OFFSETS AND THE AEROSPACE INDUSTRY

by

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ABSTRACT

A field study was performed and a literature search conducted to frame and analyze the role of offsets in the aerospace industry. The subject of offsets was defined in relation to the current environment in the aerospace industry. An overview of the US aerospace industry is provided and highlights revenue and employment trends over the past few years. This study segregated the three major sections of the aerospace industry: Airframes, Engines and Missiles.

The field study was comprised of twenty interviews with offset managers from most of the prominent firms in the prime contractor and supplier ranks. The key findings are:

- Prime contractors view offsets as a major issue for their firms but the majority of supplier companies do not.
- Organizational structures follow a decentralized, somewhat narrow, functional focus.
- Offset satisfying activities are well aligned to achieve the goals of the foreign governments that procure US aerospace products.
- Suppliers are not fully engaged in the US aerospace industry offset process.

The final chapter identifies opportunities for improving offset practices in the aerospace industry based on this study.

Specific company reviews were included in the appendix to understand the players in the industry today. This portion of the thesis divided the firms into two categories: prime contractors and suppliers.

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For family, it always starts with roots, I am eternally grateful to my parents for establishing a foundation based on humility and a strong work ethic that helped me make it through the program.

To my immediate family who put their lives on hold for the past year to join me in Boston during the program, what can I say? Nina and Jimmy have been a tremendous source of pride just witnessing their ability to cope with the major inconvenience the past year has brought. I appreciate what they both have endured on my behalf. Last but not least to my wife Carol, I am especially grateful for everything she has done, leaving the comfort of home and friends to come to Boston in order to hold our home here together while I was busy with the program. In addition to all that she served as a constant source of help and encouragement through the academic rigors of the program, helping with papers and finally serving as the editor of this thesis. Words can not express how lucky and honored I feel.

In loving memory of Anne “Dickie” Falco.
Chapter 1

Offsets in the Aerospace Industry – An Overview

Aerospace is one of the major industries in both the US and world economy. Issues that effect this industry often draw a wide range of attention from various quarters around the globe. "Offsets" in the aerospace industry is a topic which has become controversial. This chapter sets the stage for a study of offsets in aerospace by, first, defining offsets and, second, putting them into perspective in terms of the many problematic issues surrounding the subject.

Offsets are arrangements between sellers and buyers of aerospace equipment where the selling firm provides, by contract, additional benefits to the buyers beyond the equipment itself. These types of arrangements are prominent also in military equipment transactions and capital intensive industries such as power generation and telecommunications. However this report will focus on offsets in the aerospace industry.

Other studies of aerospace offsets are ongoing, a major one is currently overseen by the Board of Science, Technology and Economic Policy, National Research Council – 2101 Constitution Ave. NW, Washington D.C.20418, 202-
334-2200. The U.S. Department of Commerce, Bureau of Export Administration is also engaged in research of this subject ("Offsets in Defense Trade", 1996.).

The sellers, for the most part, are prime aerospace contractors (for both airframes and engines i.e.: Boeing, Lockheed Martin, Airbus, Pratt and Whitney, GE and others who are discussed in some detail in Appendix A) and the buyers are foreign governments (either directly or indirectly through state owned firms). The main purpose of the offset is to provide economic benefits over and above that which is necessary to support the equipment sale to the buying country as a quid pro quo for the purchase of aerospace equipment. These major procurements, in particular fixed and rotary wing aircraft, are expensive propositions and usually entail a significant portion of a developing country’s budget. This situation coupled with a shrinking world market for aerospace products presents an opportunity for buying governments to enhance their local industry and economy through the insertion of offset obligations attached to aircraft deals. The selling firms typically provide a range of services and investments to satisfy the offset obligation.

The aerospace industry use of offsets dates back to the 1950’s and 60’s when licensing and co-production of military equipment was utilized to support the reconstruction efforts of US allies. Under these types of arrangements the foreign country benefited via the production or assembly of the equipment within their own country, which bolstered employment and provided economic benefits.
Indirectly, the US Military benefited through the expanded business base of military equipment contractors, which ultimately lowered the unit cost of the equipment. Between 1947 and 1980, at least 44 different weapon systems (28 of which were aircraft, missiles, or rotorcraft) were produced in 20 or more countries under licenses granted by US producers (Mowery, 1997).

The military aerospace business spilled into the civil sector in the 1970's. The civil side of the aerospace industry was motivated more by evolving economic conditions than those of national security. The desire to share risk and financial burdens coupled with the emerging technical ability of foreign suppliers propagated the work sharing that many collaborative agreements feature. In summary, the proliferation of international collaboration in the civil aerospace industry was conceived by the military co-production / licensing activity of the 1950's and brought to life by the market conditions and economic pressures prevalent in the last three decades of the 20th century.

It is important to note that two types of offsets in the aerospace industry have emerged: direct and indirect. This distinction was refined in the Trade Promotion Coordinating Committee, "National Export Strategy: A US Strategic Response to Foreign Competitive Practices". US Government Printing Office, Washington, D.C., 1996. Direct offsets are derived from activities "directly" related to the aerospace industry. These can take the form of transfer of technical "know-how" and training. Such a transfer is intended to lead to manufacturing capability and
entry on the part of the buying country into some aspect of the aerospace industry. Deliberate investments into manufacturing facilities and capabilities are highly regarded by the buying countries. Indirect offsets stem from investing in business outside of the aerospace industry. The more technological and economically rewarding the business, the more desirable indirect offset is to the buying country. The level of appeal that the offset activity brings to the buying country has a direct impact on the value or "credit" the offset spending earns.

Offset credits are granted to buying firms as they conduct business, provide training and conduct transfers of technology, which serve to satisfy offset obligations. For example, a $10 million offset obligation may be satisfied by activities costing $1 million. Full satisfaction of the offset obligation is usually managed through an offset credit negotiation. Offset credits are typically multiples of the investment value in the buyer country or the revenue generated by business resulting from offset investments. These credits are a matter of negotiation usually between a designated body of the buying country and the selling firm. For example, in the Republic of Turkey, the Ministry of Defense has designated an Undersecretary for Defense Industries to manage the offset process as it relates to the defense industry in Turkey. Their stated objectives are to: "increase foreign currency inflows by exporting defense industry products and other related industrial Turkish products, create new production capabilities, ensure established industries self-sufficiency, and improve quality, standardization and productivity of existing industries". (Republic of Turkey,
"Offset Guidelines" Ankara-1991). These stated goals are utilized as a basis for negotiating offset credits with the selling firms. The more closely related the offset activity is to the stated objectives, the higher the multiple that is granted. Typically the multiples range from 5 to 25 times the investment / revenue generation of the specific program. Table 1-1 illustrates the scaling of credit to a hypothetical buying country (adapted from Professor J. Nicholas Ziegler Fall 1997 Governments, Markets and International Competition course). The scale represents higher multiples at the left end of the scale with lower multiples to the right.

Table 1-1

<table>
<thead>
<tr>
<th>OFFSET CREDIT CONTINUUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Investment</td>
</tr>
<tr>
<td>Vertically Integrated Manufacturing</td>
</tr>
<tr>
<td>+</td>
</tr>
<tr>
<td>Desirability from the Host Country Government's Viewpoint</td>
</tr>
<tr>
<td>Range of Multiples</td>
</tr>
<tr>
<td>25X</td>
</tr>
</tbody>
</table>
Negotiations of credits are an integral part of the offset game for two reasons. The first is that most of the offset obligations contain time sensitive deadlines with liquidated damages for non-compliance. The second is that many, if not most, business arrangements are intended to nurture long-term relationships between firms and foreign government customers. Forthright compliance with the letter and spirit of the offset obligations are essential for a positive long-term relationship to develop. The buying countries are usually spending significant sums of money on the equipment and could potentially spend more in the future. The firms, in turn, are investing significant time and managerial energy into the local economy. The relationship and resulting continued business is important to the aerospace manufacturing firms, just as important as the expansion of local capabilities in new high tech industry is to the buying countries.

The extent to which US aerospace industry satisfies offset obligations with direct business is the subject of much controversy, especially among employees of the prime contractors as well as the many industry suppliers. One estimate concludes that "between 1990-1994 the US has lost roughly 500,000 jobs in the US aerospace industry and roughly 1 million other jobs which are dependent on the US aerospace industry"(Barber and Scott 1995). Offset agreements obligate aerospace firms to create business in buying countries. This situation can exacerbate significant job losses. To a firm adversely affected by a downturn in the industry, offsets are viewed as throwing a brick to a drowning man. Parts of the aerospace industry is now reeling from the combined impact of reduced US
government spending, the downturn in the civil aircraft market of the early 1990's, and the industry wide restructuring efforts to reduce cost. These factors have had a profound impact on employment and the supply base of the industry. If offsets are growing, they may be the proverbial straw that breaks the camel's back. "While there are many causes of declining employment in the industry, we must recognize that offsets are one identifiable cause." (Herrnstadt 1997).

After job losses, the case against offsets rests on "national security". The concern is that offsets foster the proliferation of military equipment capabilities in foreign lands while diminishing the defense industrial base in the US. At the National Research Council Workshop held in 1997, Carol Evans, Assistant Professor of International Business Diplomacy, Georgetown University, commented: "Offsets encourage indigenous production of weapons systems in developing countries. This production can lead to serious but unintended proliferation problems". However, the extent to which offsets contribute to the weakening of US defense is debatable. One argument claims that US defense system exports are controlled through the export licensing process or more directly through US government to government Foreign Military Sales contracting. This makes it unlikely that high security rated systems get in the hands of undesirable nations. The counter argument is that seemingly insignificant portions of aerospace offsets can support platforms that carry weapons of destruction. Even though offsets may not directly enhance the
government spending, the downturn in the civil aircraft market of the early 1990's, and the industry wide restructuring efforts to reduce cost. These factors have had a profound impact on employment and the supply base of the industry. If offsets are growing, they may be the proverbial straw that breaks the camel's back. "While there are many causes of declining employment in the industry, we must recognize that offsets are one identifiable cause." (Herrnstadt 1997).

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defense capabilities of a foreign nation, offsets can, in theory, indirectly support the buildup of foreign military might.

These concerns raise questions as to whether or not the US government should establish policies to control offsets. Although the US government has been involved in offset policy making since 1978, its main thrust has focused on the prohibition of DOD 's direct involvement in offset contracting. The industry has dealt with the issue on its own.

At a recent workshop in Washington, DC on policy issues in aerospace offsets, Senator Jeff Bingaman, a senior member of the Armed Services Committee and the ranking Democratic member on the Joint Economic Committee shared his thoughts on this subject: “While recognizing that it is tough to gauge the negative and positive effects of offsets, their potential for weakening the long-term economic health of the US economy makes it necessary to look more closely at offsets” (Bingaman, June 1997). Senator Bingaman's comments indicate that offsets are becoming an issue that Congress and the Senate will have to deal with. The policy makers need to balance the freedom the firms have in making deals with foreign customers while not reducing benefits stakeholders in the US aerospace industry currently receive.

The key issues for offsets and the aerospace industry are many. From the aerospace firm's perspective they need to better manage offsets. They also need
to engage, educate and learn from their stakeholders such that offset obligations can be met in the future in ways that allow all parties to benefit.
Chapter 2

The Aerospace Industry – Structure and Content

The aerospace industry is comprised of two general sections of the US Commerce SIC reporting structure: Section 372 Aircraft and Engines; and Section 376 Missiles and Spacecraft. The first sector in Section 372 is SIC 3721 Aircraft. This section covers fixed and rotary wing aircraft for both military and commercial applications. The other section is SIC 3724 Aircraft Engines and Engine Parts. Engines are a significant component of an aircraft system but are treated separately for industry data collection. The main source of the information contained in this Chapter is available on the U.S. Department of Commerce web site in the Aerospace Industry Trend section (http://www.ita.doc.gov/industry/tai/green/aerhome.html).

Many major aircraft procurements are handled on a discrete basis whereby the power system (engine) is procured separately from the airframe. This results in both the airframe integrator and the engine manufacturer holding prime contracts with the customer. Both are referred to both as “primes”.

The aircraft sector that is addressed in this thesis is categorized under SIC 3728 Aircraft Parts and Equipment. This sector covers the sub-tier suppliers to the
aircraft and engine manufacturers identified above. The rest of the aerospace industry firms are collected in the Section 376 SIC's wherein guided missiles and space vehicles (3761), propulsion units and parts (3764) and auxiliary equipment (3769) are categorized. The combination of these categories is considered by the US Commerce Department Office of Aerospace to be “the aerospace industry”.

It is worth noting, however, firms categorized in other SIC’s also supply miscellaneous materials and service to the aerospace industry. Some of these other firms are included as part of the aerospace industry for various reasons depending on the context of a given study or research purpose.

The aerospace industry as identified above provides equipment to governments and air carriers all around the globe. The shipments of these aerospace products have seen a 21% decline in total value from 1992 to 1996. (U.S. Department of Commerce, 1996). (See Table 2-1). This is largely due to the downturn in U.S. Defense Department (DOD) spending in this area. Aircraft procurement by DOD has declined from 337 units in 1990 to 73 in 1997, which represents a 78% decline. Missile and helicopter procurement has seen comparable reductions.

At the same time, export sales as a percentage of the total industry shipments have grown from 32% in 1992 to 37% in 1996. It is obvious that the US
aerospace industry is becoming more dependent upon customers from foreign lands.

Table 2-1

Value of Shipments
(revenues in millions)

This situation sets up the proliferation of offsets in the aerospace industry. Prime US contractors need foreign-based sales to survive. The foreign governments understand this situation and capitalize on it for the sake of their local economies.

The value trend is as interesting as the sales trends. During the period from 1992 to 1996, the value of imports for the aerospace industry has increased as a
percent of total industry sales. In 1992, the value of import sales to total sales was 9.7%, as compared to 12.6% in 1996. This means that the US aerospace industry is procuring (on a percentage basis) more parts and equipment from abroad at a growth rate of 30% over this five year period. The major question is why? Are offsets the catalyst for this increasing trend? Or is this just an indication of a more global economy and that aerospace industry is simply catching up to other industries (i.e. the automotive industry).

Herein lies a major controversy. R.E. Scott (1998) asserts “offsets are also an important threat to future US Aerospace employment”. His report indicates that offsets are a contributor to the escalating import trend in the industry. In contrast, Sally Bath (1997) cites offsets as an example of the global economy at work in “The Airbus Experience”. Adequate data are not available to assess the contribution that offsets make to this movement in imports. What is certain, however, is that based on decreasing revenues and increasing imports the US aerospace industrial supply base is smaller in the worldwide industry today than five years ago.

Employment in the industry is down. Total employment has gone from a high in 1990 of 820,800 to 482,300 in 1996 (U.S. Department of Commerce, 1996). This represents a loss of nearly 340,000 positions, a 41% reduction in seven years (See Table 2-2). During the same period, average hourly earnings in the
The US average hourly earnings have increased 22% from $9.86 to $12.06 during this period as well (U.S. Department of Commerce, 1996). Although the growth in aerospace industry earnings is consistent with the national average,
the earnings of those still employed in the aerospace industry remains 40% higher than the average US hourly earnings.

This is perhaps one of the main attractions that foreign constituents have in the aerospace industry. Offsets drive right to the heart of this issue. Offset agreements provide a means for creating jobs through the establishment of aerospace firms in the home country where the equipment is purchased. This is an excellent means to establish high-skilled and high-wage jobs in a country in a relatively short period of time.

The situation is onerous for the US aerospace industry. With the shrinkage of US government spending, sales to foreign entities become more important to aerospace firms. When deals are discussed, buying governments seize the opportunity for the advancement of their constituency. The high wages enjoyed in the US aerospace industry may be a target for foreign governments. This scenario really played out well for some countries, such as the United Kingdom and France where aerospace firms such as Airbus and Rolls Royce are now well established in the global market.

Typically foreign governments must pay a high price for the aerospace equipment they desire. If these governments are willing to pay that price, they may also want some added value in addition to the equipment. This can drive an
emerging economy to put together a deal that also brings a portion of an attractive industry into their locale.

Champions of the US aerospace labor market argue that without some policy involvement from the US government, this trend will continue and may ultimately lead to the demise of the US industry as it is known today (Flamm, 1997). Others take the position that this situation is just another version of free enterprise at work (Bath, 1997). To attempt to regulate these matters would repeat the protectionism failures of the past.

Since the aerospace industry is facing a significant decrease in DOD spending, it is becoming more dependent upon foreign sales. Most foreign sales are accompanied by offset agreements. In order for US firms to survive in the changing environment, they must be able to deal with offsets. The research that follows was conducted to gather information on these issues from knowledgeable insiders in the aerospace industry. My questions focused on the following areas:

1. Industry Practice;
   - How is offset responsibility managed from an organization standpoint?
   - What activities are used to satisfy offsets?
   - Is, and if so how is, the supply chain integrated into the offset process?

2. Other Stakeholders:
   - US policymakers;
   - Foreign governments;
   - Industry associations.
Chapter 3

Industry Offset Management Practices

This Chapter first describes the research methods I used to collect the data on industry offset practices. The remainder of the Chapter is devoted to a comparative case study: an analysis of offset management practices observed within a sample of prime contractor and supplier segments in the aerospace industry.

Research Methods

The first order of business was to identify individuals responsible for managing offsets within specific aerospace industry firms. Although their actual titles varied, they will all be referred to here as offsets managers. This was accomplished using personal sources as well as acquiring contacts from: the Aerospace Industry Association (AIA), the Defense Industry Offset Association (DIOA) and the Lean Aircraft Initiative, Center for Technology, Policy, and Industrial Development, Massachusetts Institute of Technology. A list of contacts was developed in an attempt to cover a range of firms within the prime contractor and supplier segments of the industry. The firms contacted were selected from a combination of attendees at the 1997 spring DIOA Conference and from a group of suppliers of one of the prime contractor firms. Table 5-1 identifies the
companies included in the sample of aerospace firms (referred to as “the sample firms”).

Table 5-1

PRIME CONTRACTORS

The Boeing Company
Bell Helicopter
Lockheed Martin
Sikorsky Aircraft Corporation
General Electric Company
Pratt and Whitney

SUPPLIERS

AlliedSignal *
Astronautics Corporation of America *
    Kearfot Guidance & Navigation Corporation
B F Goodrich * - Sensors and Integrated Systems Group
Canadian Marconi
Dell Computers
DOW – UT Composite Products Inc
Kidde Aerospace and Defense
Litton Industries - Guidance and Controls Group
Parker Hannifin Corporation *
Rockwell International *
Simula Inc
SKF USA, Inc - MRC Bearings
Sundstrand Aerospace *

All of the prime contractor firms are discussed in detail in Appendix A. Also included is a review of the two primary international competitors, Airbus Industrie and Rolls Royce plc. A selection of the supplier firms (asterisks) are also reviewed in detail in Appendix B
Twenty (20) interviews were conducted with individuals from six prime contractors and fourteen suppliers. All of the prime contractors, with the exception of General Electric were selected from the DIOA Conference attendance list. General Electric was selected to represent the view of the engine manufacturers, Pratt and Whitney and Allied Signal being the only other engine manufacturers in the sample. Of the suppliers interviewed, five firms were chosen from the DIOA Conference attendance list and the remaining eleven from a selection of a prime contractor firm’s supplier community. Of those eleven firms, all but one, Dell Computer, supplied parts and materials to more than one of the prime contractors sampled.

A set of questions were posed to the offset managers of these firms in an attempt to understand the following aspects of offset activity within each firm including a sense of their offset management practices:

- **Background information** - questions about the firm’s size, products and customers, as well as, the relevance of offsets to their current business.
- **Organizational structure** – questions about reporting lines of authority and centralized or decentralized approach to managing offsets.
- **Offset activities** – the question here was to rank the top three activities that were being conducted to satisfy offset obligations.
- **Supply base** – questions about the extent to which sub tier suppliers are engaged in offset activities.
The actual list of questions appears in Appendix C. The interviews were conducted by telephone during the first quarter of 1998. They lasted from 20 to 45 minutes, follow up discussion were used to clarify the initial information collected with 20% of the interviewees. In most cases, the interviewees elaborated upon the issues raised by the first set of questions, adding personal insights as each interviewee saw fit. The results of the interviews are categorized into the following headings: (1) Offset relevance to the firm; (2) Organization of offset responsibilities; (3) Prominent offset activities; and, (4) Involvement of sub-tier suppliers. A detailed discussion of each of these topics follows.

**Offset relevance to the firm**

Table 5-2 displays the data relevant to the question “How important are offsets to your current business?”

The majority of offset managers viewed offsets as a prominent issue for their firms. But opinions on just how important differed. 15% of the sampled offset managers’ thought that offsets were not a prominent issue for their “firm”, this is the medium category below.

As displayed, one quarter of the sample did not consider offsets an issue for the Company. Keep in mind that all the offset managers interviewed work for firms that have some level of involvement with offsets driven by a customer’s request.
Table 5-2

Offset Relevance

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Total (20 firms)</th>
<th>Primes (6 firms)</th>
<th>Suppliers (14 firms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>60%</td>
<td>100%</td>
<td>43%</td>
</tr>
<tr>
<td>Medium</td>
<td>15%</td>
<td>0%</td>
<td>21%</td>
</tr>
<tr>
<td>Low</td>
<td>25%</td>
<td>0%</td>
<td>36%</td>
</tr>
<tr>
<td>Totals</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Suppliers are expected by the prime contractors to accept some level of offset obligations on programs in which “flow down” purchase orders are awarded. Obligations that give rise to the offsets for prime contractors result from sales contracts with foreign governments. Suppliers, on the other hand, are engaged only through purchase orders with the prime contractors. When a prime contractor lands a contract with offset obligations attached, they attempt to negotiate a “flow-down” of the offset requirements as part of the purchasing activity with their supply base. It is the flow down requirement that engages the suppliers to establish offset activity in a given country, generally in support of a specific program that includes some content from the supply firm.
This divergence of the level of importance of offsets is evidence of incongruent perceptions within the aerospace industry. 100% of the prime contractor offset managers affirmed the importance of offsets. But 57% of the suppliers regarded offsets as of "medium" or "low" priority. All of the prime contractor offset managers were applying considerable resources to gain support from their suppliers. In all of the firms, except one, the actual offset credits gained through suppliers were minimal. This is a growing problem because the effort expended by prime contractors did not justify the benefits derived.

This disparity is explained by managers in the supplier firms in several ways. Four of the fourteen supplier firm offset managers say there is a lack of coordination on the part of the primes – especially those primes that are in the process of consolidation. A major by-product of consolidation is the period of confusion that trails a merger. One supplier manager stated that he would get numerous calls from different operating units of the same corporation requesting support for offset obligations sometimes in the same country. Coordination within a large (and growing larger) prime contractor firm needs to include its supply base. The lack of coordination hinders the management and synergistic possibilities within the supplier firms, which most likely contributes to the suppliers limited engagement in offsets. The supplier firms are seemingly unable to see the strategic benefit of offsets to the aerospace industry and their firm. As consolidation continues, an emphasis on dealing with suppliers for offset will need to be addressed.
The other frequent mentioned reason referred to the lack of business volume for smaller firms from a program in a specific country. These firms just did not have enough business in a given country to justify a foray for offset activities alone (even if it meant displeasing a customer). In light of this situation, the suppliers thought the primes' expectations were unreasonable. They expected the suppliers to satisfy large portions of offset obligation in proportion to the amount of business the suppliers would obtain from a program.

Organization of Offset Responsibility

The reporting relationship of the offset managers within a functional area is displayed in Table 5-3. The statistics in the chart represents the percentage of firms that report to each function displayed.

The most prevalent overall structure has the offset manager reporting to program or product line management. But suppliers are over represented in this "program focus".

The implication of Table 5-3 is that offsets are an outgrowth of a particular program in the supplier firm. This is a more narrowly focused view of offsets than found in the primes.
Table 5-3

**Reporting Lines of Authority**

<table>
<thead>
<tr>
<th>Function</th>
<th>Total (20 firms)</th>
<th>Primes (6 firms)</th>
<th>Suppliers (14 firms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contracts</td>
<td>15%</td>
<td>17%</td>
<td>14%</td>
</tr>
<tr>
<td>Marketing</td>
<td>30%</td>
<td>50%</td>
<td>21%</td>
</tr>
<tr>
<td>BOD</td>
<td>10%</td>
<td>0%</td>
<td>14%</td>
</tr>
<tr>
<td>Program/Product Line Management</td>
<td>35%</td>
<td>17%</td>
<td>43%</td>
</tr>
<tr>
<td>Purchasing</td>
<td>10%</td>
<td>17%</td>
<td>7%</td>
</tr>
<tr>
<td>Totals</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

In program management, offset managers deal with offset obligations just like they deal with other program obligations. In a majority of program support functions, a clear line of responsibility is established for each area.

Manufacturing issues are handled by production management; design efforts are coordinated through engineering management, and so on. However, offsets do not have a similar focal point. In these firms offsets are not handled as a function but as an ad hoc activity. This makes the process of satisfying offset obligations a difficult one for the program oriented managers.
In other firms, offset managers reported to Contracts and Counsel (15%), the Board of Directors (10%) or the procurement arm of the organization (10%). The relationship to Contracts and Counsel reflects an integration of offset agreements into a majority of contracts with foreign-based governments and state owned firms. This reporting line is more prominent in prime contractors than it is in the supplier firms. This may well reflect the emphasis placed on offset agreements in relation to the actual prime sales agreements.

The Board of Directors reporting relationship applies to two small firms wherein the CEO manages the limited offset responsibility personally. This situation is no doubt driven by the size of the firm, the infrequency of offset issues and, the potential exposure associated with offsets. In these small firms, with limited resources, the CEO's probably get involved to monitor and control any commitments made.

The linking of procurement with offset managers is more prevalent in primes than suppliers. The firms employing this organizational relationship tighten the firms supply base to offset obligations. Most offset managers interviewed involved their supply base in the quest for offset satisfying activities. The firms that formalized this involvement said they had a high utilization of suppliers in offset activity.
The other organizational question focused on centralized versus decentralized approaches to managing offsets. The results displayed in Table 5-4 have a polarized distribution.

Table 5-4

<table>
<thead>
<tr>
<th>Method</th>
<th>Total (20 firms)</th>
<th>Primes (6 firms)</th>
<th>Suppliers (14 firms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centralized</td>
<td>15%</td>
<td>0%</td>
<td>21%</td>
</tr>
<tr>
<td>Decentralized</td>
<td>65%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>N/A</td>
<td>20%</td>
<td>0%</td>
<td>29%</td>
</tr>
<tr>
<td>Totals</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The tendency toward decentralized management of offset activity is closely related to the practice of program management reporting. There is a strong tendency to assign responsibility for managing offset obligations to the business unit that created the obligation.

In all of the prime contractors a formal decentralized reporting structure exists. The responsibility for meeting the offset obligations is placed at the various operating units. However, some form of informal central network was also evident. Many of the offset managers expressed an interest to formalize these
central management approaches. In one multi-business aerospace conglomerate, the informal central network was referred to as central assistance. The process was one of monthly-centralized reporting and, bi-annual conferences to foster networking and deal making among the various divisions. This is when training and information sharing would also take place.

Another prime contractor offset manager described a situation where the responsibility for offsets was placed with the "contracting entity". They used, however, the services of a centralized brokerage house in the corporation to identify activities carried on by other operating units of the company that were applied to the specific offset obligation in question. This matching service proved successful for this offset manager’s operation. Less formalized forms of this practice were evident in all of the primes and most of the suppliers sampled. The most prominent practice is, however, periodic gatherings of representatives of the operating units of a corporation for the purpose of sharing information on offset obligations (and on countries where the obligations must be met) to find opportunities for offset satisfying activities. This is a way of matching an offset obligation of an aerospace entity with an activity of some other entity in the organization.

Of the managers in the supply firms, 20 percent of those interviewed said that they did not have a centralized process but wanted one. These offset managers wanted a management process that would facilitate support from the entire
enterprise in meeting offset obligations. The vast majority of the offset managers work in an operating unit of a large corporation. The rest of the corporation includes units beyond aerospace such as automobile components divisions, air-conditioning companies, etc. Many companies in the aerospace industry are now consolidating with other large multi-faceted entities creating more diverse conglomerates. These multi industry enterprises have the opportunity to leverage various aspects of their businesses to satisfy offset obligations. The management practices that seem to work best in these firms are those that employ aspects of both centralized and decentralized approaches for handling offset obligations. A central function that nurtures and supports the operating units without stifling the entrepreneurial spirit of the operating units is evident in the central assistance network mentioned above.

**Prominent offset activities**

The activities used to satisfy offsets are ranked in Table 5-5. Offset managers were asked to rank the top three activities employed by their firms. Four of the offset managers contacted did not have substantial involvement in offsets to date. The ranking from the remaining 16 firms informs the table.

Parts procurement refers to materials purchased from sub-tier suppliers in the country where the offset obligation exists. The direct portion relates to materials that are used in aerospace products and indirect refers to materials that are used for other "non- aerospace" items produced by the firms. Since 20% of the offset
obligations are being satisfied by directing procurement from foreign based firms, it seems as though the supplier firms in the sample should have a keen interest in this subject.

Table 5-5

<table>
<thead>
<tr>
<th>Activity</th>
<th>Total (16 firms)</th>
<th>Primes (6 firms)</th>
<th>Suppliers (10 firms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts Procurement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>20%</td>
<td>17%</td>
<td>22%</td>
</tr>
<tr>
<td>Indirect</td>
<td>16%</td>
<td>19%</td>
<td>13%</td>
</tr>
<tr>
<td>Licensing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/ Co-production</td>
<td>17%</td>
<td>8%</td>
<td>22%</td>
</tr>
<tr>
<td>Outsourcing</td>
<td>19%</td>
<td>22%</td>
<td>17%</td>
</tr>
<tr>
<td>Technology transfer</td>
<td>23%</td>
<td>22%</td>
<td>23%</td>
</tr>
<tr>
<td>3rd Party Providers</td>
<td>6%</td>
<td>11%</td>
<td>3%</td>
</tr>
<tr>
<td>Totals</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Direct procurement from foreign-based firms diminishes business for existing US suppliers. Suppliers might be actively engaged in offsets to seize opportunities for their foreign ventures or they might at least be trying to understand the current situation so their firm's strategy can reflect current realities. What is not clear, however, is whether direct procurement was shifting to foreign suppliers for
reasons other than offsets obligations (cost, location, market access etc). Some of the offset managers said that foreign-based procurement was "something that was happening anyway". Most of the sampled firms were shifting supply sources. Few instances were uncovered where supply shifts resulted specifically from the need to achieve an offset obligation.

Licensing/co-production, outsourcing and technology transfer represents the majority of offset satisfying activities. These three activities, either directly or indirectly, lead to aerospace service or manufacturing capabilities for the buying countries. The goal of most of the buying countries is to establish and or expand their indigenous aerospace industry. This process often starts with technology transfer, which then leads to cooperative operations (either through license agreements or co-production) and ultimately leads to outsourcing operations that were formerly accomplished within the respective firm. Nearly 60 % of the offset activity falls into these categories and as such, offset activities create or expand the aerospace industry within the buying countries.

Third-party providers are independent agencies that will, for a fee, help a firm create or acquire offset activity that generates offset credits in a given country. This service covers a wide range of activities from finding a suitable in- country partner for a joint venture with the selling firm, to locating existing businesses with excess offset credits for sale. This data suggests third-party providers are used sparingly by only a few of the prime contractors. In the opinion of the offset
managers of these firms, this process is costly and their experience with this method has thus far proved unproductive.

**Involvement of sub-tier suppliers**

Sub-tier suppliers are firms that provide products and services to other organizations vertically along the value chain. For the prime contractors, sub-tier suppliers are firms that supply them materials (first tier suppliers). First-tier suppliers also have sub-tier suppliers (second tier suppliers). The suppliers in my sample are first-tier suppliers. Table 5-6 is the accumulation of responses from all the sample firms regarding their utilization of sub-tier suppliers for the purpose of satisfying offset obligations. Overall utilization of the sub-tier suppliers is relatively low. The prime contractors use their supply base much more than their own first-tier suppliers.

**Table 5-6**

**Utilization of Sub-Tier Suppliers**

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Total (20 firms)</th>
<th>Primes (6 firms)</th>
<th>Suppliers (14 firms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>25%</td>
<td>50%</td>
<td>14%</td>
</tr>
<tr>
<td>Low</td>
<td>75%</td>
<td>50%</td>
<td>86%</td>
</tr>
<tr>
<td>Totals</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Two factors contribute to the low level of involvement of suppliers in offsets. First, as business moves through the supply chain, contracts become smaller and smaller. The low utilization of suppliers in the offset process reflects such a rule. If relatively low value, low volume orders mark supplier relations with primes, there is little incentive for the supplier to become involved in their customers' offset obligations. Moreover, many supplier firms are diversifying into non-aerospace businesses and are becoming less dependent upon aerospace business. This is the second factor contributing to the low levels of engagement in offset activities by the supply base.

This apparent lack of interest on the part of supplier firms is troubling to offset managers in the prime contractor organizations because it marks an erosion of the “partnership” among primes and suppliers. The U.S. automobile industry struggled, for example, when supplier – prime relations grew difficult; rebounding only when these ties were reestablished on firmer grounds.

To conclude key findings are summarized below:

Relevance to the Firm.

Although all the offset managers from the prime contractor firms see offsets as a major issue for their organizations, the majority (57%) of supplier offset managers did not. Suppliers and primes view offsets quite differently in the US aerospace industry. Moreover, consolidation among prime contractors seems to
confuse matters and add to the difficulties prime contractor's have with their suppliers (and visa versa).

**Organization of Offset Responsibility**

Offset managers are located in Contracts or Marketing within 45% of the sampled firms. In these firms, offsets seem in a position within the organization that allows for a broad view. However, 35% of offset managers were located in the Program/ Product-line business functions. This may limit an organization's ability to discover enterprise-wide support necessary to manage and satisfy offsets successfully. Few firms (15%) employ a centralized approach.

**Prominent Offset Activities**

An equal spread of activities used to satisfy offset obligations exists among the sampled firms. 20% of the activity is in direct procurements. This effects supplier organizations who apparently take little interest in offset activities. Assuming this is a representative sample of US aerospace companies, the industry may be headed for trouble as supplier-prime relations are threatened by increased offset-based procurement. Beyond direct procurements, prime contractor firms deliver offsets in technology transfer, licensing / co-production and outsourcing. These activities seem to align with the primary goal of the
buying countries, namely, creating and sustaining an indigenous aerospace capability.

**Utilization of Sub-Tier Suppliers**

The majority (75%) of offset managers interviewed said that supplier organizations were not fully engaged in the offset process. All of the prime contractor managers, however, see offsets as a high priority for their firms. This indicates a lack of congruence within the industry. Prime contractor managers and supplier managers interviewed have much different views on the importance of offsets to their respective firms. This divergence creates a challenge for managing offsets within the US aerospace industry.
Chapter 4

Offset Stakeholders – Conclusions and Recommendations

The major stakeholders in offsets and the aerospace industry are:

- US Policy Makers
- Foreign Governments
- Aerospace Industry Groups
- Suppliers
- Prime Contractors

This Chapter will attempt to convert the insights gathered in the research into practices that the various actors can engage in to improve upon the current situation.

**US Policy Makers**

US policy makers are struggling with what, if anything, they should do about offsets attached to aerospace equipment sales of US firms. They should gather specific data from firms engaged in these arrangements in an effort to not only understand the impact of offsets, but, more importantly to determine what to do about them, if anything. My research suggests that 20% of the offset satisfying
activities result from direct procurement. This is one area where further information would help supplier organizations in the US. Specific understanding of the nature of the procurement and the previous source of supply from the prime contractors perspective could lead to an understanding of whether and to what extent this activity has an impact on supplier firms. The supplier firms could also provide information to a centralized government source pertaining to business losses by prime contractor. When this information is compared to the prime contractors input the potential exists to correlate business losses to offsets. Studies conducted to date fall short of creating a clear understanding of the impact of offsets on the aerospace industry. The focus to date has been on suppliers in the US. This is the area that needs further review. “The preservation of long-term US national security requires that attention, nourishment, and protection be given to the critical supplier and sub-tier base of the aircraft Industry” (Bozdogan, 1997).

A secondary issue was identified by three of the prime contractors, all three being helicopter manufacturers. Their position, which I share, is that the US government should find ways to help US firms gain business from foreign entities. From this perspective the important issue is bringing business into US firms to help compensate for the reduction in DOD spending. If the volume of business picks up, all organizations dependent on the US aerospace industry will benefit. US helicopter manufacturers need large orders to utilize their already reduced capacity levels. Landing prime contracts, even with offset agreements
attached, should be the first priority and one on which government help can be critical.

This can be, however, a difficult endeavor for US government officials - especially when more than one US firm bids for a given contract. But, the government can use political influence in support of US products generally even when more than one US firm is competing for a specific contract. This kind of support would help "level the playing field" because most of the competition, especially in helicopter procurements, comes from state owned foreign firms whose governments act often as advocates. The US has as much political influence (if not more) as most other governments. Adding governmental participation in many of the aerospace program decisions can help US based firms in the global market place.

Support for US firms can also come in the form of government - sponsored process improvements that would ease the export of aerospace equipment. Export licensing is currently under review; improvements in the process could help US firms competitive posture visa-vie foreign based aerospace firms.
Foreign Governments

Foreign governments as a group are difficult to address. They are obviously far-flung and diverse. However, a few general observations can be made.

First, a strategic approach to offsets as a means to an end should be developed. Many of the interviewees said that the government bureaucracies with whom they dealt puzzled them. A long-term plan on the part of foreign governments that attempt to coordinate aerospace equipment procurement needs and offsets would be a good start. Most countries prepare long-term military equipment needs. What is being suggested here is that they also plan the type and breadth of offset arrangements that would compliment and propel their respective economies. Yet a more organized approach on the part of foreign governments to offsets could potentially lead to advanced indigenous aerospace capabilities. But, if other nations are determined to establish their own aerospace industries they will probably get there sooner or later. At that point, a more open market based economic model would probably emerge leading to competition, which in theory makes for stronger not weaker firms. Open competition might well create an improved environment for the formerly DOD dependent US aerospace industry.

The second observation relates to unproductive offset programs that occur when a buying country’s campaign to expand its indigenous aerospace industry
becomes over zealous. In some cases foreign governments have tightened their offset requirements. Prime contractors have great difficulty meeting these requirements. In one case, offset credit is disallowed if a previously established indigenous firm is used by a seller for follow on business. This requirement works against establishing a long-term relationship between a US firm and a foreign based supplier. The intent on the foreign government's part is to establish competition within the local industry. But, it seems to be misguided since the aerospace industry is already over capacity. What will most likely transpire if these stringent guidelines continue is a strong push from local industry groups to create a more reasonable position.

**Aerospace Industry Groups**

The two prominent aerospace groups (AIA and DIOA) are providing a forum or cross industry information sharing as well as advocating the industry's interest in US policy matters. Most of the parties interviewed were active members of one or both of these organizations and expressed an overall positive view of the groups and their effectiveness to date.

One issue that should be taken up by these industry groups is that of offset credit brokers. A potential niche exists for a reliable resource to coordinate trading of excess offset credits between firms. This is an area where aerospace associations can provide direct industry support. The two associations possess
extensive expertise on offsets, and could no doubt provide needed support for the successful utilization of excess credits.

Suppliers

Suppliers are caught between a rock and a hard place. On the one hand they are feeling increasing pressure to help satisfy offset obligations from their customer base (mainly the prime contractors). The customer base is consolidating, which is contributing to uncoordinated requests flowing from the few remaining large prime contractors. Even with this confusion, the supply base needs to find opportunities to provide offset support for their customers. Many offset managers of supplier firms are avoiding the prime contractors’ requests for support taking the stance of “if I ignore them (the primes) they will go away”. Eight of the fourteen supply firms take an overly cautious approach to getting involved in offset activities. They were not engaged in an important aspect of their customers business (remember 100% of the prime contractors regarded offset as a high priority). Ignoring this issue seems to be an unadvisable position for supply firms to take.

Instead of reacting to the situation as it evolves through the prime contractors, the major suppliers should use all their available resources to forge relationships and offset activities in countries where they do business. As is the case for prime contractors, suppliers are in many cases a part of a larger, diverse conglomerate
that provides multiple opportunities for offset activity. These larger supplier firms should work with the rest of the US aerospace stakeholders to help build a strategy for gaining offset credits - even if they are brokered to other non-affiliated prime contractor firms.

In one supplier organization, an opportunity for this approach is evident. The supply source firm is a relatively small ($100M per annum) specialized bearing producer for most of the major prime contractors. The firm has been unable, however, to achieve any offset activity in support of their customers (mainly due to the proprietary nature of their products). Yet, this firm is a subsidiary of a large ($4 - 5 B per annum) multinational machine parts manufacturer. But, to this point, the resources of the larger corporation have not been engaged in the process of offset activity.

Another glaring shortfall is the lack of participation within sub-tier suppliers on creating offset credits. This group, in my opinion, has the most at stake in the near term. Their products and services are the most readily transferable to foreign soil. But these sub-tier firms are not engaged. They should seek out venture opportunities with other firms to create business that fits within their respective company strategies and create offset credits as well. The size and volume of these individual sub-tier firms is a stumbling block to reaching an economically viable foreign venture on their own. But, by collaborating with other industry firms, the consortiums that are created may find opportunities that would
otherwise be overlooked. Becoming involved in a partial ownership role may open the door for penetrating new markets. For example a joint venture company in Europe, with European partners, may open the possibility of doing business with Airbus, Rolls Royce, etc. Some of the larger European firms may also be interested in vertically integrating with a sub tier supplier that has relevant expertise.

These lost opportunities provide examples of how a more coordinated and shared approach might improve the identification and satisfaction of offset obligations and help sustain -- possibly grow -- the US aerospace industry.

**Prime Contractors**

Prime contractors are in a heated battle for business. The only place to turn is business from abroad. As noted earlier, this opens the door for offset agreements attached to aerospace equipment sales. The ability to deal with offsets is becoming more and more important to the prime contractors. Firms that develop a “core competency” in this aspect of international business will most likely enjoy a competitive advantage. Several recommendations follow:

First, federalize an offset organizational structure to gain the benefits of a centralized approach without incurring great cost and bureaucracy. This type of approach would decentralize the responsibility of satisfying offset obligations but add a central coordinating dimension to the management of this elusive
responsibility. The centralized body should be lean, flexible and powerful within the firm acting as a focal point to pull together information and rationalize activities across a large organization in order to find potential offset satisfying activities. Most of the prime contractors are affiliates of large multinational firms, and as such, have an array of global businesses. A federal approach to offsets can serve to identify and engage businesses that will promote a firm’s ability to add value in a given country. For example, one prime contractor, Sikorsky Aircraft, committed itself to helping a Malaysian company broaden its composite manufacturing skills as an offset to the Royal Malaysian Airforce Purchase of two S-70 BLACKHAWKs valued at about $20 million. The deal worked because Sikorsky can call upon a sister company within United Technologies (Carrier Transcold) to purchase $1.5 million worth of the Malaysian concerns’ production during the next two years (Mecham, 1998). Opportunities like this would perhaps be more readily available in well run federal system.

Prime contractors also require a proactive approach to the management of offsets. Much of my interview conversations centered on offset management that reacted to specific contract requirements as they happened. Instead of being reactionary, prime contractors could employ an ongoing process to cultivate offset activities in the foreign countries where target programs are emerging. This approach can allow a prime contractor the lead-time necessary to nurture a long-term relationship in a potential customer country. This tactic can create the edge needed when future contract awards are decided. Even if programs do not
develop in these countries, offset credits earned can be brokered to another firm. In any event, establishing pre-contract offset activities should allow time to identify and engage in beneficial business arrangements. Often times less than desirable arrangements are made in order to satisfy an impending offset deadline.

The prime contractors have an obligation to all of the stakeholders in the US aerospace industry. They are clearly the lead entity in this drama. They need to work together with the other actors, governments (both US and foreign), suppliers, and industry associations, in order to preserve the US aerospace industry.
Appendix A

Prime Contractors

Prime contractors are an integral sector of the aerospace industry. These companies identify, nurture, compete, and eventually contract with the end customer's directly for the purchase of airframe engines, missiles and space vehicles. They are for the most part included in 3721, 3724 and 3761 SIC classifications. This appendix looks at the prominent players in my sample. (The information pertaining to each company was derived from Company web-sites, 10-K filings and the World Aviation Directory- Winter 1997). Information provided for each Company includes revenue and employment data; details for export and domestic revenues is not disclosed by mandate and therefore not included here.

The prominent players in the aircraft (3721) and guided missile and space vehicle (3761) sectors of the industry are Boeing (who merged in 1996 with McDonnell Douglas), Airbus Industrie of Western Europe, and Lockheed Martin. Many other firms contribute in these sectors such as Textron (through their Bell Helicopter and Cessna operations); Sikorsky Aircraft, a wholly owned subsidiary of United Technologies, and others. An in-depth look at each of these companies follows.
The Boeing Company

Boeing is one of the world's major aerospace firms operating in two principal industries: commercial aircraft and defense/space operations. Commercial aircraft operations - conducted through Boeing Commercial Airplane Group - involve development, production and marketing of commercial jet aircraft and providing related support services to the commercial airline industry worldwide. Defense and space operations - conducted through Boeing Defense & Space Group - involve research, development, production, modification and support of military aircraft and helicopters and related systems, space and missile systems, rocket engines, and information services, primarily through U.S. Government contracts. 1997 revenues for the combined Boeing including the former McDonnell Douglas were $45.8 billion and a net loss of $178 million. Total Company revenues for 1998 are projected to be in the $55 billion range. Current employment levels are approximately 210,000 including McDonnell Douglas..

Boeing continues as a leading producer of commercial aircraft and offers a family of commercial jetliners designed to meet a broad spectrum of passenger and cargo requirements of domestic and foreign airlines. This family of commercial jet aircraft currently includes the 737 and 757 standard-body models and the 767, 747 and 777 wide-body models. The worldwide market for commercial jet aircraft is predominantly driven by long-term trends in airline passenger traffic. The
principal factors underlying long-term traffic growth are sustained economic
growth in developed and emerging countries and political stability.

Commercial jet aircraft are normally sold on a firm fixed-price basis with an
indexed price escalation clause. The commercial aircraft sales are subject to
intense competition, including foreign companies, which are nationally owned or
subsidized (i.e. Airbus Industrie).

The major focus of commercial aircraft development activities over the past three
years has been the 777 wide-body twinjet, which entered service in May 1995,
and the 737-600/700/800 family. The new 777 model is designed to meet airline
requirements in domestic and regional markets internationally. The new 737s will
provide greater range, increased speed, and reduced noise and emissions while
maintaining 737 family commonality. Boeing continues their tradition of technical
advancement in the passenger airline industry. They have been working with
some of the world's largest airlines to explore the development of aircraft capable
of carrying more than 500 passengers over longer ranges than the current 747
family. Other new products under consideration include larger and longer-range
versions of the 777.

Mergers and acquisitions have been the other mainstay for Boeing. Over the
past two years, they absorbed Rockwell's aerospace and defense business. The
major product groups of this portion of Boeing's business are rocket propulsion
including the Space Shuttle main engine; Space Station electric power; Space Shuttle integration, logistics and operations; Global Positioning System satellites; ICBM systems; tactical missiles; sensors; B1-B bomber; commercial aerostructures; aircraft and helicopter modifications; airborne laser and electro-optics; space defense; and advanced programs.

In 1997, the merger of The Boeing Company and McDonnell Douglas Corp. was completed. The Company now claims: "Boeing is now the largest aerospace company in the world. We have a strong balance of commercial, defense, and space capabilities, customers in 145 countries, a business backlog of more than $100 billion, and a future with extraordinary potential for discovery and achievement" (Condit, August 4, 1997).

The “New Boeing's” product lines in the defense and space segment now include: C-17, F-15, F/A-18, Delta II, Shuttle, and the CH-47 programs, as well as development programs, the international space station, Sea Launch, F/A-18 E and F, V-22 EMD and RAH-66 Comanche helicopter development. This segment of the business is highly dependent on changes in national priorities and U.S. Government defense and space budgets.

Significant restructuring in the form of mergers, acquisitions and strategic alliances are continuing by companies throughout the aerospace industry to maintain or increase market share, to reduce costs or obtain economies of scale,
and to be competitive for new business opportunities. Currently, Boeing's activities in the F-22, V-22, RAH-66, Sea Launch, and Civil Tiltrotor developmental programs are under joint venture arrangements. They are also a 50/50 partner with Lockheed Martin in United Space Alliance (USA) to operate NASA's manned spaceflight activities. The U.S. Government defense market environment is one in which continued intense competition among defense contractors can be expected, especially in light of U.S. Government budget constraints.

**Airbus Industrie**

Airbus Industrie is now the only other major manufacturer of civil airliners seating more than 100 passengers. With annual revenues of $11 billion, it has won approximately 30 percent of all orders for jet-powered transports in recent years. In 1997, orders and commitments for over 671 aircraft were received -- both from existing Airbus operators to increase their fleets, and from new customers who added to international airline operator base. Airbus has become a major player in this industry through their philosophy that has been followed since its creation in 1970 - develop aircraft that fill market needs, design them with the requirements of airline users in mind, and apply the best technology to produce the most comfortable and economic airplanes available.

Airbus Industrie has sold over 2,600 aircraft during its 27-year history. Approximately 1,600 are still in service with about 140 operators worldwide. The
Airbus Industrie aircraft family comprises three different aircraft groups: the 24-185 seat, single-aisle A319/A320/A321; the 220-266 seat widebody A300/A310; and the 263-400-seat widebody A330/A340. These airliners cover the operating spectrum from short/medium-haul operations to ultra long-range flights.

Headquartered in southwest France near the city of Toulouse, Airbus Industrie's role is to manage, market, sell and support the operation of the consortium's aircraft. Spare parts centers are located in Germany at Hamburg, in Singapore and near Washington, DC. Training for pilots and maintenance staff is conducted at facilities in Toulouse and Miami. A support and training center has been built in the People's Republic of China.

Europe's four leading European aerospace companies own Airbus Industrie. Aérospatiale of France and Daimler-Benz Aerospace Alrbus of Germany each have a 37.9 percent share, British Aerospace holds 20 percent, and Spain's CASA has a 4.2 percent share. These four partners have dual roles as shareholders and industrial participants, carrying out most of the design and all aircraft manufacture work under Airbus Industrie's management and coordination. The partners are responsible for their own financing of the research, development and production phases of the aircraft programs. Some 32,000 people work directly on Airbus Industrie aircraft within the partner companies. Italy's Alenia, Fokker of the Netherlands, and Belairbus in Belgium are risk-sharing associate members who participate in selected programs.
Lockheed Martin

Lockheed Martin is a highly diversified global enterprise principally engaged in the conception, research, design, development, manufacture and integration of advanced-technology products and services. For 1997, net sales reached $28 billion with employment levels of 135,000. Growth through acquisitions and mergers have also been a prominent activity for Lockheed Martin the latest of which is an $11.8-billion strategic combination with Northrop Grumman. This is on the heels of previous mergers with Martin Marietta and Loral.

Their principal business is conducted through five major operating sectors: Space & Strategic Missiles; Electronics; Information & Services; Aeronautics; and Energy & Environment. Major programs of the Space & Strategic Missiles Sector include the Titan family of launch vehicles. These include the Titan IV expendable launch vehicle, the Trident II submarine launched fleet ballistic missile; the MILSTAR communications satellite, the Atlas expendable launch vehicle, the production of various government and commercial communications and environmental monitoring satellites, and the THAAD ground-based theater air defense system. The Electronics Sector's activities primarily relate to the design, development, engineering and production of high performance electronic systems for undersea, shipboard, land-based, airborne-and space-based applications. The Information & Services Sector is involved in the development, integration and operation of large, complex information systems; engineering,
technical and management services for federal customers; transaction processing systems and services for state and local government agencies; commercial information technology outsourcing; manufacture and distribution of computer peripherals, graphics engines and intranet software; and the provision of internal information technology support to the Corporation. The Aeronautics Sector is involved in the design, development, engineering and production of fighter, bomber, special mission, airlift, antisubmarine warfare, reconnaissance, surveillance and high performance aircraft; systems for military operations; aircraft controls and subsystems; thrust reversers; and aircraft modification and maintenance and logistics support for military and civilian customers. Lockheed Martin is the prime contractor on the F-16 "Fighting Falcon" fighter aircraft, leads the team responsible for the Air Force's F-22 air superiority fighter program and provides the C-130 series airlift aircraft. In the commercial aircraft business the Sector manufactures thrust reversers for commercial jet engines. The Corporation is also involved in upgrading aircraft, including the U-2 and SR-71 reconnaissance aircraft, the F-117 fighter-bomber and earlier model C-130s. The Energy & Environment Sector is responsible for the Corporation's energy and environmental remediation businesses, including the management of various U.S. Department of Energy (DOE) activities.

The following companies are prime contractors, but their size and production volumes are much smaller than the big three companies just mentioned.
Textron Inc.

Textron Inc. is a multi-industry company headquartered in Providence, RI. The aircraft segment of their business achieved $5.4 billion in revenues in 1997, with approximately 17,000 employees. This segment is dominated by two major franchises: Bell Helicopter and Cessna Aircraft Company.

Bell is a major supplier of helicopters, spare parts and helicopter-related services. Since it was founded in 1946, Bell has delivered over 33,000 aircraft to military and civilian customers in over 120 countries. They have three military and six civilian helicopter models in current production. Its aircraft are turbine powered, and range in size from the five-place Bell Model 206 series to the Bell Model 412EP aircraft, which carries up to fifteen people. Bell's military business includes both U.S. Government and non-U.S. Government customers. Currently, Bell is supplying advanced military helicopters, spare parts and product support to the U.S. and Canadian Governments and to the governments of several countries in the Pacific Rim, Middle East and Europe. Military sales to non-U.S. customers are made only with the concurrence of the U.S. Government. Bell is also a leading supplier of commercially certified helicopters to charter, offshore, utility, corporate, police, fire, rescue and emergency medical helicopter operators. Bell's non-U.S. Government business (including non-U.S. military customers) typically represents 40% to 60% of its annual sales. Bell is teamed with the Helicopter Division of the Boeing Company ("Boeing Helicopters") in the
development of the V-22 Osprey tiltrotor aircraft for the U.S. Department of
Defense. Tiltrotor aircraft are designed to utilize the benefits of both helicopters
and fixed-wing aircraft. Bell is under a development contract to upgrade the U.S.
Marines’ fleet of AH-1W and UH-1N helicopters. Bell has two major U.S.
competitors (Boeing Helicopter and Sikorsky Aircraft) and one major European
competitor (Eurocopter). Bell markets its products worldwide through its own
sales force as well as through independent representatives. Revenues of Bell
accounted for approximately 16%, 18% and 16% of Textron’s total revenues in
1996, 1995 and 1994, respectively.

The Cessna Aircraft Company is one of the largest manufacturers of light and
mid-size business jets and single-engine utility turboprop aircraft. Cessna
designs, manufactures and sells general aviation aircraft, aircraft propellers, and
related accessories worldwide. Cessna currently has two major product lines,
Citation business jets and single-engine turboprop Caravans. In addition, Cessna
has reentered the business of manufacturing single-engine piston aircraft, and
began deliveries in January 1997.

Cessna markets its products worldwide primarily through its own sales force as
well as through a network of authorized independent sales representatives.
Cessna has four major competitors for its business jet products, two U.S. and
two foreign. Revenues of Cessna accounted for approximately 12%, 10% and
10% of Textron’s total revenues in 1996, 1995 and 1994, respectively.
Sikorsky Aircraft

Sikorsky Aircraft Corporation is a wholly owned subsidiary of United Technologies Corporation (as is Pratt and Whitney who will be discussed later). They are one of the world's leading manufacturers of military and commercial helicopters and the primary supplier of transport helicopters to the U.S. Army. All branches of the U.S. military operate Sikorsky helicopters. Their revenues in 1997 were $1.6 billion accounting for just over 6% of United Technologies' total revenues. Their current employment levels are just under 8,000.

Sikorsky produces helicopters for a variety of uses, including passenger, utility/transport, cargo, anti-submarine warfare, search and rescue and heavy-lift operations. Sikorsky also supplies helicopters to foreign governments and the worldwide commercial market. In addition to sales of new helicopters, Sikorsky's business base encompasses spare parts for past and current helicopters produced by Sikorsky, and, through its subsidiary, Sikorsky Support Services, Inc., the repair and retrofit of helicopters in the U.S. military fleet. Current production programs at Sikorsky include; the Black Hawk medium-transport helicopter for the U.S. and foreign governments; the international Naval Hawk, a derivative of the Seahawk medium-sized helicopter for multiple naval missions for foreign governments; the CH-53E Super Stallion heavy-lift helicopter for the U.S. Marine Corps; and the S-76 intermediate-sized helicopter for executive transport, offshore oil platform support, search and rescue, emergency medical
service and other utility operations. In July 1997, Sikorsky signed a multi-year contract with the U.S. Government to deliver 108 Black Hawk helicopters from July 1997 through June 2002. Under the contract, the Government currently has the right to cancel 54 helicopters scheduled for delivery from July 1999 through June 2002. Declining Defense Department budgets make Sikorsky increasingly dependent upon expanding its international market position. Such sales sometimes require the development of in-country co-production programs, such as the program in which Sikorsky participates in South Korea. Sikorsky is engaged in full-scale development of the S-92 aircraft, a large cabin derivative of the Black Hawk helicopter, for commercial and military markets. Certification of the first S-92 is expected in the year 2000. Companies in Brazil, the People’s Republic of Republic of China, Japan, Spain and Taiwan are carrying out a significant portion of the development under collaborative arrangements. Sikorsky has a 50% interest in a joint venture with Boeing Helicopters (as mentioned earlier) for the development of the U.S. Army's next generation light helicopter, the RAH-66 Comanche. The first prototype aircraft performed a successful first flight in January 1996 and is undergoing further flight-testing.

Next, we will review the large engine manufacturers: General Electric, Pratt and Whitney and Rolls Royce of the UK. The worldwide competition in aircraft jet engines is intense. Both U.S. and export markets are important. Product development cycles are long and product quality and efficiency are critical to success. Research and development expenditures, both customer-financed and
internally funded, are also important in this industry. Potential sales for any engine are limited by, among other things, its technological lifetime, which may vary considerably depending upon the rate of advance in the state of the art, by the small number of potential customers and by the limited number of airframes. Sales of replacement parts and services are an important part of the business. Aircraft engine orders tend to follow military and airline procurement cycles, although cycles for military and commercial engine procurements may differ. U.S. procurements of military jet engines are affected by the government's response to changes in the global political and economic outlook. A review of the three major players in this industry follows.

General Electric

GE is a diversified technology, manufacturing and services company with major businesses including: aircraft engines, broadcasting (NBC), electrical distribution equipment, electric motors and industrial systems, capital services, power systems, information services, lighting, locomotive, major appliances, medical systems and plastics. The company employs over 216,000 people worldwide, including approximately 156,000 in the United States. Their 1997 revenues were $90.8 Billion.

The aircraft engines group of GE accounts for approximately 8.0%, of its consolidated revenues. This group produces, sells and services jet engines,
turboprop and turboshaft engines, and related replacement parts for use in military and commercial aircraft. GE's military engines are used in a wide variety of aircraft that includes fighters, bombers, tankers, helicopters and surveillance aircraft. GE's CFM56 engine which is produced by CFMI, a company jointly owned by GE and Snecma of France, and GE's CF6 engines power aircraft in all categories of large commercial aircraft: short/medium, intermediate and long-range. Applications for the CFM56 engine include: Boeing's 737-300/-400/-500 series and the new 737-600X/-700/-800 series; Airbus Industrie's A319, A320, A321 and A340 series; and military aircraft such as the KC-135R, E/KE-3 and E-6. The CF6 family of engines powers intermediate and long-range aircraft such as Boeing's 747 and 767 series, Airbus Industrie's A300, A310 and A330 series, and McDonnell Douglas' DC-10 and MD-11 series. The GE90 engine, which was certified by the Federal Aviation Administration in February 1995, is used to power Boeing's new 777 series twin-engine aircraft. The Company also produces jet engines for executive aircraft and regional commuter aircraft, and aircraft engine derivatives used for marine propulsion, mechanical drives and industrial power generation sources. Maintenance and repair services are provided for many models of engines, including engines manufactured by competitors.
Pratt & Whitney

Pratt & Whitney, like Sikorsky, is a subsidiary of United Technologies Corporation (UTC) contributing $7.4 billion of UTC's total $24.7 billion of revenue in 1997. The current employment level is 30,000 employees. They are one of the world's leading producers of large turbofan (jet) engines for commercial and military aircraft and small gas turbine engines for business and regional/commuter aircraft. Pratt & Whitney provides overhaul and repair services and spare and replacement parts for the engines it produces, as well as overhaul and repair services and fleet management services for many models of commercial and military jet and gas turbine engines. In addition, Pratt & Whitney produces propulsion systems and solid rocket boosters for the United States Air Force ("USAF") and the National Aeronautics and Space Administration ("NASA") and provides land based power generation equipment.

Pratt & Whitney products are sold primarily to aircraft manufacturers, airlines and other aircraft operators, aircraft leasing companies, and the U.S. and foreign governments. Sales to the Boeing Company ("Boeing"), Airbus Industrie ("Airbus") and McDonnell Douglas Corporation ("McDonnell Douglas"), including sales to the Douglas Products Division of Boeing after Boeing's 1997 acquisition of McDonnell Douglas, consisting primarily of commercial aircraft jet engines, amounted to 33 percent of total Pratt & Whitney revenues in 1997. Pratt & Whitney currently produces three families of large commercial jet engines; the JT8D-200, the PW2000 series and the PW4000 series. Pratt & Whitney's JT8D-
200 powers the Boeing MD-80 aircraft. Applications for the PW2000 series include the Boeing 757-200/PF aircraft. Pratt & Whitney's PW4000 engine family powers the Airbus A310-300, A300-600 and A330-200/300 series; the Boeing 747-400, 767-200/300 and 777-200/300 series of aircraft; and the Boeing MD-11 aircraft. Boeing has announced that its Douglas Products Division will continue to produce MD-80 aircraft until current production commitments end in 1999 and that it will continue to offer MD-11 aircraft, although primarily as freight aircraft. IAE International Aero Engines AG, a Swiss corporation in which Pratt & Whitney has a 33 percent interest, markets and supports the V2500 engine. Applications for the V2500 engine include Airbus' A319, A320 and A321 aircraft and Boeing's MD-90. Boeing has announced that its Douglas Products Division will continue to produce MD-90 aircraft until current production commitments end in 1999 and that Boeing will support existing MD-90 production commitments in China through the MD-90 Trunkliner program. In view of the global nature of the commercial aircraft industry and the risk and cost associated with launching new engine development programs, Pratt & Whitney has developed strategic alliances and collaboration arrangements on commercial engine programs in which costs, revenues and risks are shared. One such collaboration is the GE-P&W Engine Alliance, LLC. This entity is an alliance between GE Aircraft Engines and Pratt & Whitney, in which Pratt & Whitney has a 50 percent interest. This entity was formed to develop, market and manufacture a new jet engine that is intended to power super-jumbo aircraft. Although no aircraft manufacturer has
as yet committed to produce a super-jumbo aircraft, the GE-P&W Engine
Alliance has continued its marketing activities.

Pratt & Whitney currently produces two military aircraft engines: the F100
(powering F-15 and F-16 fighter aircraft) and the F117 (powering C-17 transport
aircraft). All of Pratt & Whitney's F100 and F117 sales contracts are with the
USAF or with foreign governments. Pratt & Whitney is under contract with the
USAF to develop the F119 engine, the only anticipated source of propulsion for
the two-engine F-22 fighter aircraft being developed by Lockheed Martin
Corporation ("Lockheed Martin") and Boeing. The F-22 made its first flight in
September 1997, powered by Pratt & Whitney F119 engines. In addition, the
Department of Defense selected Boeing and Lockheed Martin, to proceed into
the next phase of the Joint Strike Fighter program development. Both companies
have selected derivatives of Pratt & Whitney's F119 engine as their engine of
choice to provide power for the Joint Strike Fighter demonstration aircraft.

Gas turbine engines manufactured by Pratt & Whitney Canada, including various
turbofan, turboprop and turbo shaft engines, are used in a variety of aircraft
including six to eighty passenger business and regional airline aircraft and light
and medium helicopters.
Rolls-Royce plc

Rolls-Royce, no longer related to the luxury carmaker, is the third-largest aircraft engine maker in the world, positioned behind General Electric and Pratt & Whitney. Their total revenues in 1996 were λ 4.0 billion (approximately $6.6 billion) and they retained 42,500 employees. The company's Aerospace Group makes commercial and military jet engines for armed forces, airlines, and executive and corporate aircraft operators worldwide. Its US-based Allison Engine subsidiary makes engines for helicopters and turboprop aircraft. The Industrial Power Group constructs power generation, transmission, and distribution systems and makes marine propulsion and oil and gas pump engines. The company is using joint ventures to increase its global presence (80% of its business is done outside the UK).

Rolls-Royce's aircraft engines feature power range that extends from helicopter engines as small as 450 shaft horsepower to the massive 104,000lb thrust of the Trent turbofan. Rolls Royce is positioned to compete in the international civil aircraft market. Rolls-Royce engines power over 300 airlines and 2,400 business and utility aircraft operators. The company's Trent family of high-power engines is flying in the new Airbus A330 and Boeing 777. The Trent has a power range from 55,000lb to over 100,000lb of thrust. This enables Rolls-Royce to be in the position of having a family of power plants for all the existing and planned large airliners.
Rolls-Royce also provides power to the world's armed forces for applications ranging from front line combat aircraft and large military transports to combat and light helicopters. Rolls-Royce has a wide range of military engines to offer. A network of some 250 service representatives and 70 repair bases worldwide supports their customer base of 133 armed forces in 100 countries. The military aerospace business will benefit from a $96m contract awarded by the US Department of Defense to the GE/Rolls-Royce/Allison team developing the alternate engine for the Joint Strike Fighter. In addition, the EJ200-powered Eurofighter continued to progress, with seven prototype aircraft now flying.

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The watchwords for this section of the industry are consolidation, collaboration and competition. Each one of the firms mentioned is involved with at least one other firm in the industry on some basis. The nature of competition within the industry adds to the complexity of the relationships among these firms.
Appendix B

Sub-tier Suppliers – The Industry Supply Base

This appendix some reviews some of the larger firms from my sample that are supplying parts, subsystems, and avionics to the prime contractors mentioned heretofore.

**AlliedSignal Inc**

AlliedSignal Inc. is an advanced technology and manufacturing company serving customers worldwide with aerospace and automotive products and engineered materials, including chemicals, fibers, plastics and advanced materials. In 1997 the entire company achieved $14.5 billion in sales $ 6.4 billion coming from the aerospace products where 37,000 people are employed.

AlliedSignal's operations are conducted by ten major businesses, which are grouped under three major product areas, as follows; Aerospace products (Engines, Aerospace Equipment Systems, Electronic & Avionics Systems and Government Services), Automotive products (Turbocharging Systems, Automotive Products Group and Truck Brake Systems), Engineered materials (Polymers, Specialty Chemicals and Electronic Material).
The Aerospace-related businesses serve commercial and military components of the aviation, defense and space markets with a broad array of systems, subsystems, components and services. They design, develop, manufacture, market and service hundreds of products found on all types of aircraft, from single-piston engine aircraft, business aircraft and wide-bodied 'jumbos' flown by the world's commercial airlines, to trainers, transports, bombers, fighters and helicopters used by the U.S. and other countries for national defense.

The Company's business consists primarily of original equipment (OE) sales and an extensive aftermarket business, including spare parts, maintenance and repair, and retrofitting. Worldwide customers include the U.S. and foreign governments, all of the major airframe and engine manufacturers, including Boeing, Lockheed Martin, Airbus Industrie, Aero International (Regional), Raytheon, Israeli Aircraft Industries, Northrop Grumman, British Aerospace, Cessna, Fairchild/Dornier, Dassault, Gulfstream, Bombardier, Rockwell International, Pratt & Whitney, General Electric and Rolls-Royce, as well as the world's leading airlines and business aircraft and general aviation aircraft operators, and dealers and distributors of general aviation products. The Company also provides field engineering management and technical support services to Boeing, the National Aeronautics and Space Administration (NASA), the U.S. Department of Defense (DOD), the U.S. Department of Energy, other federal civilian agencies as well as state and local governments and other commercial entities. Growth in the Company's commercial business for
aerospace products is expected, over the long term, to help mitigate the reductions in U.S. defense spending.

The B.F.Goodrich Company

BFGoodrich manufactures and supplies a wide variety of systems and component parts for the aerospace industry and provides maintenance, repair and overhaul services on commercial, regional, business and general aviation aircraft. (The Company sold the tire business in 1986). They also manufacture specialty plastics and specialty additive products for a variety of end-user applications. In addition, they produce chlor-alkali and olefins products. BFGoodrich, with 1997 sales of $3.4 billion, is organized into two principal business segments: BFGoodrich Aerospace and BFGoodrich Specialty Chemicals.

The Aerospace business, which generates over 60% of the revenues with 10,000 employ. is conducted through four major business groups. Landing Systems Group manufactures aircraft landing gear; aircraft wheels and brakes; high-temperature composites and manufactures aircraft evacuation slides and rafts for commercial, military, regional and business aviation customers, and space programs. Sensors and Integrated Systems Group manufactures sensors and sensor-based systems; fuel measurement and management systems; engine electrical and ignition system components; and polymer and composite products
for commercial, military, regional, business and general aviation customers, and for aircraft engine and space programs. Aerostructures Group (formerly Rohr Inc) designs, develops and integrates nacelle and pylon systems and provides support services. Nacelles are the aerodynamic structures that surround an aircraft's engines. Maintenance, Repair and Overhaul Group provides maintenance, repair and overhaul of commercial airframes, components, wheels and brakes, landing gear, instruments and avionics for commercial, regional, business and general aviation customers. BFGoodrich Aerospace is among the largest suppliers of aircraft systems and components and aircraft maintenance repair and overhaul service businesses in the world. They compete with other aerospace industry manufacturers (AlliedSignal for one) to supply parts and provide service on specific fleets of aircraft, frequently on a program-by-program bid basis. Contracts to supply systems and components and provide service are generally with aircraft manufacturers, airlines and airfreight businesses worldwide. The Company also competes on U.S. government contracts, generally as a subcontractor.

Parker Hannifin Corporation

Parker-Hannifin is a full-line manufacturer of motion control products, including fluid power systems, electromechanical controls and related components. For the fiscal year ended June 30, 1997, net sales were $4.1 billion and employment was 33,000. Industrial Segment products accounted for 79% of net sales and Aerospace Segment products for 21%.
Aerospace Segment sales are made primarily to the commercial, military and general aviation markets and are made to original equipment manufacturers and to end users for maintenance, repair and overhaul. The principal products of this segment are hydraulic, fuel and pneumatic systems and components that are used on most commercial and military airframe and engine programs in production in the Western world today. The Aerospace Segment offers complete hydraulic systems, as well as components that include hydraulic and electrohydraulic systems used for precise control of aircraft systems. This segment also designs and manufactures aircraft wheels and brakes for the general aviation and military markets. They also produce a fuel product line that includes complete fuel systems as well as components, in addition to pneumatic components.

Aerospace Segment products are marketed by the company's regional sales organization and are sold directly to manufacturers and end users. They have developed partnerships with key customers based on quality, delivery, and service, and price, which has enabled Parker to obtain original equipment business on new aircraft programs for its fluid control systems and components leading to follow-on repair and replacement business for these programs.
Sundstrand Corporation

Sundstrand is a multinational organization comprised of an aerospace and an industrial business segment. The total revenues in 1997 were $1.8 billion, Aerospace accounted for $1.0 billion with the remainder coming from the Industrial segment. Aerospace employment levels are approximately 6400 employees. These segments are engaged in the design, manufacture, and sale of a variety of proprietary, technology-based components and systems for diversified international markets. They recently purchased the electrical load management technology and some related business from Leach International Corporation. They have also acquired Labinal S.A.'s interest in a joint venture formed in 1989 by Sundstrand and Labinal to market and sell auxiliary power units (APUs) to the commercial transport airline market.

The Aerospace segment consists of three product lines, electric power systems, mechanical and fluid systems, and auxiliary power systems. Sundstrand is the leading supplier of aircraft electric power systems. Their systems are installed on every current aircraft platform offered by Boeing and Airbus Industrie, most McDonnell Douglas transports, several of the smaller commercial aircraft, and many of the world's military aircraft. This scope of coverage is important both for the aftermarket business it generates and for the ongoing relationships it provides with customers. With capabilities in hydromechanical, electrical generation, electronics and power electronics, and hybrid technologies, Sundstrand can design a system for each aircraft's power requirements and
usage patterns. The acquisition of Leach's electrical load management technology extends Sundstrand's current capabilities for generating and managing aircraft electric power. The electric power systems product line accounted for more than 50 percent of Aerospace segment sales over the past few years. The mechanical and fluid systems product line includes aircraft actuation systems, secondary/emergency power systems, and a range of pumps as well as systems for missile and space applications and undersea propulsion. Some of their largest actuation system programs have been for military applications. This experience base has enabled Sundstrand to expand its product offerings into commercial markets. Sundstrand produces APUs for a wide variety of commercial and military applications ranging from business jets to commercial transports. They market larger APUs for Airbus, Boeing, and McDonnell Douglas commercial transports.

Rockwell International Corporation

Rockwell is a global electronics company with leadership positions in automation, avionics and communications and semiconductor systems. Total Sales in 1997 were $7.8 billion; avionics and communications generated 22 percent of that total. Total employment level for Rockwell is 57,000 people. The current Rockwell International Corporation is the result of a recent restructuring wherein they divested their former aerospace and defense businesses to Boeing. The remaining aerospace business is generated in the avionics & communications
segment. They provide electronic equipment for flight control, cockpit display, navigation, voice and data communication, cockpit management, radar, global positioning and other systems for airlines, corporate aircraft, general aviation, government and military applications, command, control and communications devices and systems and products and systems for the land transportation market (including electronic brake systems and integrated cab electronics). Their primary markets are commercial air transport, general aviation and government avionics, where Rockwell has products such as GPS, data links and liquid crystal displays. International business, as for most firms in the industry is becoming more important and is expected to comprise almost 40 percent of Avionics & Communications sales in 1998 compared to 35 percent in 1997.

**Astronautics Corporation of America**

Astronautics is a designer, developer, and manufacturer of electronic systems. Their sales are approximately $220 million per year, with 2500 employees. $200 million of the revenues are attributed to their Kearfott Guidance & Navigation subsidiary. The products produced by Astronautics are used in a wide range of military and commercial land, sea, and aerospace applications. Astronautics provides full-service capability, including research, hardware and software design, system integration, pilot production, full production, test equipment and aftermarket support including spares, repairs, training, and field service. They are both a prime contractor to the U.S. Department of Defense and a sub-contractor
to large defense, aerospace, and electronics companies such as Northrop
Grumman. Lockheed Martin, McDonnell Douglas, Boeing, and Texas
Instruments. Astronautics produces flight and navigation instruments, air data
computers, auto pilots, flap control, CRT (cathode ray tube) and Flat Panel liquid
crystal displays, mission and display computers, radar and map display systems,
flight director computers, and flight management systems. Astronautics
equipment is a component of approximately 80% of the United States' military
aircraft. Over 20,000 aircraft around the world are equipped with Astronautics
flight instruments, displays, and computers. This sizable installed base provides
the company with a stream of maintenance revenue and opportunities for
Astronautics to upgrade existing equipment. Among the aerospace products and
places, which utilize Astronautics technology, are the F-16, B-1, B-2, C-17,
BLACKHAWK and Apache helicopters and Mirage jet fighters, the Space Shuttle,
and NASA's Johnson Space Center. In 1988, Astronautics' acquired Kearfott
Guidance & Navigation Corporation, a subsidiary of The Singer Company. The
acquisition provided a combination of Astronautics' displays and processors with
Kearfott's sensor and guidance technology.
Appendix C

Offset Interview Questions

Interviewee Firm

Is your firm a prime contractor or supplier?

Provide a brief description of your firm, including corporate structure, major products and main customers.

What are the annual revenues of the firm?

What is your position in the firm?
   Which function do you report to?

How do you manage offsets within your company? Centralized or decentralized. Please elaborate on the management practice.

How important are offsets to your current business? High Medium or Low Why?

What are the top three activities utilized to satisfy offset obligations?

Are you using suppliers to help satisfy offset obligations? How?

If you are a supplier are you involved in prime’s offsets? If so how?

Please provide any other insights or issues you have regarding offsets.
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   Rolls-Royce plc
   Sundstrand Aerospace
   Textra, Inc
   The Boeing Company
   United Technologies Corporation