1981. ACRS increases the after-tax return on capital overall by reducing taxable income. Its effect, therefore, is to reduce the relative differential conveyed by DISC with re-

[3]"The MBB/Kawasaki BK-117," *Interavia*, April 1979, p. 325.

spect to the after-tax return on capital. ACRS reduces the incentive of DISC for production for export relative to production for the domestic market.[4]

Despite the watering down of DISC benefits, other nations have taken the position that its tax advantages constitute a subsidy and are in violation of the GATT agreements. The Reagan Administration has proposed an alternative to DISC (H.R. 3810) that will provide incentive to exporters, yet be within the terms of the GATT agreement. The Administration has held firm, though, in rejecting the European Community's claim it can take compensating action because of financial losses suffered as a result of DISC's existence. It should be noted that European nations have tax incentive systems which have been challenged as illegal under the GATT, most notably the VAT tax rebate. H.R. 3810 eliminates some of the less desirable features of the present DISC provisions and contemplates forgiveness of the deferred tax on DISC income. Its requirements for significant business presence abroad are complex, however, and could result in the relocation of some U.S. jobs abroad. The proposal also fails to recognize that the present DISC provisions discriminate against military sales by giving them a lesser tax benefit.

Comparisons of tax practices in the United States and in other countries have shown that, generally, other nations provide greater tax incentives to exporters than does the United States. A recent study looking at both tax rules and actual tax practices concluded that every country studied—France, Germany, Japan, the Netherlands, Sweden and the United Kingdom—encouraged exports through its tax laws to a greater degree than the United States.[5] The study observed that "as a general rule, the number of overt 'subsidies' in domestic tax rules has been reduced in recent years, but a number still remain. It is more common for favorable provisions to appear as foreign tax provisions in a country's internal tax laws. The territorial tax systems used by the Netherlands and France are obvious examples."[6] The United States has, in the past, challenged these systems as violations of GATT.

It must be noted that there are trade implications in many national taxes that are not specifically aimed at exports, but which nonetheless reduce costs of development and operation that would otherwise have to be met by domestic industries and included in the cost of products. In fact, a major provision of the Tokyo Round of Multilateral Trade Negotiations concluded in 1979 is a countervailing duty code covering not only direct domestic subsidies but also subsidies that indirectly affect exports. It is not easy, however, to recover under this code as the domestic subsidy policies are not explicitly listed and material injury must be proved.

An in-depth study of tax and other subsidy policies that indirectly affect trade was performed by John Mutti of the University of Wyoming.[7] Mutti studied fiscal policies in seven major OECD countries: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. He looked both at aggregate effects and also at five particular industry sectors—textiles, steel, automobiles, pharmaceuticals and computers—and concluded that while significant government aid was provided by foreign nations to the industries under study, the competitive effects on U.S. producers tended to have been relatively small. However, when the overall effects of tax and subsidy policies of

[4]Treasury Department, *1980 Annual Report on The Operation and Effect of the Domestic International Sales Corporation Legislation*, December 27, 1982.

[5]Cole & Corette, "Foreign Tax Practices Affecting Exports," Washington, D.C., July 1982, prepared for the Dow Chemical Company.

[6]Ibid

[7]John Mutti, *Taxes, Subsidies and Competitiveness Internationally*, National Planning Association (Washington, D.C.), January 1982.

TABLE 3

A GENERAL BALANCE OF TAX AND SUBSIDY POLICIES AS A PERCENTAGE OF GROSS DOMESTIC PRODUCT MAJOR OECD NATIONS 1976

	Subsidy-Tax Balance					
	Capital Elements			Capital & Labor Elements		
	Benefits	Taxes	Net	Benefits	Taxes	Net
Canada	5.4	3.8	1.6	28.4	32.9	−4.5
France	6.3	2.3	4.0	37.0	39.5	−2.5
Germany	3.7	1.7	2.0	33.0	36.7	−3.7
Italy	6.5	2.2	4.3	35.7	35.8	−0.1
Japan	4.9	3.5	1.4	21.9	20.9	+1.0
United Kingdom	9.3	1.7	7.6	34.6	36.7	−2.1
United States	3.8	3.0	0.8	23.4	29.3	−5.9

SOURCE: John Mutti, *Taxes, Subsidies and Competitiveness Internationally* (Washington, D.C.), National Planning Association, January 1982, pp. 10 and 14.

the United States and the other nations were compared, investment and employment were probably discouraged to a greater extent in the United States than in any of the other countries (Table 3).

In the same study, a look at export financing in particular showed that only Canada of the leading industrial nations provided less support than did the United States (Table 4). Japan supported 49 percent of its exports with financing assistance. The other nations provided the following levels of assistance: Germany and the United Kingdom—36 percent of exports; France—10 percent; Italy—9 percent; the United States—7 percent; and Canada—4 percent.

TABLE 4

PERCENT OF EXPORTS SUPPORTED BY EXPORT FINANCING MAJOR OECD NATIONS 1976

Country	Percent of Exports Supported
Canada	4
France	36
Germany	10
Italy	9
Japan	49
United Kingdom	36
United States	7

SOURCE: John Mutti, *Taxes, Subsidies and Competitiveness Internationally* (Washington, D.C.), National Planning Association, January 1982, pp. 10 and 14.

PACKAGE PROCUREMENTS

In this age of advanced weapons and changing military tactics, it is to the advantage of a developing country to purchase combinations of weapons, or weapons packages. More often than not, package procurements mean that more advantageous prices can be negotiated, training can be done in a more organized fashion, and support more easily implemented.

It is easier for foreign governments, which have nationalized aircraft and arms industries, to put together such sales packages than it is for the United States. A nation interested in purchasing such a package would be able—in another country—to go to a single source to establish what materials and equipment were needed, to negotiate a price and arrange financing. If that customer were to come to the U.S. government for the same sort of package, it would normally take much longer to put together, and undoubtedly the price would be higher. The U.S. government would have to negotiate with each manufacturer individually for the requisite items and, of course, it could not dictate the terms of the sale to manufacturers. Where industries are nationalized, governments can do just this and then underwrite the financing as well.

In the United States, Congressional approval must also be obtained for export sales of military hardware and Congress has not frequently approved the sale of armed helicopters. Most foreign governments have no restrictions on arming rotorcraft; in many cases, sales include both equipment and ammunition. At question is not whether such restrictions should ever be made but whether restrictions are made within a sound and consistent policy framework.

Different sales practices and incentives for both industrial production and exports are simply one more example of the way in which the U.S. business environment contrasts with that of other leading industrial and many developing nations. These practices and incentives are an outgrowth of different philosophies and objectives. However, the United States, along with every other nation now competing in the world marketplace, must ask whether it is providing its exporters with sufficient incentives to help accomplish its domestic and foreign policies. If the United States does not attempt to maintain a strong competitive position in the international marketplace, it must evaluate the risks it runs including the long-term damage to the economy from loss of exports and the eventual deterioration of its industrial base. Thus, the United States must take steps to implement policies that both enhance its market position with a more supportive environment for exporters, and yet are nonprotectionist and consistent with a fair world trade environment.

APPENDIX A
MAJOR WORLD HELICOPTER MANUFACTURERS

AMERICAN MANUFACTURERS

Bell Helicopter Textron, Inc.—Bell Aircraft Corporation was founded in 1931 in Buffalo, New York. In 1951, its rotary-wing design, development and production activities were moved to Fort Worth, Texas. In 1960, Textron Inc. of Providence, Rhode Island, bought various Bell Aircraft properties. Bell established itself as Textron's largest division and, in January 1982, the company status was changed to Bell Helicopter Textron, Inc., a wholly-owned subsidiary of Textron Inc.

Over the years, Bell has designed and manufactured a wide range of military and commercial helicopters and sold over 25,000, many of which went to the military market during the sixties and seventies. Production in the early eighties will be predominantly civil although military business is still a vital part of the product mix.

Current commercial production aircraft range from a five-place turbine-powered helicopter to a 19-place aircraft. Bell is presently producing for the U.S. Army, Navy and Marines and has won the Army's AHIP (Army Helicopter Improvement Program) competition to develop a Near-Term Scout Helicopter. The program will modify current aircraft in inventory to the new Army scout configuration, one which gives the scout helicopter more power to maneuver, plus better means of locating the enemy. Bell was selected as one of the two winning ACAP (U.S. Army's Advanced Composite Airframe Program) contractors.

Another project currently underway at Bell is the XV-15 Tilt-Rotor research aircraft, which takes off vertically like a helicopter, then tilts its rotors to fly like a turboprop airplane at high speeds. The program stems from a joint contract with NASA and the U.S. Army Research and Technology Laboratories to design, manufacture and test two of these vertical takeoff and landing (VTOL) aircraft. The concept will be developed over the next decade to provide a new type of aviation transportation for both civil and military use. This program had been competed between Bell and Boeing Vertol during the early seventies. The joint team of Bell Helicopter and Boeing Vertol is currently under contract for the Preliminary Design Phase of the Joint Services Advanced Vertical-Lift Aircraft Program (JVX).

Bell helicopters are also built under license by Agusta of Milan, Italy; Mitsui & Company, Ltd. of Tokyo, Japan; and Nurtanio of Indonesia.

Boeing Vertol Company—In 1960, The Boeing Company acquired the Vertol Aircraft Company, which was originally founded in 1943 as the PV Engineering Forum Corporation by its founder, Frank Piasecki.

Since its beginning, Boeing Vertol has produced approximately 2,500 tandem-rotor helicopters for the U.S. military services, as well as many foreign nations. Today, the U.S. military operates over 1,000 of these aircraft and are currently working on major modification programs to upgrade these aircraft for many more years of service. This modification work is the bulk of Boeing Vertol's current military output.

In addition to military helicopter programs, Boeing Vertol has been in the commercial helicopter market since 1957 with its V-44 aircraft. The company is currently producing the Model 234, a 44-passenger and utility version of the Chinook CH-47.

Boeing Vertol is currently working on research projects that include the X-Wing, HLH (Heavy Lift Helicopter) and the high-speed Model 360 helicopter. The joint team of Bell Helicopter and Boeing Vertol is currently under contract for the Preliminary Design Phase of the Joint Services Advanced Vertical-Lift Aircraft Program (JVX).

Boeing Vertol continues its relationship with KHI (Kawasaki Heavy Industries) which produces the KV-107 (CH-46) under license in Japan and the Agusta Group, which produces the CH-47 under license in Italy.

Hughes Helicopters, Inc.—Hughes entered the helicopter business in 1947 with the development of the XH-17 Flying Crane Research Helicopter. The first totally new helicopter developed by Hughes flew for the first time in 1956 and was designated Model 269. This helicopter led to the development of the present day U.S. Army TH-55 trainer and the commercial Model 300. Approximately 40,000 U.S. Army helicopter pilots have received primary helicopter training in the TH-55 over the past 18 years and it continues today as the Army's only primary trainer. The Model 300C is also used extensively for civilian training in Hughes Pilot Training Centers worldwide.

In 1961, Hughes developed the OH-6A Light Observation Helicopter (LOH) for a U.S. Army competition. Having won the first production award for LOH helicopters, Hughes produced 1,440 OH-6A's for the U.S. Army through 1970. The helicopter saw extensive armed scout use during the Vietnam conflict and the remaining

aircraft continue to be operated by the active Army as well as National Guard units.

The Model 500, the civilian version of the OH-6A, was first marketed in 1968 and has been upgraded several times in the interim. It is now offered with a five-blade main rotor and a 420 SHP engine. It is used for utility and executive transport on the civilian side and is offered in anti-tank and armed scout configurations for military operations.

In 1976, Hughes AH-64 was selected by the U.S. Army for Phase II development of the advanced Attack Helicopter system. The "Apache," as it is called by the Army, completed a successful operational test conducted entirely by military personnel and the system was put into production in early 1982.

Hughes is an active participant in helicopter R&D and has been an industry leader in programs to reduce external noise. Another recent development program named *NOTAR*[R] (an acronym for *No Tail Rotor*) has attracted worldwide interest since the desire to eliminate the tail rotor has long been the dream of designers. This configuration uses simple aerodynamics to augment rotor down-wash to provide the thrust normally produced by the tail rotor. The system has been successfully flown. Hughes has also successfully demonstrated its Hughes Harmonic Control (HHC) System which uses computer-driven actuators to trip main rotor blades to reduce helicopter airframe vibration by up to 95 percent.

Schweizer Aircraft Corporation has been licensed to manufacture the Hughes Model 300 Series.

Sikorsky Aircraft—Sikorsky Aircraft was founded in 1923 by Igor I. Sikorsky, regarded by many as the father of the modern helicopter industry. In 1929, the company became a division of the former United Aircraft Corporation, presently known as United Technologies Corporation.

Igor Sikorsky's first flight of the VS-300 on September 14, 1939, marked the birth of today's international helicopter industry. By 1941, Sikorsky aircraft were in service with the Army and Naval Air Forces around the world at a time when no other U.S. helicopter manufacturing organization existed.

Following World War II, Sikorsky initiated development of several helicopters directed to both civil and military markets, including the S-51, which operated in the United States and Britain on mail-carrying and air-taxi missions, and the 10-seat S-55, the first troop helicopter. The leading Sikorsky product of the fifties, the S-58, reached a production total of over 2,200 aircraft. The late fifties witnessed the first production of Sikorsky's turbine-powered helicopters, in particular the S-61, S-64 and the S-65. During the sixties, over 1,600 of these aircraft were built, and saw worldwide service in roles ranging from short-haul airliners to heavy assault transport. Military versions of the S-61 continue in the services of many nations today. Also in the sixties, the civil versions of the S-61 formed the nucleus of the new fleet of helicopters dedicated to the support of offshore oil drilling rigs, a task in which the S-61 is still widely employed.

In the early seventies, Sikorsky began development of a new generation of helicopters which were to mark a significant forward step in technology from their sixties predecessors. These aircraft include the UH-60A Black Hawk destined to become the Army's primary utility troop transport, and the triple-turbine CH-53E Super Stallion, a heavy-lift helicopter being placed in service with the Navy and Marines. Sikorsky is also producing the SH-60B Seahawk for the Navy's anti-submarine warfare (ASW) mission; first deliveries were made in 1983. For commercial markets, Sikorsky is producing the S-76, the world's first transport helicopter designed from the outset for the civilian market.

Agusta of Italy continues licensed production of the S-61 aircraft for the civil and military markets. In addition to Agusta, Sikorsky licensees include Westland Helicopters of Great Britain and Japan's Mitsubishi Heavy Industries.

Sikorsky is presently involved in a number of major development programs. The ABC (Advancing Blade Concept) is the forerunner of a new class of helicopters with greatly enhanced capabilities. It flies 100 knots faster and has 10,000-feet higher altitude capability than present-day helicopters. Further, in terms of agility and maneuverability, it dramatically surpasses the performance of all present-day helicopters. As a result, it should see wide application to the civilian and military markets in the nineties and beyond. Sikorsky, like Bell Helicopter, is developing an advanced composite aircraft under a U.S. Army contract. In addition, Sikorsky developed the Rotor Systems Research Aircraft (RSRA) for NASA and the Army. The RSRA is the testbed for tomorrow's rotor systems, with a capability for the testing of new concepts at speeds up to 300 knots.

The Enstrom Helicopter Corporation—In its original form, as the R. J. Enstrom Corporation, this company began in 1959 to develop a light helicopter which led to the certification of the F-28. In 1968, the company was acquired by the Purex Corporation and operated for a time as part of the Pacific Airmotive Aerospace Group. The activities of this group ended in 1970 but, in 1971, the Purex shares were acquired by F. Lee Bailey and manufacturing resumed. In 1980, these shares were purchased by Bravo Investments BV, of the Netherlands, the current owner of Enstrom.

Enstrom manufactures a product line of light, utility, piston helicopters. Among them are the F-28 and the 280 series. The company is developing a four-place aircraft called the Hawk. Head offices and manufacturing facilities are located in Menominee, Michigan.

Hiller Aviation, Inc.—In January 1973, Hiller Aviation was formed by acquiring design rights, production tooling and spares of the Hiller 12E piston-engined, light helicopter from Fairchild Industries. Initially, the company provided

product support for UH-12 helicopters. Service and repair facilities were added as a first move to expand the company's business and, later, Hiller began manufacture of the aircraft from existing components. Additionally, Hiller, in conjunction with Soloy Conversions of Chehalis, Washington, developed a turbine-powered version of the UH-12.

Hiller announced in 1980 that it had concluded an agreement with Fairchild Industries to purchase all rights in the FH-100 light, turbine helicopter. The firm has introduced several product improvements and delivered their first model in late 1981. Hiller manufacturing facilities are located in Porterville, California.

Hynes Helicopters, Inc.—Originally Brantley Helicopters—after N. O. Brantley, designer of the B-1—the firm that is now Hynes Helicopters began commercial deliveries of the B-2 series in 1959. From 1966 to 1968, Brantley Helicopter Corporation was an independent division of Lear Jet Industries. In May, 1971, Michael K. Hynes bought the firm's type certificates and existing parts and tooling. The Brantley-Hynes Corporation reconditioned Brantley helicopters, manufactured spare parts, and operated a flight school in addition to selling and servicing old customer machines. New "Hynes" helicopters are now available in the H-2 and H-5 series—two, three and five-place turbo piston and jet engine and five-place twin jet engine models.

Kaman Corporation—The present Kaman Corporation was founded as Kaman Aircraft in 1945, a pioneering helicopter manufacturer. Over the past thirty-five years Kaman has evolved into a widely diversified company.

Aerospace is the genesis of Kaman and continues to be the focus of one of the largest divisions, comprised of Kaman Aerospace Corporation and Kamatics Corporation. Kaman Aerospace has broad expertise in rotary wing research and development and is the primary producer of the U.S. Navy's SH-2F helicopter and composite rotor blades for the U.S. Army's AH-1 Cobra helicopter, also found in many foreign inventories. Additionally, Kaman produces major sub-assemblies of the Sikorsky 76 helicopters.

Kamatics Corporation produces a variety of high technology self-lubricating bearings for helicopters.

Robinson Helicopter Company, Inc.— In 1973, the Robinson Helicopter Company was formed with the objective of designing and manufacturing a lightweight helicopter that could be competitive with a two/four-seat, fixed-wing, light aircraft. Robinson currently produces only one model, the R22, which entered the marketplace in 1976, and has served as a trainer and light, utility helicopter. The R22 can be described as an ultra-light, low-cost, two-place helicopter.

EUROPEAN MANUFACTURERS

Aerospatiale Helicopter Corporation—Aerospatiale Helicopter Corporation is a subsidiary of the Societe Nationale Industrielle Aerospatiale and as such is a nationalized industry primarily owned and fully supported by the Government of France. Helicopter activities are concentrated in two plants in Marignane, France (approximately 7,700 workforce) and involve the development and production of a wide range of turbine-powered helicopters.

Aerospatiale's helicopter product line ranges from single-engined to triple-engined, from the light five-seater to the 30-seat helicopter. The product line is adaptable to the requirements of civil and military operators. With this broad product line plus nationalized support, Aerospatiale is the most formidable competition to the U.S. manufacturers.

Aerospatiale actively participates in the four-way European manufacturer consortium (Westland, Agusta, Messerschmitt-Boelkow-Blohm) with a view to developing and harmonizing new European projects.

Aerospatiale Helicopters was teamed with LTV's Vought Helicopter from 1969 to 1974. At that time, the facility was purchased from LTV in its entirety but retained the name Vought for three years. The French Company is now officially registered as Aerospatiale Helicopter Corporation and the company purchased acres of land abutting the Grand Prairie Municipal Airport in Texas where it operates a reassembly point, customizing center and paint shop.The Texas facility is now the North American sales office and plans include developing a complete manufacturing capability.

For the South American continent, Aerospatiale has joined with two Brazilian partners (Aerophoto) and the State of Minas Gerais to set up the Helibras Corporation, which will market Aerospatiale products and take responsibility for production of Ecureuils and Lamas.

Currently, Aerospatiale is involved in coproduction agreements, marketing efforts and agreements to manufacture under license in the following countries: India, Switzerland, Rumania, Yugoslavia, Italy, United Kingdom, Singapore, Indonesia, People's Republic of China and the United States.

Messerschmitt-Boelkow-Blohm (MBB)—The present Messerschmitt-Boelkow-Blohm GmbH was formed in 1969 and is the largest aerospace concern in Germany with affiliation in a number of national and international corporations. MBB is a private firm in organization, but some of the ownership is held by local governments and private individuals under a complex arrangement.

MBB is heavily diversified and employs some 25,000 people at 10 plants throughout Germany. Of that number, 2,900 are involved in helicopter activities. MBB owns 30

percent of Airbus Industries, the multinational consortium that produces the Airbus series of transport aircraft.

Boeing's withdrawal in 1978 as MBB's U.S. sales representative for the Model 105 marketing led to the formation by MBB of a wholly-owned subsidiary, MBB Helicopter Corporation, in early 1979, in West Chester, Pennsylvania. The new company has reorganized its marketing department for increased activity in North and Central America.

MBB is now producing, in conjunction with Kawasaki of Japan, an 8/10 seat, multi-purpose helicopter known as the BK-117. Deliveries began in 1983.

MBB and Aerospatiale had been designated by their respective governments to design, develop and produce an anti-tank helicopter that would have met the requirements of the French and Federal German armies for service in the second half of the eighties. The program was known in West Germany as the PAH-2 and in France as the HAC. MBB had leadership in the program, which was cancelled in 1981.

Currently, MBB has a licensee agreement with the Indonesian firm, Nurtanio, for production of the BO-105.

Agusta Group—In 1977, four major Italian aerospace companies were combined under a single management structure; since that time, two others have joined and, together, they form the Agusta Group, now a nationalized industry supported by the Italian Government with minority private ownership. The company had been entirely privately owned until nationalized in the early eighties.

Currently, Agusta is producing several Bell Helicopter and Sikorsky products under license. Agusta is also engaged with Mendionali, SIAI-Marchetti and other Italian companies in production, under license, of the Boeing Vertol Chinook. It is collaborating with Westland Helicopters of the United Kindgdom in developing the Sea King replacement, to be called the EH-101.

Agusta is also engaged in the manufacture of its own commercial design, the 109A II, a light twin-engine, eight-place, multi-purpose helicopter. Agusta has also purchased the rights to produce a modified version of the Sikorsky S-61N-1-Silver, which has been widely used in an offshore oil support role.

In 1980, Agusta established its U.S. sales headquarters in Houston, Texas. The U.S. subsidiary, in addition to new sales, is to handle procurement in the United States for its Italian parent, including materials and avionics.

In September, 1982, Agusta's corporate sales headquarters and service center were moved to two locations in Philadelphia, Pa. Four additional sales offices have been established in the midwest, southwest, west and mid-central areas for marketing the Agusta A II.

Westland Helicopters, Ltd.—Westland Helicopters Ltd., a wholly-owned subsidiary of Westland Aircraft, entered the helicopter industry in 1947 by acquiring the license to build the Sikorsky S-51. In 1959, Westland acquired Saunders-Roe Ltd. and, in 1960, acquired the Helicopter Division of Bristol Aircraft Ltd. and Fairey Aviation Ltd. Westland, with head offices at Yeovil, Somerset, is a publicly-owned company which receives the support of its government through military development programs and through government grants for international co-development programs. In early 1983, reorganization of the Westland Group of Companies was announced bringing about the partial merger of Westland Helicopters, Ltd. and British Hovercraft Corporation, Ltd.

Westland is producing the Lynx, Sea King, Commando, Westland 30 and Gazelle (in cooperation with Aerospatiale Helicopter Corporation) for the military, as well as a civilian version of the Westland 30, twin-engine, 19-place, helicopter. Three Westland 30s are now in scheduled service with AirSpur, Inc. in Los Angeles, Ca.

APPENDIX B
DIRECTORY of VTOL AIRCRAFT
1983

Company and Civil Designation	Military Designation USAF	USCG	USA	USMC	USN	Present Status	Number of Places	Engine(s) Make	Horse Power	Maximum Gross Weight (Lbs.)	Useful Load (Lbs.)	Range With Useful Load (N.Mi.)	External Cargo Payload	Maximum Speed (Knots)
AEROSPATIALE HELICOPTER CORP														
SA 318C Alouette 2 Astazou	—	—	—	—	—	Opr	5	(1) Turbomeca Astazou 11A	523	3650	1660	374	1322	110
SA 3160 Alouette 3	—	—	—	—	—	Opr	7	(1) Turbomeca Artouste 111B	858	4630	2163	285	1650	113
SA 316B Alouette 3	—	—	—	—	—	Opr/ In Prod	7	(1) Turbomeca Artouste 111B	858	4850	2306	267	1800	113
SA 316C Alouette 3	—	—	—	—	—	Opr	7	(1) Turbomeca Artouste 111D	858	4960	2460	285	1800	118
SA 319B	—	—	—	—	—	Opr/ In Prod	7	(1) Turbomeca Astazou XIVB	858	4960	2413	340	1800	118
SA 330J Puma	—	—	—	—	—	Opr	22	(2) Turbomeca Turmo IV C	1588	16,315	7957	297	7715	142
SA 330L Puma		Military Version				Opr								
SA 315B Lama	—	—	—	—	—	Opr/ In Prod	5	(1) Turbomeca Artouste 111B	858	5070	2759	278	2500	113
SA 341G Gazelle	—	—	—	—	—	Opr	5	(1) Turbomeca Astazou 111A	592	3970	1843	369	1540	167
SA 342J Gazelle	—	—	—	—	—	Opr/ In Prod	5	(1) Turbomeca Astazou XIV H	858	4190	2011	407	1540	167
SA 360C Dauphin	—	—	—	—	—	Opr	14	(1) Turbomeca XVIII A	1032	6615	2818	353	2866	170
SA 361H Dauphin	—	—	—	—	—	Proto-type	14	(1) Turbomeca Astazou XX B	1380	7495	3889	297	3310	170
SA 365C Dauphin 2	—	—	—	—	—	Opr	14	(2) Turbomeca Arriel	2X670	7495	3354	245	3000	170
SA 365C1 Dauphin 2	—	—	—	—	—	Opr	14	(2) Turbomeca Arriel	2X670	7495	3340	245	2865	150
SA 365N Dauphin	—	—	—	—	—	Opr/ In Prod	14	(2) Turbomeca Arriel 1C	2X700	8490	4066	476	3748	165
AS 350D AStar	—	—	—	—	—	Opr/ In Prod	6	(1) Avco Lycoming LTS101-600A2	615	4300/ 4630	1933	412	2000	147
AS 332B		Military Version				Opr/ In Prod	21	(2) Turbo-meca Makila	2X1755	MGW,Lbs. Int/Ext: 18,408/ 20,613	9290	343	9920	160
AS 332C		Civil Version					21		2X1755		9290	343	9920	160
AS 332L		Stretched Version					25		2X1755		8970	461	9920	160
AS 332M		Military Version					25		2X1755					
AS 355E Twin Star	—	—	—	—	—	Opr	6	(2) Allison 250C-20F	2X420	4630	1895	432	2000	147
AS 355F Twin Star	—	—	—	—	—	Opr/ In Prod	6	(1) Allison 250C-20F	2X420	5071	2231	402	2300	147
AS 350B Ecureuil	—	—	—	—	—	Opr/ In Prod	6	(1) Turbomeca Arriel	641	4300/ 4630	1933	378	2000	147
AS 366G-1	—	USCG HH-65A Dolphin				Opr/ In Prod	8	(2) Avco Lycoming LTS 101-750A-1	742	8900	2722	414	1540	142
AUGUSTA AVIATION CORPORATION, INC.														
Agusta 109A II	—	—	—	—	—	Opr	8	(2) Allison 250C-20B	420	5730	2402	412	2000	168Vne

Company and Civil Designation	Military Designation USAF	USCG	USA	USMC	USN	Present Status	Number of Places	Engine(s) Make	Horse Power	Maximum Gross Weight (Lbs.)	Useful Load (Lbs.)	Range With Useful Load (N.Mi.)	External Cargo Payload	Maximum Speed (Knots)
BELL AEROSPACE TEXTRON														
	—	—	—	—	X-22A	Exp.	8	YT58-GE-8D	4X1250	18,016	1500	445	—	221.44
	X-14B	—	—	—	—	Exp.	1	GE J85-5	2X2450	3100	—	—	—	180
BELL HELICOPTER TEXTRON, INC.														
47G	—	—	OH-13E	—	—	Opr	3	Franklin VO-335	200	2350	915	212	—	86
			OH-13G	—	TH-13M									
47G-2	—	—	OH-13G	—	—	Opr	3	Lycoming V0-435	240[1]	2450	670	216	—	87
47G-2A	—	—	—	—	—	Opr	3	Lycoming V0-435	240[1]	2850	1210	200	—	91
47G-3	—	—	OH-13K	—	—	Opr	3	Franklin TV0-335	225[2]	2850	1041	205	—	91
47G-3B	—	—	OH-13S	—	—	Opr	3	Lycoming TV0-25A	260[2]	2850	885	198	—	91
47G-3B-1	—	—	—	—	—	Opr	3	Lycoming TV0-435	270[2]	2950	1090	218	—	91
47G-3B-1	—	—	TH-13T	—	—	Opr	2	Lycoming TV0-435 B1A	270[2]	2950	877	194	—	91
47G-3B-2	—	—	—	—	—	Opr	3	Lycoming TV0-435	280[2]	2950	1013[3]	208	1000	91
47G-3B-2A	—	—	—	—	—	Opr	3	Lycoming TV0-435 F1A	280[2]	2950	1108[3]	231	1000	91
47G-2A-1	—	—	—	—	—	Opr	3	Lycoming V0-435	240[1]	2850	1194	261	—	91
47G-4	—	—	—	—	—	Opr	3	Lycoming V0-540	260[1]	2950	1173	260	—	91
47G-4A	—	—	—	—	—	Opr	3	Lycoming V0-540 BIB-3	305	2950	1113	238	1000	91
47G-5	—	—	—	—	—	Opr	3	Lycoming V0-435	265	2850	1138[3]	210	1000	78
47G-5A	—	—	—	—	—	Opr	3	Lycoming V0-435 BIA	265	2850	1162	236	1000	91
AG-5	—	—	—	—	—	Opr	2	Lycoming V0-435	265	2850	1300	102	—	69
47J	UH-13J	HH-13Q		—	—	Opr	4	Lycoming V0-435	240[1]	2565	1204	258	—	91
47J-2	—	—	—	—	—	Opr	4	Lycoming V0-540	260[1]	2850	1090	226	—	91
47J-2A	—	—	—	—	—	Opr	4	Lycoming V0-540	260	2950	1117	224	—	92
47K	—	—	TH-13N	—	—	Opr	2	Lycoming V0-435	240[1]	2565	900	258	—	91
206A	—	—	—	—	TH-57A	Opr	5	Allison 250-C18	317	2900	1359	313	n/a	130
206A	—	—	—	—	—	Opr	5	Allison T50-C18	317	3000	1573	309	1200	130
206A-1	—	—	OH-58A	—	—	Opr	4	Allison T63-A-700	317	3000	1439	291	n/a	110
206A-1	—	—	OH-58C	—	—	Opr	4	Allison T63-A-720	400	3200	1315	240	n/a	110
206B JetRanger II	—	—	—	—	—	Opr	5	Allison 250-C20	400[1]	3200	1630	304	1200	122
206B JetRanger III	—	—	TH-57	—	—	Opr/ In Prod	5	Allison 250-C20J	420	3200	1565	345	1500	122
206L (LongRanger)	—	—	—	—	—	Opr	7	Allison 250-C20B	420	4050	1931	308	2000	130
206L-1	—	—	—	—	—	Opr/ In Prod	7	Allison 250-C28B	500	4150	1950	297	2000	130

1. Derated
2. Supercharged
3. Useful load is based on standard configuration, not empty weight

Company and Civil Designation	Military Designation USAF	USCG	USA	USMC	USN	Present Status	Number of Places	Engine(s) Make	Horse Power	Maximum Gross Weight (Lbs.)	Useful Load (Lbs.)	Range With Useful Load (N.Mi.)	External Cargo Payload	Maximum Speed (Knots)
BELL HELICOPTER TEXTRON, INC. (cont.d)														
206L-3	—	—	—	—	—	Opr/ In Prod	7	Allison 250-C30P	650	4150	1950	305	2000	130
204	—	—	UH-1A	—	—	Opr	7	Lycoming T53-L-1A	770[1]	7200	1956	123	—	62
204 (44′ rotor)	—	—	UH-1B	—	—	Opr	10	Lycoming T53-L-11	1100	8500	4670	205	—	95
204 (540 rotor system)	—	—	UH-1C	UH-1E	—	Opr	10	Lycoming T53-L-11	1100	9500	4670	273	—	125
204	UH-1F	—	—	—	—	Opr	9-11	GE T58-3	1272	9000	4504	283	—	100
204	—	—	—	—	HH-1K	Opr	9	Lycoming T53-L-13	1400	8500	3280	271	—	130
204	—	—	—	—	UH-1L-	Opr	9	Lycoming T53-L-13	1400	8500	3048	271	—	130
204	—	—	—	—	TH-L-	Opr	9	Lycoming T53-L-13	1400	8500	3412	271	—	130
204	—	—	UH-1M	—	—	Opr	10	Lycoming T53-L-13	1400	9500	4635	288	—	125
204	TH-1F	—	—	—	—	Opr	9-11	GE T58-3	1272	9000	2503	283	—	100
204	UH-1P	—	—	—	—	Opr	9-11	GE T58-3	1272	9000	4224	279	—	100
204B	—	—	—	—	—	Opr	10	Lycoming T53-L-11	1100	9500	4880	335	—	110
205	HH-1H	—	—	—	—	Opr	7	Lycoming T53-L-13	1400	9500	3391[2]	251	—	110
205	—	—	UH-1D	—	—	Opr	13	Lycoming T53-L-11	1100	9500	4348[3]	275	—	110
205	—	—	UH-1H	—	—	Opr	15	Lycoming T53-L-13	1400	9500	4300	251	n/a	110
205A-1	—	—	—	—	—	Opr	15	Lycoming T53-13A	1400	9500	4323	276	5000	120
209	—	—	AH-1G	—	—	Opr	2	T53-L-13	1400	9500	3691	338	—	190
209	—	—	AH-1S	MOD	—	Opr	2	T53-L703	1800	10,000	3700	295	—	170
209	—	—	AH-1S	—	—	Opr	2	T53-L703	1800	10,000	3526	290	—	170
209	—	—	AH-1S (UPGUN)			Opr	2	T53-L703	1800	10,000	3526	290	—	170
209	—	—	AH-1S (Modernized)	—	—	Opr	2	T53-L703	1800	10,000	3402	285	—	170
209	—	—	AH-1J	—	—	Opr	2	P&W T400-CP-400	1800	10,000	3390	335	—	190
209	—	—	AH-1J Iranian			Opr	2	P&W T400-WV-402	1970	10,000	3372	310	—	190
209	—	—	AH-1J Iranian TOW			Opr	2	P&W T400-WV-402	1970	10,000	3101	310	—	170
209	—	—	AH-1T	—	—	Opr	2	P&W T400-WV-402	1970	14,000	5928	310	—	190
209	—	—	AH-1T	TOW	—	Opr	2	P&W T400-WV-402	1970	14,000	5447	300	—	170
212	UH-1N	—	—	UH-1N	UH-1N	Opr/ In Prod	15	(2) P&W T400-CP-400	1800	10,500	4497	216	3383	100
212	—	—	—	—	—	Opr/ In Prod	15	(2) P&W PT6T-3B	1800	11,200	5228	226	5000	100
214A	—	—	—	—	—	Opr	16	Lycoming LTC-4B-8D	2930	15,000	5450	260	6000	140
214B	—	—	—	—	—	Opr	16	Lycoming T55-0-8D	2930	16,000[4]	5973	219	7000	140
214ST	—	—	—	—	—	Opr/ In Prod	20	GE-CT7-2A(2)	3250	17,500	8050	439	7800	130
301	XV-15 (NASA/US Army, Navy)					R&D	n/a	Lycoming T-53	1550	13,000 VTOL (15,000 STOL)	n/a	n/a	—	330
222	—	—	—	—	—	Opr/ In Prod	7-10	Lycoming LTS 101-650G-3(2)	1240	7850	2985	329	2500	150
222B (Wheel gear)	—	—	—	—	—	Opr/ In Prod	7-10	Lycoming LTS 101-750C-1(2)	1368	8250	3350	300	2800	150

1. Derated
2. Supercharged
3. Useful load is based on standard configuration, not empty weight
4. Extenal load (13,000 internal)

Company and Civil Designation	Military Designation USAF	USCG	USA	USMC	USN	Present Status	Number of Places	Engine(s) Make	Horse Power	Maximum Gross Weight (Lbs.)	Useful Load (Lbs.)	Range With Useful Load (N.Mi.)	External Cargo Payload	Maximum Speed (Knots)
BELL HELICOPTER TEXTRON, INC. (cont.d)														
222UT (skid gear)	—	—	—	—	—	In Prod	8-9	Lycoming LTS 101-750C-1	1368	8250	3376	361	2800	150
412	—	—	—	—	—	Opr/ In Prod	15	P&W PT6T-3B(2)	1800	11,600	5333	232	5000	140
BOEING VERTOL COMPANY														
Boeing Vertol 107-11	—	—	—	—	—	Opr	28	(2) GE CT-58-140	1400	22,000	10,171	200	11,500	146
Boeing Vertol 107-11	—	—	CH-46A	—	UH-46A	Opr	27	(2) GE CT-T58-8F	1350	21,400	8666	172	10,000	131
Boeing Vertol 107-11	—	—	CH-46D	—	UH-46D	Opr	27	(2) GE T58-10	1400	23,000	9770	178	10,000	144
Boeing Vertol 107-11	—	—	—	CH-46F	—	Opr	27	(2) GE T58-10	1400	23,000	9658	178	10,000	144
Boeing Vertol 107-11	—	—	CH-46E	—	—	Opr	27	(2) GE T58-16	1870	23,300	7939	148	10,000	144
Boeing Vertol 107-11	CH-113 Canada	—	—	—	—	Opr	28	(2) GE T58-8F	1350	21,400	8129	465	10,000	146
Boeing Vertol 107-11	HKP-4	—	—	—	—	Opr	28	(2) Gnome 1200	1350	21,400	10,511	521	10,000	146
	Sweden (Royal Swedish AF)													
Boeing Vertol 107-11	—	—	CH113-A	—	—	Opr	28	(2) GE T58-8F	1350	21,400	8245	521	10,000	146
	Canada													
Boeing Vertol 107-11	—	—	—	—	HKP-4	Opr	28	(2) Gnome 1200	1350	21,400	10,704	521	10,000	146
	Sweden (Royal Swedish Navy)													
Boeing Vertol 114	—	—	CH-47A	—	—	Opr	36	(2) Lycoming T55-L-7C	2850	33,000	14,712	225	14,000	130
Boeing Vertol 114	—	—	CH-47B	—	—	Opr	36	(2) Lycoming T55-L-7C	2850	40,000	20,324	210	18,000	155
Boeing Vertol 114	—	—	CH-47C	—	—	Opr/ In Prod	36	(2) Lycoming T55-L-11D	3750	46,000	24,367	239	20,000	161
Boeing Vertol 114	—	—	CH-47A	—	—	Opr	36	(2) Lycoming T55-L-7C	2850	33,000	14,712	225	14,000	130
	Thai Army													
Boeing Vertol 165	—	—	CH-47C	—	—	Opr	36	(2) Lycoming T55-L-11C	3750	46,000	24,379	239	20,000	161
	Royal Australian AF													
Boeing Vertol 173	—	—	CH-147	—	—	Opr	47	(2) Lycoming T55-L-11C	3750	50,000	27,824	239	28,000	161
	Canadian Def. Forces													
Boeing Vertol 176	—	—	CH-47C	—	—	Opr	47	(2) Lycoming T55-L-11CS/SE	3750	50,000	28,167	239	20,000	161
	Spanish Army													
Boeing Vertol 219	—	—	CH-47C	—	—	Opr	47	(2) Lycoming T55-L-11	3750	46,000	24,367	239	20,000	161
	Iranian Army and AF													
Boeing Vertol 219	—	—	CH-47C	—	—	Opr	47	(2) Lycoming T55-L-11	3750	46,000	24,367	239	20,000	161
	Italian Army													
Boeing Vertol 145	—	—	CH-47D	—	—	In Prod	47	(2) Lycoming T55-L-712	3750	50,000	26,907	229	26,000	159
Boeing Vertol 234 Chinook ER (Extended Range)	—	—	—	—	—	In Prod	20	(2) Lycoming AL5512	4075	48,500	22,194	1035	28,000	150
Boeing Vertol 234 Chinook (LR)	—	—	—	—	—	Opr	47	(2) Lycoming AL5512	4075	48,500	23,300	620	28,000	150
Boeing Vertol 234 Chinook (UT)	—	—	—	—	—	In Prod	3	(2) Lycoming AL5512	4075	51,000	30,000	264	28,000	144
Boeing Vertol 308	CH-47C	—	—	—	—	Opr	47	(2) Lycoming T55-L-11CS/SE	3750	50,000	27,912	239	28,000	161
	Argentine AF													
Boeing Vertol 309	—	—	CH-47C	—	—	Opr	47	(2) Lycoming T55-L-11CS/SE	3750	50,000	28,436	239	28,000	161
	Argentine Army													

Company and Civil Designation	Military Designation USAF	USCG	USA	USMC	USN	Present Status	Number of Places	Engine(s) Make	Horse Power	Maximum Gross Weight (Lbs.)	Useful Load (Lbs.)	Range With Useful Load (N.Mi.)	External Cargo Payload	Maximum Speed (Knots)
BOEING VERTOL COMPANY (cont.)														
Boeing Vertol 352	HC-MK1	—	—	—	—	Opr	47	(2) Lycoming T55-L-11E	3750	50,000	26,532	239	28,000	159
	Royal Air Force													
Boeing Vertol 219	—	—	CH-47C	—	—	Opr	47	(2) Lycoming T55-L-11	3750	46,000	24,367	239	20,000	161
	Libya AF													
Boeing Vertol 219	—	—	CH-47C	—	—	Opr	47	(2) Lycoming T55-L-11	3750	46,000	24,367	239	20,000	161
	Moroccan Army													
Boeing Vertol 219	—	—	CH-47C	—	—	Opr	47	(2) Lycoming T55-L-11	3750	46,000	24,367	239	20,000	161
	Egyptian AF													
Boeing Vertol 219	—	—		—	—	Opr	47	(2) Lycoming T55-L-11	3750	46,000	24,367	239	20,000	161
	Greek AF													
Boeing Vertol 414	—	—	CH-47-414		—	In Prod	47	(2) Lycoming T55-L-712	3750	50,000	27,548	236	28,000	159
	Spanish Army													
BRITISH AEROSPACE														
	—	—	—	AV-8A	—	In Service	1	Rolls-Royce Pegasus MK 103 (F402-RR-402)	21,500 lb Sea Level V/STOL Thrust	Over 23,000 lb	10,000 lb fuel + ordinance	—	—	600+
	—	—	—	TVA-8A	—	In Service	2	Rolls-Royce Pegasus MK 103 (F402-RR-402)	21,500 lb Sea Level V/STOL Thrust	Over 25,000 lb	10,000 lb fuel + ordinance	—	—	600+
CALIFORNIA HELICOPTER (SIKORSKY)														
S-58T	—	—	—	—	—	In Prod	14-16	P&W ACL PT6T-3/6	1800/ 1875	13,000	5423	282	5000	120
THE ENSTROM HELICOPTER CORP.														
Enstrom F-28A	—	—	—	—	—	Opr	3	Lycoming 0-360-CIA	205	2150	700	272	500	97
Enstrom F-28C	—	—	—	—	—	Opr	3	Lycoming[1] 0-360-EIAD	205	2600[2]	850	243	650	97
Enstrom 280	—	—	—	—	—	Opr	3	Lycoming 0-360-CIA	205	2150	700	272	500	97
Enstrom 280C	—	—	—	—	—	Opr/In Prod	3	Lycoming[1] 0-360-EIBD	205	2350	835	231	1000[2]	101
Enstrom F-28C-2	—	—	—	—	—	Opr/In Prod	3	Lycoming HIO-360-EIBD Turbo charged	205	2350	822	234	1000[2]	97
Enstrom F-28F	—	—	—	—	—	Opr/In Prod	3	Lycoming HIO-360-FIAD	225	2600[2]	1050	228	1000[2]	97
Enstrom 280F	—	—	—	—	—	Opr/In Prod	3	Lycoming HIO-360-FIAD	225	2600[2]	1050	241	1000[2]	102
GLOBE AIR INC.														
S-55T	—	—	—	—	—	Opr	11-12	Garrett TSE-331-3U 303N	800	7200	2800	280	2500	99
GRUMMAN AEROSPACE CORP.														
Grumman Design 698 (Demonstrator)	—	—	—	—	—	R&D	2	(2) GE TF 34-GE-100	9200 lb thrust (ea.)	20,000 (STO)	n/a	n/a	—	500

1. Turbocharged
2. In restricted category

Company and Civil Designation	Military Designation USAF	USCG	USA	USMC	USN	Present Status	Number of Places	Engine(s) Make	Horse Power	Maximum Gross Weight (Lbs.)	Useful Load (Lbs.)	Range With Useful Load (N.Mi.)	External Cargo Payload	Maximum Speed (Knots)
HILLER AVIATION														
Hiller UH-12E	—	—	OH-23G	—	—	Opr/In Prod	3	Lycoming 540	305	3100	1341	215	1000	96
Hiller UH-12E4	—	—	OH-23F	—	—	Opr/In Prod	4	Lycoming 540	305	3100	1264	215	1000	96
Hiller UH-12ET	—	—	—	—	—	Opr/In Prod	3	Allison C-20B	301	3100	1450	351	1000	96
Hiller UH-12E4T	—	—	—	—	—	Opr/In Prod	4	Allison C-20B	301	3100	1450	351	1000	96
FH-1100	—	—	OH-5	—	—	Opr/In Prod	5	Allison C18/C-20B	400[1]	2750	1355	396	1500	128
HUGHES HELICOPTERS, INC.														
77	—	—	AH-64A	—	—	In Prod	2	(2) T-700-GE-701	1694[2]	20,100	6635	372	n/a	196
269A	—	—	TH-55A	—	—	Opr	2	Lycoming H10-360-DIA	180	1670	662	178	500	75
300 (269B)	—	—	—	—	—	Opr	3	Lycoming H10-360-AIA	180	1670	698	191	500	75
300C (269C)	—	—	—	—	—	Opr/ In Prod	3	Lycoming H10-360-DIA	225[3]	2050	1004	224[4]	1104	91
500	—	—	OH-6A	—	—	Opr	4-6	Allison T63-A-5A	317[5]	2550	1330	276[4]	1570	130
500M (369HM)	—	—	—	—	—	Opr	4-6	Allison 250-C-18A	317[5]	2550	1380	276[4]	1620	130
500C (369HS)	—	—	—	—	—	Opr	5-7	Allison 250-C-20	400	2550	1320	287[4]	1560	130
500D (369D)	—	—	—	—	—	Opr	5	Allison 250-C-20B	420[6]	3000	1593	287[4]	2000	152
500E (369E)	—	—	—	—	—	Opr/ In Prod	5-7	Allison 250-C-20B	420[6]	3000	1545	287[4]	2000	152
530	—	—	—	—	—	In Prod	5-7	Allison 250-C-30	650	3100	1516	234	2000	152
HYNES HELICOPTER, INC.														
H-2	—	—	—	—	—	Opr/ In Prod	2	Lycoming IV0-360-AIA	180	1670	670	225	400	87
H-5	—	—	—	—	—	Opr/ In Prod	5	Lycoming IV0-540-BIA	305	2900	1200	275	800	105
KAMAN AEROSPACE CORP.														
K-888 LAMPS (Lamps Mark I)	—	—	—	—	SH-2F	Opr/ In Prod	3	(2) GE T-58-8F	1350 @	12,800	5651	367	4000	143
K-888 Export	—	—	—	—	—	In Prod	2-12	(2) GE T-58-8F	1350	13,500	6634	400	4000	136
MBB HELICOPTER CORPORATION														
BO 105C	—	—	—	—	—	Opr	5	(2) Allison 250-C20	400	5071	2542	310	1984	145
BO 105 CB	—	—	—	—	—	Opr/ In Prod	5	(2) Allison 250-C20B	400	5291	2684	310	1984	145
BO 105 CBS	—	—	—	—	—	Opr/ In Prod	5-6	(2) Allison 250-C20B	420	5291	2637	310	1984	145
BO 105 DB/DBS	—	—	—	—	—	Opr/[7] In Prod	5-6	(2) Allison 250-C20B	420	5070	2514	310	1984	145

1. Derated
2. SHP ea.
3. Derated to 190 hp takeoff and continuous
4. Range @ 5,000 ft. altitude, best range cruise speed, no reserves
5. Derated 278 SHP takeoff
6. Derated to 375 SHP takeoff
7. BO 105 variant for Civil Aviation Authority (CAA)/United Kingdom

Company and Civil Designation	Military Designation USAF	USCG	USA	USMC	USN	Present Status	Number of Places	Engine(s) Make	Horse Power	Maximum Gross Weight (Lbs.)	Useful Load (Lbs.)	Range With Useful Load (N.Mi.)	External Cargo Payload	Maximum Speed (Knots)
MBB HELICOPTER CORPORATION (cont.d)														
BO 105 LS[7]	—	—	—	—	—	Prototype	5-6	(2) Allison 250-C28C	550	5732	2800	290	2650	145
BK 117	—	—	—	—	—	Opr/ In Prod	8-11	(2) Lycoming LTS 101-650	650	6284 (6614 with external load)	2778-internal	294	2650	150
McDONNELL DOUGLAS CORP.														
McDonnel Douglas Corp.	AV-8B Harrier II V/STOL close air support aircraft					Full-Scale Development	1	One Rolls-Royce F402-RR-404 turbofan engine	21,180 lbs. of thrust	29,750	17,000 (Approx.)	Classified	9200	585 knots at sea level
McDonnell Douglas Corp.	YAV-8B advanced V/STOL light attack prototype					Prototype	1	Rolls-Royce F402-RR-404 Pegasus II	21,500 lbs. of thrust	29,750	17,000 (Approx.)	Classified	9000+	M 9.0+
ROBINSON HELICOPTER CO.														
R22	—	—	—	—	—	Opr/ In Prod	2	Lycoming 0-320	160[1]	1300	468	208[2]	n/a	102
SOLOY CONVERSION, LTD.														
Soloy/Hiller* Turbine Conversions UH-12 D/E	UH-12	D/G	—	—	—	Opr/ In Prod	3	Allison 250-C20B	420[3]	3100[4]	1450	188[5]	1250	84
UH-12 E4/L4*	—	—	—	—	—	Opr/ In Prod	4	Allison 250-C20B	420[3]	3100[4]	1450	188[5]	1250	84
Soloy/Bell 47 Turbine Conversions	Oh-13S		Th-13T											
600 Trans.	—	—	—	—	—	Opr/ In Prod	3	Allison 250-C20B	420[3]	2950[6]	1300	182[5]	1200	91
900 Trans.	—	—	—	—	—	Opr/ In Prod	3	Allison 250-C20B	420[3]	3200[6]	1550	182[5]	1200	91
Models: 47G-2A 47G-2A-1 47G-3 47G-3B-1 47G-3B-2 47G-3B-2A 47G-4 47G-4A 47G-5 47G-5A														
SPITFIRE HELICOPTER COMPANY LTD.														
Spitfire MK 1	—	—	—	—	—	Prototype	3	Allison C250-C20B	420[3]	2600	1350	308	1500	129
Spitfire MK II	—	—	—	—	—	Prototype	5	Allison C250-C20B	420[3]	2600	1275	308	1500	138
Taurus	—	—	—	—	—	Prototype	10	Twin Allison C250B	420	7827	3086	410	2203	135

1. Derated 124 hp up to 4,200 ft.
2. Range @ 5,000 ft. altitude, best range cruise speed, no reserves
3. Derated
4. 2,800 lbs. non-disposable
5. Can be altered by load configuration
6. 2,950 is non-disposable
7. Weights shown are for external loads

* Soloy's STC for Hiller Conversions was sold to Hiller Aviation, April 1983

Company and Civil Designation	Military Designation USAF	USCG	USA	USMC	USN	Present Status	Number of Places	Engine(s) Make	Horse Power	Maximum Gross Weight (Lbs.)	Useful Load (Lbs.)	Range With Useful Load (N.Mi.)	External Cargo Payload	Maximum Speed (Knots)
UNITED TECHNOLOGIES CORP. (SIKORSKY AIRCRAFT DIVISION)														
S-51	H-5H	HO-3S-IG	—	HO-3S-1	HO-3S-2	Opr	4	P&W R-985-B4	450[1]	5500	1450	264[2]	—[3]	90[4]
S-55A	UH-198	—	UH-19D	CH-19E	UH-19F	Opr	12	Wright R-1300	800	7500	2250	339	2000	97
S-55C	—	—	UH-19C	—	HRS-1	Opr	12	P&W R-1340	600	7200	2250	372	2000	88
S-58	—	—	CH34A CH34C	VH 34D UH34E UH34D	SH34G SH34H SH34J	Opr	14-16	Wright Cyclone R-1820-84	1525	13,000	5370	271	5000	107
S-58JT	—	—	—	—	—	Opr	14-16	P&W ACL PT6T-3/6	1800/1875	12,500	4923	282	5000	120
S-62A	—	—	—	—	—	Opr	13	GE CT-58-110-1	1250	7900	2967	453	3000	95
S-62C	—	HH-52A	—	—	—	Opr	14	GE T58-GE-8B	1250	8300	3017	437	3000	95
S-61A	CH-38	—	—	—	SH-3A	Opr	16	(2) GE T58-GE-8B	1250	19,100	9870	452	8000	135
S-61V	—	—	—	VH-3A	VH-3A	Opr	VIP-15	(2) GE T58-GE-5	1500	20,500	8500	495	—	133
S-61E	—	—	—	—	RH-3A	Opr	MCM-4	(2) GE T58-GE-8F	1350	19,100	5426	520	8000	136
S-61D	—	—	VH-3D	VH-3D	SH-3D	Opr	ASW-7 VIP-15	(2) GE T58-GE-5/10	1500/1400	20,500	10,168	462	8000	135
S-61L (MARK II) Airline	—	—	—	—	—	Opr	30	(2) GE CT-58-140	1500	19,000	7208	305	6500	127
S-61 (MARK II) Payloader	—	—	—	—	—	Opr	2	(2) GE CT-58-140	1500	11,600	11,600	305	11,000	130
S-61N (MARK II)	—	—	—	—	—	Opr	26-28	(2) GE CT-58-140-2	1500	20,500	7990	490	6000	130
S-61R	CH/HH-3E	—	—	—	—	Opr	27	(2) GE T58-GE-5	1500	22,050	8615	736	8000	143
S-61R	—	HH-31	—	—	—	Opr	10	(2) GE T58-GE-5	1500	22,050	8323	675	8000	140
S-64A/E	—	—	CH-54A	—	—	Opr	5 in cockpit 45 pod	(2) P&W JFTD 12A-4A	4500	42,000	22,766	220	20,000	110
S-64F	—	—	CH-54B	—	—	Opr	As 64A	(2) P&W JFTD 12A-5A	4800[1]	47,000	27,393	220[2]	25,000[3]	104[4]
S-65A	—	—	—	CH-53A	—	Opr	40	(2) GE T64-GE-6	2850	35,000	12,556	260	20,000	170
S-65B	HH-53B	—	—	—	—	Opr	23	(2) GE T64-GE-3	3080	42,000	18,676	840	20,000	162
S-65C	CH/HH-53C		—	—	—	Opr	23	(2) GE T64-GE-7	3925	42,000	18,310	699	20,000	163
S-65D	—	—	—	CH-53D	—	Opr	40	(2) GE T64-GE-413	3925	42,000	18,368	293	20,000	164
S-65D	—	—	—	—	RH-53D	Opr	MCM(6)	(2) GE T64-GE-415	4330	50,000	24,318	730	25,000	165
S-65E	—	—	—	—	CH-53E	In Prod	58	(3) GE T64-GE-416	4380	69,750	36,524	266	36,000	170
S-69	—	—	XH-59A	(ABC)	—	R&D	2	P&W ACL PT6T-3 (2) P&W J60-P-2 (Turbojet)	1800 2900 (lb thrust)	—	—	—	—	300+
S-76 MARK II	—	—	—	—	—	Opr/ In Prod	14	(2) Allison 250-C30	650	10,300	4525	466	4200	155
S-70A	—	—	UH-60A BLACK HAWK	—	—	Opr/ In Prod	14	(2) GE T700 GE-700	1560	20,250	9626	325+	8000	160
S-70L	—	—	SH-60B SEA HAWK	—	—	In Prod	3	(2) GE T-700 GE-401	1632	21,700	7932	450	6000	150
S-72	Rotor Systems Research Aircraft (RSRA)					R&D	3	(2) GE T58-GE-5 (2) GE TF 34-GE-400P (turbofan)	1500 9275 (lbs thrust)	26,200	—	—	—	300

1. Horsepower, when listed for multi-engine aircraft, is that for each engine
2. Range determined at sea level, standard day, now reserves and at speed for best range
3. External cargo payload is maximum hook capacity
4. Maximum speed is at sea level, standard day, and maximum gross weight

Company and Civil Designation	Military Designation USAF	USCG	USA	USMC	USN	Present Status	Number of Places	Engine(s) Make	Horse Power	Maximum Gross Weight (Lbs.)	Useful Load (Lbs.)	Range With Useful Load (N.Mi.)	External Cargo Payload	Maximum Speed (Knots)
WESTLAND HELICOPTERS, LIMITED														
LYNX	Multi-Role LYNX				—	Opr/ In Prod	13	2X R.R. GEM 41-1	1120	10,000	3600	320	3000	140
LYNX	Navy LYNX			—	—	Opr/ In Prod	13	2X R.R. GEM 41-1	1120	10,750	3600	300	3000	125
LYNX	Multi-Role LYNX				—	R&D	13	2X R.R. GEM 60-3	1260	12,000	5200	380	3000	150
SEA KING	MK4 Utility			—	—	Opr/ In Prod	28	2X R.R. GNOME H1400-1 or (H1400-IT)	1660	21,400	8200	664	8000	112
SEA KING	MK5 (A.S.W.)			—	—	Opr/ In Prod	4 crew +	2X R.R. GNOME H1400-1 or (H1400-1T)	1660	21,000	7800	600	8000	112
COMMANDO	MK2	—	—	—	—	Opr/ In Prod	30	2X R.R. GNOME H1400-1 or (H1400-1T)	1660	21,000	28 Troop D	360	7500	112
GAZELLE	Military Version					Opr/ In Prod	SEE UNDER AEROSPATIALE HELICOPTER CORPORATION, SA 341							
WESTLAND 30	W30-100-41 Military & Civil Version		—	—	—	Opr/ In Prod	19	2X R.R. GEM 41-1	1120	12,350	17 Passenger	70	3500	120
WESTLAND 30	W30-100-41 Military & Civil Version		—	—	—	In Prod	19	2X R.R. GEM 60-3	1160	12,800	17 Passenger	300	5000	120

APPENDIX C
THE EFFECT OF THE COST OF CAPITAL ON PROJECTS WITH LONG PAYBACK PERIODS

Corporate expenditures allocated for R&D in American companies are not only influenced by the technical and marketing attributes of the venture but also by the costs of funding required for the project. The overall levels of both R&D and capital expenditures will generally decrease as the cost of capital rises. A second consideration, equally as important, is that the allocation of funding among the various categories of corporate expenditures will be altered as the cost of capital varies. Specifically, a rise in the cost of capital will generally inhibit expenditures on items involving delayed paybacks vis-a-vis those projects whose returns are generated shortly after the initial expenditures.

To illustrate the rationale for the argument made above: A company, whose cost of capital is essentially zero (ignoring for a moment inflation and risk), is considering two projects involving, on the one hand, the acquisition of a machine tool costing $10 million, and whose payback is shown in Part A, Figure 1, and an R&D project, also of $10 million, that will not return a profit earlier than five years after the initial investment. The cash flow for the latter project is shown in Part B of Figure 1.

As indicated, the returns in this zero capital cost example are positive for both projects. The R&D project, however, offers more than twice the return of the near-term investment in a machine tool. Thus, were a choice required, the company's management would be favorably disposed to opt for funding the R&D project.

In contrast, consider the effect of a non-zero cost of funds as shown in Figure 1. In this case, a required rate of return of 20 percent is assumed; this is not unreasonable in today's high interest rate environment. In this case, the out-year cash flows are divided by a discount factor of $(1.20)^n$, with n representing the number of years subsequent to the initial investment. The sum of these so-called discounted cash flows yields the present value of the project, or its worth to the company in present-day dollars. As a result of the discounting process, the value of machine tool acquisition has been reduced by almost 30 percent, from $18 million to $12.7 million; the present value has remained positive and the acquisition can, thus, still be considered an attractive expenditure of corporate funding.

In contrast, the returns generated by the R&D project, as a result of their occurrence further out in time, have been reduced from $36 million to $9.72 million, or by

FIGURE 1

Part A

MACHINE TOOL

Year of Initial Investment	Cash Generated	Discount Factor*	Present Value
V—$10 M	0	0	−$10
1	+$6 M	1.20	+5
2	$6 M	1.44	4.2
3	$6 M	1.728	3.2
	$18		$+ 2.4
	−10		
	$8 M		

Part B

R&D

V—$10 M	−	1.0	−$10
1	−	1.20	−
2	−	1.44	−
3	−	1.728	−
4	−	2.074	−
5	+6	2.488	−
6	+6	2.986	2.009
7	+6	3.583	1.674
8	+6	4.300	1.395
9	+6	5.160	1.163
10	+6	6.192	.969
	$36 M		$−2.79
	−10		
	$26 M		

*Cost of Capital—20 percent

almost 75 percent. The negative present value in the 20 percent cost-of-capital environment indicates that the R&D project can no longer be viewed as an attractive alternative.

Granted that the above examples have been oversimplified, they do illustrate a few critical points. First, the effect of a rising cost of capital is to reduce the attractiveness of all investment programs, either long or short-term. Secondly, as the cost of capital is raised, programs involving lengthy payback periods will be affected to a greater extent than investments with near-term paybacks. As a result, during periods of high interest rates, corporate managements will be less receptive to the commitment to R&D programs and the allocation of corporate expenditures will shift away from such programs and into the less risky capital expansions.

A further inference from this line of thought is that foreign government-subsidized corporations, which do not rely on this cost of capital as a funding allocation mechanism are less sensitive to interest rate variations. That is, since other considerations, besides meeting a required rate of return, determine the R&D budget setting process, such companies will not be required to cut back on their expenditures as interest rates rise. In such an environment, American firms will be placed at a severe disadvantage which, due to the nature of R&D, may not be discernible until after the fact.

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