Technology Development and Business Strategy: A Changing Environment Impacts Practices

by

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ABSTRACT

Many high technology US manufacturing industries, and especially the aerospace industry are facing unparalleled world-wide competition in a new, faster-paced, cost-conscious, global marketplace. The process of new technology development, and its earliest introduction into product production programs, is undergoing major changes in almost all US firms as they restructure for this new global business environment. These forces of change were studied relative to their impact on how technology planning is accomplished and its interaction with company business plans. Manufacturing industries were selected and historically reviewed. An industry background was created to list major business and strategy trends known to be occurring. Independently, selective industry interviews were performed to collect complementary data on current practices and changes ongoing. A literature survey was performed to summarize major academic theories regarding planning for needed technology development, and its required interaction with firm strategic (business) planning. Results were assessed relative to the adequacy of current practices to the business environment of the mid-1990's, and the changing role of technology in industry strategy.

Thesis Supervisor: Janice A. Klein
Title: Senior Lecturer

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1. INTRODUCTION

1.1 Problem Overview

Many US high-technology manufacturing industries are facing unparalleled world-wide competition in a new, faster-paced, cost-conscious, global marketplace. Some industries, like the aerospace industry, face additional evolutionary issues. Once dominated by US defense department procurements they are now actively moving toward an international or commercial product emphasis. And, for both government procurement and commercially driven markets, affordability has become a primary program driver, closely followed by a need to dramatically reduce development time-to-market while simultaneously coping with a more knowledgeable customer with ever-growing product expectations.

Thus, almost all US firms are restructuring in both management philosophy and organizational structure for this new business environment. Similarly, the processes of new technology development, technology innovation, and early introduction into applications, appear to be also undergoing major industry changes. And, the traditional role of technology development and related innovation in overall business strategy appears to be undergoing significant evolution in the 1990's.

In a simplified context, the general background "problem" for this thesis can be defined by questions which are intended to relate directly to high-technology manufacturing industries:

- "In the years prior to the current mid-1990's, what industry business issues occurred that required such major restructuring?"
- "What were the primary changes in industry strategy that were enacted during this time frame?"
- "What impact have these trends had on the integration of technology development planning with strategic or business planning?"

Study of the first two questions provides an *external* historical perspective of factors affecting the industry. The intent being to create a contextual foundation for addressing more operationally specific questions on current industry practices regarding technology development planning. With the external context established, questions can be considered relative to the third

background question posed which switches study focus to an *internal* perspective of business and technology interface issues within high-technology manufacturing companies.

More specifically, the second thesis perspective begins an examination of operational questions dealing with interface issues associated with technology and business planning, such as:

- "How are proposed technology development programs integrated with business planning and strategies?"
- "Is the literature on frameworks, relating to management of technology, compatible with current management practices and the 1990's business environment?"

The historical context of this thesis is an approximate ten year period from the mid 1980's to the mid-1990's. Management practices studied are reflective of the 1996-97 time period.

1.2 Methodology

The general approach taken to address these questions relates closely to the organization of this thesis. For industry sectors studied, three data gathering efforts were performed:

- Assessment of industry business and strategy trends from approximately 1985 to 1995,
- Industry interviews to sample current issues and practices regarding the integration of technology planning with business and strategy planning, and
- A literature survey of academic frameworks on management of technology with a focus on integration issues relating to business/strategic planners and technology planners.

Specifically, a study was completed which examined current management practices regarding the integration of technology planning with business planning and strategies. The primary industry focus was on the Aerospace and Defense Sector but was complemented by

additional assessments of the Automotive Sector and Conglomerate Sector. These sectors were chosen because they represent manufacturing industries that have traditionally used a high degree of technology in their products and manufacturing processes to maintain a competitive position in their markets.

The scope of this focused industry study included four tasks to:

1) Provide background industry information,
2) Assess the evolution of business issues and strategies over the last decade,
3) Determine current management practices regarding integration of technology development planning with business planning and strategies, and
4) Perform a review of academic literature for relevant philosophy, models, or frameworks.

The collective objective of these tasks being to provide a foundation for assessing two related issues: (1) The adequacy of current management practices relative to the evolving industry business environment, and (2) The role of technology development and innovation in the current industry environment.

1.3 Organization

The thesis is divided into four major sections. In **Section 2 - Industry Background Information,** three industry sectors are examined to provide a business description of their sector activities and competitive environment. The source of data for this background section is primarily individual company SEC filings with emphasis on their 10K reports. **Section 3 - Industry Trends** documents results of a ten-year examination of industry trends regarding major business environment issues and industry strategy. For this examination, additional SEC filings of the seven representative companies of Section 2 were further studied. **Section 4 - Industry Practices** documents the results of industry interviews which were performed to sample the current industry practices regarding the integration of technology strategy or planning with business planning. The source of data for this section was the author's personal notes taken during the industry interviews. In the thesis effort, a clearer understanding of generic industry

practices and processes was the goal. Accordingly, industry practices as reported in this thesis make no reference to companies or people interviewed. Further, the companies interviewed were representative of the three industry sectors identified in Sections 2 and 3, but were not necessarily taken from the list of companies cited in those sections. **Section 5 - Literature Review** provides a survey of academic literature relevant to three aspects of the thesis effort; historical perspective on strategy evolution, interface issues in planning, and specific frameworks to integrate technology and business strategies. Information for the literature survey was obtained from a combination of traditional library resources and various Internet on-line resources to access general business literature. And last, **Section 6 - Conclusions** provides an overview of study results.

2. INDUSTRY BACKGROUND INFORMATION

Introduction - Because the study focus is on changes occurring in management practices regarding technology planning, aerospace and automotive companies were selected for study due to their historical emphasis on technology innovation to maintain competitive position in their markets. Additionally, in the ten year period following the mid 1980's, both industries were actively trying to expand their markets internationally, were experiencing intense domestic competition, were experiencing a growing international competition, and were undergoing significant organizational restructuring.

The section is divided into subsections on:

- Manufacturing Sectors Studied,
- Company Business Descriptions, and
- Summary - Industry Sectors & Section

2.1 Manufacturing Sectors Studied

Seven corporations were selected to represent industry sectors which use relatively high technology on manufactured products. In particular, aircraft and automobiles were selected as the product emphasis. The seven firms are listed in Figure 2-1 relative to their current primary businesses, major business activities, business segments, and some of their major competitors, as recently defined by their 1995 or 1996 Annual and 10-K Reports [1-13]. This assessment centers on manufacturing companies with three industry sectors contained in this list of seven corporations:

- Conglomerates Sector; General Electric (GE) and United Technologies (UTC),
- Automobiles and Trucks Sector; Ford Motor Company and Chrysler, and
- Aerospace and Defense Sector; Lockheed Martin, Boeing, and McDonnell Douglas.

From the perspective of strategies and management practices regarding technology, the intent of this three-sector facet of the industry study is that the industry business and strategy trends for the conglomerates automatically covers a wide range of other products and services. The two conglomerates, while having a very strong aerospace industry presence (e.g. GE's Aircraft Engines; UTC's Pratt & Whitney Aircraft Engines and Sikorsky Aircraft) also deal with a

Figure 2-1 Selective List of Aerospace and Automotive Industry Companies

Company	Primary Businesses	Business Activities	Segments	Competitors (*partial list*)
General Electric (1996) **Conglomerate**	Aerospace Appliances Information Tech Transportation Broadcasting Materials Medical Financial Power Industrial	developing manufacturing marketing financing distribution services	Aircraft Engines Appliances Capital Services Electrical Distribution & Ctl Information Services Lighting Medical Systems Motors & Industrial Systems NBC Plastics Power Systems Transportation Systems	General Motors Hitachi Matsushita Maytag Raytheon Rolls-Royce Siemans Textron Time Warner United Technologies Westinghouse Whirlpool
United Technologies (1995) **Conglomerate**	Aerospace Building Systems Parts & Services Automotive	research development production services	Otis Carrier Automotive Pratt & Whitney Sikorsky Aircraft Hamilton Standard	Aerospatiale Boeing General Electric ITT Industries Lockheed Martin McDonnell Douglas Rolls Royce Textron
Ford Motor Company (1995) **Auto & Truck**	Trucks Cars parts and services Financial Services	manufacture assembly sale financing	Automotive Operations Financial Services Group	BMW, Chrysler Deere, Honda General Motors Fiat (+see Chrysler)
Chrysler (1996) **Auto & Truck**	Trucks Cars Financial Services Insurance	manufacture assembly sale parts & accessories	Automotive Operations Financial Services	Ford, Toyota Hyundai, Isuzu Mitsubishi, Mazda Nissan, Peugeot Volvo (+ see Ford)
Lockheed Martin (1995) **Aerospace & Defense**	space systems military aircraft aircraft support, logistics	conception research development design manufacture integration services	Space & Strategic Missiles Aeronautics Information & Technology Electronics Energy, materials	Aerospatiale Boeing General Electric McDonnell Douglas Northrop Grumman Siemens TRW, UTC
Boeing (1996) **Aerospace & Defense**	commercial aircraft rocket engines information services defense & space	research development production marketing modification & support	Commercial Airline Group Defense & Space Group	Airbus British Aerospace General Dynamics Lockheed Martin Northrop Grumman Textron, UTC
McDonnell Douglas (1996) **Aerospace & Defense**	fighter/attack aircraft helicopters missiles, space, electronics commercial aircraft financial services	design development production support	McD Aerospace McD Military Transport Douglas Aircraft McD Financial Services McD Realty	Aersospatiale Airbus, Boeing Lockheed Martin Northrop Grumman United Technologies General Electric Textron

wide range of activities unrelated to either the aerospace or automotive industries (e.g. GE's NBC broadcasting and GE Appliances; UTC's Carrier Air Conditioning and Otis Elevators).

As the business environment of the aerospace and automotive industries changed over time, the added perspective that this permitted was to evaluate whether the corporate strategies and trends of the two conglomerates differed significantly from the corporate strategies of the more focused aerospace and automotive corporations. Additionally, the two conglomerates had established a long history of successful commercial and international business activity and, as the aerospace and automotive industry sectors moved toward less military and more global activities, another perspective permitted was to assess whether the two conglomerates were more adept at responding to the globalization needs than the less diversified aerospace and automotive companies.

2.2 Company Business Descriptions

A description of the selected companies is provided as an amplification of the primary businesses and activities information listed in Figure 2-1. Its purpose is to provide company background information regarding the nature of their industry business activities, and an overview of industry competition characteristics. Due to the purely background nature of this information, the following briefs contain selective but liberal extraction from the individual company 10-K reports. As the primary source of information was documentation provided by the companies in the 1995 or 1996 Annual and 10-K Reports, the overviews provided are considered to be a relatively current (mid 1990's) presentation of each company's interpretation of its industry perspective.

2.2.1 The Conglomerates Sector

The General Electric Company (GE) is one of the largest and most diversified industrial corporations in the world. GE has engaged in developing, manufacturing and marketing a wide variety of products for the generation, transmission, distribution, control and utilization of electricity. Over the years, development and application of related and new technologies have broadened considerably the scope of activities. The Company also offers a wide variety of services including: financial services; network television and broadcasting services; product

support services; electrical product supply houses; electrical apparatus installation, engineering, repair and rebuilding services. The GE product lines are very diverse ranging from a large retail business in appliances to the very high technology products used in aerospace, defense and medical diagnostic applications.

The GE operations in all sectors by strategy and management direction seek to maintain a leadership position (i.e. number one or number two) in most major markets served Aggressive and able competition, often highly concentrated and worldwide, is encountered in virtually all areas of the Company's business activity. The competitive climate is characterized by changing technology requiring continuing research and development commitments and by capital intensive needs to meet customer and producer requirements.

GE has substantial export sales from the United States and has majority and minority or other joint venture interests in a number of foreign companies. Those interests are engaged primarily in manufacturing and distributing products and services outside the United States similar to those sold domestically.

United Technologies Corporation (UTC) provides high technology products to the aerospace, building systems and automotive industries throughout the world. UTC's companies are industry leaders. As for GE, the UTC philosophy relative to its diverse mix of businesses is to maintain a leadership position in its markets. Currently this industry status has been achieved by its Pratt & Whitney Aircraft Engines (commercial and military), Sikorsky Aircraft (helicopters), Otis (Elevator and Escalator and Services), and Carrier (Heating, Ventilation, and Air Conditioning) business units. Aggressive efforts to achieve a similar market status are ongoing in the Hamilton Standard (Engine Controls, Propellers, Flight Systems) and in United Automotive (Automotive Components and Electrical Systems) business units. Also similar to GE is the implication that technology has played an important role in UTC's overall corporate strategy.

The competitive climate of the UTC businesses can be divided into three generalizations; one for each of UTC's three industry segments. In the *aerospace segment*, high technology is a cornerstone with lengthy and capital intensive product development cycles which are sensitive to technology changes. Such characteristics result in a relatively small number of products being the mainstay of revenues. Competition is intense with differentiation dependent on performance,

quality, price, delivery schedule, warranties, guarantees, service, and complex technology transfer and co-production arrangements with international customers. Competition has been increasing from foreign and domestic sources.

In the *building segment*, comprised of highly global and commercial product lines the marketplace is subject to changes in economic, industrial, and international conditions, which include: increases in interest rates; changes in legislation and in government regulations; changes in technology; decreases in construction starts; and substantial competition from a large number of companies including other major domestic foreign manufacturers. Competition usually focuses on price, delivery schedule, product performance, service and other terms and conditions of sale. Increasingly, in foreign markets, utilization of local manufacturers, distributors and sales channels is essential for emerging market penetration, success and growth.

The *automotive segment*, is directly sensitive to the demand and cycle of the automotive industry; i.e. periodic short-term releases issued under annual orders for a percentage of the respective manufacturer's requirements. As such, business is strongly affected by the general market demands for automotive production and a large number of ancillary factors such as economic, industrial and international conditions, interest rates, prices of raw materials, prices of petroleum based products, and significant foreign and domestic competition. The competitive discriminators in this industry are being able to consistently deliver on time, high quality products, and more recently assuming partnership roles with the original equipment manufacturers.

Overall, UTC garnishes about 40% of its revenues from foreign business and almost 60% of its employees are located in foreign countries.

2.2.2 Automotive Sector

Ford Motor Company is the world's largest producer of trucks, and the second largest producer of cars and trucks combined. The Company is the world's only true full-line vehicle producer, and is one of the largest providers of financial services worldwide. In 1995, Ford held a 20.7% share of the US car market and a 31.9% share of the US truck market.

The principal business of Ford is to manufacture, assemble and sell cars, trucks, and related parts and accessories. Profitability is affected by many factors; changes in unit sales volume; the mix of vehicles and options sold; and the ability of the Company to achieve cost

efficiencies and to recover cost increases through higher pricing. Further, the industry is capital intensive, it operates from a relatively high fixed-cost base which can result in large changes in earnings with relatively small changes in unit volume.

The automotive industry in the USA is seasonal in nature. Retail sales followed by production rates vary from month to month reflecting a seasonal behavior. The United States automotive industry is highly competitive and is characterized by a wide variety of product offerings. It has been the practice in the industry to introduce some new models almost every year, usually requiring changes in design and engineering, for which substantial financial and other commitments must be made far in advance of production. Consumer demand is influenced by quality, price, styling, safety, reliability, economy and utility. The Company's ability to satisfy changing consumer preferences can affect sales and earnings significantly. Unit sales vary with the level of total industry demand. That demand is dependent on general economic conditions, the cost of purchasing and operating cars and trucks, the availability and cost of credit, the availability and cost of gasoline, and reflects the fact that cars and trucks are durable items, the replacement of which can be postponed.

The products of Ford are sold in most of the markets of the free world and major initiatives are underway to expand Ford sales into other developing countries.

Chrysler Corporation operates also in two principal industry segments: Automotive Operations and Financial Services with a focus on its core automotive business. In 1995, Chrysler held a 9.1% share of the US auto market and a 21.3% share of the US truck market.

The Automotive Operations include the research, design, manufacture, assembly and sale of cars, trucks and related parts and accessories. All products are marketed through retail dealerships. As for Ford, business is highly competitive with respect to a number of factors, including vehicle quality, pricing, development and introduction time, appearance, size, special options, distribution organization, warranties, reliability, safety, fuel economy, dealer service and financing terms.

Cyclic market demand typically requires the use of pricing and incentives to increase profitability. Sales are also significantly affected by the pricing actions of its principal competitors. Long term profitability depends on its ability to continue its capital expenditure and

vehicle development programs and to market its products successfully in an increasingly competitive environment. The success of new vehicles will depend on general economic conditions, competition, consumer acceptance, product quality, new product development, the effect of governmental regulation, and the strength of marketing and dealer networks.

Chrysler manufactures, assembles and sells cars and trucks under various brand names primarily in the United States, Canada, and Mexico. The Company participates in other international markets through its wholly owned subsidiaries.

2.2.3 Aerospace and Defense Sector

The **Lockheed Martin Corporation (LMC)** operates principally in four business segments: Aeronautics, Space and Strategic Missiles, Electronics, and Information and Technology Services. With the merger of Lockheed and Martin, as well as the pending merger with Loral, this corporation has significantly broadened its business sectors. However, with only one-quarter of its business revenues falling in non-aerospace related areas, for this study it remains classified within the Aerospace and Defense sector.

LMC is engaged in the design, manufacture, integration and operation of a broad array of products and services ranging from aircraft, spacecraft and launch vehicles to energy management, missiles, electronics, and information systems. The Corporation serves customers in both domestic and international defense and civilian markets, with its principal customers being agencies of the US Government.

Lockheed Martin encounters extensive competition in all of its lines of business with numerous other contractors on the basis of price, technical, and managerial capability. The on-going consolidation of the United States defense industry has intensified this competition. More generally, the aerospace and defense business involves rapidly advancing technologies and is subject to many uncertainties resulting, for example, from changes in federal budget priorities, particularly the size and scope of the defense budget, and dependence on Congressional appropriations. Substantial efforts are undertaken continually on a long-term basis in order to maintain existing levels of business.

Other characteristics of the industry are complexity of designs, the difficulty of forecasting costs and schedules when bidding on developmental and highly sophisticated

technical work, and the rapidity with which product lines become obsolete due to technological advances and other factors characteristic of the industry. Due to the intense competition for available government business, the maintenance and/or expansion of government business increasingly requires the Corporation to generate working capital and invest in fixed assets.

With 70% of sales made to the United States Government, a significant portion of the Corporation's sales are subject to inherent risks, including uncertainty of economic conditions, changes in government policies and requirements that may reflect rapidly changing military and political developments and the availability of funds.

The Boeing Company is one of the world's major aerospace firms. The Company operates in two principal industries: commercial aircraft, and defense and space. Business activities involve research, development, production, modification, marketing, and related support services to its customers of commercial jet transports, military aircraft, helicopters, and related systems, space systems and missile systems.

The worldwide market for commercial jet transports 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. Demand for the Company's commercial aircraft is further influenced by world trade policies, government-to-government relations, environmental constraints imposed upon airplane operations, airline industry profitability, technological changes, price, and other competitive factors.

The Company's ability to deliver jet transports on schedule is dependent upon a variety of factors, including availability of raw materials, performance of suppliers and subcontractors, and certifications by the Federal Aviation Administration. The introduction of new commercial aircraft programs and major derivatives involves increased risks associated with meeting development, production and certification schedules.

The Company's defense and space segment is highly sensitive to changes in national priorities and U.S. Government defense and space budgets. 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. The Company's ability to

successfully compete for and retain such business is highly dependent on its technical excellence, demonstrated management proficiency, strategic alliances, and cost-effective performance.

The Company's commercial aircraft sales are subject to intense competition from aircraft manufacturers, including foreign companies which are nationally owned or subsidized. To meet competition, the Company maintains a program directed toward continually enhancing the performance and capability of its products and has a family of commercial aircraft to meet varied and changing airline requirements. Since the 1970s, the Company has maintained approximately a 60% share of the available commercial jet transport market.

The Boeing company has a long history of international marketing and currently derives over 40% of its revenues from foreign sales.

The McDonnell Douglas Corporation operates principally in four industry segments: military aircraft; missiles, space, and electronic systems; commercial aircraft; and financial services. Primary business activities include: research, design, development, production, support, and marketing of the following major products: military transport aircraft, attack and fighter aircraft, military and commercial helicopters, tactical missiles, space launch vehicles and space station systems, commercial transport aircraft, and related customer support and spare parts.

Programs and products comprising most of the Company's business volume are of a highly technical nature, comparatively few in number and high in unit cost. These products have traditionally required long product development cycles, were capital intensive, and had relatively long production lives.

There is significant price and product competition in the aerospace industry, both in military and commercial programs. The Company's military segments compete in an industry composed of a few major competitors and a limited number of customers. The number of competitors in these segments has decreased over the past few years due to consolidation brought about by reduced defense spending. However, competition for military programs remains significant.

The Company's commercial aircraft sales are subject to intense competition from aircraft manufactured by other companies, both foreign and domestic, including companies which are

nationally owned or subsidized and have a larger family of commercial aircraft to meet varied and changing airline requirements. The Company's principal competitors in commercial aircraft are The Boeing Company and Airbus Industrie. The Company's presence in this industry is currently focused on its existing product line, its current MD-95 twin jet development program, and its commercial aircraft modification, support, spare parts and related services.

2.3 Summary - Industry Sectors & Section

For the thesis effort, a focus has been placed on relatively high-technology manufacturing corporations. Within that context, three industry sectors were selected for concentrated study; Conglomerates, Automotive, and Aerospace & Defense. The primary focus will be placed on the Aerospace & Defense Sector. Associated relationships where possible will be made relative to the Conglomerate Sector and the Automotive Sector.

Within these industry sectors, seven corporations were selected to further assess the business activities, basic competitive atmosphere, and degree of international emphasis which exist. An overview summary of primary businesses, activities, segments, and competitors of the seven corporations was provided in Figure 2-1.

Additionally, a current brief on each of the corporation's business descriptions was extracted from company 10-K and Annual Reports to sense a company-by-company interpretation of business and industry environment. A condensation of the Section 2.2 company information follows in an integrated sector-by-sector format.

In the **Conglomerate Sector**, both GE and UTC are diverse in their business activities featuring a wide variety of products and services. Both emphasize; the application and competitive advantage of advanced technology; active involvement in the application and development of new technologies; and diversity of business activities which include expansive retail product lines as well as high technology aerospace and medical products. Additionally, a further emphasis on expanded business activities into services has been ongoing for the last decade at least.

The sector is characterized by intense competition worldwide. As such, maintaining a competitive advantage requires constant investment in new technology, capital intensive product development, and increased attention to customer expectations regarding service, quality, and

product warranties or guarantees. Customer expectations continue to grow and have been accelerated by competitor actions and an increasing and more current customer knowledge of new technology.

The conglomerate sector is characterized by extensive international activities with expansive business, sales, and service networks well established from the early to mid 1980's due to their retails operations (GE; appliances, and UTC; air conditioners and elevators). Using their international resources for competitive advantage and synergy, the focus of both corporations is to significantly expand their aerospace businesses internationally, especially in developing markets. Both GE and UTC have considerable foreign revenues and are considered to be true global corporations of the mid 1990's.

In the **Automotive Sector**, as represented by the Ford and Chrysler business descriptions, a focused product emphasis is on the manufacture, assembly, and sale of automobiles and trucks in a wide variety of product offerings and brand names, as well as related parts and services. The industry is characterized by capital intensive product development cycles and the need for its corporation members to invest in technology development to maintain profitability and competitive status. The business is highly seasonal and is characteristically sensitive to changing market demand related to changing customer preferences and customer price sensitivity. The industry has traditionally offered customers new model introductions yearly.

The US industry has always been highly competitive and this has intensified over the last twenty years as domestic market share has continued to be eroded by a growing number of foreign automaker competitors; especially the Japanese auto makers. Due to the increased competition, customer expectations continue to increase significantly in areas of price, quality, styling, standard features, safety, reliability, economy, etc. To achieve competitive advantage, significant investment is occurring in technology development and process re-engineering. Such initiatives are aimed at decreasing product development time, increasing operational production flexibility, and decreasing new product introduction time-to-market.

Profitability is extremely sensitive to economy of scale factors which are affected by competition, customer preferences, and overall world/US economic factors which affect market demand. As compared to the conglomerates, while the automotive sector is emphasizing international sales growth it is still considered today to be more domestic than global.

In the **Aerospace & Defense Sector**, as reflected by the business descriptions of Lockheed Martin, Boeing, and McDonnell Douglas, the industry focus is primarily aircraft for both commercial airlines and government agencies. The business embraces research, design, manufacturing, integration, assembly, and sales of aircraft, spacecraft, and launch vehicles. Significant research and development activities for new technology are typical within the sector. The market for aircraft is driven by long term trends reflecting commercial airline traffic growth, and by government procurements primarily for military or defense aircraft systems. Characteristics of the industry include complexity of design, lengthy product development cycles, and a high degree of sensitivity to economies of scale. Typically, only a few product offerings are permitted due to the capital intensive nature of the business, the certification process, and the lengthy development cycle.

Competition has intensified markedly over the last 10-15 years due to increased foreign competition eroding market share in commercial aircraft, and a continually decreasing US defense budget. The industry has been undergoing significant consolidation, organizational restructuring, and process re-engineering. Profitability margins have decreased due to the competition, increased customer expectations, and an intense customer focus on affordability in both acquisition and life cycle contexts. Consequently, all sector companies are seeking new market opportunities and the current focus is on international markets; especially in the developing countries of the world with an emphasis on the Pacific-Rim area. Boeing currently because of its traditional worldwide markets for commercial aircraft is best positioned as an international corporation and is moving toward being a global corporation.

Lockheed Martin is still dominated by its government business but consolidation in the industry has virtually reduced prime players to three from a 1950's total of sixteen. At the time of this thesis study, Boeing was in the process of acquiring McDonnell Douglas. And while moving to be a global corporation, Boeing was also positioning to aggressively compete with Lockheed Martin for the few but still highly lucrative government procurements left in the 1990's. Northrop-Grumman is the third major player remaining in this sector.

3. INDUSTRY TRENDS

Introduction- During a 1997 spring semester seminar at MIT, Mr. James Champy co-author of "Reengineering the Corporation"[30] and author of "Reengineering Management"[31] recounted how, in the immediate years prior to the 1990 time frame, there were at least four major factors which provided a catalyst (if not a mandate) for significant changes to take place in U.S. industries if they were to maintain or regain a leadership role in their markets.

The four major factors cited by Champy were:

- Fundamental competition was changing with new competitors entering the market with service being a key discriminator in differentiating their products from their competitors.
- Competitors were actively reducing product cycle times which existing, older, larger companies were finding it very difficult to respond to.
- Customers were becoming more sophisticated, technologically knowledgeable, and significantly more demanding in their expectations.
- And, significant business and global market changes were accelerating!

Champy's four major factors of the late 1980's would seem to be an excellent beginning and preamble to this section. The intent here being to examine and summarize major changes in industry environment and corporate strategy that occurred over an approximate ten-year period from the mid-1980's to the current mid-1990's. The results of a historical review of the industries selected are discussed in this section from two perspectives: (1) external factors which were stated as industry concerns by its executives, and (2) strategies actually defined by the same industry executives. The two perspectives were selected to provide a context for understanding the evolution and current state of industry practice regarding management of technology, and gain insight regarding changes in its role in overall business strategy.

The approach taken was to examine SEC filings[1-29] from the seven companies over the time period from 1985 through 1995. The historical focus for this examination was on three years; 1985, 1990, and 1995. The examination involved looking for specific business concerns of an external nature in primarily areas of foreign competition, world economy, and world geopolitical issues. A pictorial timeline overview of some of the more dramatic events which

occurred in this time period is presented in Figure 3-1. The premise of this study was that an accumulation and interaction among these three external factors occurred during this time period

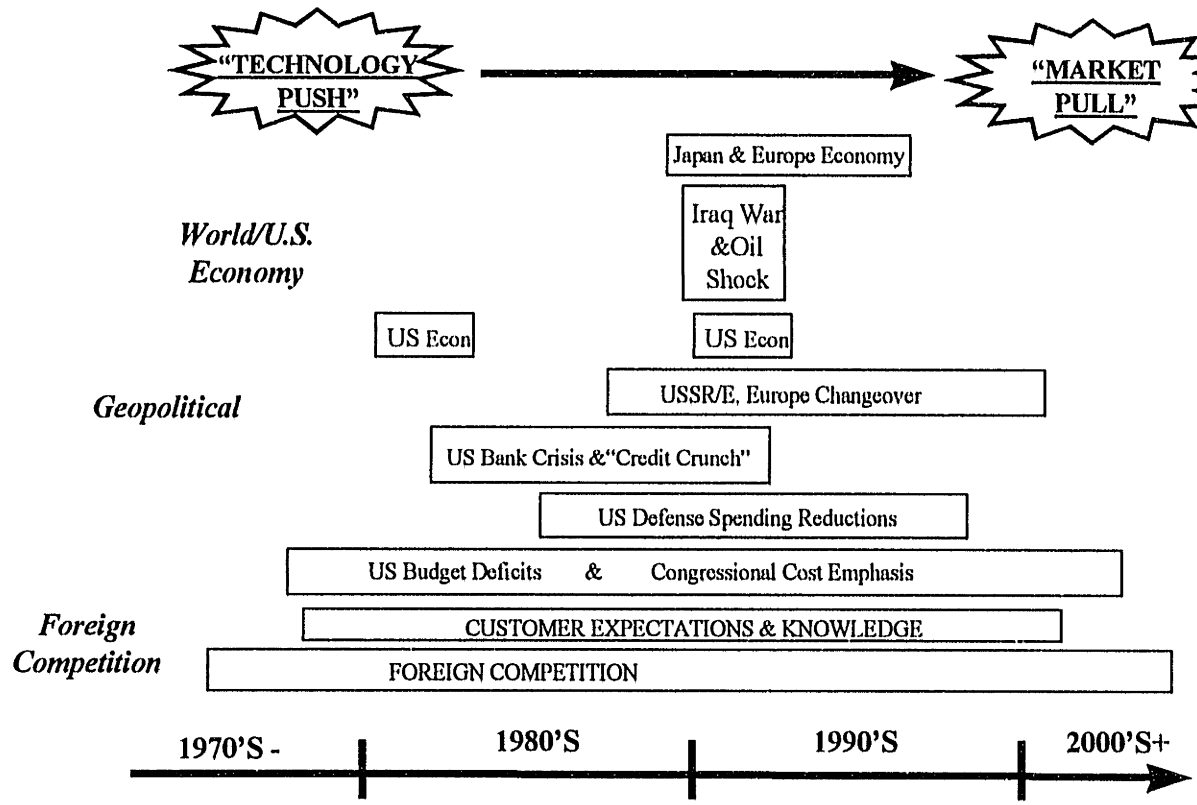


Figure 3-1 Timeline of Multiple Factors Impacting Industries

and was significant in changing industry strategy. Thus, to provide insights on the extent of the latter statement, a listing of major strategy initiatives and actions was also reviewed and tabulated for the same review years.

Relative to industry practices during this time period, an important observation is that industry product development emphasis shifts from a "technology push" position to a customer driven "market pull" position. Understanding better this aspect of a changing industry focus was one of the main reasons for studying the business and industry strategy trends over the last ten years.

3.1 Business Issue Trends

To limit this part of the study to a tractable level, a primary focus was placed on the aerospace related industries with particular attention directed to the aircraft manufacturers among the seven companies listed in Figure 2-1. However, the majority of issues examined relate to external factors which influence most manufacturing industries, and would likely have impacted the automotive industry sector as well. Where obvious conclusions or context can be made regarding the automotive sector it will be explicitly provided.

The list of 'issues affecting industry,' which were extracted from the SEC filings,[1-29] are presented in Figure 3-2. These executive business concerns are classified according to the year they were cited, and further classified into sub-categories; Market/Competition, U.S. or International (geopolitical), Industry Specific, and U.S./World Economy. This list, of course, is but a sample and is certainly incomplete, and at best is reflective of a much larger and more complex reality. But, even with that awareness, this list clearly indicates major forces of change were occurring in the industry.

A summary interpretation of trends follows which consolidates the sub-categories of Figure 3-2 into a discussion which focuses on foreign competition, the impact of United States and World economies, and the impact of geopolitical events. The intent is to present a historical perspective of trends in strategy which clearly indicated that major changes were occurring in the industry, among its member companies, and in particular influenced the role (and management) of technology.

Commercial Markets - From the sample concerns of Figure 3-2, it was clear that by 1985, competition had significantly increased for a variety of reasons. A major reason was foreign competition had made major inroads into the commercial aircraft industry in the form of the European consortium Airbus Industries. Additionally, the impact of the foreign competition had been to change forever customer expectations relative to quality, technology, service, time-to-market, sales inducements, and most importantly cost-consciousness. In 1985, two clear business realities were that market shares had decreased and profit margins were being narrowed to maintain current market positions. Trends that had been evolving steadily since the 1970's[1] (A similar, but more severe, happening had occurred in the automotive industry due to the competition from the Japanese auto makers.)

Figure 3-2 Business Environment Issues and Time Frame

Note: "(X)" indicates the presence of the "(-- issues in parentheses --)" and "X" indicates general issue was cited

Issues Affecting Industry	Category	1985	1990	1995
World economic slowdown or (recession in U.S.)	Economy	x	(x)	
undervalued dollar; and ('Credit Crunch') hits industrial companies		x	(x)	
Economic conditions in major world markets		x	x	x
fuel or energy costs; and (Oil shocks)			(x)	
Employee training requirements for new technology; union issue	Industry	x		
Information handling revolution		x		
Airline traffic growth (decline)		x	(x)	
Over capacity in industry; industry structural changes; restructuring		x	x	x
Airline industry profitability (lack of profitability)		x	(x)	x
Historic cyclicality; short; automobile sales or long; aircraft sales			x	
Restructuring of the world airline industry; mergers, alliances, etc.			x	
Military and commercial R&D efforts are more complementary				x
Tax laws; accelerated income tax payments on long-term contracts	US	x	x	
U.S. Government regulations; e.g. environment & safety	Government	x	x	x
Federal deficit; Gramm-Rudman Bill; reduce defense spending	(Political)		x	x
Smaller U.S. defense market; budgetary constraints; few programs		x	x	x
DOD pressure to cancel or delay military development programs		x	x	x
DOD pressure to stretch out procurements of existing programs			x	
Changing National priorities; defense strategy shifts to third world		x	x	
Reduction and changes in military force structure; new requirements			x	x
Defense procurement changes; increased contractor investment/risk		x	x	
Multi-year procurement contracts		x		
Fixed-price contracts; long-term production options			x	
Multiple source contracting; teaming arrangements		x	x	x
Lowering of progress payment rates and profit objectives			x	
Mandatory refund policies on spare parts; performance warranties		x	x	
U.S. government acquisition reform efforts; commercial standards				x
Hostilities in Middle East - Iraq invasion of Kuwait	International		x	
Post cold-war relations with Soviet Union; then fall of Soviet Union	(Political)	x	x	
Political Evolution in Eastern Europe; political/economic stability		x	x	x
Overseas sales of combat aircraft (limited)		(x)		
Aircraft sales potential identified in developing countries		x	x	x
Collaboration with overseas aerospace manufacturers; increase sales		x		
Localization of manufacturing required; international sales		x	x	x
Intensified highly competitive defense and aerospace markets	Market/	x	x	x
Increased levels of airline financing commitments (for sales)	Competition	x		
Requirements for participation in the disposition of older aircraft		x		
Emphasis on electronics & electronic systems for aircraft/aerospace		x		
Fierce and multi-faceted competition; allows new competitors		x		
Intense civil and government customer emphasis on cost control		x		
Joint Ventures, alliances, partnerships, globalization required		x	x	x
Affordability; paramount concern; military, airline, civil customers				x

Defense Markets - For the US defense-dominated aerospace companies of that same time (1985), a similar result was occurring for somewhat different reasons. The United States fiscal policies had continued to result in budget deficits which were a heated subject of congressional debate.

Congress began to center on cost reduction in all new military weapon system procurements. The reduction of defense spending as a mechanism to reduce the budget deficit was a major legislative focus of the 1985 time period. The consequence of this congressional focus was a series of US government procurement changes which greatly reduced defense contract opportunities and increased the financial burdens of companies wishing to participate in defense contract competitions.

The 1985 time frame of Department of Defense (DOD) procurement policies (Reference Figure 3-2) is extremely interesting because there is a tendency in 1997 to falsely sense most business or industry environment issues are a "new 1990's global happening" or were singular events caused by the fall of the Soviet Union, but the following issues were already established industry concerns in 1985:

- Defense budgetary constraints (few programs),
- Defense customer emphasis on cost control and affordability,
- Delays or cancellations of military development programs,
- Shifting national priorities and defense strategies to third world,
- Increased contractor investment/risks for future programs,
- Multiple source contracting with teaming arrangements, and
- Refund policies on spare parts and warranties.

In the same 1985 time frame, while US commercial markets reacted to a growing foreign competition, defense contractors were also dealing with reduced market demands, reduced or limited profitability, and a significantly different set of defense procurement agency (customer) expectations. Plus, industry was actively voicing that it was being further constrained by the growing number of legislative enactments concerning environmental and safety issues, and seemingly unfavorable tax laws.

In 1985, for both military and commercial aerospace products, the aerospace and defense industry realized that production over-capacity existed if they continued to emphasize mostly domestic demand opportunities. It was also apparent to the aerospace industry that levels of productivity were too low, and not improving at a fast enough rate, if desired levels of profitability or shareholders' value were to be achieved. (At the same time, for reasons dominated

by lost market share due to foreign competition, the same conclusion had been reached by the automotive industry. Productivity in the US automotive industry was not competitive to foreign companies. And, in the aerospace industry productivity was not superior to Airbus.)

By 1990, it was obvious that additional factors occurred in the late 1980's which had exacerbated the earlier situation. The fall of the Soviet Union brought greater pressure to reduce defense spending and curtail or delay ongoing military programs. Early industry attempts to increase sales of military products to international markets were less than successful for a variety of factors; world economics, political naïveté, and geopolitical tensions in various areas of the world. And, attempts to increase sales of commercial products to international markets were likewise influenced by the same factors as well others such as instabilities of developing country governments, an undervalued US dollar relative to foreign currencies, and the lack of worldwide consensus and agreement on policies regarding open, global or 'free-market' trade.

Also, major new aspects of doing any military product business (and often commercial aircraft business) with foreign customers in the international markets required that US companies: Gain US government and foreign government approval of sales; Establish joint venture, alliance, or partnership relationships; Commit to localization of manufacturing content in the foreign country; and, Agree to technology transfers. The era of simply selling US made products offshore had ended simultaneously with the increase in worldwide customer expectations and the growing customer knowledge of current technology.

However, in the 1990 time frame, some unique business concerns were additionally indicated. The Iraq invasion of Kuwait (and the subsequent active involvement of the United States) caused a new "oil shock" or cost of energy crisis to further impact a world economy which was entering a recession era characterized by decreased levels of gross domestic products (GDP's) in almost all of the industrial nations (including the US). Government spending increased, while revenues decreased due to higher unemployment levels, which added to an already unacceptable US budget deficit.

At that time it was uncertain whether the Iraq War would alter the inclination of Congress to reduce defense spending. During the five year period ending with 1990, defense strategies continued to shift, the armed services were reorganized and reduced, and opportunities for profitable military procurements became additionally constrained. Further, with the economic

recession ongoing, airline profitability was reduced, the airline industry was restructuring, and future demands for new or replacement commercial aircraft were significantly reduced, often with previously negotiated options not being exercised. Competition issues had further intensified to the point that restructuring of US aerospace and related industries was actively underway or being considered.

Unfortunately, concurrent with the desire to restructure, further difficulties were encountered by companies which needed to borrow heavily to invest in modernization of facilities aimed at increasing their productivity. Two factors in particular caused a so-called "credit crunch" to occur; (1) The U.S. Savings Bank industry was being restructured and undergoing major regulatory and policy changes (affecting credit criteria) due to the excessive losses and bank failures which occurred in the mid to late 1980's; and (2) World demand was also taxing existing money supplies due to the economic rebuilding ongoing in Eastern Europe following the fall of the Soviet Union, and due to the monetary crises in South America. Consequently, restructuring in industry was slowed because interest rates were relatively high and money was difficult to obtain. (For the automotive industry, with its market-demand always sensitive to economic bad news, a similar story existed relative to productivity, market demands, competition, credit availability, and restructuring due to over-capacity in the industry.)

By 1995, the same themes were carried forward another five years with a growing emphasis on the need for increased US sales to international markets. "Globalization" had become a common terminology in discussing business concerns. The defense procurement opportunities, if anything, were fewer in number with continued political pressure to make additional reductions in defense spending. Then (and in 1997), and for the foreseeable future, little likelihood existed for a change in defense spending trends, as national priorities centered on third world issues and local areas of conflict.

"Affordability" had become the focus of all customers; domestic and international. As a subset of affordability goals, the U.S. government had begun to move seriously toward procurement acquisition reform and a reduction of the use of government specifications versus commercially available specifications. Further, considerable efforts in 1995 were well underway to define, at onset, government research and development (R&D) projects that had both commercial and military objectives and benefits in mind.

And, rules of engagement for sales in international markets continued to emphasize and require inducements beyond the simple sale of product. Some examples were: a local foreign country manufacturing content in the production of products, technology transfers, joint ventures or formal partnerships to gain market access, and a desire for equal status as a partner versus a subcontractor role.

3.2 Strategy Trends

The corporations were next examined for strategy trends during that same ten year period; sampling 1985, 1990, and 1995. The principal objective was to identify trends in strategy as a further context for understanding the evolution, focus, and appropriateness of current management practices regarding technology planning and its role in company strategy.

Companies were studied to document major themes regarding their individual strategic visions and associated strategic actions as indicated by the publicly released information of their executive management. SEC filings[1-29] were again the principal sources of information. From this information, two data perspectives were created: (1) A separate chart for each corporation was created which listed key characteristics of the company's strategy for 1985, 1990, and 1995, and (2) A second set of three tables, one for each year examined, was created which focused on eight strategic concerns, judged to be common to the industry sectors, which were framed against the individual strategic visions/actions previously determined for all seven companies.

The purpose of the first perspective was to assess company-by-company trends within the industry sectors, and to identify common strategic concerns. The latter being the starting point for the perspective represented by the second set of charts. All charts which were created to document company strategy are contained in Appendix I - Key Characteristics of Individual Company Strategies. The set of three tables for 1985, 1990, and 1995, which were created to document the industry strategic concerns correlated against individual company strategic actions, are contained in Appendix II - Industry Concerns Framed Against Company Strategies. Figures 3-3 and 3-4 are representative examples of the two perspectives of information used in this phase of the study.

The eight strategic concerns were determined by judgment after examining the individual charts (Appendix I) of each company over the ten year period and deciding on the common

Figure 3-3 (Typical Co. Data Sheet) Appendix I; Table II - United Technologies (UTC) - Key Characteristics of Strategy (Mission & Growth)[3,16,17]

COMPANY	End Of Year	VISION/MISSION	STRATEGY FOR GROWTH
United Technologies Corporation (UTC) *"...leader in four large and growing markets - aerospace, defense, building and automotive"* Robert J. Daniell; CEO Harry J. Gray, Chairman Employees: 193,000	**1985** *"...will expand our position in these markets by being more efficient, aggressive and innovative, ...because of the excellence of our employees."*	•strength and position in core businesses •expand position in 4 core markets •position for sustained profit growth •generate a superior return on equity •provide excellence in products and services •be more cost-effective •orderly growth in sales and earnings •assure that United Technologies is "united"	•confirm the strength of core businesses •identify operations that do not fit long-term objectives •reduce number of personnel and overhead •identify opportunities for improved profits •integrate our technical and managerial skills more effectively •be more efficient, aggressive, innovative •involve employees; productivity improvement and growth efforts
United Technologies Corporation (UTC) *"...will continue to grow because our core businesses are market leaders and because we are well positioned in international markets."* Robert J. Daniell; CEO Chairman Employees: 193,000	**1990** *"The globalization of the aerospace industry offers tremendous opportunities.... International partnerships and business alliances are critical to gaining entry to these markets."*	•core businesses are market leaders •growth opportunities in international markets •sustain global growth •globalization of the aerospace industry •strict code of ethics	•international partnerships •international business alliances •focus on Europe and Pacific Rim •reduce reliance on U.S. defense contracts; fixed price programs •implementing cost reduction and asset management programs •instituting performance improvement initiatives •invest prudently in research and development and capital assets
United Technologies Corporation (UTC) *"UTC businesses are number one or two in all industries in which they compete, yet they continue to remake themselves in 1995....."* George David; CEO Robert J. Daniell, Chairman Employees: 171,000	**1995** *"...globe spanning corporations like UTC ....with their ability to transfer technology, invest globally, open new markets and develop new products, will be disproportionately successful in the increasingly competitive world economy of the decades ahead."*	•core businesses are market leaders •growth opportunities in international markets •sustain global growth; "Be There First" •globalization of the aerospace industry •only acquisitions that support core businesses •greater productivity and profitability •strict code of ethics •emphasis on diversity •commitment to safety and environment •better work force through education	•first into developing markets •double Joint Ventures by year 2000 •strengthen core businesses - acquisitions and alliances •focus on Europe and Pacific Rim •process re-engineering & Kaizen •educated work force; on job learning •encourage self development; for "employment security" •reaffirmed traditional commitments to employees •corporate advertising "Be There First"

Figure 3-4 (Typical Relational Data Sheet)
Appendix II; Table II (1 of 4) 1990 Industry Sector Issues Framed from Co. Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1990 Strategy Overview	GE	UT	F	C	L	M	B	MD
1. Clear Business Focus									
	core businesses are market leaders		X						
	confirm the strength of core businesses		X						
	identify operations that do not fit long-term objectives		X						
	two core businesses; automotive and financial services			X					
	divested Ford Aerospace & reduced farm/industrial equity			X					
	acquisition of Jaguar Limited in the UK			X					
	core automotive and financial service business				X				
	new organization structure; sell Gulfstream, MMC				X				
	remain primarily a defense contractor; focus on core businesses					X			
	pursue skill-related opportunities; leverage our core skills					X			
	consolidate core businesses; divest others					X			
	move into new, but closely related businesses					X			
	preeminent position; space and defense electronics						X		
	strengthen balance sheet; core businesses & core capabilities						X		
	expand businesses into information systems/systems integration						X		
	expand non-defense areas; acquisition opportunities core areas						X		
	divestiture of commercial real estate holdings in Florida						X		
	build for the future; understand the long term objectives							X	
	commit to a profitable defense and space business sector							X	
	reorganized into profit and loss centers							X	
	divesting of deHavilland division of Boeing Canada							X	
	position for aerospace downturn; product mix/variety								X
	new programs represent the future of the corporation								X
	sell nonessential assets divest information systems units								X
2. Compete Worldwide (with reduced opportunities)									
	suppliers are trusted partners in process	X							
	teams work out, self-confidence, boundaryless, speed	X							
	raise the bar of excellence another notch	X							
	search around the world for better ways	X							
	reduce number of personnel and overhead		X						
	identify opportunities for improved profits		X						
	be more efficient, aggressive, innovative		X						
	involve employees; productivity improvement & growth efforts		X						
	reduced time and cost to bring new products to showroom			X					
	be low-cost producer; high-quality vehicles worldwide			X					
	showroom advantage; innovative/appealing products			X					
	use advanced technology, employees skills and knowledge			X					
	partnership with suppliers and dealers; commitment excellence			X					
	early interaction of suppliers in new product development			X					
	Alpha Manufacturing Technology Center; pilot projects			X					
	highest quality, lowest cost producer; broad product line				X				
	produce world class vehicles; long-range plan; LH sedan 1992				X				

themes which seemed to exist. To gain further insight, a trend summary representing an integrated interpretation of all industry sectors was created and is presented in Figure 3-5. This industry summary lists the eight strategic concerns and the relative degree of importance ("emphasis") which seemed to be associated with them.

Figure 3-5 Overview of Industry Shifts in Strategy Focus Over 10 Years
(Judged applicable to all sectors)

Strategic Concern	1985 Emphasis	1990 Emphasis	1995 Emphasis	10Yr trend
Clear "Core" or Focus for Business	High	Highest	Medium	Same -
World wide Competitive Capability	Highest	High	Highest	Same
Ability and Opportunities for Growth	High	High	Medium	Same -
Customer Expectations & Satisfaction	Medium	Medium -	Medium -	Same
Technology and Innovation	**Medium +**	**Medium -**	**Lowest**	**DWN**
Human Resources	**Lowest**	**Medium**	**High**	**UP**
Shareholder Value	Medium	Lowest	Medium	Same
Appropriate Organizational Structure	**Lowest**	**Medium**	**High**	**UP**

A qualitative assessment of frequency of issue and emphasis among the seven corporations led to the classifications of industry "emphasis" that are presented in the chart. It is recognized that all "strategic concerns" appearing in a corporation's public documents indicates that they are "important". Therefore, by definition, all of the eight are "important". But, the perspective intended by the results presented is to identify qualitatively which of the eight concerns seemed to have had the 'highest' emphasis relative to others, which could be judged to have had the 'lowest' emphasis, and which had emphasis ('medium') in between these two extremes. And, more importantly, what industry trends could be deduced by examining the changes in emphasis which occurred over this period.

Review of the results revealed some ten-year industry trends did exist. As might be expected, based on the business concerns indicated by the previous assessment (Section 3.1), continuous industry emphasis is placed on maintaining a clear core-business focus, achieving or maintaining competitive capabilities, seeking opportunities of business growth, and focusing on

customer satisfaction or expectations. With achieving or maintaining competitive capabilities being the consistently 'highest' emphasis over the entire ten year period.

What was also expected, because of restructuring and downsizing which prevailed in the industry, were the clear and continual increases in emphasis which occurred regarding attention to human resources and selection of the appropriate organizational structure (both classification trends going from 'lowest', to 'medium', to 'high' emphasis over the three periods).

Also interesting, but in the opposite direction, was the decreased industry emphasis regarding the role of technology and innovation which trended from a 1985 relatively upper range emphasis classification of 'medium +', to a 1990 lower range classification of 'medium-', to finally in 1995 a classification of being the 'lowest' emphasized concern in strategic actions. This likely can be attributed to the industry preoccupation with entering new international markets, restructuring, and over-capacity. And, the industry emphasis on competitive position, without a parallel emphasis on technology and innovation, is considered to be an indication that industry products had made a transition from 'technology push' designs (circa 1985) to customer-driven, affordability designs (circa 1995), leaving technology with an as-required 'market pull' role to fill.

3.2.1 Industry Sectors

While the study data is not extensive or quantified sufficiently to permit evaluation of detailed differences in the three sectors represented by the seven companies, some observations were made.

The Conglomerates - Both General Electric and United Technologies appeared to have defined a consistent and focused strategy throughout the period from 1985 to the present. Simply stated both seem to have embarked early on a corporate vision of increased value to the shareholder through a strategy emphasizing increased productivity coupled with a healthy growth in business (greater profit margins with increased sales). As conglomerates, both first emphasize attention to their 'core businesses' (rather than 'core capabilities') which GE required to be "number 1 or number 2" in their markets and UTC required to be "world leaders in their markets".

Both seemed more clearly than the other sectors to have identified in the 1985 time period the importance of growth in international business as a key requisite for success in the future.

And, more significantly to have implemented a knowledgeable and focused strategy to achieve that growth. Both actively took advantage of their non-aerospace business expertise which had already established inroads into developed markets like Europe and Japan, as well as in the developing markets of Asia or more broadly the Pacific-Rim countries. Their established international networks were an emphasized part of their strategy to seize the "tremendous [growth] opportunities" possible through "globalization of the aerospace industry".[3]

For the conglomerates (and their aerospace businesses) the strategic emphasis was consistently placed on value, international growth, and productivity improvements. Consistent with the other companies studied, the strategic emphasis was a direct reaction to concerns related to intensified foreign competition and lost (or limited) market share. But, compared to the other sectors studied, the conglomerates, with a clear corporate focus on international growth, seem to have better clarified their customer focus (e.g. In defining aerospace product requirements, foreign military and international commercial customers had to be considered in concert with US customers). Which in turn, seemed to better align their actions regarding productivity goals.

Thus from 1985 to 1995, the GE and UTC strategic focus turned sharply to international competition, shareholder value, growth, attention to a different more-demanding customer mix, and especially the need for significantly improved productivity. These emphasis areas are felt to be the primary motivation behind mandatory restructuring which occurred in their organizational structure, management practices, operational processes, and human resources policies. It also implied a significantly more integrated and balanced joining of technology and business planning.

They clearly were "....positioning for the future..." and had early defined the changes needed to do business in the "..increasingly more competitive 1980's... [and the future] era of greatly intensified worldwide competition." [14]

The Automotive Sector - Much has been documented about the Automotive Sector and its response to the loss of domestic market share to foreign competitors [32,33]. The observations made here are not intended to be of significant import to that extensive literature. Here the interest is: 'Were there obvious differences in the basic timing and characteristics of their strategies, overall and regarding technology in particular, relative to other manufacturing intensive

industries?' Other industries, like the Aerospace Sector, that also had lengthy, capital intensive, high-technology, product development cycles.

In the SEC filings examined, what seemed different was that while the conglomerates and the Aerospace and Defense Sectors were divesting non-core businesses, and backing away from the purely portfolio logic of the 1970's and early 1980's, both Ford and Chrysler were doing the opposite. Both made major acquisitions or continued to operate in non-automotive businesses. So much so, that in the 1985 Chrysler Annual Report, its CEO (Lee A. Iacocca) proclaimed to its shareholders that Chrysler was "....expanding and diversifying, and becoming more complex. [And, was]....no longer just a North American automotive company."[20] Ironically, it was diversification in the Aerospace businesses that both Ford and Chrysler were actively pursuing in 1985. While the traditional Aerospace Sector companies were clearly sensing reduced market opportunities. One suspects that Ford and Chrysler believed that the technology base of the Aerospace businesses would be synergistic with the technology needs of their core automotive businesses. Regardless, this diversion of their corporate attention was short-lived. Both, Ford and Chrysler, divested these non-automotive businesses by 1990, and since have focused all their management energies solely on their automotive and truck product lines.

Aside from the diversification "flip-flop", the two automotive companies appear remarkably similar in their strategic visions and actions taken. For both, a pronounced focus is placed on the obvious need to meet the foreign competition threat to their domestic market shares. Their strategic objectives were centered on productivity to achieve product cost competitiveness, and quality to meet increased customer expectations (in reaction primarily to the Japanese competitor). Both, early in the ten year period, were actively working new management approaches for increasing productivity. These initiatives centered on new technology and new "team" organizational constructs which reduced management hierarchy and provided a mandate to "...challenge every aspect of the design, engineering, and manufacturing of vehicles."[21]

Additionally, relative to the other industry sectors studied, Ford and Chrysler seemed, more visibly and specifically, to dedicate their resources toward reduced product development cycles, to focus the use of new technology, and to create strategic applied manufacturing technology development centers (i.e. 'Alpha Manufacturing Technology Center', and 'Chrysler Technology Center'). More importantly this product development and technology focus seemed

to be intimately and purposefully intertwined with their new team philosophies. Their combined intent being to achieve a concurrently faster introduction of new technology, faster design evolution in general, and establish new standards in quality (standards more competitive with the Japanese auto makers).

A strong and early sense of the value of their human resources also seems to consistently be woven into their strategies for increasing productivity. Simultaneous attention was paid to elevating the knowledge and skills-base of employees while effecting a transition to greater employee initiative and responsibility with fewer layers of management. The SEC filings communicated what appears to be a sincere, dedicated, and focused restructuring of their companies supported at the top and actively involving people at all layers of their organizations.

Both had initiatives ongoing regarding growth in international markets. The domestic market still seemed to be the center of their attention, but the process and organizational restructuring underway appeared to be positioning both companies for head-to-head, aggressive, and cost competitive moves into international markets in the future.

As an aside observation, it was apparent that a "clone-like" similarity existed between the visions and strategic actions implemented by Ford and Chrysler. Little significant difference in their activities was observed. In 1995, Ford reflected on its actions by stating "The changes we've made are designed to make breakthrough improvements particularly in cost, efficiency, quality, product excellence and customer satisfaction..."[7] And in that same year, Chrysler reflected on its actions by stating "...new corporate culture embraces change faster and more eagerly than our competitors."[5]

A final comment regarding the Automotive Sector, is that there appeared to be a greater, more aggressive, integrated, and focused role for technology innovation than was visibly apparent in the Conglomerate or Aerospace companies. Additionally, while undergoing significant change, the Automotive Sector management of technology appeared to be actively supported by top management and cohesive.

The Aerospace & Defense Sector - Greater variance was observed among the individual company strategies and their trends within this sector. Philosophical messages were quite similar to both the Conglomerate Sector and the Automotive Sector. But, observations become less

clear relative to individual company comparisons and trend interpretations within the sector. Issues of limited markets (commercial and defense), competitive capabilities, shareholder value, and productivity are cited by each of the four corporations (prior to 1993, Lockheed and Martin Marietta were two separate corporations, and in this study were examined as such until 1995 when they merged into Lockheed Martin). And, these issues led to substantial changes in their organizational structures and their management practices.

But, overall their appears to be a slower move toward substantial change than in the other sectors and it appears much more diffused and less specific. Arguably, this may be attributable to the longer product development cycles of the aircraft industry as compared to the automotive industry, and the fact that operational day-to-day activities of these companies are overwhelmingly focused on existing production runs which unlike the automotive industry span decades not just one year! Further, while both sectors are in a capital intensive industry, the economies of scale are dramatically different; i.e. production runs involving hundreds or maybe a few thousand aircraft over perhaps decades versus hundreds of thousands of automobiles in one year! Further, the tooling and manufacturing resources used in current production runs must usually be preserved due to requirements associated with the certification process. Such requirements constrain management's ability to quickly revolutionize their production processes.

Nonetheless, with reduced defense spending clearly identified as a significant concern by all in the 1985 time frame, there appears to be a span of at least five years before significant steps were taken to implement major strategic changes. It is suspected that, in 1985, none of the four aerospace corporations studied was really convinced that it would be the one to suffer a loss of market share or profitability (though all of them were forecasting tight times!). This is unlike the Automotive Sector where companies were already suffering from at least a 25% loss of domestic market share in 1985. In contrast, the 'tough times' of lost market share had also not impacted the Conglomerates of GE and UTC, but it is to their credit that they seemed, in the mid-1980's, capable of marshaling a major strategic move for change without the need for a current crisis.

From 1985 to 1990, Lockheed, Martin-Marietta, Boeing , and McDonnell-Douglas began to emphasize a strategic focus on core capabilities, competitive improvements, and the need for some degree of reorganization. Philosophical emphasis on quality using some form of "Total Quality Management" (TQM) was instituted across the industry (although except for McDonnell-

Douglas not necessarily calling it TQM). "Teams" and "concurrent engineering practices" were proliferating similar to the other two sectors studied. But, the extent to which these operational and philosophical changes were implemented relative to production programs and development programs is not clear.

Boeing and McDonnell Douglas appear to emphasize earlier than Lockheed and Martin-Marietta the importance of human resources in their strategic initiatives. But, by 1995 (with a combined Lockheed Martin entity), all three corporations had become immersed in a wave of re-engineering, organizational restructuring, continued downsizing (although the greatest reductions had occurred in the early 1990's), human resource initiatives, and major concerns regarding the need for further industry consolidation.

When the author was writing this thesis (early 1997) a final chapter in the consolidation of major aircraft manufacturers was announced; the acquisition of McDonnell-Douglas by Boeing. Admittedly, this knowledge may have biased the author's interpretations. When the McDonnell-Douglas SEC filings were reviewed, they seemed to convey a distinct feeling of impending crisis, changing philosophies, technological drifting, and a lack of focus in their overall future direction. This sense was not derived from a lack of what was stated, but more from an impression that too much was stated regarding new strategic initiatives, in all businesses, at the same time. The question the author repeatedly found himself asking was "Where is their future focus?" The strategic vision of MDC did not seem clear during the entire ten year period from 1985 to 1995; other than to "win the next fighter contract"!

A contrasting observation is made regarding change in this sector as reflected by repeated comments made in the Boeing SEC filings.[10,11,27] Almost all other companies were espousing 're-engineering', 're-inventing', 'flexibility', etc. , in one form or another, to indicate an urgent almost 'crisis' need for substantial (or dramatic) changes in their organizations and processes, if they were to compete in the new global marketplace. Compelling, by its counterpoint to MDC, are Boeing statements in both 1990 and 1995 which emphasized "continual improvement" or "steady incremental improvements."

A constant sense of strategic direction, leadership, and historical confidence was clearly communicated by Boeing statements which emphasized not wrenching change but history and the strength of its people; e.g. In 1990, "75th year.... proud of our past ....excited about our future....

the 1990's may prove to be the most innovative and productive period in Boeing History"[27], and in 1995; "...we need great leaders at every level ---- men and women who can inspire and encourage the spirit of working together."[10]

A summary comment regarding the Aerospace & Defense Sector is that in all corporations a more fully integrated business planning process was evolving. A process where the role of technology, even for purely military fighter aircraft, had changed from being the "technology push" product definition leader, to now being a "participant" in product planning with many other parties (e.g. marketing, finance, manufacturing, suppliers, customers). The product development environment was now one of customer-driven "market pull". And for technology planners, their "participant" role did not even imply "equal", when all customers were focused strongly on affordability as the key competition discriminator!

3.3 Summary - Industry Trends

A historical review of the business environment and the strategies of selected corporations was performed over a ten year period from 1985 to 1995. The purpose being to gain insight on the industry external business environment (business trends) and the internal environment (strategy trends), as a precursor to understanding current management practices. To do this within the practical constraints of the thesis effort, information was collected primarily from SEC filings for three specific years in this period; 1985, 1990, and 1995.

A context of economic, geopolitical, and foreign competition factors surfaced from the information obtained. Business environment issues were summarized in Figure 3-2 and subdivided into five "context" categories, further indicating if they occurred in either 1985, 1990, or 1995. Summary observations follow regarding the trend of business issues and the resulting trend in business strategies.

Business Trends - The list of issues from 1985 indicates clearly that the "great changes of the 1990's" had antecedents in the early to mid-1980's. The 1985 business concerns included; productivity, reduced defense budgets, lost market share to foreign competition, share holder value, and a customer focus on cost-consciousness.

In the 1990 time frame, these same issues were significantly exacerbated by US/World economic factors which included the world recession, money crises in world markets, the bank failure crisis of the US, the scarcity of credit due to increased worldwide demand aggravated by the restructuring occurring in the former Soviet Bloc countries, and the "oil shock" caused by the Iraq invasion of Kuwait. The industry sectors were actively pursuing new international market opportunities. But, opportunities were few, industry expertise and knowledge in the international marketplace was just beginning to gain proficiency, and the world economy was unfavorable. And, a distinct over-capacity situation was creating an imperative for industry consolidation in the Aerospace Sector.

By the 1995 time frame, the same themes are carried forward another five years with industry efforts accelerating to increase US business activities in international markets. Globalization was a focus of business activities and "affordability" had become the focus of all customers domestic and international. Progress was being made to establish formal rules of conduct in the international trade community and bringing closer to fruition a true free-trade market environment.

Strategy Trends - After assessment of individual company-by-company strategy trends for the ten year period, industry and sector observations regarding trends and differences were documented. From an industry perspective, throughout the ten year period consistent strategic emphasis had been placed on maintaining a clear business focus, competitive capabilities, business growth, and customer satisfaction. A trend toward increased emphasis on human resources and organizational structure had occurred. And significant for this study, a decrease in strategic emphasis was observed relative to the role of technology and innovation.

While limited in nature, some sector-by-sector observations were made. For the conglomerates, it was obvious that a consistent and focused strategy had been defined and followed from the mid-1980's to the mid-1990's. Central in their strategy had been an emphasis on becoming global corporations through aggressive pursuit of new business in international markets. The conglomerates, with their diversity of business activities and an existing international network possessed global expertise and knowledge. They were openly effecting strategies intended to create synergy among their business units which, in particular, was intended to accelerate the growth of their international aerospace business.

The automotive sector early in the mid-1980's was continuing to diversify and ironically into aerospace businesses. This diversion from core automotive business was corrected by 1990. Other than that one issue of business focus, the actions of the automotive sector were consistent in their strategic emphasis on productivity, quality, customer satisfaction, competitive positioning, and team management practices. A clear trend to increase international sales was evidenced in evolving strategies but more emphasis was placed on maintaining their domestic market share in the face of continued and intensified foreign competition. Further, while other factors were certainly sharing priorities with technology development and innovation, the auto industry appeared to be more explicitly using advanced technological capabilities in their strategies than was apparent in the other sectors.

The Aerospace and Defense Sector had the greatest variance in strategic trends probably as a result of their industry consolidation and restructuring activities which dominated the ten year period. The philosophical content of strategies was quite similar to the automotive and conglomerate sectors. But, unlike the automotive sector in the mid 1980's, a significant reduction in market share (at least in the defense segments) had not occurred as yet. And, overall there appeared to be a slower move toward substantial change than in the other two sectors.

It was suspected that in the first half of the ten year period assessed (1985-1990) none of the aerospace companies anticipated that they would be the one to suffer as market opportunities and industry revenues declined. Thus, it was only in 1990, when some "winners" and "losers" were more clearly identified, that meaningful strategic change appears to take place.

In 1995, with opportunities for growth still limited in the US commercial and defense areas, a customer-driven competitive emphasis on "affordability" dominated strategies for growth in the markets. The role of technology, even for the remaining military programs, had changed from a "technology push" driver of design, to an "as required" participant in a "market pull" design development environment. Overall, major strategic emphasis was clearly aimed at an accelerated US industry entry into the international market, and for companies to become global.

4. INDUSTRY PRACTICES

Introduction - To complement the previous aspects of the thesis effort, four industry corporations were selected for direct interviews regarding industry current practices. The corporations selected included two from the aerospace industry sector (Company A and Company B), one from the automotive sector (Company C), and one from the conglomerate sector (Company D).

The format for the interviews was one-on-one informal discussions with various levels of technology and business management within the corporations. The discussions were guided or framed via a previously supplied write-up provided by the author, documented as Figure 4-1, which provided a brief overview of the thesis focus and some associated general topics for preparing for the discussion. Specifically, three "closely related questions concerning the decision making processes surrounding technology innovation in today's global marketplace" (reference Figure 4-1) were stated as the "primary thesis focus" and were used as a starting point in the discussions.

The three questions focused discussions on company processes used to integrate technology planning with the company's business plans. Discussions would tend to gravitate toward practices used to plan specific projects, followed by practices used to identify associated technology development needs. The discussions clearly indicated that these processes over the last ten years had changed significantly due to the changing business environment. And, discussions would generally progress toward the third question, namely: With the changing business environment, how is the role of technology changing relative to company strategy?

The results of the four interviews dealing with current industry business issues and practices are documented in the following sub-sections:

- Business environment issues or concerns,
- Integration of technology and business planning,
- Discussion on Aerospace Sector levels of sustained R&D (Section 4.2.1.1), and
- Summary - Industry Practices.

4.1 Business Environment Issues or Concerns (1997)

An integration of the interview inputs is documented in this section. Because of the qualitative nature of the interview process and the limitations of time, this discussion is very

Figure 4-1

Pre-Meeting Information Forwarded to Companies Visited

GENERAL TOPICS FOR DISCUSSION:

DURING THE LAST 10 YEARS MUCH HAS EVOLVED REGARDING CHANGES BEING EFFECTED IN U.S. MANUFACTURING INDUSTRIES AS A DIRECT RESPONSE TO AN EVOLVING GLOBAL MARKETPLACE AND EXPANDING WORLDWIDE COMPETITION. PRODUCT DEVELOPMENT CYCLES, DEVELOPMENT PHILOSOPHIES, ORGANIZATIONAL STRUCTURES, PROFITABILITY, TECHNOLOGY INNOVATION, MERGERS AND ACQUISITIONS, PARTNERSHIPS, ALLIANCES, COLLABORATIONS, CUSTOMER EMPHASIS, PRODUCT ATTRIBUTES (E.G. AFFORDABILITY, QUALITY, RELIABILITY, DURABILITY, MAINTAINABILITY), ETC. ARE ALL TOPICS OF MANAGEMENT DISCUSSION AND STRATEGIC PLANNING IN ALMOST ALL INDUSTRIES.

THROUGH INDUSTRY INTERVIEWS, AN ATTEMPT WILL BE MADE TO DOCUMENT (FROM THREE INDUSTRY PERSPECTIVES) THE INFLUENCE OF THESE CHANGES ON TECHNOLOGY AND BUSINESS PLANNING AS CURRENTLY BEING PRACTICED. THE THREE PERSPECTIVES ARE SENIOR MANAGEMENT ("INNER CIRCLE" BUSINESS STRATEGISTS), SENIOR MANAGEMENT TECHNOLOGY PLANNERS, AND WORKING-LEVEL TECHNOLOGISTS (E.G. LEADERS OF THE CORE TECHNOLOGY DEVELOPMENT ACTIVITIES). THE PRIMARY FOCUS IS ON THE CHALLENGES AND PRACTICES REGARDING COMMUNICATION, PRIORITIZATION AND SPONSORSHIP OF TECHNOLOGY DEVELOPMENT PROJECTS, THEIR CURRENT IMPORTANCE, AND HOW THEY ARE DIRECTLY OR INDIRECTLY LINKED TO BUSINESS GOALS.

ASSUMING THE ABOVE INDICATES THAT A FASTER-PACED, WORLDWIDE, COMPETITIVE ECONOMY NOW EXISTS, THE PRIMARY THESIS FOCUS IS TO ATTEMPT TO ANSWER THREE CLOSELY RELATED QUESTIONS CONCERNING THE DECISION-MAKING PROCESSES SURROUNDING TECHNOLOGY INNOVATION IN TODAY'S GLOBAL MARKETPLACE:

I. "How today must the technology and business segments of a company operate to adequately communicate and integrate new technology innovation ideas within their business strategies?"

II. "Specifically, how today do new technology development projects get proposed, sponsored, prioritized, and intimately linked to business plans?"

III. "How is the role of technology changing relative to strategy?"

subjective. However, the responses from all four interviews were strikingly consistent regarding current business (or industry sector) environment issues, and current practices related to the integration of business strategies with the planning of technology.

A summary of industry environment issues raised in the interviews is presented in Figure 4-2. Each issue is placed in one of the eight categories which were used in Section 3.2 - Strategy Trends. The intent of this section is to highlight some additional insights on these issue categories which were obtained from the interviews, and which reinforce or amplify results concluded in Section 3.

Regarding business focus, the central issue was the changing role of technology due to primarily three factors: the marketplace emphasis on partnerships or teaming, the evolving international nature of the marketplace, and the intensified competition. In particular, there was clear agreement, from either a technology or a business perspective, that the industry was operating in a "market-pull" environment. As such, technology was recognized as important but realistically was "only one of many" important and necessary elements of a successful strategy; an "enabler no longer the 'technology-push' driver".

For the aerospace and defense sector, this was repeatedly stated to be a consequence of the reality of teaming and partnerships. These new business arrangements necessitated such an intimate sharing of technology among partners that there were "no technology secrets anymore" among the prime contractors; at least no technology secrets sufficient to differentiate competitors. Thus, a new competitive advantage focus has evolved which centers on approaches to meet customer affordability requirements. This new focus increasingly moves companies toward a more systems oriented perspective in their competitive strategies.

In the US automotive industry sector, a similar "affordability program goal" focus was voiced for maintaining domestic market share, establishing a competitive advantage, and positioning them for international market growth. However, while this emphasis indicated that an intense "platform pull" existed to assure the application relevance of technology development, a greater focus and dependence on technology to achieve strategic goals seemed to exist.

Figure 4-2 Summary of Current Industry Environment Issues

Category	Business Environment Issues/Concerns
Business Focus:	Environment changed; changing core needs, alliances; market "pull" environment
	Technology only one of many necessary issues; enabler not driver
	Strategies depend on product line & time frame; transition; leader to 'equity partner'
	Focus; cost reduction of manufacturing processes versus performance increases
	No technology secrets anymore"; program success drives sharing all
	Sharing forced competitive advantage to emphasize other areas; affordability
	Technology is still a basic part; but systems perspective emerging
	IT enables; coordinate/control partnership/alliances
	Industry conservative and slow to change or act
Competition:	Competitors more than customers drives product development
	Focus of corporate efforts to meet affordability goals
	Reduction in development cycle time; flexibility
	U.S. quality more still needs to be done
	Manufacturing competitive capability an industry challenge versus Japanese
	U.S. competitive edge may be in innovation relative to new market segments
Growth:	Sources of growth are increasingly outside the United States
	Taking serious growth in the international market; competition is tough
	International influence; requires new core competencies; international supplier management
	Foreign govt.; National objectives combined with commercial sales
Customer:	Competitors increase expectations of customers
	Market is international; customer expectations, present value, customer knowledge
Technology	Technology only one of many elements in competitive advantage and innovation
& Innovation:	"Program Pull" system; application needs drive what technology is worked
	R&D projects need program sponsorship
	Technology pace; commercial/military all different
	Technology requirements change with evolving priorities;
	--cost (maybe performance) WITH challenges to requirements'
	'Challenge' to meet high requirements; focus affordability
	Cost drives design changes to manufacturability
	R&D in process short-term (current business); L-T Responsibility still exists
	New technology is 'affordability'; no 'discretionary/sustained' yearly budgets
	Sustained R&D disappearing & more innovation needed
	Project "information overload"; need better visibility of new technology ideas
	Systems benefit environment/perspective for technology; 'how to transition to applications'
	Evaluations of new technology not given a fair comparison
	Issues for acceptance of new technology; Need tools to evaluate technology on programs
Human Resources:	To execute all employees must know the plan
	Need improved communication/teamwork/understanding
Value:	Technology value: "an ability to exploit to/with customers", "zero value if not in a product"
	Technology payoff subjective; "as far as you can see"; prioritization criteria hard to define
Organization	Linkage needs; internal capabilities/applications and direction of technology
& Structure:	Affordability 'systems perspective' attitude; multi functional participation required
	Companies typically not organized well for this form of planning/strategy making
	People performing multiple tasks; concern about knowledge depth
	Engineering control of technology concern; separation from customers, mfg., & operations
	Communication and transportation technology enables a global environment
	New military customer focus; interactive DOD/industry technology planning

For all industry sectors, the use of information technology (IT) was cited as being integral to process change initiatives aimed at reducing inefficiencies in the design development process, integrating internal design and manufacturing processes with external suppliers, and standardizing design and logistics support databases.

Integrating both "competition" and "customer" categories of interview results, indicated that industry senses that their roles as competitors and the actions they take to maintain competitive advantage do more to drive product development than customer requirements by themselves. That is, the competitive actions taken are the real source of rising customer expectations!

Reinforcing the industry trends cited in Section 3, consensus was evident in all industry sectors on the importance of international markets to future business growth, as well as the increasing stiffness of international competition. And, with the opportunity for growth came the need to develop new core competencies, relative to foreign government and foreign company interactions, that are required to establish international business activities. Some examples of the new competencies required are current knowledge of the evolving international rules of the free-trade market, foreign "localization" requirements of at least some manufacturing activities, technology offsets, national objectives tied to company objectives, a growing list of international supplier management issues, not to mention the expected differences in culture.

The industry environment more explicitly dealing with the management of technology and innovation had undergone (perhaps was still undergoing) dramatic change. In all sectors, a market-driven "program pull" or "platform pull" process and emphasis now existed for R&D planning and technology innovation activities. A focus on current business (i.e., "as far as the eye can see") dominated discussions of R&D project planning and indicated a definite "short-term" emphasis. But, it was also voiced that a responsibility for facets of all sectors to remain current on more distant time-horizon technologies still existed.

The customer and competitive focus on affordability was indicated to be driving R&D planning to the extent that "affordability" itself was labeled as the "new technology" of the 1990's. The degree to which this was occurring was strongly reinforced by the consensus opinion on evolving industry product development requirements. These trends were consistently cited by all industry sectors interviewed.

In particular, Product development requirements had indeed changed. The industry discussions implied requirements had evolved through three phases of emphasis to the present:

- **Prior to the mid-1980's** - driven by performance requirements,
- **From mid-1980's to early 1990's** - driven by cost and performance requirements, and
- **In 1996-1997** - driven by affordability, maybe performance, and with *challenges to requirements* expected in order to meet affordability goals.

A further implication of the current affordability, application-focused, nature of technology development was provided by a discussion which centered on the "value" of new technology. A definition of "technology value" was expressed which seems particularly descriptive of the current, competition-driven, industry environment. The definition stated that technology has "value" if it has "an ability to be exploited with customers", and further has "zero-value if not able to be used in a product."

Consistent R&D funding was also discussed. In previous years (before the early 1990's), a significant amount of funding was available for what sectors seemed to label "discretionary or sustained" R&D funding which was traditionally used for non-program-specific R&D. Most companies indicated that this source of R&D funding was being significantly reduced. A consequence of multiple factors, such as: R&D budgets being decreased from past percent-of-revenue levels; Organization restructuring emphasizing "product or platform team" work units; Functional or generic technology support groups being de-emphasized within the previously matrix-styled organizations; And, R&D funds becoming directly aligned with program-specific issues. In Section 4.2.1.1, this concern will be further detailed and discussed relative to its impact on planning technology development.

In the area of human resources, agreement seemed to exist regarding the increased value being placed on employees. Discussions indicated that particular attention was being placed on: Better communication or "flow down" of company strategic visions and goals; Achieving a more knowledgeable and skilled workforce; And, continued use of teamwork management practices to achieve higher levels of productivity.

4.2 Integration of Technology and Business Planning

In both the Aerospace & Defense and the Automotive Sectors the interviews indicated that industry practices existed which were specifically defined to integrate and align technology planning with business needs. The current practices appeared to have evolved in the Automotive Sector as a derivative of team-management experiments (e.g. Ford's Alpha Team, and Chrysler's Liberty Project), which took place in the late 1980's, were continued, and have been accelerated in the current 1990's. In the Aerospace and Defense Sector, the current practices seem to be a more recent change in practices fostered by the dramatic downsizing, consolidation, and reorganization that impacted all of the industry beginning in approximately 1990.

The planning processes, as described, were intended to address the dynamic nature of customer requirements (and competitor actions) relative to new government or commercial programs. Central was the need to create a process to assure program requirements were fully understood and that scarce technology development resources were properly focused to meet those requirements in the most efficient manner possible. As discussed, the principal elements of current business and technology integration processes include:

- A formal yearly process of business/technology planning,
- Interaction and feedback with all implementation participants,
- Continuous customer interaction to define/evolve external requirements,
- Assessment of core technology capabilities (strengths and weaknesses),
- Definition of global strategies to meet customer requirements,
- Linkage of internal and external requirements impacting strategy (not all technology),
- Team approach such as integrated product teams (IPT's) to integrate all functions,
- System benefit assessments on technology relevance through use of the IPT's,
- Challenge requirements (system benefit vs. Specification) through use of the IPT's,
- Continuous review to permit flexibility with customer/competitor issues, and
- Emphasis on communication and flow down of plan to all employees.

In the following, the Aerospace Sector and the Automotive Sector processes will be discussed in greater detail. In both, a conscious effort will be made to discuss information obtained in a context which is felt to be reflective of generic industry processes, with **no specific references made to companies or people interviewed**. This is felt to be appropriate due to the inherently subjective nature of an interpretation of informal discussion information, the relatively

limited time allowed for the interviews, and to safeguard any proprietary information that the author may have inadvertently been exposed to during the informal interview discussions.

4.2.1 Aerospace & Defense Sector Practices:

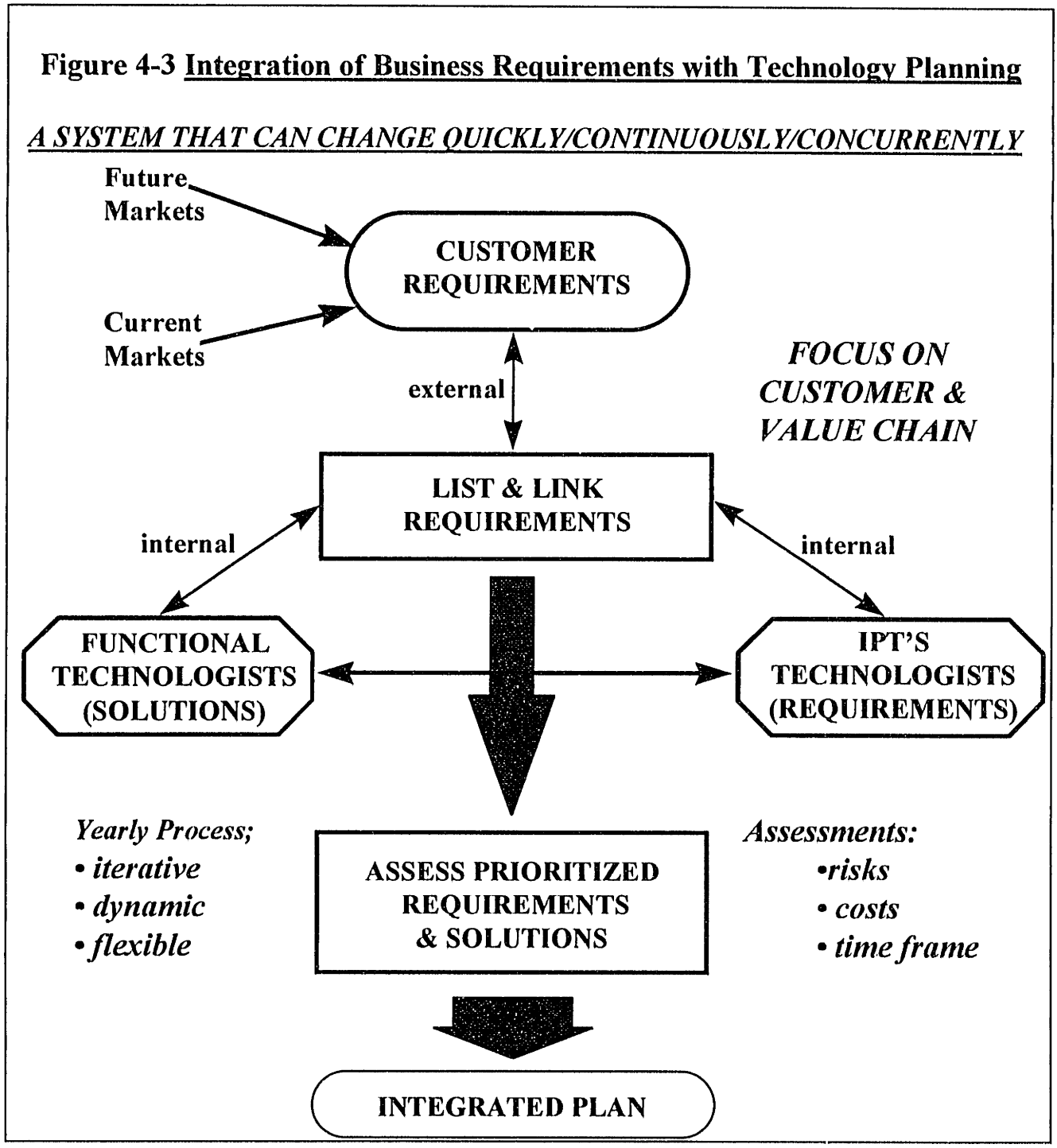
Two aspects of the sector's current technology and business planning process will be discussed in greater detail: (1) The interaction of internal and external participants in evolving an integrated business and technology development plan, and (2) A time line of events typical of internal and external interactions which would occur during the planning process.

Evolving an Integrated Business and Technology Development Plan - A notional flow of activities reflective of the integration of business requirements and technology planning is illustrated in Figure 4-3. The focus of this discussion is to describe the process more fully relative to: The interactions that occur among process participants in defining internal and external technology development requirements; The focus and process leading to "solutions" to the identified requirements (i.e. proposed R&D technology development tasks); The process of correlation and prioritization with existing and future 'lines of business" or "product lines"; And, some additional comments regarding its role in organizational alignment.

In Figure 4-3, it is noted that the "customer requirements" task actually collects inputs from three sources; ongoing production programs, current or existing market opportunities for new business, and future market opportunities for new business. Also, implicit in the Figure 4-3 overview is that executive management has already defined appropriate new business development candidates consistent with the strategic mission/vision of the company.

Internally, the key company people responsible for defining external "customer requirements" are the individual program managers and the associated leaders of ongoing program product teams (e.g. IPT's). Two sources for internal requirements are also solicited; non-program technology specialists, and specific-program technology specialists. The intent of this internal solicitation is twofold; (1) Define the existing strengths and weaknesses of current company technology capabilities from both a generic technology and a current program's perspectives, and (2) List the internal requirements for technology development required to overcome current program technology deficiencies, and to provide for future technology for new business opportunities.

Figure 4-3 Integration of Business Requirements with Technology Planning



The non-program (generic technology) specialists within the organization are typically design and manufacturing engineering specialists residing in functional departments (for matrix-style organizations), and the program-specific technology specialists tend to be senior members of the same technology disciplines that are currently assigned to specific product lines.

At this stage of the process, some degree of initial management review occurs (perhaps at lower supervision levels) to assure that all business plan programs have been addressed, that non-essential technology concerns are eliminated early, and that a cursory identification of known "high priority" technology development requirements occurs early in the process. It would appear that this latter step provides an early internal baseline of what management feels is truly a "high priority" technology development need, and what is not. The entire requirements list is then assessed by appropriate technology specialists relative to what technology approach is needed to meet the requirement, the degree of technology development related to the approach, the scope of work effort involved, and some assessment of the likelihood for project success.

Next, the total list of requirements and associated technology development solutions are collectively prioritized, based on business plan strategies, risk, cost, time frame, and likely budgets available. In all cases, a direct business benefit link was required between each technology development project and a product line. It would appear that within the industry some companies require this connectivity to be formally established, in that a 'program sponsor' must be identified with each project or it is automatically eliminated from consideration. The final list is debated in joint upper-management and project-author (and [or] owner) meetings to "fine tune" the classification data of each project. Last, a budget-limited list of R&D programs for the next year is established with specific business connectivity, goals, schedule, and budgets clearly identified.

For the most part, process closure appears to occur when the final plan is formally presented to the President of the company as a means of assuring complete alignment with both business objectives and financial guidelines, as well as top management awareness of technology risks that are associated with the business plan that it supports.

Certain variations in the process were observed among the companies interviewed and in the industry at large. Depending on organizational structure, R&D budgets were sometimes independently distributed from a non-program specific source such as an Engineering, Technology Group, or a source independent of both programs and engineering such as a Business Department which was held responsible for the process described. And, it also appears that within the industry, some or all of the available R&D budgets were controlled by individual programs or product lines. The industry point made in discussions was not where the R&D budgets reside but

how well the process for defining technology activities aligns and prioritizes needed technology development with business plan objectives and strategies.

This apparent budget control "indifference" was somewhat countered by concerns also voiced regarding who organizationally should "own" the process. Traditional departments within high technology organizations, such as Engineering or Program Management Departments, were cited as exhibiting well-intended but real biases in their strategies for technology development. The Engineering Departments are traditionally accused of being isolated from both external and internal customers, and thus define strategies for technology development that tend to be long-term, "exciting and new" perhaps, but not sufficiently value-focused on applications or customer needs. Similarly, Program Management Departments are traditionally accused of being too preoccupied with "today's problems" and thus define technology development strategies that tend to be too short-term, concentrating on today's production or field problems to the exclusion of technology development essential for future, longer-term, business growth.

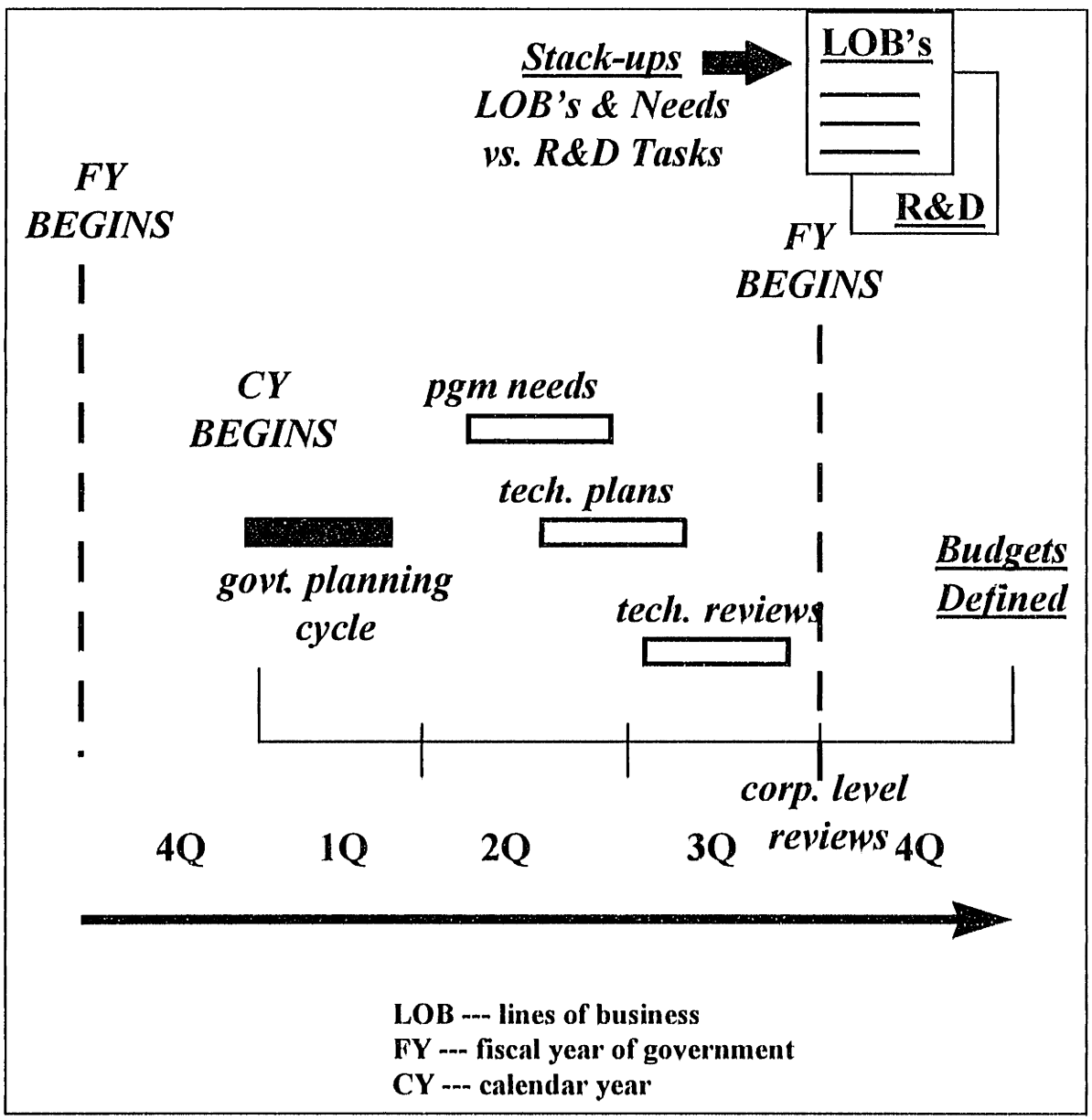
Time Line of Business Planning Activities - The planning practices described above were also discussed in the context of a formally defined yearly process intended to be interactive with parallel customer program definition and acquisition planning/procurement activities. The ideal outcome was that this type of planning process, with continual reviews during the year, would create a flexible planning system. One that changes quickly, continuously, and concurrently throughout the organization reflecting a dynamic reality of changing customer needs and competitor actions.

For aerospace and defense procurements, commercial or government customers tend to evolve new program requirements and technology roadmaps over a multiple year time frame. For military and commercial aircraft, roadmaps may span a decade or more of early pre-program discussions and trade-studies involving all aspects of the new aircraft system. Typical focus may be on mission requirements, life cycle costs, field support, reliability goals, performance goals, etc. as well as the enabling technologies required. Yearly interactions with the customer are required as aircraft design specifications evolve, requirements change, and long lead-time enabling technology development projects are defined and initiated.

A conceptual time line of yearly technology development planning events is depicted in the notional illustration presented in Figure 4-4 which is reflective of a government customer.

The most important aspect of this time line of events is that the customer's planning process milestones are used as pacing milestones for the industry planning process. For government activities, their planning process is typically offset from the normal January to December calendar year and is aligned with a September to August fiscal year. Consequently, as illustrated, the government planning cycle is usually completed in the first quarter of the calendar year. In the 1990's, with limited government contracted R&D (CRAD) opportunities, and literally only one or two major government procurement programs. A concentrated effort to

Figure 4-4 Yearly Planning Process Time-Line of Events



interact meaningfully with government planning activities is desired and generally in concept seems to be in place in the industry.

With reference to Figure 4-4, the industry goal is to time the completion of internal company business and technology planning activities (business focus, program needs, technology needs, development plans, correlation with product lines, etc.) such that it permits an effective interaction with its government planning counterparts. Planning activities emphasize a thorough understanding of current government procurement desires early in the year with timely roadmap interaction/feedback meetings occurring no later than the fourth quarter of the calendar year. The culmination of these interactions is to permit timely and focused "turn-on" of internal company R&D projects each year.

Ideally, with the process depicted in Figure 4-3, a sequence of planning activities will exist that minimizes any loss of internal R&D development continuity (i.e. each year on 1 January, R&D projects are initiated or continued, fully defined, and with budget authorization). It also is intended to maximize correlation of technology development benefits and priorities with the company business plan strategies. The idea being to simultaneously meet the existing product line needs, position for future business opportunities, and align and position internal R&D projects to increase the likelihood that relevant government CRAD or major new procurement programs can be won in future industry competitions.

From an individual company's business perspective, the purpose of industry/government meetings (usually involving industry briefings as well as one-on-one company meetings) is to provide early inputs to beneficially (in a competitive context) influence the evolving new government weapon systems requirements. Additionally, from an industry perspective, these meetings act to align more closely government and industry understanding of the technology used in existing aircraft systems and current industry capabilities. Which permits a more realistic development of goals for defining the enabling-technology development programs needed to meet requirements for the future aircraft system procurements. It is in meetings such as these, that new acquisition procurement sensitivities are also discussed. And, as occurred when requirements shifted to focus on affordability, these system-benefit discussions may in fact lead to changes in historically used criteria for the selection of future technology development programs.

Such meetings provide an important feedback into the industry planning processes (Figure 4-3) at the "customer requirements" level, and act to alter prioritization criteria, technology needs lists, technology development correlation with existing product lines (Figure 4-4), and may initiate a reassessment of internal process capabilities (e.g. the 1990's industry need to improve overall design cycle efficiency and productivity to meet desired affordability goals). The implication being that any one company that can meet a new requirement may have a competitive advantage. But, conversely, if meeting a new requirement is truly not feasible, early industry efforts can be singularly or collectively initiated to communicate that concern to the government agencies.

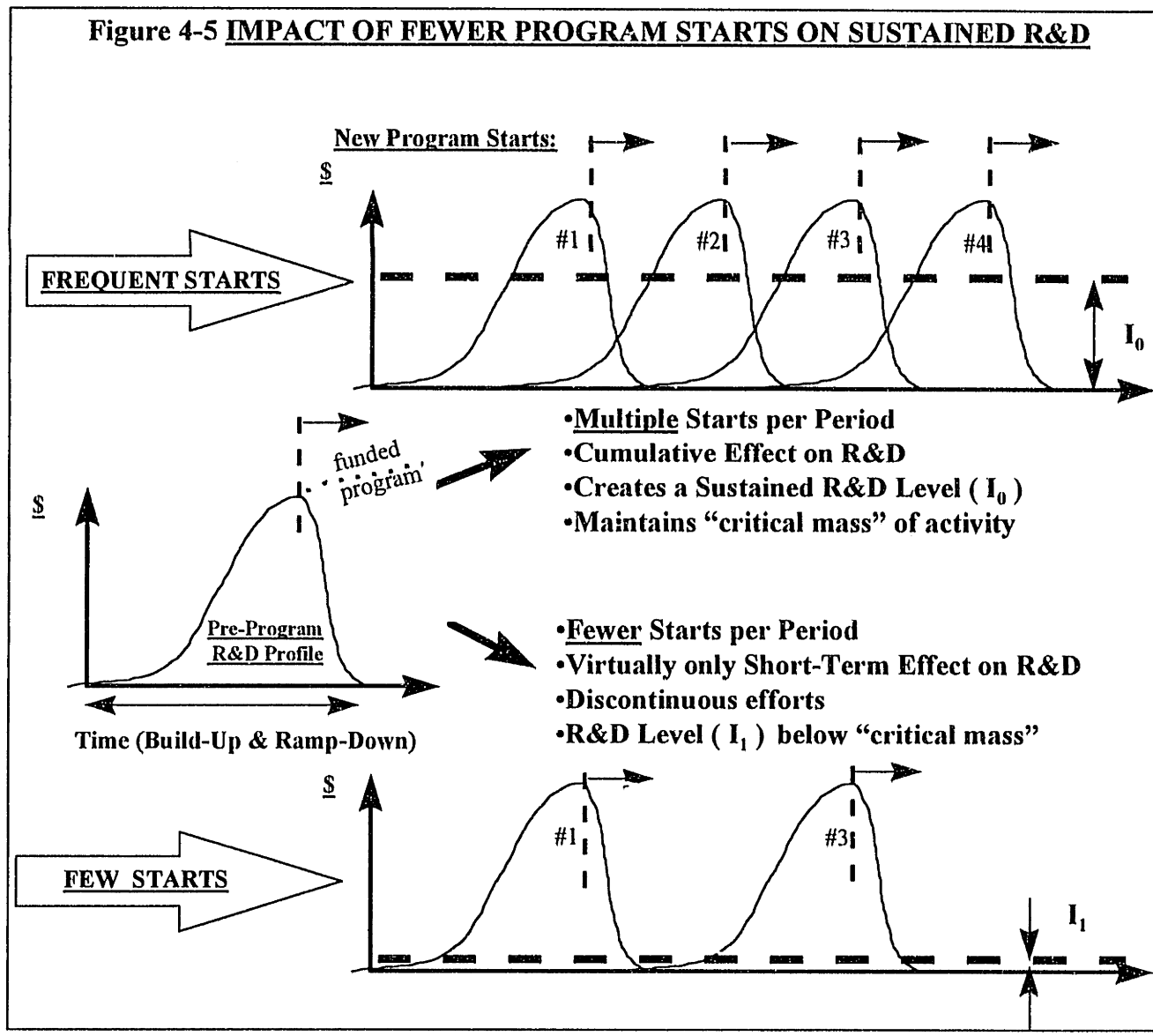
4.2.1.1 Discussion on Levels of Sustained R&D

This section will address a specific issue associated with a decrease in the number of program starts in the aircraft industry, and its potential affects on sustained levels of technology development in any one company. This subject was an interesting and very specific focus of one of the interviews which took place in an Aerospace & Defense Sector company meeting.

To more graphically illustrate the key aspects of the concern, Figure 4-5 provides a notional depiction of the yearly expenditures that historically occur in pre-program R&D activities. The time duration for R&D expenditures to build-up to a peak and then phase-out is reflective of typically long periods of time (approximately 7-10 years) which occur before major military weapon system contracts are actually awarded. As discussed in Section 4.2, during this period significant evolution occurs in the design specification. Further, a considerable amount of specific R&D activity occurs internal to competing companies to assure enabling technologies and other technology capabilities are ready to be employed when the product development phase is initiated.

The historical observation was that, prior to the mid 1980's, new program starts of one sort or another would probably occur every 4-5 years, each with its associated pre-program R&D efforts. The cumulative effect, of multiple pre-program R&D for this frequency of new program starts, was of sufficient magnitude that considerable interaction and leverage occurred across a wide range of technology areas. Further, a continuous 'critical mass' of technology activity was thus sustained (primarily in functional areas of generic technology development). This is

Figure 4-5 IMPACT OF FEWER PROGRAM STARTS ON SUSTAINED R&D



illustrated by the upper right graphic in Figure 4-5, and in particular the discussion centers on the observation that a minimum level of sustained R&D activity occurred, denoted as "I_0".

However, if the same individual profile for pre-program R&D activity occurs not every 4-5 years, but say every 8-10 years, then no longer does a sustained cumulative level of R&D activity necessarily occur. In fact, discontinuities may occur in activities such that periods of time are experienced when no R&D activity occurs at all. This effect is illustrated in the graphic at the lower right of Figure 4-5, where a very low level of cumulative R&D is depicted as occurring at the "tails" of the two pre-program R&D profiles (designated by "I_1").

Now, the author recognizes that this is a notional depiction of a speculative effect. However, the discussion creates a realistic framework for recognizing that funding must exist for

work to be done, that the magnitude of funding dictates the number of people that can be used, and that the duration of funding controls the continuity and scope of what can be worked.

Relative to the current Aerospace & Defense Sector, this discussion raises some serious questions regarding the state of ongoing technology development in the industry today. The number of new major programs has indeed dropped to a level approaching one every 10 years. The discussion raises some new questions:

- How has this reduction in new starts over the last 10 years affected the critical mass of technology development that was implied to have existed in the 1980's?
- How fragmented has current technology development efforts become as sustained R&D funding sources disappeared or were eroded?
- How continuous and of sufficiently long-term in scope are today's industry technology development programs?

Unfortunately, at this point in the thesis effort, only the questions can be raised and their study will have to be left for another time and investigation. But, from a technology planning perspective for the future, a legitimate and previously unmentioned concern has been raised and should be an important aspect of an integrated business and technology planning activity. Namely, answers to the following questions should be addressed in planning activities:

- Has the critical mass of technology development areas been sustained?
- Has the scope/content of technology development become too short-sighted?
- Have the technology development efforts become discontinuous or fragmented?
- If any of the above issues exist, are core competencies being threatened?

4.2.2 Automotive Sector Practices:

A similar application focus for technology development was evident from discussions on the automotive industry practices. Details of the process were not as evident as for the aerospace industry but a clear sense of their philosophy for managing technology development did emerge. For the case of Company C, the focus was centered on a "Platform Team Concept" that had

philosophies which were similar to the IPT's previously discussed for the Aerospace & Defense Sector.

The team concept principally was intended to coordinate all functions that play a value-added role in the product development cycle activities. A specific attribute of this concept was the active participation of suppliers in the operational team process. The central objective, which appears to have been achieved, was to significantly reduce product development cycle times. Results were cited which indicated that dramatic reductions have been achieved in the cycle time needed between "freeze and launch". From cycle times of greater than five years being common in the late 1980's, cycle times are now being documented which are less than two years in duration. Apparently, such efficiency benefits and associated practices at Company C were patterned after, and evolved from, earlier industry experiences as typified by the Chrysler Project Liberty Project and the Ford Alpha Team initiatives.

But apparently, the Platform Teams were not sufficient to accomplish the needed range of process improvements, and a consistent company-wide level of appropriate technology development. A more formal approach was defined for assessment of new technology innovation ideas. The focus of new organizational elements was on communication of technology awareness, and assessment of relevant innovation ideas with specific platform applications. The goal was to create greater platform visibility of new technology opportunities, and to foster faster platform introduction decision-making, as well as assuring a company-wide consistency in technology awareness was maintained across platforms and team members.

Thus, to complement Platform teams, and to make more efficient generic technology development, three additional organizational entities were created:

- Technology Clubs,
- Advanced Technology Council, and
- A "Challenge" Fund.

Numerous Technology Clubs were stated as existing throughout various levels of the overall organization, with apparently six major ones defined at the General Manager level of management. The purpose of these "clubs" was to assure that managers get together (across and within platforms) and collectively review new technology or process improvement ideas. The

resulting management visibility process is intended to garner more quickly the platform sponsorship necessary for obtaining sufficient funding to bring the idea to application fruition. Different levels of formality exist in this process of technology innovation review. Technology dissemination is an additional aspect of the Technology Club activities via the same new technology idea/application review process.

The Advanced Technology Council was described as being comprised of participants from the major platforms and the University community. The Council acted as a more focused element of technology dissemination and additionally was a bridge to external sources of new technology via University interactions. Here also, advanced technology concepts were discussed in the form of new initiative proposals fostering new ideas or new sources of technology innovation. The upper management visibility was intended to identify and help champion major ideas for sponsorship, budget, and staffing to permit an earlier application introduction.

Last, the Challenge Forum was described as being a "technology pull" mechanism for soliciting new ideas each year from the University community. Platform technology related problems are posed to the University researchers in the form of a "challenge" to evoke proposal ideas for new or novel technological solutions. If solution proposals are accepted, funding would be arranged for additional development of the idea. The philosophical focus of this activity appeared to be aimed at more independent or "outside the box" uses of existing or advanced technology, and acted as another mechanism for faster and more applied technology innovation.

Overall, Platform Teams managed the introduction of technology innovation in a very systems-benefit based context which assured relevance to the application and a value-based justification for any new innovation. Primary responsibility resided at the platform management or group leader level to make it happen, including technology needs and any related innovation. As such, the Platform Team process appeared to begin with initial evaluations of technology strategies needed to meet the general vehicle requirements and business success goals associated with the customer, competitor, and financial objectives for the program.

It is in early team meetings to formulate the specific technical approaches to be employed that significant "stretch objectives" were often defined by the Platform Team itself. In a real sense, motivated to be successful, the Platform Team acts as a "technology pull" for

advancing technology and encouraging innovation. The process was thus one of informal evolution which was described as being "not clearly stated but happens."

A final aspect of technology management within the Platform approach dealt with assuring a complete system integration was occurring among the technologies and disciplines being employed (internally and externally through the supplier network). So-called "Chunk Teams" were discussed which were created to actively integrate the various pieces of the activity into one product system. Typically, these teams would provide ideas to help meet objectives or avoid potential interface problems, often contributing across multiple platforms and design areas. The discussion indicated an 'ad-hoc' advisory form of authority might exist whereby the recommendations of this team were not a dictate but influenced technology use and resource allocation to achieve platform objectives.

A closing emphasis was made regarding the use of information technology (IT) as being a central enabler and a key element of the process re-engineering that was essential for meeting productivity goals. Integral, to reduced product development cycle times, was the significantly reduced levels of organizational hierarchy in the Platform Team approach. Thus, to achieve the needed level of project control, IT was used to standardize design databases and create a real-time ability to coordinate and determine the status of all activities. Use of IT permitted; much faster communication of ideas and status; faster awareness of new technology and implementation; better coordination of design data; and better control of partnerships and alliances.

From a technology innovation perspective this efficiency appeared to be singularly important, the marked reduction in product development cycle time (while maintaining quality) has apparently permitted Company C to cost-effectively introduce new products, with production validated manufacturing processes, without the need for more time-consuming and costly prototype evaluation or incremental technology introduction through derivative models. The competitive advantage of such product introduction flexibility and efficiency is clear and no parallel capability was observed in the Aerospace & Defense Sector.

4.2.3 The Conglomerates:

No specific interview data were obtained regarding details of processes used to align technology and business planning. However, some philosophical insight was obtained relative to

its role, its importance, and perhaps some related issues concerning organizational structure.

As discussed in Section 3 - Industry Trends, conglomerates like General Electric and United Technologies, have a significantly more mature and expanding international presence than the other two sectors. Additionally, both have a much more diversified spectrum of business activities. Thus, the interview for this sector reflected a more global and strategic business perspective. The Conglomerate Sector strategies for continued business success (at rates of return that the shareholders expect) were discussed. The strategies centered on growth in the international market with an emphasis on the developing countries. Additionally (reflective of both GE and UTC), business units were expected as part of their strategic vision to maintain a world leadership position in their respective markets. This required continually striving for improved business performance in markets being targeted.

An integrated business planning process was an essential aspect of effecting the proper tactical and strategic actions necessary to achieve goals. In agreement with the other sectors, it was acknowledged that technology was only one of many elements that must be considered in the definition of a successful business strategy. In addition, this interview emphasized the lengthy list of non-technology issues, which by themselves, can lead to failure (lack of profitability and growth) in the international markets of developing countries. Some of which were mentioned in other sector interviews; such as, localization content, offset technology credits, etc. Others, like government free-trade regulations, currency exchange issues, non existent distribution channels, and government stability had not been touched upon.

The point being made for the conglomerates was that they must be good in several businesses. While technology was a fundamental underpinning in the international market, it was relatively low on the scale of management challenges which threaten business success. The environment was and is extremely dynamic and evolving. Companies must be very efficient to compete and very flexible to adapt to the changing business environment. Thus, as an example, we see a GE strategy evolving which envisions a truly "boundaryless" company relative to global markets, with minimal rigidity in its organizational structure.

In that dynamic global market context, it was noted that industry's reaction to new markets is a "confluence" of the established management biases of its existing leaders, who for the most part do not have experience in these new theaters of business. The mark of good leaders in

this environment is that they have the ability to continually adapt or change their strategies as feedback from the new market dictates.

A final note or example, of this dynamic environment and the need to continually reassess the validity of past biases, was forwarded relative to the evolving rules of the international market. Unlike the late 1980's, practices such as Japan's or Europe's rules of market behavior are no longer considered appropriate today. Specifically alluding to recent changes underway in both countries as they contend with very low economic growth, high unemployment, and inflexible policies regarding labor forces. Food for thought regarding existing business school frameworks!

4.3 Summary - Industry Practices

Four industry corporations were selected for direct interviews regarding industry current practices. The corporations selected included two from the aerospace industry sector (Company A and Company B), one from the automotive sector (Company C), and one from the conglomerate sector (Company D). Discussions focused on the management practices concerning integration of technology and business planning and the role of technology in the current industry business environment. No companies or people interviewed are mentioned specifically.

A summary and integration of the inputs was presented and discussed relative to current business issues and concerns, specific models for integration of technology and business planning, and a concern regarding sustained levels of R&D funding. Information obtained from all interviews exhibited significant similarity relative to business environment, issues, and concerns. In the section on specific models, practices were detailed and discussed separately for the Aerospace & Defense Sector and the Automotive Sector.

A summary of the specific business issues and concerns derived from the interviews was documented in Figure 4-2 with entries subdivided into the same categories as were used in Section 3 - Industry Trends. The interview data was closely aligned with the Section 3 results. Business issues centered on the current "market pull" impact on the role of technology, the impact of teaming and partnerships, the focus on affordability requirements, and the need for new competencies regarding the international market.

Competitive advantage was a key goal of all companies. But, in the Aerospace Sector, a common theme surfaced that indicated that teaming and partnerships, typical now on almost all programs, had virtually eliminated technology as a significant competitive factor; especially with affordability being the highest priority. The point made was that there are "no more technology secrets" among the prime aerospace companies. Over the last decade, with mandated teaming requirements, prime contractors were forced into sharing technology in order to achieve program success. In so doing, a great 'leveling' of technology knowledge occurred in the industry. Thus, companies looked elsewhere for ways to achieve competitive advantage, and have currently focused on system-based integration of all technologies to meet or exceed customer affordability requirements.

The section then examined in quite some detail specific models the industry is using to manage the integration of technology with business planning. Central to these practices were customer requirements, customer/industry interaction, assessment of core capabilities, linkage of internal and external needs relative to technology development, team based approaches to assess the systems benefit of any technology development proposal, alignment of all technology with a business sponsor, and a time-line of events which permitted timely and focused interaction with the customer's acquisition or technology planning activities. The key elements and customer interaction sequence of these processes were detailed in Figures 4-3 and 4-4.

Additionally, a discussion centered on a potential loss of continuity and long-term perspective in current aerospace industry R&D funding practices. This concern arose due to the existence of fewer new aircraft programs being spread over a longer period of time. The viewpoint forwarded (Section 4.2.1.1) was that program pre-proposal R&D efforts in the past would tend to overlap, involve generic technology development, and sustain a critical mass of R&D staff. Thus, continuity of efforts, people skills, and longer-term commitments were maintained. Today, an aerospace industry concern is that this technology development base is being fragmented, reduced in scope, falling below critical-mass, and becoming discontinuous over time due to a short-term business focus. The concern touches on elements of technology and business planning which are felt to deserve greater evaluation, but could not be addressed further in this thesis effort.

5. LITERATURE REVIEW (Strategy and Technology Planning)

A literature review was performed to provide insight regarding the body of literature relating to the integration of technology planning with business planning and strategies. In the following sections, that review is documented relative to three perspectives which were examined:

1. **Historical Perspective** - Survey of literature on the historical evolution of industry practices regarding the creation of corporate strategy. The intent being to better understand the overall context of current strategy development practices relative to its historical evolution.
2. **Interface Issues** - Survey of literature regarding the existence of interfaces (including social and political perspectives) between technology planning and business planning in the overall process of corporate strategy development. The intent being to gain a perspective on the academic viewpoints regarding interface issues in integrating technology and business planning.
3. **Integration of Technology & Business** - Survey of literature regarding specific guidance relative to management of technology and its role in business planning and overall strategy formulation. The intent being to gain a perspective on specific academic frameworks which might be relevant to current practices which were studied.

5.1 Historical Perspective of Strategy

During the last six decades "strategy" has worn many labels and has evolved using management practices which reflect a dynamic and changing focus.[34-35] This evolution is previewed by a survey of definitions and perspectives, detailed in Figure 5-1, drawn from five references[36-40] spanning the last 3 decades. Even this cursory overview indicates major shifts have occurred in the focus and methodologies employed. A recent article describes firms having to contend with the "constraining influence of the external business environment on the choices (goals) and courses of action (strategies) available to the firm,.....[with a firm's survival determined by] .....how well it is able to adapt its capabilities to match the conditions imposed by an inconsistent environment."[42]

Figure 5-1 Definition of Corporate Strategy Activities

Author	Year	Strategy - Definitions & Perspectives
Ackoff[36-37]	1970	"..the design of a desired future and of effective ways of bringing it about" "..a process that involves making and evaluating each of a set of interrelated decisions before action is required..." The parts of which include: Ends, Means, Resources, Implementation, and Control. Underlying theme is the value of the "logic of scientific thinking", "the marriage of management and management science."
Ackoff[38]	1981	Proper function of planning - creation of the corporate future, "...enable managers to increase their control of the future and their ability to respond effectively to what they do not control." "A participative way of dealing with a set of interrelated problems when it is believed that unless something is done, a desirable future is not likely to occur; and that if appropriate action is taken, the likelihood of such a future can be increased."
Hamermesh[39]	1985	Three aspects: business, corporate, and institutional. "The pattern of decisions in a company that determines and reveals its objectives, purposes, or goals, produces the principal policies and plans for achieving those goals, and defines the range of business the company is to pursue." Propounds the "portfolio approach" to strategic planning. "...analytic techniques that aid in the classification of a firm's businesses for resource allocation purposes and for selecting a competitive strategy on the basis of the growth potential of each business and of the financial resources that will be either consumed or produced by the business."
Oster[40]	1994	"..begins with the desire of an organization to outperform the market." "...a commitment to undertake one set of actions rather than another and this commitment necessarily describes an allocation of resources." "Economics is a central ingredient in strategic planning." "...increased interest in the human side of strategy, in understanding the role of leaders in setting and implementing strategies, and in understanding how organizational power is both created by strategic choices and how it influences those choices." "Planning provides not only a way to manage change, but a way to create change." "Decision making..... occurs with limited information."
Grant[34]	1995	Multiple roles. Primary purpose is to confer success through guiding management decisions toward establishing and sustaining competitive advantage for the firm. Also, a vehicle for communication and coordination within an organization. Four critical elements: (1) Goals - simple, consistent, and long-term; (2) Understand the competitive environment; (3) Objective appraisal of resources; (4) Effective implementation.

A more detailed discussion, describing the historical evolution of nomenclature, philosophy, management practices, tools, and organizational structure, is considered a necessary foundation to an assessment of corporate practices in the late 1990's.

During the late 40's and 50's, the corporate focus centered on **budgetary planning and control** which responded to significant corporate scale expansion in a relatively stable post World War II period of economic growth. The primary executive concerns were "coordinating individual decisions and maintaining top management control."[34] Emphasis was placed on financial budgeting, investment planning, and financial project appraisal. The growth of large,

influential financial departments within the corporate structure (and the increased role of the CFO) can be traced to this period.

The 60's, a period of **corporate planning,** responded to further corporate expansion and diversification with many corporations evolving into conglomerates. Corporate acquisitions of a wide variety of diverse businesses (often implying vertical integration) were made as a strategy for continued growth. Corporate diversification, vertical integration, and growth through economies of scale and scope, caused executive emphasis to focus on growth planning. The principal concepts were market forecasting, diversification, and analysis of synergy. During this period organizational changes occurred creating corporate planning departments.

During this same 60's period of emphasis, motivated by long-term corporate planning, technology and R&D programs proliferated Corporate spending as a percent of revenue increased markedly and government-funded high technology R&D programs were also expanded. Not coincidentally, this was also a ten year period of acutely focused national technology development due to the cold war competition with the Soviet Union coupled with President Kennedy's space program focus of having a "US man on the moon by 1970." Ironically, it was also the period of time when serious debate started concerning whether the US (or corporate US) was getting its money's worth from R&D.[40]

The 70's brought a period of increased diversification (early 70's) and more formalized **corporate strategy** practices. The methodology of the 60's was formalized in management practices employing strategic business units (SBU), portfolio planning, and analysis of experience curves.

But, in the late 70's corporate enthusiasm for diversification decreased significantly due to the combined external effects of visible foreign competition, economic instability marked by high inflation (macroeconomics instability[34, 35]), and a lack of significant synergy benefits from the corporate diversification practices of the previous 10 years. A shift from corporate planning to strategic management[35] occurred in the 70's. Mintzberg[35] concludes that the formalized planning efforts were inherently flawed by citing three "fallacies of strategic planning"[35] ---fallacy of prediction (can not account for external forces), fallacy of detachment (strategy is emergent through the evolving process of management), and fallacy of formalization (inferior to informal flexible systems). Interestingly, Ackoff, [38] much earlier in 1981, appears to have concluded

similar shortcomings and stated similar benefits derived from multi-level participation in strategic planning, organizational learning, process flexibility, and the recognition of a dynamic or emerging strategy.

During the 80's, corporate emphasis on **analysis of industry and competition** created a significant shift regarding strategy development. The Japanese competition in a variety of industries (e.g. steel, automobiles, electronics) had substantially altered the position of US industry in the global marketplace. With the loss of market dominance (and substantial market share) US industry took a serious look at ways to analyze more effectively the industries that they competed in and their competitive position in those industries. Emphasis was placed on "choice of industries, markets, and segments and positioning within them."[34] Acquisition and current conglomerate business holdings were now scrutinized using models primarily developed to assess "the potential attractiveness of an industry."[40]

In particular, the "Five Forces Model"[43] (i.e. potential entrants, substitute products, power of buyers, power of suppliers, and intensity of competition) helped corporate strategists and economists "to explain the overall level of profitability one might expect in a given industry."[40] During this period, many "unattractive"[34] acquisitions of the 60's and 70's were divested as corporations made major moves to focus their activities on more profitable business segments and become more competitive in the increasingly international marketplace.

In the 80's, a further contribution by Michael Porter was especially noteworthy because of his specific acknowledgment and discussion regarding a perspective that "technological change is one of the principal drivers of competition."[44] Porter's detailed definition of the value chain, and "technology's role in the value chain and the resulting ability of a firm to achieve low cost and/or differentiation through its value activities,"[44] coupled with his earlier work modeling the competitive framework of an industry, appears to have been seminal in laying a needed foundation for industry strategy models.

In the late 80's to the current mid-90's, Porter's clarion works on **competitive advantage**[43,44] appear to be consistently used in the most recent practices regarding industry strategy development. The emphasis became a "quest for competitive advantage"[34] with a focus on sources of "competitive advantage within the firm and the dynamic aspects of strategy."[34] This led to new strategic concepts which now include emphasis on: core competencies, core

capabilities, reduced business cycles, and quality. Associated (ongoing) organizational changes include: corporate restructuring, reengineering, downsizing, human resources, corporate learning, international strategic alliances, and aggressive use of enabling information technology.

5.2 Interface Issues

As a prelude to this part of the literature review, a relatively current interpretation of modern corporate life is appropriately provided by Brownlie's article --- "A highly volatile technological environment and unpredictable competitive circumstances are characteristic conditions of a turbulent business climate." [42] He proceeds to associate the impact of technological change itself as a causal factor creating the "highly volatile" environment with which firms must then contend. Accordingly, he argues that in developing successful long-term corporate strategies "the firm must focus its analysis of trends, events and possibilities on the technological component of the environment."[42] With strong incite into the workings of modern corporations, he further states that: "Technology decisions in general, and R&D decisions in particular, must therefore be taken within the context of the firm's overall corporate strategic planning if they are to be consistent with it.....[but] this demands a level of communication, coordination, and multidisciplinary effort that is not consistent with the typical isolation of these [technical] specialist functions."[42]

Brownlie's paper further emphasizes the need for disciplined use of technology forecast analysis to assess the technological changes to which the firm may be susceptible. The prime responsibility for performing this technology forecast function is the firm's R&D group which must then be intimate to the process which develops the firm's corporate strategy. However, Brownlie cites as a "major weakness" of current strategic planning, "...its lack of integration of, and inadequate plans for, R&D."[42]

The article focuses on two factors which lead to this "weakness": (1) Isolation of the R&D function within the firm, and (2) Lack of top management involvement in directing long-term R&D effort. Of particular relevance to the thesis theme, the article states "....isolation of R&D was thought to be largely due to poor communicative efforts and the inadequate planning of R&D actively within the context of the firms overall strategic business planning."[42]

A paper by Adler, McDonald, and MacDonald, pursues a related subject by describing the characteristics and stages of development observed in R&D groups which consistently maintained "sustained technical accomplishments and business success."[45] Three key characteristics are observed and defined: (1) Posture/direction (clear and accepted mission, objectives, and strategic plans), (2) Policies (manages technology as a business; articulated policies guide operations), and (3) Adaptation capability (ability to quickly respond to the volatile external business environment). Associated with these characteristics are four stages of development which proceed from an undesired "isolated" group through "reactive", "proactive", and finally to the ideally "integrated" group.

The authors have detailed an extensive list of characteristics which they believe can be used to establish criteria for benchmarking the effectiveness of R&D groups. A tailored overview of the paper's comprehensive categorization of characteristics (traits) and associated elements and stages is created in Figure 5-2. By focusing only on the extremes of group development stages (i.e. "isolated/reactive" and "integrated") even this cursory examination reveals clear characteristics which unfortunately are found all too often to reflect an ineffective end of the scale exists in industrial R&D organizations. Of paramount concern is the lack of "long term understanding of how technology can contribute to shaping business strategy."[45] Of almost equal concern would be the lack of "cooperation and goodwill between internal departments that promote collaborations to meet company objectives."[45]

At this point, a very brief but focused article on CEO expectations, seems relevant as a backdrop for framing expectations of effectiveness for R&D groups (or listing areas of needed improvement!), and for placing in perspective their value and expected role in formulating corporate strategies. The article summarizes a study which was designed "to examine the need for greater R&D leadership within industrial corporations."[41] The paper overviews a series of interviews with CEOs who were asked: "What can R&D do to be more effective in stimulating and managing innovation within your firm?"[41] The following key issues were revealed:

Figure 5-2 Strategic Management - Stages of R&D Group Effectiveness[45]

Traits	Elements	Definition	Isolated/ Reactive R&D Groups	Integrated R&D Groups
Posture or Direction	•Mission	•clear sense of purpose and values; should be localized to work groups	•none or very general •exists; not communicated, understood, or accepted •describes posture but not technical areas to be mastered	•shared understanding within work group and throughout business •characterization of core technologies; clear mission/posture each category •L-T understanding technology can contribute to shape business strategy
	•Objectives	•guides for resource allocation decisions; relates to mission; broader than goals which are tied to specific action plans	•only semi-quantified; internal; not benchmarked •some related to specific projects	•clear fit with business objectives •sets direction for long term •good metrics of the groups output and processes •intra and inter functional metrics accepted in group and throughout the business •includes balancing the risk profiles of project portfolio •align with other functions' objectives and strategies
	•Strategic Plan	•defines the development path along which key capabilities will evolve	•no plan or only some focus to work projects •driven by group desires not by mission •no inter work group or product line linkages •lack information on L-T business needs	•fully integrated with other functions in company •technology goals and tasks are shared across business •defined for three or more product generations •specifies development path for product/process/support technology •clear make/buy criteria; external sourcing of technology •focused set of hi-leverage initiatives; builds capabilities ahead of needs
Policies & linkages	•Technical Projects: Selection	•policies regarding processes, resources, and linkages; empowering and guide daily decision making	•favors mostly short term projects •little inter product analysis •erratic priorities set; unclear team charters •little interfunctional participation •conflicts on work priorities; unstable staff •minimum project leader guidance/training	•clear links between selection criteria and business •cross functional planning and execution •continual improvement with post-mortems and quality measures •projects are milestone driven •differentiated project management procedures for different projects •scheduling and capacity planning avoid resource contention
	•Funding	•R&D budgets	•last year's, "gut feeling"; industry average	•flexible related to business potential; minimal fluctuations; 3 yr. approvals
	•Structure	•organizational issues	•ego/political conflict not strategic priorities •acceptance of status quo •centralized authority	•optimizes communications and achievement of strategic objectives •flexible enough to support and promote initiative and entrepreneurship
	•Internal Linkages	•cooperation and goodwill between internal departments to promote collaborations to meet co. objectives	•visible friction between departments •mistrust of work group functions •"we/they" syndrome •cooperation at top or at operational levels but not both •no effective bridging mechanisms	•multi-skilling of specialists •awareness and respect of other functions developed by systematic cross-functional assignments and job rotations •joint development efforts across functional subunits

(1) The need for a "higher level of comfort with the strategic direction of (and the value contributed by) technology in their business.

(2) "A strong wish for a readily accessible yet sophisticated means of determining whether things were pretty much on course (but no expectation of quantifying)".

(3) The above are aggravated by "the lack of a complete, supple, and shared language for defining exactly --- and in what degree --- technology is important to each individual business."[41]

Additional concerns included a need for: improved benchmarks, sustained focus on the market, better attention paid to internal users, better project management, use of external sources of technology acquisition, better internal linkages to R&D groups, and a better sense of timing. This article would appear to reinforce significantly the characteristics defined by Adler, McDonald, and MacDonald (reference Figure 5-2) and, in reverse, the characteristics of the "isolated/reactive" column of Figure 5-2 reinforces (or explains) the observations cited by Wolff.[41]

To further reinforce the existence of integration issues existing between the technical R&D community and the business world of the CEO's, the following excerpt is presented: "Business people think we speak a strange language, and conversely. There needs to be some sort of commonality developed in order that both sides can understand what the other is talking about, what each side needs to do its job well, and how to integrate the business and the technology side most efectively."[41]

Complementing the interface issues raised by the literature reviewed so far, additional concerns were found in literature regarding completeness of knowledge relating to the interpretation of social and political influences which are inherent in the industrial processes of technological change. These perspectives are discussed by Robert Thomas in his book which examines "the process of technological change in organizations,.....to make possible explicitly comparative case studies by dramatically expanding the temporal and organizational analysis of technological choice."[46]

In so doing, the author develops a "**power-process perspective**" [46] (PPP) which he states "brings to the study of organizations and organizational decision making a political sensitivity that has been out of the mainstream of technology studies for far too long."[46] The central theme of the

PPP framework is that it seeks to "simultaneously diverge and bridge"[46] two historical academic perspectives for describing industrial technology change: (1) Technological Determinism which implies organizations are driven by new technologies which are exogenous forces of change, and, alternatively, (2) Social or Strategic Choice which implies that technology is driven by the premeditated strategic choices made by organizations

Thomas argues that both models are relevant but are limited by a "static, temporal, and historical" context imposed by researchers who emphasized the outcomes of recorded industrial technological change rather than the processes leading up to the outcomes. In developing his PPP construct, Thomas asserts that the actions of individuals and groups within the organization which precede and follow formal decisions to implement new technology or strategic choice must be examined as an integral part of the technology innovation process.

Thomas derives the PPP construct from qualitative assessment of case studies, taken from the aircraft, computer, metalworking (aluminum), and automotive industries. He examines the evolution of events throughout the stages of the new technology innovation process; i.e. problem identification, technology selection, and technology implementation. The case studies reinforce Thomas' belief that the industrial innovative change process is not static but has dynamic, interactive, and iterative characteristics. Further, these characteristics are affected by both an historical conditioning of the organization and the organizational "power" of the individuals involved in the process.

Such conclusions are further reinforced by another author (Thomas, P.)[47] who finds that the "management literature is highly prescriptive and is underpinned by objectivist and functionalist assumptions about management."[47] Citing examples taken from corporate case studies of management decision researched by him, conclusions are drawn which indicate that management "prescriptions" never really work as they are intended because they do not take into account the social and political perspective which existed in the realistic context of the original organization from which they were derived. Consequently, "the development of a more critically informed perspective, which recognizes the problematic nature of management itself,....is long overdue."[47] The central concern is a need to emphasize the social and political process of change which acts as an additional reality surrounding any technological change which occurs or is desired.

The social and political perspectives are further assessed in an examination of "factors associated with the supportive use of technical information at the level of the individual, the organization, and the project. .... that the supportive role.....is political and symbolic in nature."[48] The author compares his results against the "mainstream literature" belief that projects are selected according to prescriptive and formalized techniques (logical and quantitative approaches). While detailed in its assessments the central concern is that "organizational decision making, particularly with respect to decisions that allocate resources within organizations, is inherently political in nature."[48]

A major aspect of the article deals with the difficult issue of communications between general management and R&D staff. Coupled with an "unwillingness to speak business English" three additional traits/concerns of the technical community are cited which are felt to contribute to the problem: (1) Right to publish results, (2) Differences in "time horizons" of R&D versus project areas, and (3) Researchers identify more strongly with their profession than their firm. While not surprising and certainly not new, the political and social aspects of these issues are clear and could interfere with "mainstream literature management prescriptions."[48] Recognizing the social and political nature of negotiation, bargaining, persuasion, network building, and communication would seem to be an important perspective relative to effective management practices.

A related aspect of the need for improved communications has recently been emphasized by Schein in two articles dealing with the realities of three particular cultures and the sub-cultures within all industrial organizations. The existence of the "operator", "engineering", and "executive cultures"[49,50] is believed by Schein to be a major causal factor in the observed inability of organizations "to learn how to learn."[50]

From the perspective of this literature review (the technology planning integration and interface issues between R&D engineering groups and their strategy planning business counterparts), the existence of cultural groups implies that they will continue to fail to "learn effectively until they recognize and confront the implications of the their occupational cultures."[50] This may also be an intimate factor affecting their ability to interact effectively in developing shared and interactive technology and business planning leading to an overall corporate strategy.

Schein concludes with recommendations centering on recognition of: "....how deeply embedded the shared, tacit assumptions of executives, engineers, and employees are.....must find ways to communicate across cultural boundaries .....establishing some communication that stimulates mutual understanding rather than mutual blame.....learn how to conduct cross-cultural 'dialogues'.....[and] learn how to evolve those cultures around their strengths."[50] These issues may also be fundamental to the efficient development of corporate strategies.

5.3 Integration of Technology and Business Strategies

The focus for this part of the review is to sample the literature for more specific guidance regarding the management of technology relative to its role and integration in overall company strategy and business planning. As a bridge to the prior sections on strategy evolution and interface issues, the following quote from Lowe[51] serves nicely to provide a link to established academic strategy concepts and a value-based focus for practical management methodology needs:

> "On the basis that the technologies employed by a company are an important group of resources we can extend Porter's concept of strategy[43,44]. A corporate technology strategy is therefore concerned with the use, development or adoption of technologies to maximize the competitive advantage of the business. [Thus].....the value of technology is best assessed in terms of competitive advantage. Technology yields this if it can improve the company's cost position or product differentiation. Thus the firm has to consider which technologies to develop; what risks to take; whether to be a leader or a follower. [And] .....to achieve competitive advantage, the technology strategy must be integrated within the company's overall business strategy. .....there is no room for splendid isolation here! "[51]

Specific Models Discussion:

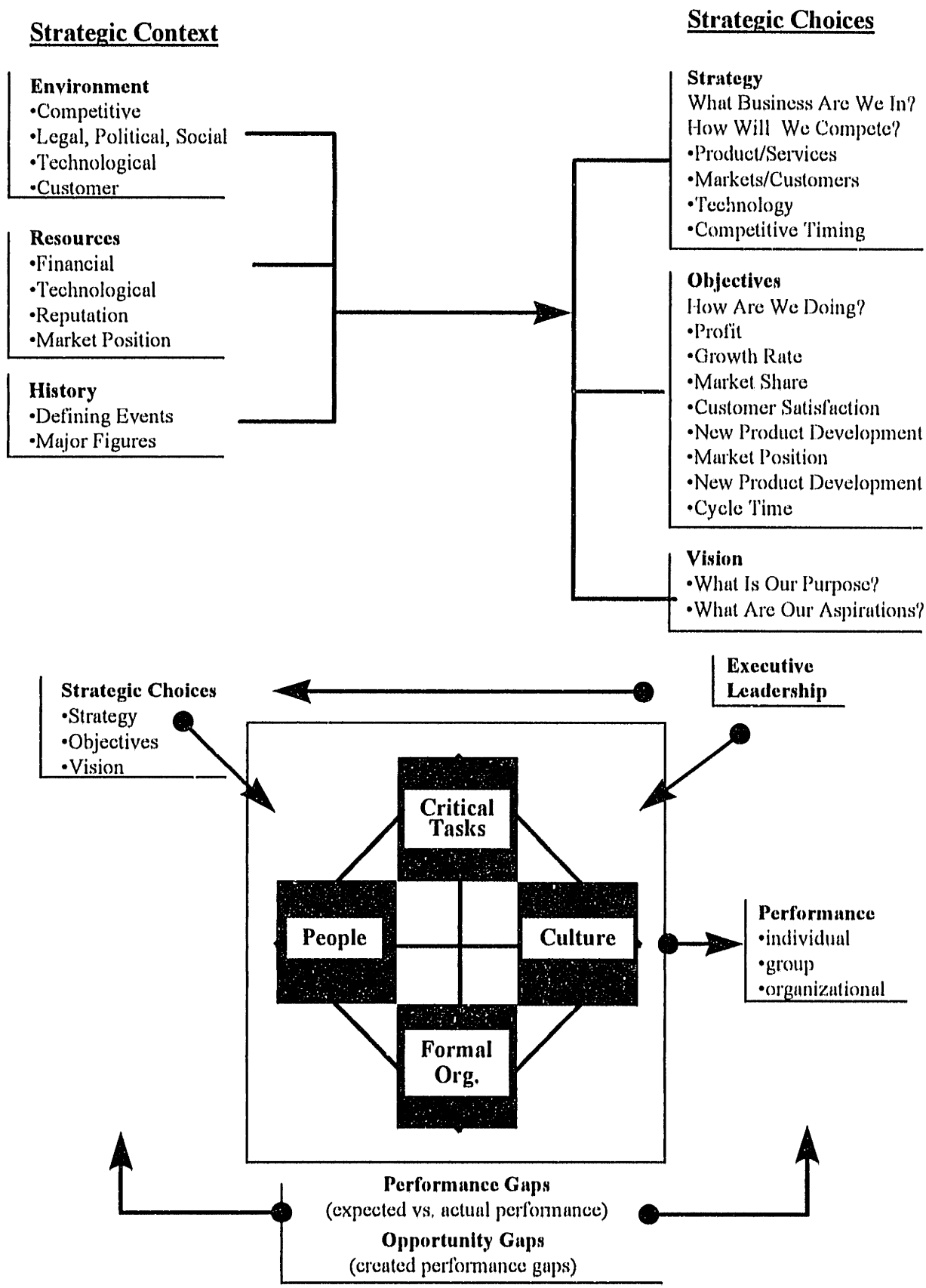
A significant number of issues which must be addressed is discussed by **Tushman and O'Reilly**[52] with a focus on models that address innovation and its associated "organizational

change and renewal"[52]. The objective of their book being to provide operational approaches for managers to use such that they "could sustain incremental change while simultaneously leading revolutionary change .....[which is required] to ensure success for tomorrow."[52] Perhaps more important is the authors' contention that to achieve continued business success (competitive advantage), a significant level of appropriate innovation must be occurring within the company. The authors' approach for managing appropriate innovation is to identify company "performance or opportunity gaps" relative to the industry ----- and if none exist to create them! The point being that innovation requires change, and change to be accepted by organizations requires a need to feel threatened (the "gaps"). Without such a focus for change, companies tend to become complacent, stagnate, and eventually lose industry market share and competitive positions.

As illustrated in Figure 5-3, while not specifically addressing technology from the perspective of Aerospace or Automotive sectors, the context of issues they discuss is a generic theme felt to be highly relevant to all high technology industries. From an overall practices perspective, the authors' discussion of the integration of "strategic context", "strategic choices", "organizational congruence", "performance and opportunity gap assessment", and overall process flow for defining innovation planning seemed especially relevant and complete for purposes of this study. The environment of the industry and the company as listed under "strategic context" and the questions posed under "strategic choices" are direct contributors to all business strategies. Similarly, they are clearly central for focusing and defining core competencies, and for understanding the relevance of technology in strategy.

The lower half of Figure 5-3 is felt to be directly related to technology planning and integration with business strategies. The authors describe a process which integrates business planning inputs (" strategic choices") with an assessment of the combined capabilities of the company relative to culture, people, and organization. The purpose being to define performance and opportunity gaps. The authors call the overall interaction of these elements "congruence". Specific weaknesses uncovered are the basis for focusing development or acquisition of the needed capabilities. Those capabilities identified can be new enabling technologies or needed technology development projects. Thus, this approach would seem to be equally applicable to overall company strategy and business planning efforts as well as for formally beginning the process of integrating technology planning.

Figure 5-3 Tushman & O'Reilly[52] - "Defining Problems & Opportunities"



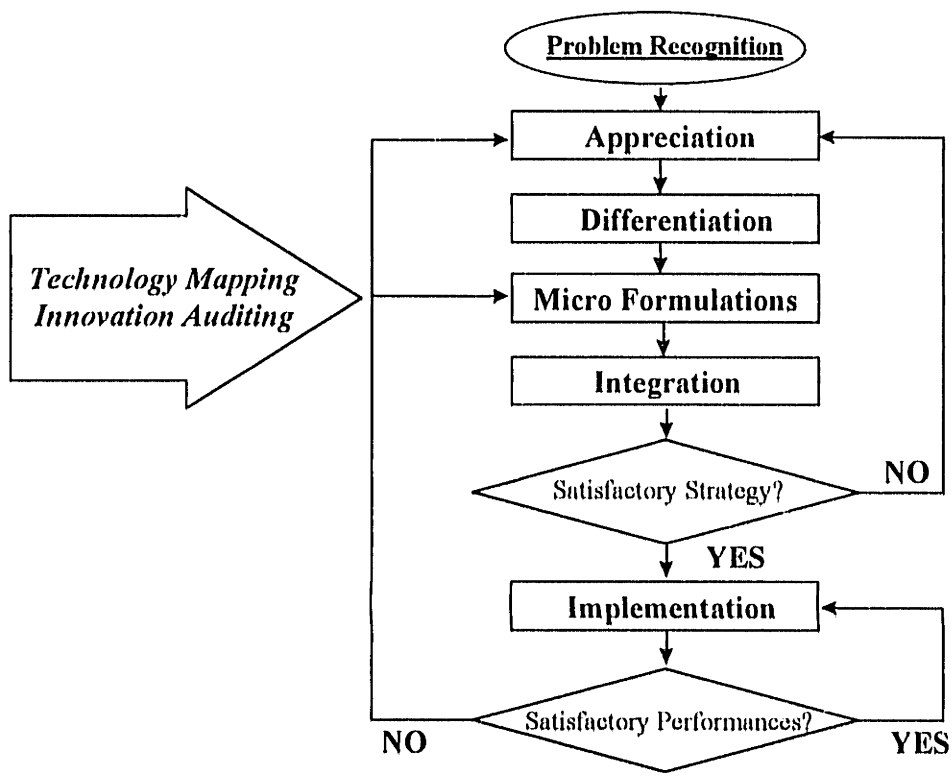
A specific model was also proposed by **Goodman and Lawless**[53] which directly addresses the inherent difficulty of integrating technology and business strategies. In Figure 5-4, their Adaptive Rationality Model (ARM) is illustrated.

The key feature of this model is that it seeks to integrate and balance strategist planning characteristics that tend to be polarized by two seemingly incompatible extremes; i.e.

(1)Use of the "high-rationality" model, which is usually reflective of planners having to deal with the world of finance methodology (e.g. discounted cash flows, expected-value analysis, return on investment) and who typically wish to be extremely factual and logical regarding all strategies, versus

(2) Use of the "low-rationality" model, which is usually reflective of planners having to deal with what they feel is a not-quantifiable and ambiguous environment that has real threats which must be addressed, but they are all qualitative in nature.

Figure 5-4 Adaptive Rationality Model[53]



The implication being that technology oriented planners ironically favor the "low-rationality" model because of the inherent risk and uncertainty associated with technology R&D projects that are inherently dynamic "learning processes". And, the executive business planners favor the "high-rationality" models which embrace firm schedules, very specific objectives, and highly quantifiable measures of performance (e.g. finance metrics of performance).

For high technology industries, the ARM model would conceptually permit the integration of technology planning and business planning within its iterative framework. The feedback loops and decision making nodes of the model would ideally permit strategy formulators a basis for accommodating an inherently dynamic technology development reality within more traditional business world contexts. The feedback loops are specifically intended to permit strategic assessment of technology benefits (and associated development risks) before strategies are implemented, as well as permitting adaptation of strategies as actual technology performance data is received.

As an integral part of technology planning, the authors recommend the use of "technology mapping" and "innovation auditing" tools to gain both an external and internal perspective on the technology needs of the company. *Technology mapping* is explained as an external view of the company and is "aimed at assisting the corporation to make better decisions about the selection of the appropriate technology strategy."[53] This mapping focus is intended to provide the company with insight regarding industry relevant technologies, their rate of change, the particular aspects of the technology changing, its potential impact on the companies success or failure, and the role of outsiders in the technology. And, *innovation auditing* is explained as an internal perspective relative to a company's industry capabilities and its ability to seize market opportunities. This tool requires assessment of "the firm's innovation process, its comparative position, and its preparative position."[53] For both tools specific methodology is described in their book.

For the purpose of this review, the important aspect of these two tools is that they provide a basis for assessment of the same "performance and opportunity gaps" that were identified by Tushman and O'Reilly in the previous literature review discussion. Additionally, by using the results obtained from these tools in the "formulation", "integration", and "performance check" steps of the ARM model another strong parallel can be made with the Tushman and O'Reilly model (Figure 5-3).

Alignment of technology strategy with business strategy is also discussed in a paper by **Chester**[54] with particular attention directed to methodology regarding the organization of central research laboratories. Core competencies and technical networking were cited as integral to "the evolving global culture of technical business management"[54]. As an extension of the previous works reviewed, Chester's discussion seemed especially relevant because it integrated technologies available external to the company into the internal strategy development process. This indicated another avenue of strategy decision making; namely whether a company should develop technology (deemed to be important) internally, or acquire it from outside sources.

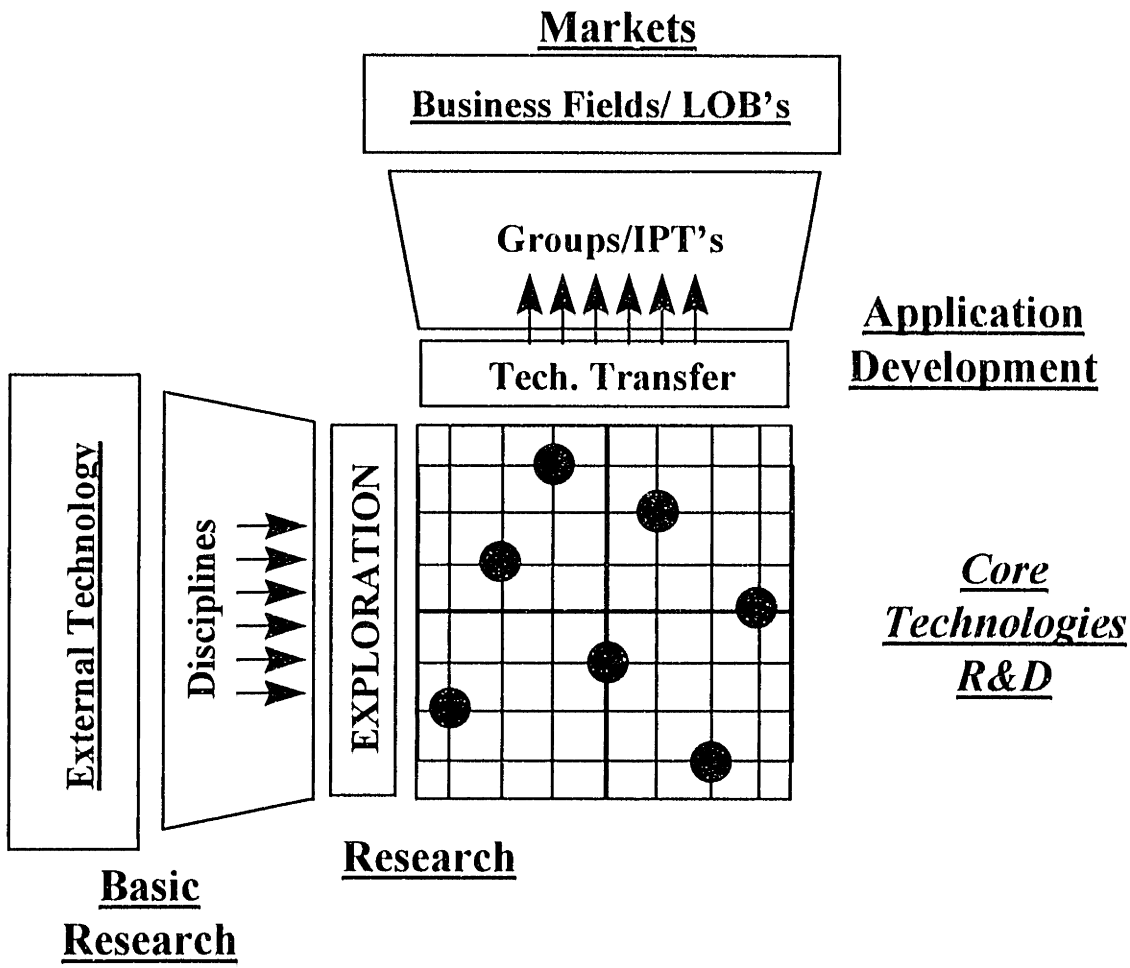
From Chester's viewpoint, if the technology needed is directly related to the companies core competencies the company should be developing it internally. If important, but not directly related to core competencies, it can likely be more efficiently obtained through external sources. Based on consideration of "organizational memory and teamwork required to make them an effective competitive weapon",[54] Chester differentiates more finely which technologies are truly within the "core-competency" category from others that are important but are termed "key-technologies". Chester's overall focus of business and technology integration (which is fundamentally similar to the previous literature reviews) is illustrated in Figure 5-5, which was copied from his paper. This figure helps to illustrate the basic integration process he describes as it was apparently employed by Siemans Corporation. Chester's specific inclusion external sources of technology in the planning process is considered an important facet of strategies for the 1990's.

An additional aspect of Chester's discussion centered on the flow of technology development from "exploration" to "transfer" into applications, and is also implied in Figure 5-5. It is important to appreciate the evolution and sequence of technology development phases in the development of technology/business strategies, and that they influence associated technology and business strategy risks.

Specifically the following phases of development and technology transfer are indicated;

- Basic research,
- Research,
- Core technology R&D,
- Application development,
- Transfer, and
- Final use in applications in the "business fields".

Figure 5-5 Conceptual Integration of External & Internal Technology[54]



The primary point being that technology transfer is the goal of any technology development being performed. Secondarily, the uncertainty of outcome inherently increases the closer you are to basic research. Communicated awareness of these realities of technology development (and associated risks) among business and technology planners is an essential foundation to a credible integration of technology within business strategies.

Another important aspect of integration strategies is the leadership role of top management. This element of management practices is discussed by **Gluck and Foster**[55] relative to management's "role in overseeing technological advance in product lines." The paper emphasized the important function of top management to define:

- What business focus technological change should pursue,

- How much risk to take,
- The balance between market opportunity-risk and technological-risk, and
- When to stop and when to redirect projects.

A complementing facet of the leadership issues was its timing. The authors correlated effective management leadership with the phases of the product development cycle. Specifically aligning types of management guidance with each of the major phases in the cycle. Most importantly emphasizing the need for the most active guidance in the study phases when the greatest and most cost-effective impact could be made on product development (i.e. before the product design was finalized and production tooling committed).

Gluck and Foster's emphasis on product development cycle phases as a setting for innovation seems particularly well aligned with the product development cycles of the industry sectors studied in this thesis. The emphasis, of this 1975 paper on the role management plays in creating a balance between market opportunity-risk and technological-risk, is a testament to the generic and timeless nature of this issue.

Last, this paper describes an additional aspect of the iterative nature of developing business and technology strategies, namely, the need to define criteria for "pulling the plug" on projects that fail to meet expectations.

The last review discussed in this section is on a book by **Betz.**[56] This author touched on two additional perspectives deemed to be complementary to the issues and practices surrounding integration of technology and business strategies.

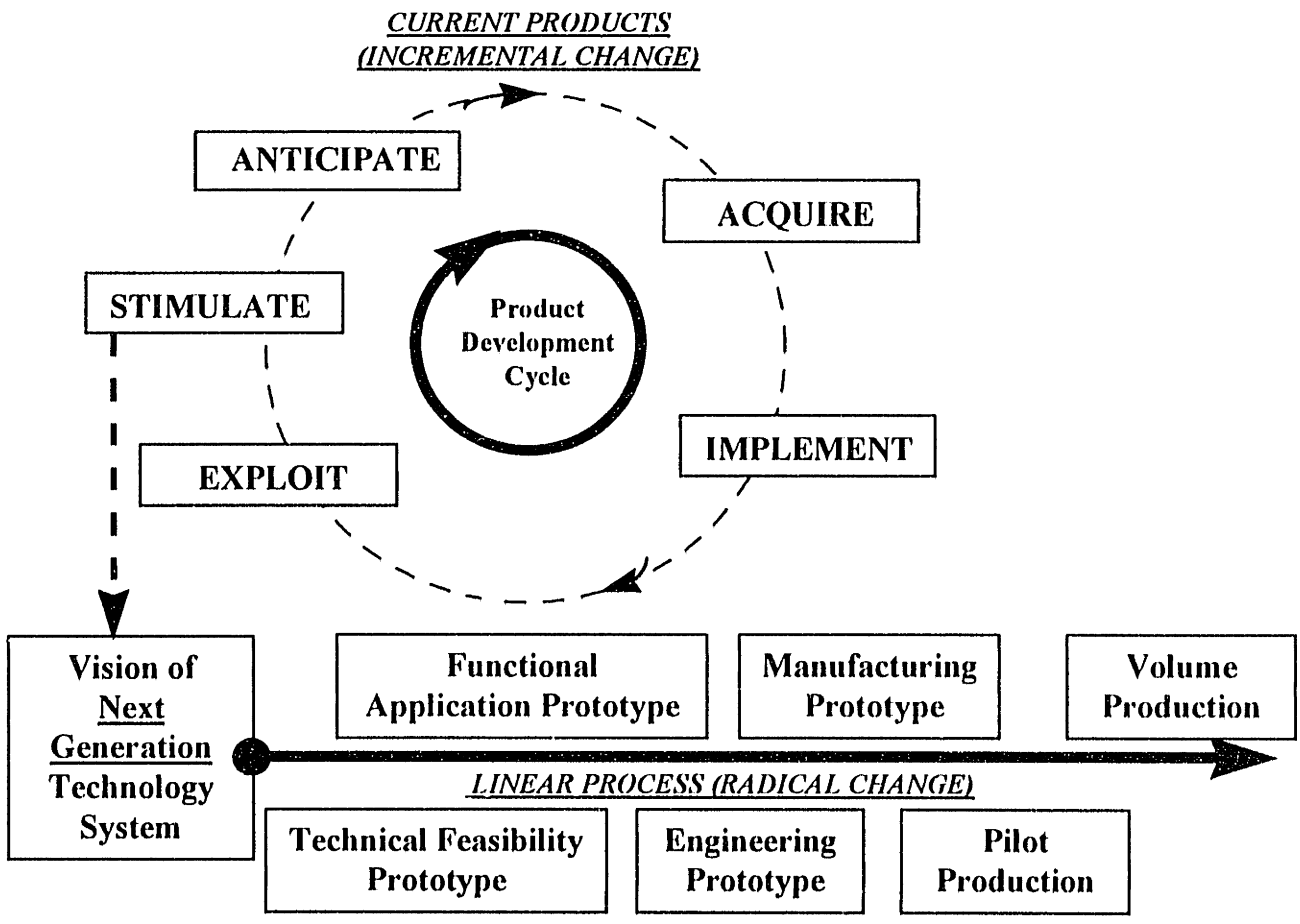
The first perspective deals with the importance of what is called the "strategic attitude" of a company. The point made by Betz is that while a "strategic plan is preparatory to a specific action, ...strategic attitude is preparatory to all action."[56] As Betz defines the term:

> "A strategic attitude prepares in general for any action by formulating a perception about the nature of action by commitment to types of action, and by preparation and training for action."[56]

The philosophical point being emphasized is that "strategic attitude" as defined above implies that sufficient communication of the business concerns must occur such that "perception" of its importance has permeated the organization. A sufficiently understood need for strategic action precedes a meaningful marshaling of employee efforts to "commit" to the needed efforts. As opposed to interfunctional "bickering" and token participation by those involved.

A second concern discussed by Betz is illustrated in Figure 5-6 which represents a model of two types of change which can occur in products; incremental and radical. Betz defines incremental change as being a "cyclical process" about an existing product, or the type of change that can be associated with the development cycle of an evolving product. In contrast, a radical change is defined by Betz to be a linear process which effects sufficient change such that the output no longer can be entirely associated with any previous product or processes. Thus, as

Figure 5-6 Model of Radical (linear) and Incremental (Cyclic) Changes in Products[56]



depicted in Figure 5-6, its associated flow of actions are more representative of actions leading to the "next generation" product or technology system.

This model of the two types of change was relevant to the literature review for two reasons. First, the management of change in both incremental or radical forms is the central issue underlying any company's ability to advance beyond their current business or technological level of existence. Thus, growth in any form (expansion or seizing new market opportunities) requires change to be implemented within the organization. A second relevancy was that this model, as depicted in Figure 5-6, helps to reinforce the earlier discussion on managing change (Tushman and O'Reilly[52]) that opened this section's review of general models found in the literature.

It is also implied in Figure 5-6, that ideas generated by the "incremental change" process may act as a catalyst for "radical change" concepts. A company atmosphere that encourages and integrates both types of change is considered a key to an effectively managed innovation process.

5.4 Summary - Literature Review

A literature review has been performed which summarized literature regarding corporate strategy development, interface issues with technology planning (R&D groups), aspects of associated organizational structure, and frameworks for the integration of technology and business planning.

The initial section focus addressed the historical mainstream evolution of overall corporate strategy development, possible interfaces with technology planning, characteristics of an effective technology or R&D group, and some associated concerns regarding social, political, and cultural perspectives.

From that initial literature review focus, an attempt was made to summarize (Figures 5-1 & 5-2) some of the important characteristics of corporate strategy development which may suffer due to a lack of effective integration and linkage between business planners and technology planners.

A final emphasis was directed to the literature which discussed issues, philosophy, specific frameworks, and tools that have been proposed to integrate technology planning with business planning and strategies. Models by Tushman and O'Reilly[52], and Goodman and Lawless[53] were discussed because they deal specifically with the overall integration of a company's strategic

context, strategic choices, and implementation of strategic action. Both provided specific models that address the integration issues of technology planners and business planners. The association of innovation with successful management and integration of technology was also discussed. The additional complexity of integrating external sources of technology acquisition and assuring effective technology transfer into products was addressed by the review centering on a paper by Chester[54]. Additional topics were discussed that amplified this discussion relative to the leadership role of top management, the balance of market and technology risk, and a philosophical point was discussed regarding a company's "strategic attitude"

The frameworks appear relevant, in all three perspectives of the literature review, to the current industry needs and practices as discussed in Section 4 - Industry Practices. However, some features and realities of the current business environment create a new context for these academic models that deserves additional attention by business management academicians. While not necessarily a list of "cons", business environment and organizational issues limit considerably the utilitarian aspects of many of the current academic models. A specific list of issues believed to need further study is provided in the conclusions found in Section 6.1.

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6. CONCLUSIONS

Introduction - A study was completed which examined management practices regarding the integration of technology planning with business planning and strategies. The primary industry focus was on the Aerospace and Defense Sector but was complemented by additional assessments of the Automotive Sector and Conglomerate Sector. These sectors were chosen because they are predominantly comprised of manufacturing companies that traditionally use a high degree of technology in their products and manufacturing processes. The scope of the study included four tasks to:

1) Provide background industry information,
2) Assess the evolution of industry business issues and strategy over the last decade,
3) Assess the current (1997) management practices regarding the integration of technology development planning with business planning and strategies, and
4) Perform a review of academic literature for relevant philosophy, models, or frameworks.

The collective objective of these tasks being to provide a foundation for assessing two related issues: (1) The adequacy of current management practices relative to the evolving industry business environment, and (2) The role of technology development and innovation in the current industry environment. In the following sub-section, final study conclusions will be documented followed by "a concluding comment". Additionally, in Appendix III an executive summary of the results of the four tasks performed (detailed in Sections 2 through 5) is provided for reference purposes.

6.1 Conclusions

Context for Discussing Current Practices - Comparison of results obtained from the industry interviews (Section 4) with the industry business and strategy trends (Sections 2 and 3) provides a basis for addressing the adequacy issue of management practices relative to the current (mid 1990's) industry environment. The industry interviews clearly indicated that the three US

industry sectors sampled were very sensitive to a business environment that has changed and evolved over the last 10-15 years. Survival in the late 1990's and into the next century, demands companies respond to issues which include intense global competition, industry over-capacity, lack of world class productivity, increased customer expectations, loss of market shares, a "market pull" environment for technology, and cost-consciousness.

In this environment, management practices regarding business planning and its integration with technology planning had indeed undergone major changes since the mid-1980's. Changes were first made to fundamental industry business structure; accelerated by the industry acknowledgment of lost market share, over-capacity, and productivity issues (starting in the mid-1980's for the Automotive Sector, and in the late-1980's to early-1990's in the Aerospace and Conglomerate Sectors). Initial objectives being to improve competitive advantage, maintain market share, and increase shareholder value.

These industry structural changes emphasized improvement of overall productivity through significant downsizing and organizational restructuring; the former to immediately lower operational costs, and the latter to increase operational efficiency and flexibility. Associated with the organizational restructuring was a marked reduction of middle management layers and an universal movement to team-management concepts to dramatically reduce product development cycles, increase productivity, and improve quality. While the customer had always been recognized as important, the new environment further emphasized customer satisfaction. In particular, obtaining a competitive advantage now centered on product differentiation through superior response to increased customer expectations; which more and more were being driven by customer demands for greater product "affordability".

This is a necessary context for understanding current management practices regarding the integration of technology planning with business planning and strategies.

Industry Technology Planning Practices - In all sectors interviewed, a consistent set of practices appeared to be in place which sought to be responsive to the new business realities. A high degree of similarity existed among all three sectors relative to their management practices regarding the integration of technology with business planning. All practices placed highest priority on understanding and aligning technology planning with business plans. The business

plans identified market opportunities that were to be pursued and this was followed by emphasizing a clear understanding of customer expectations and requirements.

At face value, the principal features of current industry technology planning processes are really not different from established "textbook" management methodology. Process elements include alignment with business plans, complete understanding of customer technical requirements, linkage and prioritization of internal technology needs with the external technology needs (i.e. 'technology gaps' from: competitor capabilities, requirements not met by current capabilities, deficiencies in current capabilities for current product lines, new capabilities for future business opportunities), proposal of technology projects to meet requirements, costing of proposals, assessment of risk, prioritization, budget limitations, final management review, and authorization to proceed.

But the process differences that did exist are substantial. They include: the focus of all technology planning on value-added alignment with customer requirements, the interaction of planning processes with the new 'team-management' groups (e.g. IPT's, Platform Teams) within the organization, an emphasis on clearly defining an internal 'business or program sponsor' for each technology project proposed, a greater emphasis on linkage between internal and external requirements, greater communication of strategies to all layers of the organization, focus on system-benefit analysis for technology R&D project justification, and the inclusion of suppliers and external technology sources in the company planning processes. All of these process elements (plus the conventional elements) provide a solid "pro" basis for declaring the current management practices to be "adequate" and adapting to the current business environment.

But, some reservations or "cons" are noted. Implementation is still evolving in the industry. Synergy of company participants in this new participative environment of planning has not been validated; e.g. consolidated companies through mergers and acquisitions, internal company restructuring of internal groups, team inputs versus functional organization inputs, supplier participation, outside technology sources. Communication issues still exist especially upward from lower layers of organizations and the encouragement/visibility/sponsorship of new innovative technology ideas. Traditional functional R&D groups appear to be disappearing or becoming part of specific program organizations as traditional matrix organizations are restructured to emphasize value in terms of known business activities. R&D efforts may have

become overly short-term in their scope with a potential loss of 'critical mass' in generic technology development as value-added current program technology issues are emphasized to increase shareholder value. Additionally, in this environment a concern is raised regarding the scope of industry technology development and its balance between short-term needs and long-term needs for future business opportunities.

Role of Technology - Part of the changing business environment is related to the role of technology in business strategy. The study repeatedly focused on the fact that product development had shifted from a "technology-push" design environment to a "market-pull", technology as-required environment. In current practices, technology development proposals are subject increasingly to a system-benefit comparison to other product or program needs, which in fact may not be technology related (e.g. distribution channels). But, from a systems perspective, resolution of these non-technology needs may contribute more to meet the overall affordability goals of the customer than will proposed technology development.

Therefore, for the foreseeable future it is likely that R&D projects will continue to require direct program or business sponsorship, and a clear system-based benefit justification if they are to be funded. This does not take away from the fundamental need to maintain a technical core competency. That is still the foundation upon which the industry is built, but it is now recognized as only one of many such foundation members deemed to be important to a program's success.

The industry practices have indeed adapted to changing business environment and appear to be properly focused. Industry results measured by shareholder value would indicate success. But, concerns exist regarding industry's long-term ability to sustain that success. If technology development is de-emphasized or fragmented due to a short-term planning emphasis, the 'critical mass' of technology 'experts' may not be sustained in currently restructured organizations (i.e. program emphasized, team dominated). If that happens, companies may find that they no longer are adequately supporting their core technical capabilities which,while not sufficient, are still necessary to maintain their competitive advantage.

Academic Frameworks - Some conclusions were made on the adequacy of reviewed academic literature regarding management of technology, and the integration of technology planning with business planning. From a "pro" perspective, a strong case can be made that the basic processes underlying the practices discussed are more than adequately covered by the

existing body of literature. In this thesis, as detailed in Section 5, significant insight and guidance can be found in a variety of books and articles which outline all aspects of the technology planning processes described by industry interviews.

However, some features and realities of the current business environment create a new context for these academic models that deserves additional attention by business management academicians. While not necessarily a list of "cons", business environment and organizational issues limit considerably the utilitarian aspects of many of the current academic models. To promote greater applicability and efficiency of current academic models, the following issues are suggested as a basis for additional academic study and model development:

Technology Planning - Issues Suggested for Additional Academic Study
• Technology planning which is performed by a multi-functional team that includes non-technical participants and outside organizations such as suppliers,
• Organizational issues occurring when no functional responsibility exists outside of 'product or platform teams' or 'lines of business' for technology planning;
• Organizational issues caused by mergers or acquisition where multiple technical groups in different locations must interact in technology planning,
• Technology planning that occurs in teaming environments that are program focused but involve multiple companies and perhaps multiple cultures,
• Lack of sufficient tools or methodology to adequately quantify technology development risk or uncertainty of success,
• An excessive burden of data gathering for such things as 'innovation audits', 'Benchmarking', 'technology gaps', etc. (Models are needed that narrow technology options through initial screening based on early integration with evolving business plans),
• The role of executive leadership in providing adequate definition of strategic mission, vision, and candidate business opportunities to technology planners,
• Communication of planning and strategies to all employees and its fundamental relation to organizational alignment for successful implementation,
• Role of idea generation at lower levels of the organization in technology planning processes,
• Relation of organizational funding sources for R&D planning to overall process efficiency, and
• Better understanding of short, near, and long-term planning in the current global environment.

A Concluding Comment

I believe a central industry failing is not the identification of new or innovative technology, but the lack of useful planning information among the technical and non-technical personnel, managers, and executives *needed to assess technology benefits*. Pre-planning information is needed to foster an internal mutual understanding of a company's business goals, competition realities, technology capabilities, and financial constraints. When such information is missing, it prevents realistic or proactive discussion of the use of (or need for) technology development to achieve business objectives.

Up-front objective criteria, for establishing a minimum required impact on business goals, are typically not defined to guide technology development planning. In such organizational environments, technology is perceived to independently evolve via isolated researchers, and then a reactive attempt is made to fit what is available to the current business need. Industry needs to turn that around --- project a customer need and define a consensus technology strategy aimed at timely (short, near, and longer-term) technology development ***clearly identified by strategic intent to provide a competitive marketplace advantage***.

The practices and frameworks reviewed seem to be moving in that direction. But, the use of competitive advantage criteria, clearly defined and proactively discussed as a precursor to definition and initiation of technology development still seems lacking. It would seem to be the one company agreed upon, market-driven, focus that would create alignment among researchers, program management, functional management, and executives, and ***permit consensus agreement on the specific strategic actions needed to meet business objectives***.

In today's global competitive environment, US industry can not afford the luxury of internal isolation and loss of productive participation that the lack of such criteria creates in the technical communities of its companies. ***The development and communication of such criteria must be considered a mutual and fundamental "core-responsibility" of a company's executive business and technology leadership.***

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APPENDIX I

KEY CHARACTERISTICS OF INDIVIDUAL COMPANY STRATEGIES

Table I - General Electric - Key Characteristics of Strategy (Mission & Growth)[1,14,15]

COMPANY	End of Year	VISION/MISSION	STRATEGY FOR GROWTH
General Electric "...our combination of different business cultures and shared values gives GE the ability -and flexibility - to win in world markets." John F. Welch; CEO & Chairman Employees: 304,000 (81% U.S.)	**1985** "... increasingly more competitive 1980's..... era of greatly intensified worldwide competition.." " ..positioning for the future.."	• 15 critical businesses; grouped into **3 circles** – core manufacturing, technology, and services • being number 1 or 2 in market share • company and businesses must change faster than the world around it. • compete successfully in world markets • **Shared Values** include: > excellence; measured by customer satisfaction > change accepted as a rule rather than exception > open, candid, interactive continuous communications; key to trust, commitment > effective leadership; manage paradox > dynamic resource allocation process	• divest businesses that don't fit GE's future; strengthen productive capabilities of core areas: > core manufacturing; commanding or leading market position; investment for growth > core technology; synergistic acquisitions & investment in R&D > core services; grow by adding entrepreneurial people and making related acquisitions • outside "**circles**"; support core businesses • outside "**circles**"; contain GE Ventures • 70% of earnings come from technology and services • commitment to maintain worldshare
General Electric **"a boundaryless company"** ohn F. Welch; CEO & Chairman Employees: 298,000 (79% U.S.)	**1990** "...GE is picking up speed and with that speed a competitive advantage."	• a boundaryless company > suppliers are trusted partners in process > customers are the lifeblood of a company	• work out, self-confidence, boundaryless, speed • all employees satisfy customer needs • internal functions blur; they form a team • customer service is everybody's job • wring out NIH from the culture • raise the bar of excellence another notch • search around the world for better ways
General Electric " ..company focusing on huge growth opportunities as we look to the millennium" "... a company intent on getting bigger..." John F. Welch; CEO & Chairman Employees: 222,000 (68% - U.S.)	**1995** ... seize five of the biggest growth opportunities in our history..."	• creation of a new kind of company • shape a global enterprise • create in GE - spirit and soul of a small company • seize 5 of the biggest growth opportunities: > globalization > new products > information technology > installed-base service > quality • majority of GE revenue from outside U.S.	• No.1 or No. 2 - fix, sell, or close; restructuring • Self-confidence, simplicity, speed • "Work-Out" - Involve everyone; > management selection and training • boundaryless behavior; > endless search for best practices > looking outside the traditional boundaries • "stretch"; beyond being as good as you have to be • compensation; stock options - company performance > more significant than salary/bonus growth

Table II - United Technologies (UTC) - Key Characteristics of Strategy (Mission & Growth)[16,17,3]

COMPANY	End Of Year	VISION/MISSION	STRATEGY FOR GROWTH
United Technologies Corporation (UTC) "...leader in four large and growing markets - aerospace, defense, building and automotive" Robert J. Daniell; CEO Harry J. Gray, Chairman Employees: 193,000	1985 "...will expand our position in these markets by being more efficient, aggressive and innovative. ....because of the excellence of our employees."	•strength and position in core businesses •expand position in 4 core markets •position for sustained profit growth •generate a superior return on equity •provide excellence in products and services •be more cost-effective •orderly growth in sales and earnings •assure that United Technologies is "united"	•confirm the strength of core businesses •identify operations that do not fit long-term objectives •reduce number of personnel and overhead •identify opportunities for improved profits •integrate our technical and managerial skills more effectively •be more efficient, aggressive, innovative •involve employees; productivity improvement and growth efforts
United Technologies Corporation (UTC) "...will continue to grow because our core businesses are market leaders and because we are well positioned in international markets." Robert J. Daniell; CEO Chairman Employees: 193,000	1990 "The globalization of the aerospace industry offers tremendous opportunities.... International partnerships and business alliances are critical to gaining entry to these markets."	•core businesses are market leaders •growth opportunities in international markets •sustain global growth •globalization of the aerospace industry •strict code of ethics	•international partnerships •international business alliances •focus on Europe and Pacific Rim •reduce reliance on U.S. defense contracts; fixed price programs •implementing cost reduction and asset management programs •instituting performance improvement initiatives •invest prudently in research and development and capital assets
United Technologies Corporation (UTC) "UTC businesses are number one or two in all industries in which they compete, yet they continue to remake themselves in 1995....." George David; CEO Robert J. Daniell, Chairman Employees: 171,000	1995 "...globe spanning corporations like UTC ....with their ability to transfer technology, invest globally, open new markets and develop new products, will be disproportionately successful in the increasingly competitive world economy of the decades ahead."	•core businesses are market leaders •growth opportunities in international markets •sustain global growth; "Be There First" •globalization of the aerospace industry •only acquisitions that support core businesses •greater productivity and profitability •strict code of ethics •emphasis on diversity •commitment to safety and environment •better work force through education	•first into developing markets •double Joint Ventures by year 2000 •strengthen core businesses - acquisitions and alliances •focus on Europe and Pacific Rim •process re-engineering & Kaizen •educated work force; on job learning •encourage self development; for "employment security" •reaffirmed traditional commitments to employees •corporate advertising "Be There First"

Table III - Ford Motor Company - Key Characteristics of Strategy (Mission & Growth)[19,7]

COMPANY	End of Year	VISION/MISSION	STRATEGY FOR GROWTH
Ford Employees:	**1985**	•	•
Ford "Meeting the intensifying competition of the 1990's" Harold A. Poling; Chairman Philip E. Bentron Jr.; President Employees: 368,500 (49% U.S.)	**1990** "Our challenge is to achieve process improvement that leads to better quality and efficiency throughout the company."	• two core businesses; automotive and financial services • showroom competitive advantage; innovative/appealing products • reduced time and cost to bring new products to showroom • be low-cost producer; high-quality vehicles worldwide • be competitive in engineering, production, and distribution costs • earn owner loyalty and ensure total buying experience • use advanced technology, employees skills and knowledge • meet tougher vehicle emissions and safety regulations • sound product and strategic plans • strength of management & dedicated employees • partnership with suppliers and dealers; commitment to excellence • shorten launch time and cost of new vehicles • introduce new vehicles; N. America, Europe, Asia-Pacific	• commitment to training, education, skills enhancement • divested Ford Aerospace & reduced farm/industrial equity • acquisition of Jaguar Limited in the UK • significant investment for new products; world capital funding • improve productivity with quality our first priority (TQE) • achieve >30% profits/year from financial services • modernization of facilities in next 5 years • early interaction of suppliers in new product development • flexibility of modular design and manufacturing concepts • using advanced applications of CAD, CAE, and CAM • analytic simulations rather than prototype & for ergonomics • Ford's Alpha Organization; world class & competitive costs • Alpha Manufacturing Technology Center; pilot projects
Ford "[improvement]... essential for us to continue to be successful in an increasingly competitive global industry" Alex Troutman; Chairman Employees: 346,990 (53% U.S.)	**1995** "The changes we've made are designed to make breakthrough improvements particularly in cost, efficiency, quality, product excellence and customer satisfaction."	• leverage global resources; become world's leading auto company • Ford environment of shared knowledge & continual learning • be lean and fast moving • lower cost and create greater value; for customer satisfaction • increase sales; major force in new/emerging & mature markets • profitable growth; maximize ROI; major changes are behind us • maximize shareholder value through product excellence • remain a world class competitor in financial services • strengthened dealer relationships to boost customer satisfaction • customer service rather than merchandising parts • 'Ford 2000' reorganization; one global automotive organization	• cost reduction strategy; operate more efficiently, reduce product complexity, eliminate waste and streamline processes • record wave of vehicle launches • growth in new markets • empower small teams; leverage world resources; best practices • increase new products by 50%; cut development time by 1/3 • reduce costs; product spending as percent of revenue declines • transform Ford; single set of worldwide processes and systems • 'One World One Team'; few layers management/ bureaucracy • 'stretch targets' to reduce costs and improve quality • leadership training school for dealers and their employees • reorganized Ford Service Division; customer focus

Table IV - Chrysler - Key Characteristics of Strategy (Mission & Growth)[20,21,5]

COMPANY	End of Year	VISION/MISSION	STRATEGY FOR GROWTH
Chrysler "...expanding, diversifying, and becoming more complex. ...no longer just a North American automotive company." Lee A. Iacocca; CEO & Chairman Employees: 114,200 (78.4% U.S.)	**1985** "...actively diversifying to help the Company grow, to strengthen the car and truck business, to increase non-automotive earnings, to reduce exposure in economic downturns, and to increase shareholder value."	• diversify for strength; supplement core automotive areas > shareholder value, growth, broaden base of operations > target new growth areas financial services, aerospace • leading high technology manufacturer in the world • lowest cost producer; highest profit per unit • new technology/concepts & new financial strength > revolutionize the relationship of people and machines > world class quality, cost, and technology • competing to win; cost competitive with Japan • flexibility and entrepreneurial freedom to compete • provide products consumers want • modern capacity; to be tough, competitive, profitable • stronger foreign relationships • personnel have skills to use technology effectively • speak out on national issues of concern to industry	• major corporate reorganization; flexibility to manage diverse businesses; more decentralized structure • divide into four Chrysler operational groups; Motors, Financial Corporation, Gulfstream Aerospace, and Technologies • long range product plan to 1990 • establish closer relationship overseas > Mitsubishi, Samsung, Maserati, Lotus agreements • drive for higher quality and productivity • **Liberty Project**; challenge every aspect of the design, engineering, and manufacturing of vehicles > modular: save cost, raise quality, reduce complexity • increased product and capital spending program • purchase Gulfstr ; expanding aerospace and defense • increased significantly technical training
Chrysler "...produce world-class vehicles that are in sync with our customers' wishes." Lee A. Iacocca; CEO & Chairman Employees: 124,000 (72% U.S.)	**1990** "...new organization structure.... to keep Chrysler on course and moving forward. ...with exciting, top-quality new products and a lean approach to doing business."	• core automotive and financial service business • highest quality, lowest cost producer • customer satisfaction • produce world-class vehicles • operate like small companies; no bureaucracy • inroads in world markets • broad competitively priced product line • innovation and continuous improvement • "whole car" approach • flexibility in work schedules with unions • more affordable cost structure	• long-range product plan; LH sedan launch 1992 • new organization structure; sell Gulfstream, MMC • reorganized development into "**Platform Teams**" > trust, respect, and risk-taking; broader buy-in > a systems approach; an integrated package > team responsible; knows goal; suppliers in team • **Chrysler Technology Center**; development teams > close to labs; faster better technology transfer • reduce excess capacity; cost reduction program • cut salary work force, Mfg. Operations & product lines • training employees; new systems and tooling
Chrysler " Creating and distributing shareholder value: ...in a position to maximize both." Robert J. Eaton, CEO & Chairman Employees: 91,000	**1995** "...new corporate culture embraces change faster and more eagerly than our competitors." "...put customers first...our dealers and our suppliers are partners..."	• focus is on creating value; core automotive business • customer-driven product-creation process • new company culture for competitive advantage > inspired, empowered workforce teams • aggressive capital expenditure program • aggressive vehicle development program • expansion overseas continues to evolve • investing in people	• financial stability > pay down debt, fully funded pension plan • aggressive product development program • focusing on quality; reducing costs • continuously improving operations & processes • develop our international markets • maintain sustainable dividends & strong balance sheet

Table V(a) - Lockheed evolution to Lockheed-Martin - Key Characteristics of Strategy (Mission & Growth)[22,23,8]

COMPANY	End of Year	VISION/MISSION	STRATEGY FOR GROWTH
Lockheed ".....we intend to be a formidable competitor" Lawrence O. Kitchen; CEO and Chairman Employees: 87,800 (98.6% in U.S.)	**1985** "[We have]..... a solid foundation for our pursuit of new opportunities in a very competitive marketplace."	• maintain competitive position in the aerospace industry • technology leadership critical to nation's defense programs • ensure profitable growth in future • leadership, direction, innovation in a dynamic environment • improve financial position	• continue R&D spending to support programs • continue investment in plant and equipment • build capabilities in electronics and communications development and production • increasing investment in new business efforts • support facilities for advanced aircraft development > radar signature, weapon system simulation • "skunk works" for classified aircraft development
Lockheed "premier aerospace company" Daniel M. Tellep; CEO & Chairman Employees: 73,000	**1990** "..picture gratifyingly different from a year ago."	• remain primarily a defense contractor • focus on core businesses • emphasize profitability over growth • sharpen competitiveness • pursue skill-related opportunities • greater shareholder value • progressive corporate governance	• reduce dependence on defense from 74 to 60% • consolidate core businesses; divest others • move into new, but closely related businesses • leverage our core skills • Improve financial performance • reduce capital spending; equal to depreciation • reduce our debt to capital ratio to <33% • maintain strong cash flow • reduce operational costs; improve efficiency • trim 10,000 employees
Lockheed Martin "..opening a new chapter in the future of our industry." Daniel M. Tellep; Chairman Norman R. Augustine; President and CEO Employees: 160,000	**1995** " 'Mission Success' ...to achieve superior performance and total customer satisfaction..."	• total system solutions; unmatched by competitors • reinforced position in U.S. military aircraft • continue to expand internationally • strengthened information systems business • improve competitive position in defense electronics business • maintain role as DOE's largest service provider • gain greater presence in environmental remediation business • enhance international business base (>15% sales)	• review business portfolio • corporate wide consolidation plan > maximize efficiencies > improve global competitiveness > expand long term employment prospects > enhance shareholders value • increase economies of scale • broadly leverage best practices • capitalize on corporate wide synergy > centralized procurement > consolidate 5 into 3 laboratories > establish 8 centers of excellence • leveraging our financial strength

Table V(b) - Martin-Marietta evolution into Lockheed-Martin - Key Characteristics of Strategy (Mission & Growth)[24,25,8]

COMPANY	End of Year	VISION/MISSION	STRATEGY FOR GROWTH
Martin "..continue to redefine the scope of Martin Marietta's future. ...in response to changing conditions in traditional markets for defense and space systems." Thomas G. Posenall; Chairman and CEO Employees: 66,000	**1985** "...young program mix, excellent technology base, and strategic emphasis on information systems, ...key to continued growth."	• concentration on technology intensive businesses > aerospace, information systems, materials • extension of competence to developing growth markets • increase non-aerospace government programs • increased productivity and lower cost • maintain highest level of quality • very best company in the aerospace sector • young program mix, excellent technology base • emphasize information/communication systems	• reduce exposure to cyclical base industries; commodity interests • aggressive pursuit of new businesses • reduced debt-to-capitalization ratio • restructure into core technology businesses • broaden space and defense program base • reduce cost, increase productivity, maintain high quality • invest in technologies which are foundation of future growth • equity investment to strengthen our array of technologies • commit resources to maximize winning programs • major expansion of Corporation's R&D center
Martin "..opening a new chapter in the future of our industry... ...enters 1991 in a strong competitive and financial position.." D. Tellep; Chairman N. Augustine; Pres. and CEO Employees: 65,500	**1990** "...long history of product quality and devotion to mission success, a carefully built strategy, a focus on addressing future customer requirements...."	• preeminent position; space and defense electronics • strengthen the balance sheet; concentrate on core businesses & core capabilities > expand businesses into information systems > expand businesses into systems integration > expand into non-defense areas • highest standard of ethical conduct • broad program mix on high priority programs	• capitalize on preeminent position in space and defense electronics • accelerate growth in the aggregates business • take advantage of defense acquisition and consolidation opportunities • expand into appropriate non-defense government markets • pursue non-defense acquisition opportunities related to core areas • reduce overhead; strengthen competitive position • divestiture of commercial real estate holdings in Florida
Lockheed Martin "..opening a new chapter in the future of our industry." Daniel M. Tellep; Chairman Norman R. Augustine; President and CEO Employees: 160,000	**1995** " 'Mission Success' ...to achieve superior performance and total customer satisfaction..."	• total system solutions; competitive advantage • reinforced position in U.S. military aircraft • continue to expand internationally • strengthened information systems business • improve competitive position in defense electronics business • maintain role as DOE's largest service provider • gain greater presence in environmental remediation business • grow international business base (>15% sales)	• review business portfolio leveraging our financial strength • corporate wide consolidation plan > maximize efficiencies, improve global competitiveness > expand long term employment prospects, shareholders value • increase economies of scale • broadly leverage best practices • capitalize on corporate wide synergy > centralized procurement > consolidate 5 into 3 laboratories > establish 8 centers of excellence

Table VI - Boeing - Key Characteristics of Strategy (Mission & Growth)[26,27,10]

COMPANY	End of Year	VISION/MISSION	STRATEGY FOR GROWTH
Boeing "Boeing products are well suited to airline requirements over the next ten years." T. A. Wilson; Chairman and CEO; Shrontz; Pres. Employees: 104,000	**1985** "..market conditions and technological advances would converge in the early 1990's for an all-new commercial airplane [7J7]...."	• products suited to airline requirements over next 10 years • highest priority; quality in design and manufacturing • future emphasis on electronics and systems • basic Ethics Creed; highest ethical standards • enhance company's competitive position • position for future commercial and government programs	• 'family concept' for aircraft models • purchased deHavilland Aircraft of Canada; commuter aircraft • acquisition of government contracts aligned with future programs • train employees in skills required by new technology • intense cost-reduction effort initiated; **Operation Eagle** • maintain quality in design and manufacturing • study various approaches to enhancing strength in electronics
Boeing "[Our mission].. be the number-one aerospace company in the world, ...quality, profitability, and growth." Frank Shrontz; Chairman and CEO; Condit; Pres. Employees: 160,000	**1990** "75th year...proud of our past – excited about our future..... the 1990's may prove to be the most innovative and productive period in Boeing history."	• build for the future; understand the long term objectives • improve the use of our human resources; teamwork • more focused and efficient approach to achieving goals • develop new products and technology • continue 'family concept' for aircraft models • 777; set new standard for engineering excellence • share in commercial transport market; to 2005 ($460B) • commit to a profitable defense and space business sector > reorganized into single profit and loss center > successful performance; win high priority programs • continuous improvement; meet customer expectations	• development of 777; cost effective and efficient manner • launched new commercial widebody twinjet; Boeing 777 • 777; demonstrate better process for design/building aircraft • flight test prototype for the Advanced Tactical Fighter (ATF) • improve our performance in defense and space operations • improve productivity and increase capacity • invest in new equipment and facilities and R&D • expanding training programs for all employees • divesting of deHavilland division of Boeing Canada • expand capacity; while maintaining high standards of quality • simplify organization structures; **'design build teams' (DBT)** • steady incremental improvements; every aspect of processes
Boeing "Our goal in every product sector is to be the value leader of our industry." Frank Shrontz; Chairman; Condit CEO and President Employees: 117,000	**1995** " ..we need great leaders at every level – men and women who can coach and inspire and encourage the spirit of working together."	• deliver superior products in less time at lower cost • maintaining access to foreign markets • deliver more value to customers than anyone else can • positioned to compete in space and defense operations • increase market share in space and defense • increase electronics and systems capabilities • simplify the way we design, build, support airplanes • maintain quality, performance and reliability of products • cut waste and improve productivity • people key to driving change in organization • seek better ways to tap skills and creativity of work force • committed to continuous improvement and learning	• continue the 'family concept' for aircraft models • delivered first 777 to United Airlines • emphasis on reliability, efficiency, and comfort • improve customer service; 'best in business' customer support • 'one stop shopping' for customer support; spares, training, field • demonstrate abilities as large scale systems integrator • perform well on major defense and space operations • reduce employment to desired levels for increased productivity • improve the way we select, train, and promote managers • work with other countries; develop and improve their industry • open offices in China and India

Table VII - McDonnell Douglas Corporation - Key Characteristics of Strategy (Mission & Growth)[28,29,12]

COMPANY	End of Year	VISION/MISSION	STRATEGY FOR GROWTH
McDonnell Douglas ".....prepare carefully and vigorously for the few major combat aircraft programs expected to be launched in the next 10 years." S. McDonnell; Chairman/CEO Employees: 97,067	**1985** "Vitality is apparent in the variety of work being done to prepare for new programs."	• organizational self renewal; **'Five Keys'**; strategic management, participative management, human resource management, quality/productivity, ethics • commit to ethical , reliable, and efficient performance • compete successfully in new aerospace programs • committed to MDC's future in information systems • produce MDC aircraft at the lowest cost; high quality • broaden capabilities and uses of MDC aircraft • overseas sales of military and commercial aircraft • profitable niches; array of civil/military transports	• cost control; investments in plant, facilities, staff • reshape debt structure • improve combat aircraft lines; F-15, AV-8B, F-18, AH-64 • maintain a broad range of major combat aircraft programs • strengthen current products; invest in associated facilities • product enhancements; broaden aircraft capabilities/uses • collaboration with overseas aerospace manufacturers • launch MD-87, continue C-17 development • co-production agreements with China for MD-80's • solicit airlines for potential 1989 launch of MD-11
McDonnell Douglas "Great products are only one of the marks of a great company. ....prove that we can provide operating and financial performance that is equal to the performance of our products....." J.F. McDonnell; Chairman/CEO Employees: 121,190	**1990** "near term, we must find ways to generate and conserve cash..." "[While we]... look years and even decades ahead ....the importance of winning each competition has grown."	• invest in new military programs (ATF, LH,C-17) • new programs represent the future of the corporation • redefine cost structure of corporation • position for aerospace downturn; product mix/variety • broad set of capabilities; use in pursuing new business • continue to improve operating performance • tap full talents and energy of all our people • restructure organization; teamwork/leadership focus • continue to invest in new commercial aircraft • launch a long range competitor to 747; MD-12X • pursue international military/civil aircraft sales	• trim $700M from cost structure; reduce worker by 14,000 • ration R&D expenditures and capital investments in 1991 • sell nonessential assets divest information systems units • improved performance; productivity on MD-80 >30% • company money for initial phase of new military programs • first flight certification; first deliveries MD-11 • completion of assembly of first C-17 • MD-80 deliveries increased; 900 fewer workers • Total Quality Management System; reduce inventories • strip away bureaucracy and autocracy at all levels • investigate risk-sharing partners for MD-11
McDonnell Douglas "[Partnership efforts] ..key to achieving the goal of making our products more affordable and desirable to our global customers." John McDonnell; Chairman, Harry Stonecipher; President and CEO Employees: 63,612	**1995** "...advancing technology will lead to new thresholds of affordability and opportunity." "...affordability a matter of paramount concern for all of our military customers.... the airlines, and other commercial customers."	• increase share of US/global defense procurements • grow faster than competitors in launch business • revitalize our commercial aerospace business • 3 success foci; affordability, innovation, partnerships • affordability; changes in the way we operate • greater value to customers; increase shareholder value • most technologically advanced products at lowest cost • win new business but meet previous commitments • abandon "go it alone" and "not invented here" habits • gain a competitive advantage using cooperative efforts • employee support; closer alliances through all levels • keep promises to customers; meet/exceed expectations	• **IPDT's (integrated product development teams)**; make our products simpler, less costly to manufacture/assemble • teams; develop innovative solutions to complex problems • **Employee Performance Incentive Plan**; incentive income • re-engineering design, manufacturing , business processes • new inventory, purchasing, data management systems • advanced manufacturing processes; analytic simulations • work closely with customers/suppliers in design process • training and equipping employees better • unique modular assembly; reduce costs and cycle time • flexibility to address each customers specific needs • improved economics at low prod. rates; cellular concepts

APPENDIX II

INDUSTRY CONCERNS FRAMED FROM COMPANY STRATEGIES

Table I (1 of 3) 1985 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1985 Strategy Overview	GE	UT	F	C	L	M	B	MD
1. Clear Business Focus									
	15 critical businesses; 3 core circles; mfg., tech, and services	X							
	divest businesses that don't fit; strengthen core productivity	X							
	synergistic acquisitions & investment in R&D	X							
	strength and position in core businesses		X						
	identify operations that do not fit long-term objectives		X						
	diversify for strength; supplement core automotive areas				X				
	purchase Gulfstream; expanding aerospace and defense				X				
	restructure into core technology intensive businesses						X		
	broaden space and defense program base						X		
	study various approaches to enhancing strength in electronics							X	
	committed to MDC's future in information systems								X
2. Compete Worldwide (with reduced opportunities)									
	be1 or 2 in market share; compete successfully in world markets	X							
	co. & businesses must change faster than the world around it.	X							
	be more efficient, aggressive, innovative		X						
	world class quality, cost, and technology				X				
	competing to win; cost competitive with Japan				X				
	flexibility and entrepreneurial freedom to compete				X				
	modern capacity; to be tough, competitive, profitable				X				
	Liberty Project; challenge every aspect of the design, engineering, and manufacturing of vehicles				X				
	maintain competitive position in the aerospace industry					X			
	extension of competence to developing growth markets						X		
	commit resources to maximize winning programs						X		
	highest priority; quality in design and manufacturing							X	
	enhance company's competitive position							X	
	position for future commercial and government programs							X	
	'family concept' for aircraft models							X	
	acquire government contracts aligned with future programs							X	
	intense cost-reduction effort initiated; Operation Eagle							X	
	compete successfully in new aerospace programs								X
3. Growth Opportunities (need international markets)									
	long range product plan to 1990				X				
	stronger foreign relationships				X				
	establish closer relationship overseas				X				
	target new growth areas financial services, aerospace				X				
	increasing investment in new business efforts					X			
	aggressive pursuit of new businesses						X		
	increase non-aerospace government programs						X		
	purchased deHavilland Aircraft of Canada; commuter aircraft							X	
	broaden capabilities and uses of MDC aircraft								X
	overseas sales of military and commercial aircraft								X
	profitable niches; array of civil/military transports								X

Table I (2of 3) 1985 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1985 Strategy Overview	GE	UT	F	C	L	M	B	MD
4. Customer Expectations (& satisfaction of customers)									
	provide excellence in products and services		X						
	be more cost-effective		X						
	drive for higher quality and productivity				X				
	provide products consumers want				X				
	maintain highest level of quality						X		
	products suited to airline requirements over next 10 years							X	
	maintain quality in design and manufacturing							X	
	organizational self renewal; 'Five Keys'; strategic management, participative management, human resource management, quality/productivity, ethics								X
	commit to ethical , reliable, and efficient performance								X
	produce MDC aircraft at the lowest cost; high quality								X
5. Technology & Innovation (timely, applied, & affordable)									
	outside "circles"; support core businesses	X							
	adding entrepreneurial people and making related acquisitions	X							
	leading high technology manufacturer in the world				X				
	new technology/concepts & new financial strength				X				
	revolutionize the relationship of people and machines				X				
	increased product and capital spending program				X				
	technology leadership critical to nation's defense programs					X			
	continue investment in plant and equipment					X			
	build capabilities in electronics and communications development and production					X			
	continue R&D spending to support programs					X			
	support facilities for advanced aircraft development					X			
	"skunk works" for classified aircraft development					X			
	emphasize information/communication systems						X		
	reduce cost, increase productivity, maintain high quality						X		
	invest in technologies which are foundation of future growth						X		
	equity investment to strengthen our array of technologies						X		
	major expansion of Corporation's R&D center						X		
	future emphasis on electronics and systems							X	
6. Human Resources (skill and knowledge levels)									
	integrate our technical and managerial skills more effectively		X						
	involve employees; productivity improvement & growth efforts		X						
	personnel have skills to use technology effectively				X				
	increased significantly technical training				X				
	basic Ethics Creed; highest ethical standards							X	
	train employees in skills required by new technology							X	

Table I (3of 3) 1985 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1985 Strategy Overview	GE	UT	F	C	L	M	B	MD
7. Growth/Shareholder Value (sustained/maximum profits)									
	investment for growth	X							
	position for sustained profit growth		X						
	orderly growth in sales and earnings		X						
	generate a superior return on equity		X						
	reduce number of personnel and overhead		X						
	identify opportunities for improved profits		X						
	shareholder value, growth, broaden base of operations				X				
	lowest cost producer; highest profit per unit				X				
	ensure profitable growth in future					X			
	leadership, direction, innovation in a dynamic environment improve financial position					X			
	increased productivity and lower cost						X		
	reduce exposure to cyclical base industries; commodity interests						X		
8. Appropriate Structure Alignment/Attitude of Co. (how to organize for strategy) (communication for change)									
	Shared Values; excellence, change, communications, leadership	X							
	assure that United Technologies is **"united"**		X						
	corporate reorganization; flexibility to manage diverse businesses; more decentralized structure				X				

Table II (1 of 4) 1990 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1990 Strategy Overview	GE	UT	F	C	L	M	B	MD
1. Clear Business Focus									
	core businesses are market leaders		X						
	confirm the strength of core businesses		X						
	identify operations that do not fit long-term objectives		X						
	two core businesses; automotive and financial services			X					
	divested Ford Aerospace & reduced farm/industrial equity			X					
	acquisition of Jaguar Limited in the UK			X					
	core automotive and financial service business				X				
	new organization structure; sell Gulfstream, MMC				X				
	remain primarily a defense contractor; focus on core businesses					X			
	pursue skill-related opportunities; leverage our core skills					X			
	consolidate core businesses; divest others					X			
	move into new, but closely related businesses					X			
	preeminent position; space and defense electronics						X		
	strengthen balance sheet; core businesses & core capabilities						X		
	expand businesses into information systems/systems integration						X		
	expand non-defense areas; acquisition opportunities core areas						X		
	divestiture of commercial real estate holdings in Florida						X		
	build for the future; understand the long term objectives							X	
	commit to a profitable defense and space business sector							X	
	reorganized into profit and loss centers							X	
	divesting of deHavilland division of Boeing Canada							X	
	position for aerospace downturn; product mix/variety								X
	new programs represent the future of the corporation								X
	sell nonessential assets divest information systems units								X
2. Compete Worldwide (with reduced opportunities)									
	suppliers are trusted partners in process	X							
	teams work out, self-confidence, boundaryless, speed	X							
	raise the bar of excellence another notch	X							
	search around the world for better ways	X							
	reduce number of personnel and overhead		X						
	identify opportunities for improved profits		X						
	be more efficient, aggressive, innovative		X						
	involve employees; productivity improvement & growth efforts		X						
	reduced time and cost to bring new products to showroom			X					
	be low-cost producer; high-quality vehicles worldwide			X					
	be competitive in engineering, production, distribution costs			X					
	showroom advantage; innovative/appealing products			X					
	use advanced technology, employees skills and knowledge			X					
	partnership with suppliers and dealers; commitment excellence			X					
	early interaction of suppliers in new product development			X					
	improve productivity with quality our first priority (TQE)			X					
	Alpha Manufacturing Technology Center; pilot projects			X					
	highest quality, lowest cost producer; broad product line				X				
	produce world class vehicles; long-range plan; LH sedan 1992				X				

Table II (2 of 4) 1990 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1990 Strategy Overview	GE	UT	F	C	L	M	B	MD
2. Compete Worldwide (with reduced opportunities) ----continued----									
	a systems approach; an integrated package				X				
	team responsible; knows goal; suppliers in team				X				
	reduce excess capacity; cost reduction program				X				
	sharpen competitiveness					X			
	reduce overhead; strengthen competitive position						X		
	broad program mix on high priority programs						X		
	more focused and efficient approach to achieving goals							X	
	development of 777; cost effective and efficient manner							X	
	launched new commercial widebody twinjet; Boeing 777							X	
	improve our performance in defense and space operations							X	
	improve productivity and increase capacity							X	
	expand capacity; while maintaining high standards of quality							X	
	continue to improve operating performance								X
	improved performance; productivity on MD-80 >30%								X
	MD-80 deliveries increased; 900 fewer workers								X
3. Growth Opportunities (need international markets)									
	opportunities in international markets; sustain global growth		X						
	globalization of the aerospace industry		X						
	significant investment for new products; world capital funding			X					
	introduce new vehicles; N. America, Europe, Asia-Pacific			X					
	inroads in world markets				X				
	reduce dependence on defense from 74 to 60%					X			
	capitalize on preeminent position in space/defense electronics						X		
	take advantage; defense acquisition/consolidation opportunities						X		
	expand into appropriate non-defense government markets						X		
	share in commercial transport market; to 2005 ($460B)							X	
	successful performance; win high priority programs							X	
	broad set of capabilities; use in pursuing new business								X
	pursue international military/civil aircraft sales								X
	investigate risk-sharing partners for MD-11								X
4. Customer Expectations (& satisfaction of customers)									
	customers are the lifeblood of a company	X							
	all employees satisfy customer needs	X							
	customer service is everybody's job	X							
	earn owner loyalty and ensure total buying experience			X					
	customer satisfaction				X				
	continuous improvement; meet customer expectations							X	

Table II (3 of 4) 1990 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1990 Strategy Overview	GE	UT	F	C	L	M	B	MD
5. Technology & Innovation (timely, applied, & affordable)									
	use advanced technology; modernization of facilities next 5 years			X					
	flexibility of modular design and manufacturing concepts			X					
	using advanced applications of CAD, CAE, and CAM			X					
	analytic simulations rather than prototype & for ergonomics			X					
	innovation and continuous improvement; **"whole car"** approach				X				
	Chrysler Technology Center; development teams				X				
	close to labs; faster better technology transfer				X				
	develop new products and technology; **'family concept'**							X	
	777; set new standard for engineering excellence							X	
	777; demonstrate better process for design/building aircraft							X	
	flight test prototype for the Advanced Tactical Fighter (ATF)							X	
	invest in new equipment and facilities and R&D							X	
	invest in new military programs (ATF, LH,C-17)								X
	company money for initial phase of new military programs								X
	continue to invest in new commercial aircraft								X
	launch a long range competitor to 747; MD-12X								X
6. Human Resources (skill and knowledge levels)									
	integrate our technical and managerial skills more effectively		X						
	advance employees skills and knowledge			X					
	strength of management & dedicated employees			X					
	commitment to training, education, skills enhancement			X					
	training employees; new systems and tooling				X				
	highest standard of ethical conduct						X		
	improve the use of our human resources; teamwork							X	
	expanding training programs for all employees							X	
7. Growth/Shareholder Value (sustained/maximum profits)									
	emphasize profitability over growth; greater shareholder value					X			
	Improve financial status; reduce debt to capital ratio <33%					X			
	reduce capital spending; equal to depreciation					X			
	strengthen cash flow reduce operation costs; improve efficiency					X			

Table II (4 of 4) 1990 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1990 Strategy Overview	GE	UT	F	C	L	M	B	MD
8. Appropriate Structure Alignment/Attitude of Co. (how to organize for strategy) (communication for change)									
	a **boundaryless company**	X							
	wring out NIH from the culture	X							
	internal functions blur; they form a team	X							
	strict code of ethics		X						
	Ford's Alpha Organization; world class & competitive costs			X					
	cut salary work force, Mfg. Operations & product lines				X				
	operate like small companies; no bureaucracy				X				
	flexibility in work schedules with unions				X				
	more affordable cost structure				X				
	reorganized development into **"Platform Teams"**				X				
	trust, respect, and risk-taking; broader buy-in				X				
	progressive corporate governance					X			
	trim 10,000 employees					X			
	simplify organization structures; **'design build teams' (DBT)**							X	
	steady incremental improvements; every aspect of processes							X	
	redefine cost structure of corporation								X
	restructure organization; teamwork/leadership focus								X
	strip away bureaucracy and autocracy at all levels								X
	Total Quality Management System; reduce inventories								X
	trim $700M from cost structure; reduce worker by 14,000								X
	ration R&D expenditures and capital investments in 1991								X

Table III (1 of 4) 1995 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1995 Strategy Overview	GE	UT	F	C	L	B	MD
1. Clear Business Focus								
	only acquisitions that support core businesses		X					
	strengthen core businesses - acquisitions and alliances		X					
	remain a world class competitor in financial services			X				
	focus is on creating value; core automotive business				X			
	reinforced position in U.S. military aircraft					C		
	strengthened information systems business					C		
	review business portfolio					C		
	maintain role as DOE's largest service provider					C		
	gain greater presence in environmental remediation business					C		
	increase market share in space and defense						X	
	increase electronics and systems capabilities						X	
	positioned to compete in space and defense operations						X	
	demonstrate abilities as large scale systems integrator						X	
	increase share of US/global defense procurements							X
	grow faster than competitors in launch business							X
	revitalize our commercial aerospace business							X
	win new business but meet previous commitments							X
2. Compete Worldwide (with reduced opportunities)								
	No.1 or No. 2 - fix, sell, or close	X						
	Self-confidence, simplicity, speed; search for **best practices**	X						
	"stretch"; beyond being as good as you have to be	X						
	core businesses are market leaders		X					
	process re-engineering & Kaizen		X					
	be lean and fast moving			X				
	leverage global resources; be world's leading auto company			X				
	cost reduction strategy; operate more efficiently, reduce product complexity, eliminate waste and streamline processes			X				
	empower small teams; leverage world resources; best practices			X				
	increase new products by 50%; cut development time by 1/3			X				
	reduce costs; product spending as percent of revenue declines			X				
	'stretch targets' to reduce costs and improve quality			X				
	new company culture for competitive advantage				X			
	focusing on quality; reducing costs				X			
	continuously improving operations & processes				X			
	total system solutions; unmatched by competitors					C		
	improve competitive position in defense electronics business					C		

Table III (2 of 4) 1995 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1995 Strategy Overview	GE	UT	F	C	LM	B	MD
2. Compete Worldwide (with reduced opportunities)								
----continued----	maximize efficiencies; improve global competitiveness					C		
	leverage best practices; capitalize on corporate wide synergy					C		
	continue the 'family concept' for aircraft models						X	
	deliver superior products in less time at lower cost						X	
	committed to continuous improvement and learning						X	
	maintain quality, performance and reliability of products						X	
	cut waste and improve productivity						X	
	perform well on major defense and space operations						X	
	3 success foci; affordability, innovation, partnerships							X
	affordability; changes in the way we operate							X
	most technologically advanced products at lowest cost							X
	gain a competitive advantage using cooperative efforts							X
	unique modular assembly; reduce costs and cycle time							X
	improved economics at low prod. rates; cellular concepts							X
	IPDT's (integrated product development teams); make our products simpler, less costly to manufacture/assemble							X
	work closely with customers/suppliers in design process							X
3. Growth Opportunities (need international markets)								
	seize 5 biggest growth opportunities: globalization, quality (1,5)	X						
	seize 5 biggest: new products; IT ; installed-base service(2,3,4)	X						
	growth opportunities in international markets		X					
	first into developing markets; **"Be There First"** ; global growth		X					
	focus Europe and Pacific Rim; double Joint Ventures by '2000		X					
	globalization of the aerospace industry		X					
	increase sales; major force in new/emerging & mature markets			X				
	grow in new international markets; continue expansion overseas			X				
	expansion; enhance international business base (>15% sales)					C		
	maintaining access to foreign markets						X	
	work with other countries; develop and improve their industry						X	
	open offices in China and India						X	
4. Customer Expectations (& satisfaction of customers)								
	strengthened dealer relationships to boost customer satisfaction			X				
	customer service rather than merchandising parts			X				
	lower cost and create greater value; for customer satisfaction			X				
	reorganized Ford Service Division; customer focus			X				
	customer-driven product-creation process				X			
	improve customer service; 'best in business' customer support						X	
	'one stop shopping' for customer support; spares, training, field						X	
	deliver more value to customers than anyone else can						X	
	keep promises to customers; meet/exceed expectations							X
	flexibility to address each customers specific needs							X

Table III (3 of 4) 1995 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1995 Strategy Overview	GE	UT	F	C	LM	B	MD
5. Technology & Innovation (timely, applied, & affordable)								
	aggressive capital expenditure program				X			
	aggressive vehicle development program				X			
	aggressive product development program				X			
	advanced manufacturing processes; analytic simulations							X
	teams; develop innovative solutions to complex problems							X
6. Human Resources (skill and knowledge levels)								
	compensation; stock options - company performance	X						
	management selection and training	X						
	emphasis on diversity		X					
	better work force through education; on job learning		X					
	reaffirmed traditional commitments to employees		X					
	encourage self development; for "employment security"		X					
	Ford environment of shared knowledge & continual learning			X				
	leadership training school for dealers and their employees			X				
	investing in people				X			
	expand long term employment prospects					C		
	people key to driving change in organization						X	
	seek better ways to tap skills and creativity of work force						X	
	improve the way we select, train, and promote managers						X	
	training and equipping employees better							X
	Employee Performance Incentive Plan; incentive income							X
	employee support; closer alliances through all levels							X
7. Growth/Shareholder Value (sustained/maximum profits)								
	majority of GE revenue from outside US	X						
	greater productivity and profitability		X					
	profitable growth; maximize ROI; major changes are behind us			X				
	maximize shareholder value through product excellence			X				
	financial stability				X			
	pay down debt, fully funded pension plan				X			
	maintain sustainable dividends & strong balance sheet				X			
	enhance shareholders value; increase economies of scale					C		
	leveraging our financial strength					C		
	greater value to customers; increase shareholder value							X

Table III (4 of 4) 1995 Industry Sector Issues Framed from Company Strategies

Industry Issue	Strategic Emphasis Issue of Companies 1995 Strategy Overview	GE	UT	F	C	LM	B	MD
8. Appropriate Structure Alignment/Attitude of Co. (how to organize for strategy) (communication for change)								
	creation of a new kind of company; shape a global enterprise	X						
	create in GE - spirit and soul of a small company	X						
	"Work-Out" - Involve everyone; **'boundaryless'** behavior	X						
	strict code of ethics		X					
	process re-engineering & Kaizen		X					
	Ford 2000' reorganization; one global automotive organization			X				
	transform Ford; single set of worldwide processes and systems			X				
	'One World One Team'; few layers management/ bureaucracy			X				
	inspired, empowered workforce teams				X			
	corporate wide consolidation plan; centralized procurement					C		
	establish 8 centers of excellence; consolidate laboratories into 3					C		
	reduce employment to desired levels for increased productivity						X	
	simplify the way we design, build, support airplanes						X	
	abandon "go it alone" and "not invented here" habits							X
	re-engineering design, manufacturing , business processes							X
	new inventory, purchasing, data management systems							X

APPENDIX III

THESIS EXECUTIVE SUMMARY OF TASK RESULTS

Appendix III - Thesis Executive Summary

Industry Background (Section 2) - The business activities of the Aerospace, Automotive, and Conglomerate companies studied include research, design, manufacturing, integration, assembly, and sales of their aircraft or automotive products. They are also involved in considerable customer interaction regarding associated parts and support services. The industry sectors share common business description traits regarding their operations and competitive environment. All companies are actively involved with the application of advanced technology to maintain competitive advantage. This requires constant investment in and development of new technologies. Their product development cycles are typically lengthy and capital intensive.

Competition worldwide is intense and has been eroding commercial market share in all sectors. Some industry differences do exist among the sectors in this area of comparison. The Automotive Sector has been more severely impacted with a loss of U.S. domestic share of about 30%, primarily to the foreign auto makers. The Aerospace Sector has had its worldwide commercial market share also threatened primarily by the European consortium Airbus Industrie, while its defense market share has bee dramatically reduced due to decreases in U.S government defense spending. Consequently, with intensified competition driving companies to greater efforts in achieving competitive advantage, customer expectations have continued to be fueled regarding service, quality, safety, product warranties, etc.

All sectors are actively seeking to increase productivity through a variety of organizational restructuring, process re-engineering, and for Aerospace Sector major consolidation of companies due to over capacity issues in that sector. Profitability margins are small due to the competition, increased customer expectations, and an intense customer focus on affordability in both acquisition and life cycle contexts.

All three sectors were looking for new market opportunities for business growth with an emphasis on increased international sales. The conglomerates have made significant inroads to the new markets already because of synergy gained by their established world wide networks of sales, distribution networks, and expertise gained from their existing international, non-aerospace, retail product businesses. The automotive sector is moving to expand into international markets and has significant joint ventures and other international interests but is still most focused on the

existing foreign challenge to its Domestic market share. The aerospace sector likewise is actively moving to become more international and eventually global but has first focused on consolidation and the smaller but still lucrative government procurements. The conglomerates can be considered to be global companies today. The Automotive and Aerospace sectors are positioning to become global but the background data indicated that they feel they must further alter their operations to attain the flexibility and productivity needed to compete profitably in the global market.

Industry Business and Strategy Trends (Section 3) - The study of industry trends in both business environment and strategy were assessed to better understand the context of ongoing industry changes.

Business Trends - The listing of issues and realities in **1985** clearly indicated that the great changes of the 1990's really began in the early to mid 1980's and included such issues as productivity, reduced defense budgets, lost market share to foreign competition, share holder value, and a customer focus on cost consciousness. In the **1990** time frame, these same issues were significantly exacerbated by U.S./World economic factors. The industry sectors were actively pursuing new market opportunities. But in the early 1990's there were few, maybe due to the lack of company expertise in, and knowledge of, the international marketplace coupled with the unfavorable economic environment. As had happened in the mid-1980's for the automotive sector, a distinct over-capacity situation was creating an imperative for industry restructuring or consolidation in the aerospace sectors. By **1995**, in all sectors studied, globalization was a focus of business activities, and "affordability" had become the central requirement of all customers; domestic and international.

Strategy Trends - After an assessment of individual company-by-company strategy trends covering the last decade, results were combined to make observations at the industry or sector level. From an industry perspective, strategy emphasis had been on maintaining: a clear business focus, competitive capabilities, business growth, and customer satisfaction. A continual increase in emphasis had occurred in human resources and organizational structure. And significant for this study, a continual decrease in emphasis was observed relative to the role of technology and innovation.

While limited in nature, sector by sector observations were also made. In the Conglomerates, it was obvious that a consistent and focused strategy had been defined and followed from the mid 1980's to the present (1997). Central in their strategy had been an emphasis on becoming a global corporation and aggressive pursuit of new international markets. In implementing this strategy, they were aided by the diversity of their business activities and their existing international network of global expertise and knowledge. The conglomerates studied (GE and UTC) were effecting strategies intended to create synergy among their business units and accelerate the growth of their international aerospace businesses.

The Automotive Sector early in the mid 1980's was continuing to diversify and ironically into aerospace businesses. This diversion from core automotive business was corrected by 1990. Other than that early issue of business focus, the automotive sector strategies consistently placed emphasis on productivity, quality, customer satisfaction, competitive positioning, and and the use of "team" management practices to achieve strategic objectives. A clear trend to increase international sales was evidenced in evolving strategies but more emphasis was placed on maintaining their domestic market share in the face of continued and intensified foreign competition. Further, while other business issues shared priorities with technology development and innovation, the auto industry seemed more aggressive in their strategic use of new technology as compared to the other sectors studied.

The Aerospace and Defense Sector, had the greatest variance in strategic trends; probably a result of their major industry consolidation and restructuring activities which dominated the ten year period. The philosophical content of strategies was quite similar to the automotive and conglomerate sectors. But, unlike the automotive sector in the mid 1980's, a significant reduction in US aerospace industry market share (at least in the defense segments) had not occurred as yet. Overall there appeared to be a slower move toward substantial change until the early 1990's.

It was suspected that in the first half of the ten year period assessed (1985-1990) none of the aerospace companies anticipated that they would be the ones to suffer as the market opportunities and revenues declined. It was only in 1990 when some "winners" and "losers" were more clearly identified that more focused strategic change appears to take place. With opportunities for growth still limited in the U.S. domestic commercial and defense areas, a competitive emphasis on "affordability" dominates the 1995 strategies for growth in the markets.

The role of technology, even for the remaining military programs, has now transitioned from a "technology push" driver of product design to an "as required" participant in a "market pull" business environment. In 1995, a major strategy emphasis was clearly aimed at accelerating sector entry into the international markets and becoming true global corporations.

Industry Practices (Section 4) - Four industry corporations were selected for direct interviews regarding industry current practices. The corporations selected included two from the aerospace industry sector (Company A and Company B), one from the automotive sector (Company C), and one from the conglomerate sector (Company D). Discussions focused on: (1) Their current management practices related to the integration of technology and business planning, and (2) The role of technology in the current industry business environment.

A summary and integration of the inputs was presented and discussed relative to current business issues and concerns, specific models for integration of technology and business planning, and a concern regarding sustained levels of R&D funding. Information obtained from all interviews exhibited significant similarity relative to business environment, issues, and concerns. Practices were detailed and discussed separately for the Aerospace & Defense Sector and the Automotive Sector.

A summary of business issues and concerns derived from the interviews was documented in Figure 4-2. The current concerns when subdivided into the same categories as were used in Section 3 - Industry Trends, were closely aligned with the pre-interview trends of Section 3. Business issues centered on four themes: (1) Impact of the current "market pull" environment on the role of technology; (2) The impact of teaming and partnerships; (3) The industry focus on affordability requirements; and (4) The need for new competencies regarding international markets.

Competitive advantage was a key goal of all companies. But, in the aerospace sector, a common theme surfaced which indicated that industry "teaming and partnerships" had virtually eliminated technology as a significant competition discriminator, especially with affordability being the highest priority. The point being that while technology was still a foundation of competitive position, there were "no more technology secrets" left among the prime aerospace companies. Over the last decade, with teaming requirements, prime contractors were forced into sharing technology in order to win programs and to achieve program success. In so doing, a

great leveling of technology knowledge has occurred. Currently, aerospace sector companies are looking elsewhere for ways to achieve competitive advantage. A new "core competency" is evolving which is focused on a system-based integration of all technologies to meet or exceed customer affordability requirements.

Industry models currently in use were examined. Emphasis was placed on generic aspects of processes used to manage the integration of technology with business planning. Central to these practices were customer requirements, customer/industry interaction, assessment of core capabilities, linkage of internal and external needs relative to technology development, team-based management approaches, "system-benefits" analysis of technology development proposals, alignment of all technology with a business sponsor, and a time-line of events which permitted focused interaction with the customer's acquisition (or technology planning) activities. Key elements and customer interaction sequence of these processes were detailed in Figure 4-3 and Figure 4-4.

A particular R&D concern of the aerospace industry was raised that centered on a loss of continuity and long-term perspective. At issue was the current aerospace industry R&D funding practices which have resulted in fewer new aircraft programs, being spread over a longer period of time. The viewpoint forwarded was that pre-proposal R&D efforts, for major military procurements, in the past tended to overlap, involved generic technology development, and sustained a "critical mass" of R&D staff. Thus, a continuity of efforts, people skills, and longer term commitment was maintained. In contrast, with so few major procurements, the observation voiced was that the technology R&D base is currently being fragmented, reduced in scope, falling below "critical mass", and becoming discontinuous over time --- due to a short-term business focus. These trends are aggravated by industry consolidation and lower technology needs as industry turns to commercial markets for new business opportunities. From a management perspective, these issues are serious and touch on elements of technology and business planning which deserve further study and consideration.

Literature Review (Section 5) - A literature review was performed which examined corporate strategy development, interface issues with technology planning (R&D groups), and academic frameworks for the integration of technology and business planning.

The review of strategy development and interface issues included: a historical perspective on the evolution of corporate strategy development; possible interfaces with technology planning; characteristics of an effective technology or R&D group; and some associated concerns regarding social, political, and cultural perspectives. The latter concerns, as summarized in Figures 5-1 and 5-2, highlight key characteristics of corporate strategy development which may suffer due to a lack of effective integration and linkages between business planners and technology planners.

The last part of the literature review centered on issues, philosophy, and specific frameworks, and tools that have been proposed to integrate technology planning with business planning and strategies. Models by Tushman and O'Reilly[19], and Goodman and Lawless[20] were discussed because they deal specifically with the overall context of a companies strategic context, choices, and implementation of strategic action. Both provided specific models that address the integration issues of technology planners and business planners. The association of innovation with successful management and integration of technology was also discussed. The additional complexity of integrating external sources of technology acquisition and assuring effective technology transfer into products was addressed by the review centering on a paper by Chester[21]. Additional topics were discussed that amplified this discussion relative to the leadership role of top management, the balance of market and technology risk, and a philosophical point regarding a company's "strategic attitude" as a necessary aspect of effective implementation of strategic actions was also discussed.