Technical Collaboration in Industry: Opportunities and Constraints

An Aerospace Technical Council Project
in collaboration with
The Aerospace Research Center
and
Procurement and Finance Council

An AIA Internal Publication Draft

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Introduction

The competitive strength of the U.S. aerospace industry in foreign and domestic markets depends heavily on maintaining technological leadership. Competitors from other nations are often heavily subsidized by their governments; many are even government-owned. This makes it increasingly difficult for U.S. firms to compete effectively in the marketplace. Reductions in U.S. government funding for civil aerospace R&D have, at the same time, increased the burden of responsibility for R&D borne by U.S. aerospace firms.

The U.S. electronics industry and others have turned to R&D collaboration as one means to strengthen the competitive position of U.S. firms. The U.S. government has actively promoted various types of R&D collaborative ventures that would pump more private funds into R&D in the United States.

To evaluate the need for and potential benefits of R&D collaboration in the U.S. aerospace industry, the Aerospace Industries Association of America, Inc., conducted an exploratory study of R&D collaboration in the industry. The study included a review of the international competitive position of the U.S. aerospace industry, a review of the U.S. antitrust environment for collaborative R&D, a review of collaborative R&D efforts conducted by other U.S. industry groups, and an assessment of industry attitudes toward R&D collaboration.

Using the information compiled during the analytical reviews, AIA sent a questionnaire to CEO's of each of its member firms to gather information about their opinions of R&D collaboration and its applicability to the needs of the industry. To corroborate the results obtained from the questionnaire and gain further insight into CEO attitudes, personal interviews were conducted with these CEO's and other top managers in a representative group of AIA member firms. Survey responses or personal interviews were provided by 75 percent of AIA's member firms.

The sections which follow present the conclusions and recommendations that grew out of this investigation; a summary of the international competitive position of the U.S. aerospace industry; and a perspective on the U.S. antitrust environment and collaborative R&D which has been undertaken previously. The final section presents the detailed results of the aerospace CEO survey and personal interviews.

Conclusions and Recommendations

Two major conclusions emerged from the evidence on international competition and the U.S. antitrust environment for collaborative R&D.

1. **U.S. shares of free world aerospace sales and civil aerospace R&D declined significantly between 1960 and 1980,** despite large increases in the share of R&D funded by the private sector in the United States. There has been an upward trend in U.S. civil aeronautics research funding through NASA in recent years, but it is inadequate to overcome two decades of neglect. Unless the U.S. adequately maintains its share of free-world aerospace R&D, its ability to maintain its strong balance of trade position in this critical industry will be seriously jeopardized. Since 1980, the United States has changed from a net exporter to a net importer of civil aircraft products in its trade with its principal aerospace competitors—France, West Germany, and the United Kingdom.

Because of the role aerospace plays as a technological leader in manufacturing and systems technology, a decline in aerospace R&D is likely to have a long-term negative impact on the strength of other U.S. industries.

Collaborative R&D in the U.S. aerospace industry would help achieve greater results from limited R&D funds and partially counter the competitive disadvantages created by foreign collaborative efforts and government subsidies.

2. **Current U.S. antitrust laws inhibit but do not preclude "procompetitive" R&D collaboration.** The aerospace industry and others have created R&D collaboration projects which benefited both the industry and society in general; however, reforms in antitrust statutes are needed to clarify the law with respect to R&D and to reduce unnecessary obstacles to R&D ventures.

The results of the survey and personal interviews with aerospace CEO's provide additional insights regarding the feasibility and impact of R&D collaboration in the aerospace industry, from which the following five conclusions are drawn.

3. **R&D collaboration is supported in concept by the majority of aerospace CEO's** but they also recognize serious practical problems in achieving collaboration. Agreements are usually difficult and time-consuming to work out; and firms are especially wary of losing technological advantages over competitors through collaboration. Opinion within the aerospace industry is divided regarding whether or not foreign firms should be excluded from collaborative R&D projects. The biggest hurdle in organizing collaborative R&D is to create a procedure for determining areas of mutual research interest without prematurely revealing the identity and areas of strategic interest of prospective participants.

4. **CEO's generally prefer collaboration on basic research and on advancement of fundamental technologies,** unless market access is obtained from the collaboration. While some firms would like to see more collaboration in the development of complete systems and subsystems, the motivation for such col-

laboration is market access and financial risk-sharing rather than technological progress.

5. **Most CEO's would probably agree to and support a "catalytic" role for AIA in spurring collaborative aerospace R&D** but there is wide-spread conviction that AIA should not attempt to run R&D projects directly. Most respondents and interviewees prefer to minimize the number of intermediaries, letting companies collaborate directly when they find suitable opportunities.

6. **Few CEO's believe there is any need at present for an aerospace R&D program comparable to the electronics industry's Microelectronics and Computer Technology Corporation (MCC)** but smaller-scale collaborative ventures are likely to be feasible, if they are well planned and have strong leadership. The success of these initial projects would determine whether larger projects might be worth consideration.

7. **R&D collaboration is less potent than more direct measures,** even though it is helpful in squeezing more results out of existing R&D funds. In particular, it is believed that increased government funding for aerospace R&D, less restrictive rules related to reimbursement of industry-performed Independent Research and Development (IR&D) through government contracts and expanded investment tax credits for R&D (to stimulate more corporate funding) would each have much greater impact than collaboration in promoting R&D and in strengthening the competitive position of U.S. aerospace firms.

The actions which AIA can and should take based on these conclusions are discussed below.

RECOMMENDATIONS

Four principal recommendations for AIA action appear warranted by the findings and conclusions of this study. AIA should:

1. Press for reforms in tax and procurement laws and regulations that would encourage greater private R&D investment by all U.S. industries.

2. Press for increased U.S. government funding of R&D in civil aviation and space, because the competitive strength of the U.S. aerospace industry in foreign and domestic markets depends heavily on maintaining technological leadership.

3. Explore, through the Aerospace Technical Council, AIA's potential to catalyze R&D collaboration in the aerospace industry by providing the means for firms to identify and discuss possible technical areas suitable for collaboration.

4. Support antitrust reforms that will facilitate joint ventures by reducing civil suits against firms who undertake "procompetitive" R&D collaboration.

Each of these recommendations is discussed in further detail below.

National R&D Promotion Policies

Edwin Mansfield and other respected scholars have shown that the benefits to society from R&D greatly exceed the benefits which accrue to the individual firms

which conduct R&D. Because of this fact, government support for R&D investments should be encouraged. R&D throughout U.S. industry would be encouraged by treating R&D expenditures the same as other corporate investments for purposes of computing the investment tax credit. The present R&D tax credit appears to be of little or no benefit to firms that already have sizeable R&D budgets.

Specific support for civil aerospace R&D is also justified because of the technological leadership role played by the industry. Such support can be provided through direct funding of R&D, such as that provided through the National Aeronautics and Space Administration (NASA) and its predecessor, the National Advisory Committee for Aeronautics (NACA), or through expanded R&D tax credits (e.g., in addition to making the 25 percent R&D tax credit permanent, providing a meaningful credit for continued, sustained research and development activity; allowing all research and experimentation expenditures to qualify for R&D tax credit; and accelerating amortization of the cost of acquired research). Most aerospace CEO's also believe that less "micro-management" of independent R&D by the Department of Defense and less stringent limitations on the level of a company's IR&D investment that is reimbursable through DOD and NASA contracts would result in more R&D in the U.S. aerospace industry, thus benefitting U.S. industry as a whole.

AIA has prepared a number of reports examining the impact of present policies on the aerospace industry and the U.S. economy as a whole and recommending appropriate policy changes. *Trade and R&D Policies: An Aerospace Industries Association Proposal* (January 1984) is the latest and most complete discussion of these issues. Other industry groups have made essentially the same points. AIA should continue to press the case, bolstering its arguments where necessary and feasible with increasingly detailed analysis of the likely impacts of the different policy alternatives on both the aerospace industry and the total U.S. economy.

Catalyze R&D Collaboration

AIA may be able to promote R&D collaboration without taking a direct management role in individual collaboration projects. In particular, AIA could provide a means for member companies to identify and discuss technical areas which might be suitable for collaboration. Once areas of common interest have been identified, firms could then work out the details of a collaboration agreement directly, with little or no future AIA involvement.

The role of "catalyst" is critical in stimulating R&D collaboration. As the survey and interviews indicate, firms are usually reluctant to reveal to their competitors which technical areas are of greatest concern to them, particularly when those areas represent new strategic thrusts for the firm. Under such circumstances, no firm wants to make the first move; and the role of match-maker becomes important. The match-maker talks in confidence with each firm to identify areas of possible interest. Based on these discussions, areas of commonality are likely to emerge. Firms with areas of apparent commonality can be informed that others share their interest and, if they wish to explore these interests further, the match-maker can bring the prospective participants together for the necessary discussions.

There are several ways in which the Aerospace Technical Council might provide a match-maker for its members, providing the necessary confidentiality for initial disclosure and screening.

For the first step . . .

- Gather information on a confidential basis from firms on possible areas of interest for collaboration (and suggested scope of projects), then determine areas of commonality among firms for further discussion in a second step

For the second step . . .

- Bring together firms who have declared common areas of interest on which they might be willing to collaborate (leaving out firms who decide they are unwilling to disclose their interest to others)

Or,

- Conduct technical collaboration workshops on specific topics likely to be of interest to a number of firms, in which the critical technical and organizational issues for each topic can be aired. Representatives of other U.S. industries likely to have a significant interest in the topic might also be invited to participate.

Finally, based on these "catalytic" steps taken by AIA, firms who believe they have sufficient common interests to undertake a specific R&D project or projects on a collaborative basis can work out a mutually satisfactory agreement on their own.

If the firms themselves believe that further direct involvement by AIA is appropriate, they are free to propose it. This was the approach which led to the APT (automatically programmed tools) project in which AIA encouraged Illinois Institute of Technology Research Institute (IITRI) to manage the project, with AIA playing a key monitoring role from the late 1950's to the early 1970's . Based on comments in CEO interviews, it is possible that such an on-going role for AIA might arise where research on a specific topic of wide-spread interest is being sponsored at multiple universities and/or research institutes. However, it is considered unlikely in cases involving only a small number of firms.

Antitrust Reforms

AIA should support the reforms embodied in Title II of the Reagan Administration bills (H.R. 3878 and S. 1841). These bills provide the protection from antitrust litigation needed to facilitate R&D collaboration, while not imposing significant new requirements. Other bills generally impose new requirements which could adversely affect business flexibility and add new administrative burdens.

Rising International Competition

Loss of World Market Share

Since 1970, the United States' share of free-world aerospace sales has declined by 25 percent—from nearly 80 percent of free-world sales in 1970 to 66 percent in 1975, and to 61 percent in 1980. As shown in Figure 1, the countries of the European Economic Community (EEC), on the other hand, have increased their share of free-world aerospace sales from less than 15 percent in 1970 to nearly 28 percent in 1975, and to over 33 percent in 1980. The share accounted for by other producing nations has remained relatively unchanged during this period.

The gain in market share by EEC countries since 1975 is largely a result of increased market penetration in military products. Figure 2 shows that approximately 70 percent of 1975 free-world military aerospace sales were accounted for by the United States. By 1980, less than 60 percent of these sales were by U.S. firms. While the United States has increased its share of free-world civil aerospace sales from 70 to 76 percent during the 1975-1980 period, this has not been enough to offset the loss of share in military markets, which are larger. Military aerospace sales represented about 50 percent of the U.S. total in 1980, while EEC military aerospace sales accounted for about 72 percent of their total aerospace sales in 1980. The loss in the U.S. share of military aerospace sales may be the forerunner of future losses in civil aerospace market shares, particularly if European governments continue to promote and expand the collaborative development of aerospace programs into civil areas.

The penetration of foreign competitors is even more apparent when the aerospace market is segmented into its major components—airframes, engines, equipment, and space. As shown in Figure 3, the United States is losing its clear leadership in all of these market segments except space-related products. Even in space-related products, the U.S. position is certain to be challenged in the near future by Japan and France, and perhaps by others. Japan, for example, is currently developing its own space program and has banned purchases of foreign-made (i.e., non-Japanese) satellites during the development period.

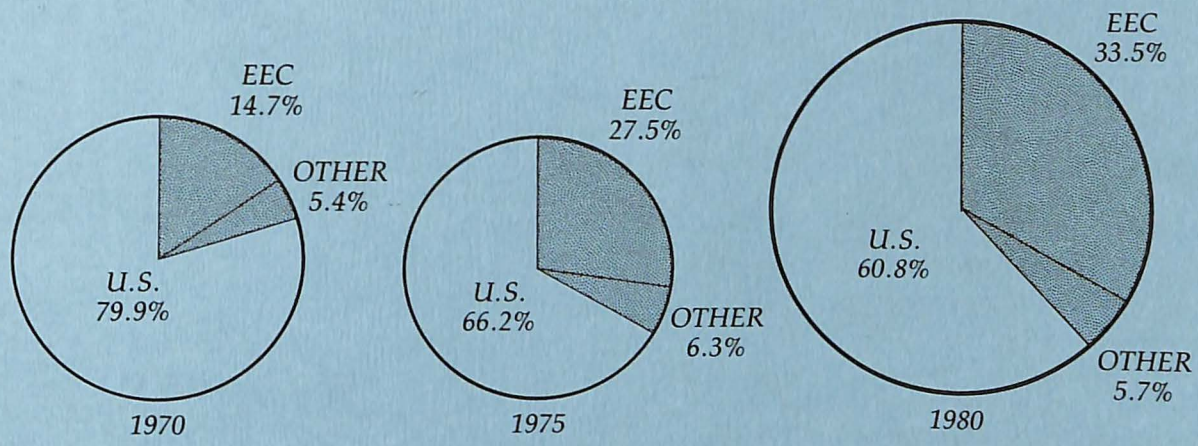
Loss of Domestic Market Shares

In addition to increased competition in international markets, the U.S. aerospace industry faces rising import competition within the United States. Table 1 shows the decline in U.S. production shares in the domestic market for aircraft parts, aircraft engines and engine parts, large transport aircraft, and helicopters.

The combination of reduced domestic and international market shares has led to a sharp decline in the U.S. trade balance with the EEC in aerospace products, which are the leading manufactured export of the United States.

FIGURE 1

Free-World Aerospace Sales By Producing Country
1970-1975-1980

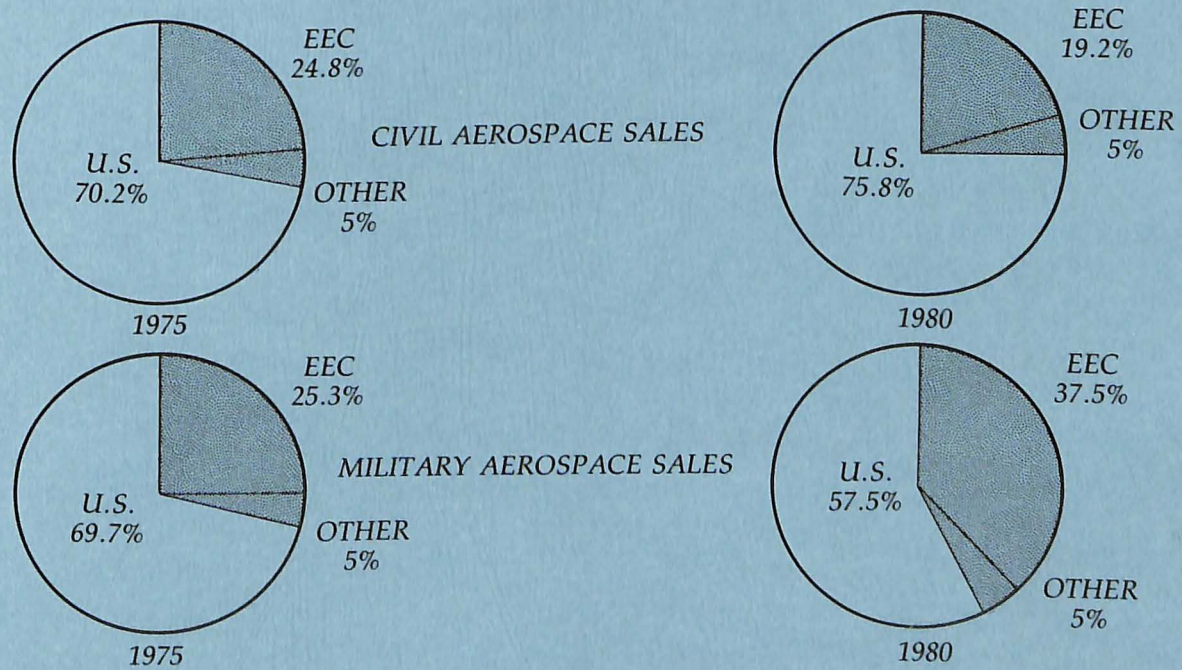


Source: Shriner-Midland Company, compiled from official European Economic Community (EEC) and U.S. data.

Note: Based on constant 1972 dollars. (1) U.S.—excludes "non-aerospace" sales. (2) EEC—data include intra-community transactions. (3) Other—estimated.

FIGURE 2

Civil & Military Aerospace Sales
(U.S., EEC, Other Countries)

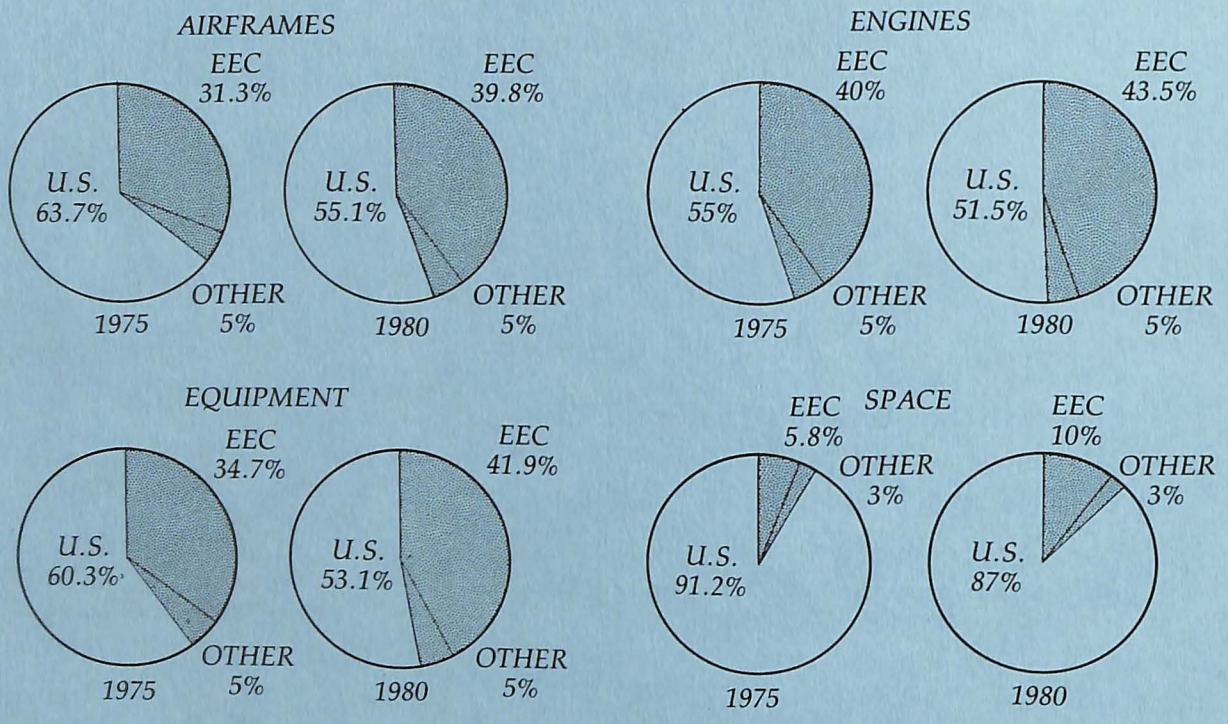


Source: Shriner-Midland Company, compiled from official EEC and U.S. data.

Note: Percentage based on current year U.S. dollars. (1) U.S.—excludes "non-aerospace" sales. (2) EEC—data exclude intra-community transactions. (3) Other—estimated.

FIGURE 3

Aerospace Sales By Type



Source: Shriner-Midland Company, compiled from EEC and Aerospace Industries Association (AIA) data.

Note: (1) Sales figures for U.S. exclude "non-aerospace" sales and include military and civil sales. (2) EEC data understated since data for United Kingdom are incomplete (excludes airframes). (3) EEC—data include intra-community transactions. (4) Other—estimated.

TABLE 1

IMPORTS AS PERCENT OF U.S. CIVIL AIRCRAFT SALES

YEAR	CIVIL HELICOPTERS	LARGE CIVIL TRANSPORT AIRCRAFT	AIRCRAFT ENGINES & ENGINE PARTS	AIRCRAFT PARTS
1970	—	0	1	5
1971	—	0	1	7
1972	—	0	6	12
1973	11	0	7	11
1974	8	0	7	12
1975	7	0	6	10
1976	9	0	4	9
1977	9	12	3	8
1978	12	3	5	9
1979	14	6	5	9
1980	17	9	8	13
1981	26	7	15	14
1982	36	7	16	20

Source: U.S. Department of Commerce and Aerospace Industries Association

In 1982, for the first time, the United States registered a deficit in civil aircraft trade with France, West Germany and the United Kingdom.

U.S. FOREIGN TRADE BALANCE—CIVIL AIRCRAFT
U.S. vs. France, W. Germany, and United Kingdom
(Millions of Current Year Dollars)

	1980	1981	1982
U.S. Exports	$1571	$1253	$ 464
U.S. Imports	−520	−698	−657
Net Trade Balance	+ $1051	+ $ 555	− $ 193

Source: U.S. Department of Commerce

Smaller U.S. Share of Aerospace R&D

Intertwined with the decline in U.S. share of domestic and international markets is a decline in U.S. investment in aerospace R&D, relative to that of the major competitor countries. Figure 4 shows total funds for U.S. aerospace R&D for 1960, 1970, and 1980. Measured in constant 1972 dollars, U.S. government spending for aerospace R&D declined from $4.6 billion in 1960 to $4.4 billion in 1970 and to $3.7 billion in 1980. Figure 5 shows that during the same period EEC government funding for combined civil aviation and civil space R&D increased from a share of less than 3 percent in 1960 to over 20 percent by 1980.

While EEC governments were increasing their direct and indirect investment in aerospace R&D, the U.S. government reduced its share of U.S. aerospace R&D from approximately 90 percent of total funding in 1960 to 72 percent in 1980. As a result, the U.S. share of total free-world aerospace R&D has declined. The U.S. Department of Commerce, in its assessment report, *U.S. Competitiveness in High Technology Industries,* comments:

> "The average annual level of U.S. government-sponsored R&D was 32 percent lower in the 1970's than in the 1960's. The decline continued in 1980 when total U.S. expenditures fell 13 percent from their 1979 levels."

Even though corporate funding has increased from 10 percent of U.S. aerospace R&D in 1960 to nearly 28 percent in 1980, the reduction in U.S. government funding has been too large to be completely offset by increased private effort. The primary source of civil aeronautics funding in the United States is the National Aeronautics and Space Administration (NASA). In real terms, aeronautics R&T funding through NASA increased between 1978 and 1980 and then decreased in FY 1981 and 1982 (Table 2). FY 1983 and 1984 funding and the Adminstration request for 1985 represents improvement and reflects awareness on the part of the Reagan Administration that potential gains in aviation warrant federal research investments in aeronautics. Nonetheless, the proposed funding levels are inadequate to overcome two decades of neglect in many areas of aeronautical research. The inadequacy becomes more apparent from an examination of budget estimates through FY 1989. Aeronautical R&T increases at an average annual rate of only 5.2 percent from $342.4 million in FY 1985 to $419 million in FY 1989. Assuming a predictable rate of inflation, aeronautical R&T decreases in buying power. This is not an encouraging sign for the continuing competitive leadership of the U.S.

aerospace industry. Unless the United States maintains its share of free-world aerospace R&D, it is unlikely to maintain the position of the U.S. aerospace industry as the leading contributor to net exports of manufactured goods.

TABLE 2

THE AERONAUTICAL COMPONENT OF THE NASA BUDGET
(Millions of Dollars)

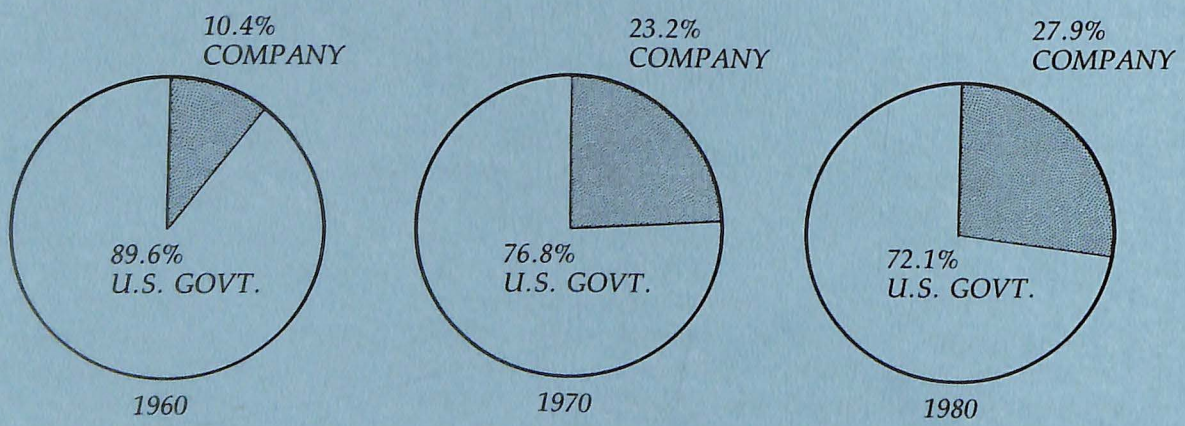
	FY78	FY79	FY80	FY81	FY82	FY83	FY84	FY85	FY86[a]	FY87[a]	FY88[a]	FY89[a]
CURRENT DOLLARS												
Aeronautics R&T	228	264	308	271	265	280	302	342	368	381	400	419
CONSTANT DOLLARS[b]												
Aeronautics R&T	152	162	173	139	127	129	133	144	148	147	148	150

Source: U.S. Government Budget, various years.

[a]Estimate as reported in "Five-Year NASA Budget Plan," *Defense Daily*, March 6, 1984, p. 32.
[b]Based on FY GNP deflators.

FIGURE 4

Total Funds For Research and Development
U.S. Aerospace Industry 1960-1970-1980
(Percent of Total R&D Funds/U.S. Government and Total R&D Funds/Company)

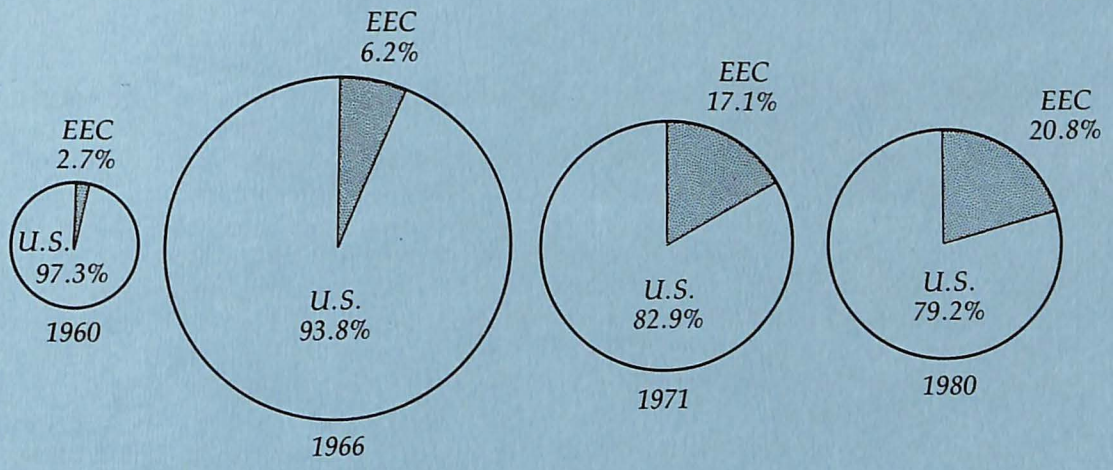


Source: Shriner-Midland Company, compiled from AIA data.

Note: Actual percent of company (private) funding is probably higher than percent indicated for each year shown since company funding does not include company-financed R&D contracted to outside organizations such as research institutes, universities and colleges, or other non-profit organizations.

FIGURE 5

Government R&D Funding for Combined Civil Aviation and Civil Space 1960-1966-1971-1980 EEC and U.S.



Source: Shriner-Midland Company, compiled from National Science Foundation, EEC and Organization for Economic Cooperation and Development (OECD) data.

Note: Based on constant 1972 dollars.

Antitrust and R&D Collaboration

Antitrust laws do not preclude R&D collaboration, but the mere possibility of being sued for treble damages under antitrust laws has discouraged R&D collaboration. Both the Carter and Reagan Administrations, along with Congressional and U.S. business leaders, have advocated antitrust reforms to reduce the perceived legal hazard in undertaking collaborative R&D ventures. The Justice Department has issued guidelines for setting up legally acceptable R&D collaboration efforts, and there are numerous antitrust reform bills pending in Congress.

Even without these reforms, antitrust laws have not prevented collaborative R&D; they have merely made it more complicated. A number of U.S. industries—including aerospace—have engaged in collaborative R&D projects which have not violated antitrust rules.

The sections which follow discuss the status of reform efforts, the general antitrust environment in the United States and its likely direction, and some of the collaborative R&D efforts which have been conducted by U.S. industry.

Reforming Antitrust Rules for R&D

In 1979, the Justice Department issued guidelines under which it believed R&D could be conducted on a collaborative basis without violating antitrust laws. These guidelines, though helpful in indicating the Justice Department's attitude on the matter, provided no protection against private suits, which have always been viewed as equally as great a threat as government suits. This led to the introduction in Congress of more than a dozen bills aimed at providing special treatment for collaborative R&D under antitrust laws.

The major features of antitrust reform bills introduced in Congress at the close of 1983 are presented in Figure 6. The most significant features are those shielding R&D collaboration from classification as a *per se* violation of antitrust and from treble damage penalties. Among the reform measures introduced, the Administration bills (S. 1841 and H.R. 3878) appeared to provide the most benefit with the least amount of new restrictions. The Administration's proposal would require the courts to use a "rule of reason" in judging collaborative R&D ventures and to limit awards to actual, rather than treble, damages. It would also require plaintiffs to pay all court costs if the defendant were found not guilty, thereby discouraging "frivolous" suits whose principal objective is harassment of the defendant. Collectively, these three provisions would substantially reduce the risk for participants in collaborative R&D ventures.

To receive the antitrust protection offered under the Administration proposal, firms would be required to formally notify the Justice Department of the planned collaborative R&D venture and disclose certain information, but no additional restrictions are placed on the venture's conduct, such as licensing rules, duration of the venture, and so forth. Other bills offered similar features but most levied

added requirements of one sort or another before protecting the proposed venture from antitrust prosecution, as Figure 6 indicates.

In both the House and Senate, efforts have been underway to produce revised bills acceptable to the various sponsors. S. 1841 (Thurmond) and a later bill, H.R. 5041 (Rodino), appeared, as of late spring, to have an excellent chance of passage in the 1984 session of Congress. Both are very similar to the Administration bill and, in fact, are supported by the Administration.

FIGURE 6

COMPARISON OF ANTITRUST REFORM BILLS FOR COLLABORATIVE R&D

Major Features	HR 3878 Moore-head (Admin)	S 1841 Thur-mond (Admin)	S 568 Tsongas	S 737 Mathias	S 1383 Glenn	S 1561 Dole	HR 108 Edwards	HR 1952 Synar	HR 3393 Sensen-brenner	HR 3641 Fish	HR 4043 Fuqua
Detrebling of Damages	(1)	(1)	(4)	(3)		(1)	(3)	(4)	(2,4)	(2)	(2)
"Reason" vs "per se" rules	X	X	Implied	Implied	Implied	X	Implied	Implied	Implied	Implied	X
Applies to Full Range of R&D	X	X	X	X	X	X	X	X	(5)	X	X
Attorney's Fees Paid	X	X	X	X	X	X	X	X	X	X	X
DOJ Notification	X	X		X		X		X	X		X
DOJ "Certification"			X		X		X				
Withdrawal of Exemptions			X	X	X		X	X			X
Venture Structure Qualifications				X				X	X		
Market Share/Sales Qualifications				X				X	X		
Mandatory Licensing Period			6 yrs	3 yrs				3 yrs	3 yrs		3 yrs
Venture Term Limited				10 yrs				10 yrs	15 yrs		
Access by Non-US Firms			(6)	(6)							
Small Business Provisions				X				X			

Source: Shriner-Midland Company Analysis of Individual Bills.

Notes:
(1) Liability limited to actual damages if venture is previously disclosed to Dept. of Justice.
(2) Liability limited to actual damages for R&D activities only.
(3) Liability limited to actual damages if Dept. of Justice has pre-certified the venture.
(4) Liability limited to actual damages if venture meets standards set out in the bill.
(5) Excludes joint marketing of products, price fixing & other anti-competitive practices from protection.
(6) Must be U.S. firms or citizens, unless home country permits foreign participation in similar ventures.

The Antitrust Environment for R&D

While passge of reform legislation will have a positive effect, it will not create a sweeping change. In general, currently proposed reforms would clarify existing doctrine but would not change the basic rules for R&D collaboration.

The key element in judging collaborative R&D is whether it will substantially reduce competition in the relevant marketplace. Collaboration that extends beyond R&D to the division of potential markets among competitors is not permissible because it reduces competition, but "pro-competitive" R&D collaboration among two or more competitors to accelerate technological progress, and thus increase competitiveness in the marketplace, is permissible.

Even before the publication of the Justice Department guidelines for collaborative R&D in 1979, most proposed R&D ventures examined by the Department were cleared, usually without major modifications (though occasionally with much delay). In the view of most attorneys, government prosecution for R&D collaboration has been and will remain unlikely, whether or not new reforms are enacted. An immediate, significant hazard under current law is private antitrust litigation, often with the principal objective of harassing the defendents or to compel a settlement rather than with a real expectation of winning treble damages in court. It is this hazard which the current reform proposals are intended to reduce, placing more of the cost of litigation on the plaintiff if his case is weak.

Antitrust laws largely preclude collaborative development of products by competitors who are able to undertake independent development at the same or a more rapid pace than can be achieved cooperatively. On the other hand, collaborative research (either basic or applied) that advances the general level of technology more rapidly than would independent research is arguably "pro-competitive" and should be permissible under the Department of Justice guidelines. The thorniest area of antitrust law for those concerned with meeting growing foreign competition is failure of the statutes to differentiate between domestic and international markets. Case law also appears ambiguous. Most antitrust experts seem to agree that present laws do not allow domestic competitors to collaborate against foreign competitors for the purpose of gaining a larger share (or protecting an existing share) of the domestic market. However, it is possible for two or more firms to collaborate for other "procompetitive" purposes without violating the law.

As a general rule, to be judged "procompetitive" and thus avoid antitrust violations, collaborative R&D focused on product development should not include all firms within the industry. It is generally understood that collaboration in basic research or in development of advanced technologies which can be used as one of many inputs in the production and marketing of competing products is unlikely to raise antitrust concerns, provided participating firms do not try to enter into agreements that divide up markets among them or otherwise reduce competition. It appears that the narrower the scope of the agreement and the shorter its duration, the less likely it is to raise antitrust issues.

U.S. Experience in R&D Collaboration

Several U.S. industries—notably iron and steel, natural gas, and electric power—have long-standing programs of collaborative R&D without violation of antitrust laws. In the case of natural gas and of iron and steel, the industry trade association has been the coordination point; in the electric power industry, a new and separate entity was created especially for collaborative R&D—the Electric Power Research Institute (EPRI). More recently, firms in electronics, semiconductors, and microcomputing (including several members of AIA) have helped form the Semiconductor Research Corporation (SRC) and the Microelectronics and Computers Corporation (MCC)—two different approaches for R&D collaboration.

Despite the intense competition which characterizes it, the U.S. aerospace industry itself has a long history of companies working together in major R&D projects, sometimes at the instigation of the government and sometimes independently. Firms often team up to compete for government contracts and to develop new aerospace products. A firm may take a leadership role on one project while simultaneously taking a subordinate role on another team involving some of the same participants. Thus, unlike other industries in which collaboration would be a totally new experience, the aerospace industry has considerable experience and expertise in organizing and managing projects involving many participants.

From the mid-1950's until the early 1970's, the aerospace industry, through AIA, collaboratively sponsored an on-going research program on automatically programmed tools (APT) at Illinois Institute of Technology Research Institute (IITRI). The program is widely regarded as a major success which benefited the entire industry. Many aerospace firms currently participate in various collaborative research projects with universities and non-profit institutions.

International Collaboration

Collaboration among international competitors in the aerospace industry is increasingly a typical pattern. The Airbus program, for example, has not only involved collaboration among firms from a number of European countries but financial "launch assistance" and "equity participation" by their governments.

Several U.S. aerospace firms are active in collaborative projects with foreign firms. For example, a recent National Science Foundation study identified over 50 collaborative arrangements between U.S. and foreign firms in the aerospace industry since 1970 (Appendix B). About 25 percent of these 50 projects are joint ventures, while the remainder are cooperative agreements of various forms (except for four nonfinalized agreements). The cooperative agreements include 10 technology licensing agreements, 16 co-production agreements, four exchange of information agreements, and seven identified as not being in any of these three categories. The number of these collaborative agreements increased during the 1970's, especially after 1977.

About 60 percent of the collaborative agreements were with Europe, 20 percent with Japan and 10 percent with Canada. The agreements involve mostly large U.S. firms—Boeing, McDonnell-Douglas, Lockheed, General Electric and United Technologies, in particular. Most were for joint development or production activity, rather than strictly for R&D collaboration, but they show clearly that collaboration among competitors is not new in the aerospace industry.

Collaboration outside the United States may be easier than it is within the United States. Japanese and French antitrust laws are less of an obstacle than are U.S. laws, and collaborative R&D programs are conducted in several industries, including aerospace, which have been targeted by the national governments in those countries. In Germany, collaboration between industry and universities is extremely close.

Despite strict EEC antitrust rules patterned after those of the United States, the EEC has exempted several collaborative research arrangements in such areas as nuclear oxide fuels, electronic components and aerospace (notably, Airbus). Press reports have recently suggested that further loosening of EEC antitrust rules regarding R&D may be coming, perhaps in response to proposed U.S. reforms.

Aerospace Attitudes and Concerns Regarding R&D Collaboration

A critical factor in the success or failure of R&D collaboration is the degree of commitment of top management. To engage top management commitment and attitudes on R&D collaboration, AIA conducted a mail survey of CEO's in its member firms. In addition, personal interviews were conducted with CEO's and other top executives in a cross-section comprised of more than one-fourth of AIA's member firms.

Industry Response

The survey and personal interviews were conducted in December 1983 and January 1984. Respondents were assured that their individual replies would be treated as confidential and aggregated to prevent disclosure of their identity. The survey questionnaire and detailed responses are shown in Appendix A.

Top managers in a total of 36 AIA member firms (78 percent) either responded to the survey questionnaire or participated in executive interviews. Written survey responses were received from 29 firms, approximately 63 percent of AIA's current membeship. Personal interviews were conducted at 15 firms, of which 12 provided interviews directly with the CEO or the head of the aerospace unit and, of that group, four provided additional interviews with the chief functional officers for technology, finance, and legal.

Only one firm declined to participate in interviews when requested. On the other hand, seven firms agreed to participate in personal interviews but declined to return the survey questionnaire.

R&D Collaboration—Pros and Cons

CEO's generally see R&D collaboration as desirable in concept but difficult to achieve in practice. Seventy-eight percent of the survey respondents indicated that more technical collaboration is desirable. Of these, 28 percent see collaboration as "definitely desirable." On the other hand, 14 percent of the firms indicated more collaboration in the industry is "probably undesirable." Seven percent viewed collaborative aerospace R&D as "neutral;" while none said it was "definitely undesirable."

Of the seven interviewees whose firms did not complete questionnaires, four viewed R&D collaboration as generally desirable, two were neutral, and one saw it as undesirable. These results are roughly the same as those obtained on the questionnaires, which suggests that non-response bias in survey responses is not likely to be significant.

The principal benefit of collaborative R&D cited by respondents is "increased cost-effectiveness of R&D spending" (79 percent ranked it either first or second in importance), followed by "increased competitiveness in international markets" (65

percent). "More rapid technical progress" was cited by 41 percent, while 24 percent cited "greater competitiveness of my company versus all others." Ten percent cited one or more other benefits as the most important.

"Loss of technological advantage over competitors" was considered to be the most important detriment, cited as first or second in importance by 62 percent of respondents. The detriment ranked next in importance is closely related to the first, "increased chance that proprietary information will be revealed" (55 percent). Lower rankings were given to "loss of project control" (38 percent) and "greater difficulty in controlling access by third parties" (21 percent). Seven percent cited other negative factors as the most important.

In personal interviews, CEO's and other top corporate executives emphasized that the major factor inhibiting R&D collaboration is the concern that hard-earned proprietary technical know-how will become known to competitors, causing the firm to lose its technological advantage over competitors. Although this concern is expressed in various terms by different executives, the possibility of losing technological advantage to competitors is clearly the major barrier to R&D collaboration.

Even discussing potential areas of collaboration in basic research can be a highly sensitive issue, since it may reveal future strategic moves of interest to the firm. Several firms were willing to discuss areas of possible collaboration with the interviewer, but some were not. In a few instances, this unwillingness was due to the firm's work in classified defense projects. However, executives in some firms clearly are concerned that knowledge of their areas of basic research interest will be used to decipher their long-term competitive strategy.

Collaborative Research Versus Development

Opinions are divided on whether emphasis needs to be placed on "R" or on "D" in technical collaboration. This difference in viewpoint was evident in personal interviews, but it also appeared in responses to the questionnaire. Nevertheless, the majority appears to favor collaboration at the "R" end of the spectrum, without precluding collaboration in product development in specific instances.

The questionnaire asked, "At what stage in the R&D process do you think more collaboration would be desirable, if antitrust concerns could be met?" The response was as follows:

Basic science research	69%
Advancement of general aerospace technology	55%
Development and testing of major subsystems	24%
Development and testing of complete systems	7%
All of the above	7%
None of the above	10%

When "all of the above" responses are added to each level, 76 percent favor collaboration in basic research and 62 percent support collaboration in the advancement of general aerospace technology—a majority in both cases. However, sizable minorities favor further collaboration at the "D" end of the spectrum.

Interviews suggest that collaboration in product development and testing (and in production) is considered vital by many firms not for technological reasons but

for obtaining access to certain markets, most notably markets in other countries. A few interviewees also viewed such collaboration as necessary among domestic firms to counter government-assisted collaboration among foreign competitors.

Alternatives to Collaboration

Respondents were also asked to rank in importance various factors affecting the competitive technological strength of the U.S. aerospace industry, including R&D collaboration. This question helps to place R&D collaboration in its broader policy context and to evaluate its impact against other policy alternatives.

Technical collaboration ranked third among seven suggested alternatives, as shown below.

Rank	*Policy Alternative*	*Percent*
1	More favorable tax treatment of R&D costs in the U.S.	62%
2	Increased U.S. government funding of aerospace R&D (by NASA, DOD, or other agencies)	59%
3	GREATER FREEDOM TO UNDERTAKE COLLABORATIVE R&D	34%
4	"Launch assistance" funding by the U.S. government similar to that provided by several European governments	21%
5	Reduced emphasis on foreign "co-production" by DOD	14%
6	Easier access to risk financing for development of major new products	10%
7	Other important factors (see below)	10%
8	Restrictions on collaboration with non-U.S. companies	3%

Both the survey and the personal interviews strongly indicated that R&D collaboration, though important, has less impact on U.S. technological competitiveness than would changes in the tax treatment of R&D or increased government spending on aerospace R&D. Many respondents and interviewees cited current restrictive policies related to reimbursement of IR&D (independent research and development) under government contracts as an impediment to further R&D spending by firms.

A number of interviewees suggested that R&D should have the same investment tax credit as other investments in future productivity. Other alternatives proposed by respondents are shown in Appendix A.

Foreign Competition or Collaboration

The most controversial subject probed in the survey and interviews turned out to be the degree to which non-U.S. firms should be excluded or included in collaborative R&D. Opinions are divided and strongly held, and, perhaps surprisingly, do not correlate particularly well with a firm's degree of concern with foreign competitors.

The questionnaire asked, "Are you more concerned about foreign competitors than about U.S.-based competitors?" The responses are summarized below.

Much more concerned about foreign competitors	17%
Slightly more concerned about foreign competitors	28%
Concerned about the same by each	24%
Slightly more concerned about domestic competitors	3%
Much more concerned about domestic competitors	28%

Elsewhere the questionnaire asked, "Should private foreign-owned companies be included in collaborative aerospace R&D?" Respondents were asked to answer the question with regard to each of four different R&D stages. The overall results are summarized below.

Should Foreign Owned Companies Be Included?

Definitely yes	3%
Probably yes	17-21%
Neutral	14-28%
Probably no	28-41%
Definitely no	21-28%

While a narrow majority voted "no," 17-21 percent voted "yes" and 14-28 percent of the respondents voted "neutral."

It would be reasonable to expect a close correlation between a firm's concern with foreign competition and its attitude toward foreign participation in collaborative R&D; however, this does not seem to be the case among the firms surveyed or interviewed. While it holds true for some companies, there are many cases in which companies report great concern about foreign competition and also vote for including foreign-owned firms in collaborative R&D. The explanation for this seeming paradox is linked to firms' attitudes toward collaboration as a market access strategy, as opposed to a technical superiority strategy. Personal interviews tended to bear this out; firms who saw collaboration as a critical tool for gaining access to foreign markets generally favored at least some freedom to include foreign firms and to oppose steps that might bar such collaboration. In general, it appears that most aerospace firms oppose steps that would limit their flexibility, even if they sacrifice protection to achieve it. A number of CEO's said flatly that they were opposed to "protectionist" measures even though they were seriously concerned about foreign competition. Nevertheless, as one CEO looking at collaborative aerospace R&D put it, "A blanket policy on foreign participation is probably the thorniest issue there is."

Other Findings

Respondents widely support changes in antitrust laws that would encourage technical collaboration, but most interviewees suggested that such changes would not lead to a substantial rise in collaborative R&D because of the various business obstacles mentioned earlier—principally concern with the loss of competitive advantage and the time and effort required to make a collaborative project work.

CEO's and corporate legal counsel may view antitrust as less of a barrier to R&D collaboration than do R&D executives. This appeared to be true in some of the firms where executive interviews were conducted with the entire top man-

agement team, and also in some of the questionnaire responses. If so, it may reflect the fact that CEO's and corporate legal counsel are more familiar with the details of antitrust than are technologists. It may also help explain, along with the practical difficulties of working out agreements, why the number of collaborative R&D projects has been so small.

Organizational Approaches to Collaboration

The survey and interviews ultimately addressed the organizational approaches that might be feasible, if R&D collaboration were to be pursued.

Generally, respondents preferred to collaborate with universities and/or research centers on projects involving basic research or advancement of technology rather than during the development of specific systems or products. During the later stages of development they prefer to collaborate with other firms, using universities or research centers only if needed for specific expertise.

Respondents also tended to favor "ad hoc" to "on-going" efforts for future collaborative R&D activities. Comments on the questionnaire and personal interviews suggest that CEO's believe on-going R&D projects tend to develop into self-perpetuating bureaucracies and are thus less responsive to the firm's needs. Several of those who favored some kind of R&D collaboration suggested that several small collaborative projects might be undertaken initially to prove their effectiveness. If they proved to be productive, they would serve as models for further collaboration within the industry.

Because of the extensive publicity given to the recently-formed Microelectronics and Computer Technology Corporation (MCC), CEO's were asked whether a similar organization was needed in the aerospace industry. On the survey, 21 percent of respondents favored establishing an MCC-type collaboration effort in the aerospace industry, while 31 percent were neutral and 39 percent were negative. Several CEO's feel the MCC approach is not needed in aerospace because its technological problems and competitive structure are much different than those of the electronics and microcomputer industry. More important, however, most CEO's feel that an "MCC-like" approach has yet to prove its success. Several also commented that the keys to success in such ventures are (1) to select target areas which will gain industry support, (2) to have a highly respected "champion" to promote and develop the project, and (3) to find a chief executive to lead and manage it who has strong credentials in both technology and management, plus integrity of the highest calibre.

AIA's Role

AIA may be able to play a catalytic role in encouraging R&D collaboration, but most respondents and interviewees do not favor assigning it responsibility for direct coordination or management of collaborative projects. The questionnaire noted that "some industry associations play a direct role in coordinating collaborative R&D" and asked "should AIA serve such a role . . . in the U.S. aerospace industry?" The response is shown below.

Definitely yes	7%	Probably no	41%
Probably yes	14%	Definitely no	24%
Neutral	14%		

Comments by respondents and interview discussions frequently noted that AIA lacks the facilities and staff needed to conduct R&D, and that the AIA staff lacks the necessary experience in managing R&D projects. More important, most respondents and interviewees prefer to minimize the number of intermediaries, letting companies collaborate directly when they find suitable opportunities.

On the other hand, a number of CEO's suggested in personal interviews that AIA might serve well as a "catalyst" for collaboration, provided it did not try to directly manage or operate projects or create a new R&D collaboration bureaucracy. One possible way in which this might be achieved would be to allow the Aerospace Technical Council committee structure to discuss possible areas for technical collaboration, which could then be implemented by the companies themselves. CEO's asked to comment on this kind of approach generally saw it as acceptable. Another concept suggested as a "possibility" by some during the interviews involved using the AIA as a conduit for channeling funds to universities or research institutes for basic aerospace research; however, others saw such an effort as likely to be controversial.

Summary

In summary, the survey and personal interviews indicate that the majority of aerospace CEO's support the idea of more technical collaboration but see many practical difficulties in achieving it, even if proposed antitrust reforms related to R&D are made. Support apparently exists for the development of a small number of well-planned and well-focused projects which might show whether firms would actually benefit from collaborative R&D in aerospace technologies. Further effort will be needed to define the areas for such projects and the leadership needed to bring them to fruition.

APPENDIX A

SUMMARY OF RESPONSES TO AIA TECHNICAL COLLABORATION SURVEY OF U.S. AEROSPACE CEO'S

The attached questionnaire form shows tabulated responses from 29 AIA member firms. No responses of individual firms are identified, to assure confidentiality. Comments provided by respondents are shown in consolidated form if the same comment was made by more than one respondent.

Certain questions require respondents to rank various possible answers. In tabulating responses to these questions, the number of respondents ranking an answer either first or second was used as the ranking factor. Percentages shown for responses are total for both first and second ranking of that particular answer. The purpose of this procedure is to properly reflect the importance of an item that may be ranked second by many respondents but rarely marked first. Where this procedure is used, rankings and percentages are noted with an asterisk (*).

TECHNICAL COLLABORATION QUESTIONNAIRE FOR AEROSPACE CEO'S

INTRODUCTION

Many experts believe that the international competitiveness of U.S. industries could be strengthened if there was more R&D collaboration among U.S. companies. While some R&D collaboration has existed in the past in the form of teaming agreements, jointly-funded research at universities, and similar arrangements, more extensive R&D collaboration has generally been limited because of fear of antitrust suits, unwillingness to share certain technical information, and other factors. Efforts have been made in recent years by the U.S. government to reduce the restrictiveness of antitrust laws (via Justice Department guidelines) where collaboration is principally concerned with R&D, and further reductions are currently being sought by the Reagan Administration.

It is generally agreed by legal experts that current antitrust laws deter collaborative R&D among competing companies when collaboration reduces competition in the market place. On the other hand, collaborative R&D which has "pro-competitive" effects is generally acceptable. The farther collaborative R&D is from the marketing of specific products, the less likely it is to be considered in violation of antitrust laws. Teaming agreements, in which there is buyer-seller relationship among participating companies, are a special form of collaboration that also do not violate antitrust laws if properly drawn. Proposed legislative changes in the antitrust laws would generally clarify these principles; among other things, they would eliminate the treble damages penalty a court could apply if it ultimately determined that a specific collaborative R&D agreement was in violation.

Several U.S. industries have long-standing collaborative R&D programs which have not violated antitrust laws. Other U.S. industries are preparing to undertake more R&D on a collaborative basis because of changes in antitrust policy, changing competitive pressures, and other factors. Their motivations, objectives, and approaches differ from one industry to the next. This survey is aimed at determining the attitudes of aerospace CEO's toward R&D collaboration, including what you see as its objectives, the type of R&D in which you believe collaboration is most important, and the mechanisms with which you would feel most comfortable.

Within this context, please respond to the questions that follow.

* * *

1. Does your company generally believe that a greater amount of collaborative aerospace R&D is desirable?

Definitely yes	28%
Probably yes	52%
Neutral	7%
Probably no	14%
Definitely no	None

2. What does your company see as the principal benefits of collaborative R&D? (Rank, with "1" the most important, and add any others you consider important)

Rank*		Percent*
3	More rapid technical progress	41%
1	Greater cost-effectiveness of R&D spending	79%
2	Greater competitiveness of U.S. companies in international markets	66%
4	Greater competitiveness of my company versus all others	24%
5	Other benefits	10%

What do you see as the principal detriments? (Again, rank with "1" most important and add others you feel are important)

Rank*		Percent*
1	Loss of technological advantage over competitors	62%
3	Loss of project control	38%
4	Greater difficulty in controlling access by third parties	21%
2	Increased chance that proprietary information will be revealed	55%
5	Others	7%

3. At what stage in the R&D process do you think more collaboration would be desirable, if anti-trust concerns could be met?

Basic science research	69%
Advancement of general aerospace technologies	55%
Development and testing of major subsystems	24%
Development and testing of complete systems and products	7%
All of the above	7%
None of the aove	10%

4. Should private foreign-owned companies be included in collaborative aerospace R&D?

	Definitely Yes	Probably Yes	Neutral	Probably No	Definitely No	
Basic science research	3%	17%	28%	28%	24%	100%
Advancement of general aerospace technologies	0%	17%	21%	41%	21%	100%
Development and testing of major subsystems	0%	17%	14%	38%	28%	100%
Development and testing of complete systems and products	0%	21%	27%	41%	28%	100%

Comments

"Appropriateness of foreign participation varies with respect to areas of science and technology. U.S. industrial participants should have discretion regarding allowability of foreign participation to assure equitable technological benefits."

"Most advantageous would be joint ventures on major products or systems."

"Must be assessed on a case-by-case basis."

Rankings and percentages represent respondents combined first and second choices.

"Would oppose U.S. government funding of foreign R&D performers unless a unique capability exists that should not be created in the U.S."

"The reason for collaboration is to strengthen the U.S. industrial base."

"The primary purpose would be to improve the U.S. position vis-a-vis private foreign-owned companies receiving subsidies from foreign governments."

5. Are you more concerned about foreign competitors than U.S.-based competitors?

Much more concerned about foreign competitors	1%
Slightly more concerned about foreign competitors	28%
Concerned about the same by each	24%
Slightly more concerned about domestic competitors	3%
Much more concerned about domestic competitors	28%

Why?

"Competition is competition, wherever it resides."

"With some exceptions, most aerospace competition in international markets is among U.S. firms."

"We have little or no foreign competition."

"Governments in foreign countries more actively support R&D through financial programs."

"No clear foreign leadership (concerned about the same)".

6. Please rank the following in terms of the contribution you believe they would make to the competitive strength of the U.S. aerospace industry (1 is most desirable, 99 is least desirable)

3	Greater freedom to undertake collaborative R&D	34%
6	Easier access to risk financing for development of major new products	10%
4	"Launch assistance" funding by the U.S. government similar to that provided by several European governments	21%
2	Increased U.S. government funding of aerospace R&D (by NASA, DOD, or other agencies)	59%
5	Reduced emphasis on foreign "co-production" by DOD	14%
8	Restrictions on collaboration with non-U.S. companies	3%
1	More favorable tax treatment of R&D costs in the U.S.	62%
7	Other important factors (please indicate)	10%

"Full recovery of IR&D costs."

"More Eximbank financial support."

"Trade-oriented foreign policy."

"Eliminate government sole source procurement."

"Better cooperation between government, university and industry in the conduct of basic research."

"Pragmatic policy and streamlined system for control of exports."

"Promotion of free and fair trade agreements."

"Stable, balanced fiscal and monetary policy with emphasis on outyear deficit and correction of exchange rate misalignments."

7. Which of the following organizational approaches to collaborative R&D would your company prefer for each type of R&D?

	Basic Research	Advance Technology	Develop Subsystems	Develop Systems
Single project collaboration focused at universities or research centers with particular expertise	59%	31%	3%	3%
Continuing, coordinated program of collaborative R&D focused at a research center or university	55%	52%	3%	3%
Single project collaboration among particular companies with limited university or research center involvement	11%	38%	59%	38%
Continuing, coordinated program of collaborative R&D involving a combination of company and outside (university, research center, etc.) personnel and facilities	35%	48%	17%	10%

If any of the above approaches would be unacceptable to your company, please write "no" in the appropriate space.

NOTE: One response was marked "no" to all of the above; two were marked "no" to all "Develop Subsystems"; one was marked "no" to both "Develop Subsystems" and "Develop Systems".

8. In recent months the microelectronics computer industry has established MCC, a major collaborative R&D venture. MCC will make extensive use of company research personnel, augmented by selected university and staff researchers, in joint development of specific products. This is in sharp contrast to the approach taken by the other recently formed collaborative R&D group, Semiconductor Research Corporation (SCR), which principally provides funding for university-based research to advance general semiconductor technology. Should the U.S. aerospace industry take an approach to collaborative R&D similar to MCC?

Definitely yes	None
Probably yes	21%
Neutral	31%
Probably no	24%
Definitely no	14%
No response	10%

Why?

"The large number of major aerospace and other DOD contractors in MCC program indicates an initial favorable evaluation of MCC approach by the aerospace industry."

"Previous university-based programs only marginally successful."

"Aerospace's concentrated industry structure reduces justification for joint product development. Collaborative research approach would differ markedly from MCC's."

"Should wait 1-2 years to see how successful MCC is. Value not yet proven."

"Too early to tell."

"Approaches and goals are generally the same within semi-conductor industry. This is not the case with aerospace. Rather, single project could allow focus on specific areas of mutual concern. There are exceptions; e.g., companies set up a non-profit company to develop NASTRAN, or noise work."

"Afraid of loss of proprietary position."

"MCC is involved in generic technology in the field of computers and semi-conductors. Their member needs are more vertically integrated and are threatened by intense Japanese activitiy

organized by MITI. So far the same set of facts do not apply in aerospace; but they could in the future."

"In unique situations where a project is too large for any one company or university, and for the good of DOD needs, more rapid progress in R&D could probably be made by the collaborative resources of more than one institution being brought to bear on a problem or requirements.

9. If you generally favor an approach similar to MCC, what changes do you think would be needed to adapt it to better suit the U.S. aerospace industry?

"Details have to be worked out *after* the technical objectives, and participants, have been selected. MCC and SRC should provide ideas and information."

"Must be assessed on a case-by-case basis."

"Because of the vertical integration of the companies involved in MCC, it would be hard to adopt their approach to aerospace needs. Present collaboration in research and technology through NASA, because of its massive facilities, might be a better approach in certain areas of aerospace technology. Similar use of other unique facilities, USG-owned and operated, may be possible on collaborative aerospace technical programs."

"Not sufficiently familiar with MCC to offer useful comment."

10. Some industry associations play a direct role in coordinating collaborative R&D. Should AIA serve such a role for collaborative R&D in the U.S. aerospace industry?

Definitely yes	7%
Probably yes	14%
Neutral	14%
Probably no	41%
Definitely no	24%

Why?

"AIA could act as a "catalyst"—get parties together."

"AIA would create additional bureaucracy if involved."

"AIA involvement could result in conflicts within AIA and among its members."

"AIA not technically but more politically oriented."

"AIA lacks technical staff."

"AIA is in the best position to elicit industry priorities and developments which would best benefit from collaborative R&D."

"AIA has many good capabilities, but additional staff and expansion of activities would be required."

"AIA could provide a focus for industry which cannot be achieved independently."

"AIA coordination is needed only to facilitate the convening of potentially interested parties. Industry participants should handle details."

"AIA should not formalize a specific approach. It is our belief that collaboration lends itself more to *ad hoc* arrangements among specific companies for specific projects rather than the generalized overall approach."

11. What other factors do you believe are important in assessing the need and possible mechanisms for collaborative R&D in the U.S. aerospace industry?

"Open, active interest by CEO's."

"Specific market being targeted."

"Successful implementation of several projects." "Loss of entrepreneurial approach."

"Conferences sponsored by AIA to produce lists of collaborative possibilities."

"Domestic competition—squeeze-out of non-participants."

"More senior level understanding of critical challenges facing the aerospace industry by leaders in industry, government, and academia—if collaborative effort is going to work."

"Need and mechanisms primarily are influenced by the structure of the industry and by world market characteristics."

"An analysis of the potential benefits to the contributors is needed. A pilot project for a specific R&D area would probably be beneficial as a means of testing the feasibility of collaboration."

"There is a need. We should try some collaborative efforts with *several* relatively small projects."

"A detailed study of the degree and trends of foreign product penetration into traditional U.S. aerospace marketplaces would need to be conducted to focus on areas for potential R&D collaboration. The study must assess subsidization of foreign competition on commercial ventures in order that the full spectrum of forces impacting this issue are considered."

"NEED—In the broad sense, enough studies have already been done from which we can conclude that some kind of collaborative R&D effort within the U.S. is justified. The next step in the total process would be to identify the more important technical areas where it would make sense to implement actions. MECHANISMS—The mechanisms/organizational approaches to be employed would be developed after the specific areas of work are identified and defined."

"Two separate efforts are needed: one aimed at the airframe area, the other at weapon suppliers."

"Other factors would include the size of the program, both in terms of costs and time, and the ability to allocate resources to the program without putting the future of the corporation at risk. This would hold for major new development programs. Another factor is the availability of unique technical resources, or facilities, that will be important in their contribution to collaborative efforts. Any foreign competition perceived as a threat wherein the foreign strategy is to target some aspect of aerospace business may possibly be responded to by collaborative R&D in the U.S. aerospace industry."

"A major concern for subcontractors and material suppliers would be that the prime airframe companies would collaborate in R&D in the disciplines and areas of interest of their suppliers, thus enhancing backward integration by the primes."

APPENDIX B

COLLABORATIVE PROJECTS BETWEEN U.S. FIRMS AND FOREIGN FIRMS OR GOVERNMENTS IN THE AERONAUTICS SECTOR BETWEEN 1970 AND 1982*

	Companies Involved	Civil (C) or Military (M)	Type** of Collaborative Effort	Research (R) Development (D) or Production (P)	Year of Agreement	Description of Effort
1.	McDonnell Douglas and British Aerospace	C, M	NF	D	Discussion stage	Development of V/STOL aircraft
2.	McDonnell Douglas and British Aerospace	M	NF	D	Discussion stage	Development of VTXTS jet transfer aircraft
3.	McDonnell Douglas and British Aerospace	M	CoPro	P	Current	Produce 336 AV-813's (Harrier II's) for U.S. Marine Corps
4.	McDonnell Douglas and British Aerospace	M	CoPro	P	Current	Manufacture frames for jump jet fighter for U.S. Marine Corps and Royal Air Force
5.	McDonnell Douglas and Fokker (Netherlands)	C	JV	D, P	1981 terminated in 1982	Develop and produce 150 seat aircraft
6.	McDonnell Douglas and McDonnell Douglas Canada	C	CoPro	P	Current	McD Can produces aircraft components for McD
7.	McDonnell Douglas and Japanese Government	M	CoPro	P	Current	Japan has licensed production programs for F-4, F-15, and P-3C
8.	McDonnell Douglas and Dilworth Secord Meagher and Assoc. (Canada)	M, C	Lic	D	1979	McD licensed cyrogenic wind technology as part of program to develop high tech projects in connection with offer to supply F-18A Hornet fighter aircraft to Canadian military
9.	McDonnell Douglas and Messerschmitt-Boelkow-Blohm Gmbll (Germany)	M	Ex	D	1978	Exchange of technical info relating to development of highly sophisticated fighter aircraft

*Source: *Alan Rapoport and Carol Erlebach, "Collaborative Projects Between the United States and Foreign Aeronautics Industries," National Science Foundation, draft report October 1982.*

** ***Table Key***
JV = Joint Venture
Coop = Cooperation Agreements
Lic = Technology Licensing Agreements
CoPro = Coproduction Agreements
Ex = Exchange of Information Agreements
NF = Nonfinalized Agreements

	Companies Involved	Civil (C) or Military (M)	Type** of Collaborative Effort	Research (R) Development (D) or Production (P)	Year of Agreement	Description of Effort
10.	McDonnell Douglas and Avions Marcel Dassault-Berguet and Societe National Industrielle Aerospatiale (France)	C	Coop	D, P	1977	Agreed to develop and market a medium range jetliner for the 1980s
11.	McDonnell Douglas and Government of Canada	?	JV	?	1976	Formed Canadian Aerospace Ltd.
12.	Boeing and Dornier Reparaturwerft Gmbll (Germany)	M	CoPro	P	Current	German company installs mission avionics in E 3A's (AWACS) produced by Boeing for NATO
13.	Boeing and Civil Transport Development Corporation (Japan)	C	CoPro	P	Current	Japanese firms manufacturing fuselage panels and other components accounting for 17% of Boeing 767 airframe
14.	Boeing and Aeritalia	C	CoPro	P	Current	Working relationship on Boeing 767
15.	Boeing and Canadair	C	CoPro	P	Current	Working relationship on Boeing 767
16.	Boeing and Government of USSR	C	Ex	D	1974	Scientific and technical cooperation as a step towards joint development of aircraft
17.	Lockheed and Fujitsu (Japan)	C	Lic	marketing	1982	Fujitsu can sell Lockheed's software for CAD/CAM for cars, aircraft and ships
18.	Lockheed and Government of Japan	M	Lic	P	1978	Japan will assemble 45 P-3C Orion manufacturing kits (four engine turboprop antisubmarine warfare aircraft) produced by Lockheed
19.	Lockheed and Rolls Royce	C	CoPro	P	?	Rolls Royce to produce engine for LT1011
20.	Lockheed and Government of USSR	C	Ex	D	1973	Joint work in navigation systems, oceanological apparatus and civil aircraft development
21.	General Electric and Rolls Royce (UK)	C	NF	D, P	Discussion stage	GE negotiating to enter British-Japanese joint venture to develop RJ 500 for new generation 150-seat transport
22.	General Electric and Alfa-Romeo (Italy)	C	Lic	P	1981	Alfa-Romeo licensed to produce 1600 T 700 turboshaft helicopter engines for Italian and other European helicopter programs

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23.	General Electric and Kvaerner Brug A/S (Norway)	C	Lic	P	1977	Kvaerner Brug licensed to manufacture and sell GE LM 2500 aircraft derivative gas turbine engine
24.	General Electric and Societe Nationale d'Etudes et de Construction de Moteors d'Aviation (SNECMA) (France)	C, M	JV	D, P	1977	To jointly develop and produce CFM 56 engine for commercial aircraft and military tankers
25.	Pratt & Whitney (United Technologies) and Rolls Royce Ltd (UK)	C	NF	D, P	Discussion stage	P&W negotiating to enter British-Japanese joint venture to develop RJ 500 engine for new generation 150 seat transport
26.	Pratt & Whitney (United Technologies) and Rolls Royce Ltd (UK)	M	Coop	D, P	1980	Jointly develop and produce engine for V/STOL jet fighters
27.	United Technologies and j.v. Verenigde Machinefabriken Stork NV (Netherlands)	M	JV	Service	1981	Build and operate a facility in Netherlands to test, overhaul, and repair fighter planes
28.	United Technologies and Airbus Industries	C	JV	CoPro	1977	P&W will supply its JT 2D-59A turbofan jet engine for a new generation of A-300 Airbuses
29.	United Aircraft (United Technologies) and Moterenund Turbinen-Union Gmbll (Germany) and Fiat SpA (Italy) and Alfa-Romeo (Italy)	C	Coop	D, P	1973	Joint development and production of JT 10D commercial aircraft engine
30.	United Aircraft (United Technologies) and Mitsubishi Heavy Industries (Japan)	C	Lic	D	1972	Provide for additional licensing of aviation oriented projects
31.	Avco and Piaggio (Italy)	C	CoPro	P	Current	Avco supplies turboprop version of LT 101 engine for fixed wing P-166-DL3 aircraft produced by Piaggio
32.	Avco and Aerospatiale (France) and Messerschmitt Boelkow-Blohm/ Kawasaki (Germany and Japan)	C	CoPro	P	Current	Avco supplies LT 101 engines to power Aerospatiale's AS 350 commercial helicopter & MBB/Kawasaki's BK 117

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33.	Avco and British Aerospace	C	CoPro	P	Current	Avco supplies wing sets and Lycoming turbo engines for BAe 146 aircraft
34.	Avco and Canadair	C	CoPro	P	Current	Avco produces ALF 502 turbofan engines for twin engine Canadair "Challenger" executive jet
35.	Fairchild Industries and Saab-Scania A.B. (Sweden)	C	JV	D, P	1980	Develop and manufacture a 30 passenger commuter airplane
36.	Fairchild Industries and Sonaca (Belgium)	C	Lic	P	1979	Sonaca granted right to assemble and market lightweight aircraft seats newly developed by Fairchild
37.	Piper Aircraft and Embraer (Brazil)	C	Lic	P	?	Embraer began civil aircraft production by assembling models of Piper
38.	Piper Aircraft and Short Brothers Ltd. (Ireland)	M	CoPro	P	1979	Short Brothers to produce Piper's Tomahawk training plane for European and African markets
39.	Northrop and Republic of China, Republic of Korea, and Switzerland	M	CoPro	P	Current	Northrop producing part of F-5 airplane and participating in coproduction agreements
40.	Wilcox Electric, Inc. (Northrop) and Australia	C	JV	D, P	Current	To further develop a microwave landing system developed by Australia which could eventually replace current ILS—instrument landing systems
41.	Ayden Corporation and Turkish Air Air Force Foundation (Turkey) and Tusus (Turkey)	C,M	JV	P	1982	To manufacture and repair avionics, communications, and radar systems
42.	Martin Marietta Corp. and Nissan (Japan)	C, M	Coop	D	1982	Nissan entered broad agreement to obtain basic technology for the development of aerospace and defense related equipment from Martin Marietta
43.	Garrett Corporation (Signal Companies) and Embraer (Brazil)	C	Coop	D, P	1981	Garrett agreed to develop and manufacture airbearing environmental control systems for the new EMB 120 commuter aircraft

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44.	Boeing Vertol and two unidentified foreign manufacturers	C	Lic	P	1981	BV licensed two foreign manufacturers to build various models of its 107 and CH47 helicopters
45.	Bell Helicopter (Textron) and Mitsui Co. (Japan)	C	CoPro	P	1981	Bell agreed to coproduce its 214 transport in Japan with Mitsui
46.	Cessna Aircraft Co. and Tensa (Argentina)	C	Ex	D, P	1980	Long term manufacturing distribution agreement, incorporating exchange of technology and distribution techniques and Tensa will produce 420 Cessna aircraft over 5 years
47.	Twin Fair Inc. and Airbus Industries	C	Lic	P	1979	Twin Fair licensed Airbus to manufacture two new Guppie type aircraft
48.	Grumman Corporation and British Aerospace	M	JV	——	1979	To offer Tornado combat jets for sale to U.S. Air Force and low level aircraft for NATO use in Europe
49.	Menasco Manufacturing Co. and La Societe E.R.A.M. (France)	C, M	Coop	?	1977	To collaborate on aerospace programs in the U.S., Canada, France and Brazil
50.	William Lear and Canadair	C	JV	D, P	1976	To build new twin jet aircraft with range of 5,000 miles suitable for executive jet market or for commuter runs
51.	Rockwell Industries and Fuji Heavy Industries (Japan)	C	Coop	D, P	1975	Agreed to jointly develop two pressurized twin engine business aircraft
52.	Pan American World	C	JV	?	1973	Formed an unidentified aircraft venture
53.	TRW Inc and Mitsubishi Steel Mfg. Co. (Japan)	C, M	JV	P	1971	Joint venture in Japan to produce precision castings for use in jet engines and gas turbine blades