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The Jet Engine Business

Opportunities and Strategies in the Asia-Pacific Region

by

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Foreword

This paper is a result of the author's summer internship assignment with Pratt & Whitney (P&W), one of the major manufacturers of jet engines in the world. Although P&W has many aspects to its business, this paper will only concentrate on P&W's large commercial engine business, jet engines sold to commercial airliners and cargo operations all over the world.

The objectives of this paper are manifold. First, it seeks to educate the reader about the jet engine business, its structure and the global players involved in it. Specifically, it would describe how the industry structure and new trends have changed the industry's monopolistic competition environment. Second, the author will suggest ways in changing the rules of the game and developing a competitive advantage in the light of the current environment. Finally, the paper will touch on how challenges, opportunities and the dynamics in the Asia-Pacific region can change the rules of competition. This will emphasize the fact that although the business is global in nature, there are variations in its character that is region and even airline specific. These variations can be a means of developing a competitive advantage for Pratt & Whitney (or the other major contenders for that matter).

The bulk of the information in writing this paper was obtained through the author's summer internship experience. This is supplemented by publicly available information obtained from Pratt & Whitney as well as additional library research. As a result, reference will only be made when the source of information can be distinctly identified. Information that is proprietary is either disguised or is only referred to in a very general manner so as to avoid violating secrecy agreements that the author has signed as a condition of employment with Pratt & Whitney.

Views expressed in this paper are that of the author alone and may or may not represent the views of Pratt & Whitney or any of its employees.

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I. Introduction

The commercial jet engine business is an interesting example of a non-cooperative monopolistic competition. There are three major global players in the market that are currently engaged in bitter competition against each other. To an extent, price of the engines has become the bottom line differentiating factor in winning sales to major airlines. As a result, profitability has suffered across the board and the engine makers have basically mortgaged their future by "giving away" engines in return for a hopefully healthy annuity stream from engine spare parts sales in the future. With engines getting more reliable and using fewer parts than before, quantification of this annuity remains vague. This is an industry gone berserk.

The challenge now is how to stop this seeming death spiral. Applying Game Theory to the situation shows a future that is not bright. First, all three firms have as their dominant strategies to increase their engines' installed base. They all hope that annuity from spare parts sales could finance new engine development programs to stay ahead of competition while at the same time provide healthy returns to shareholders. Second, overcapacity in an industry that relies significantly in economies of scale by amortizing engine development costs to as many engines as possible makes the situation worst. There is therefore no Nash Equilibrium in this industry.

The answer may lie in Chamberlin's Theory of Monopolistic Competition. In his theory, Chamberlin stresses product differentiation and selling costs, pointing out that most companies have a market partially distinct from their competitors. Although the nature of the jet engine business is quite different from steel mills, an example that Chamberlin refers to, an expanded interpretation of his theory may be a way to alleviate the pressure on pricing in the jet engine market.

An analysis of the jet engine competition would be found wanting though without a playing board for the competitive forces to play themselves out. This is where the dynamic markets of the Asia-Pacific region can provide fertile grounds for the evolution of a differentiation strategy.

n. Characteristics of the Jet Engine Business

To understand competition and the various challenges and opportunities confronting the business world wide as well as the different idiosyncrasies of the various regions like the Asia-Pacific, it will be worth understanding the business' unique set of characteristics.

A. *Cyclical*

Like many high technology industries, the aerospace industry is very cyclical. The cycle mainly follows the booms and busts in the economy with some lag and is significantly affected by regional conflict or war as well as the prices of oil. The root cause of course is that less people travel during an economic downturn, when there is a war or conflict somewhere, and when costs of airfare are high due to higher costs of fuel.

In the past, as the airline industry was being deregulated, the players were not as adept at competing with each other under totally different rules. Aircraft orders basically increased when passenger loads were up which also put pressure on aircraft manufacturers to launch new models during strong economies. However, due to the lengthy development period for new aircrafts and engines, launches could coincide with an economic downturn that then puts a lot of pressure on manufacturers to either cut prices or stop production and lay-off personnel. The jet engine business is significantly affected by this cycle mainly because the bulk of the discounting provided to airlines come from the manufacturers of jet engines rather than the airframers (manufacturers of airplane bodies). It is only in the last few years that the airlines understood the competitive environment and have therefore driven their companies more financially than they previously have done. This, in a way, has added rationality in aircraft and engine orders.

B. *Razor and Razor-Blade Business*

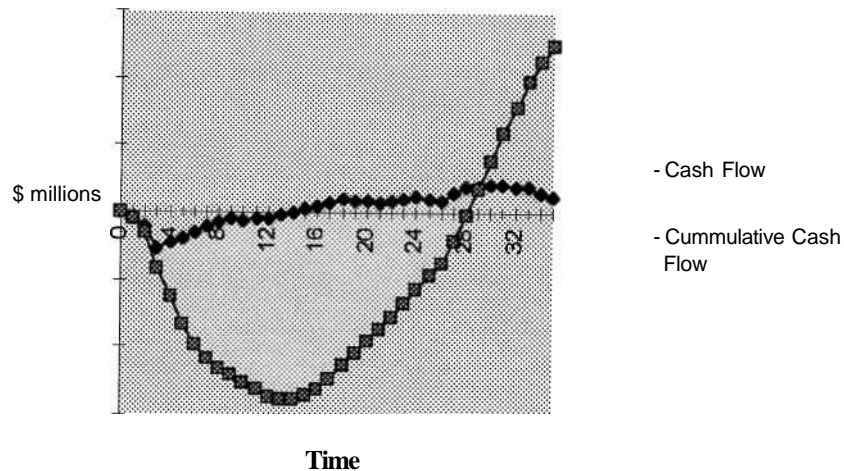
Unlike the airframe (aircraft frame without engines) business that generates less of its revenues from spare parts, the jet engine business is a razor and razor-blade business where jet engines are sold at break-even or even at a loss. Manufacturers then expect to generate revenues from the spare parts stream that flows in throughout the life of the engine which could be as long as 30 years. Normally, spare parts of a particular jet engine can only be obtained from its own manufacturer. Consequently, a jet engine can be cheaper than the sum of its parts.

However, the newer jet engines today have less spare parts and are more reliable than the older engines. For example, 20 years ago, a 747 engine with a shop visit rate of once every 4,000 hours was considered good. Today, a rate of once every 10,000 hours is barely competitive. In addition, a high bypass engine in the 1980's would generate over

three times its list price over a 25 year period. Currently, the ratio has declined to just a little over one.

Figure A below is a concept of a typical pay-back graph of an engine program that manufacturers have to deal with every time they launch a newly developed engine.

Figure A - Engine Program Pay-back Graph



C. Revenue Sources

Due to the size and complexity of the jet engine business it has multiple sources of revenues. The major sources of revenues for a jet engine manufacturer in the commercial arena are as follows:

1. New Engine Sales

Before the advent of multiple sourcing of engines, this part of a manufacturer's revenue source used to provide healthy margins. In the current intensely competitive environment however, a manufacturer will be satisfied if it only breaks even on engine sales. Most of the time however, the manufacturer actually does not make any money on new engine sales. The question posed now is how much is a manufacturer willing to lose on an engine sale and still be profitable in the long-run.

New engine sales are either for new airframes or replacement engines for older airframes. As a result, it is possible for an engine manufacturer to get into an airline by ousting an incumbent through replacement engine sales.

2. New Spare Parts Sales

This is the cash cow of an engine manufacturer and could last the whole lifetime of an engine which is between 25-30 years. Depending on the engine though, this may not kick in until the 4th to the 6th year when an engine goes for an overhaul. After the 6th year, the engine is considered mature and would need a steady stream of replacement parts. Majority of the spare parts for a particular engine are sold by that engine's manufacturer. A small portion are made by third party FAA certified parts manufacturer. Spare parts between different makers are normally not interchangeable therefore the higher margins generated in this part of the business. Historically, revenues generated from spare parts in the lifetime of an engine would be equivalent to more than three times the engine's list price. Currently, with more reliable engines with less spare parts, that revenue has come down to a little over an engine's list price.

3. Surplus Spare Parts Sales

These are basically refurbished or remanufactured spare parts. This is a growing business on its own as a result of the cost consciousness of the airline industry. Like any refurbished item, these parts may be almost as good as new but cost less than new. There are a few third party players in this segment whose competitive edge is in their being able to source, inventory and resell these parts to airlines and overhaul shops efficiently. However, these third party players would normally send the parts back to the original equipment manufacturers (either the engine manufacturer or its suppliers) to be refurbished and certified. This segment is competing and eating away business from new spare parts sales.

4 Overhaul and Repair Services

There are various players in the overhaul and repair services market. These players include: (1) the engine manufacturers themselves which set up specific business units to provide this service; (2) the major airlines which run their own overhaul facilities for their fleet as well as other airlines' fleet; and (3) engineering companies which may or may not be related to an airline or engine manufacturer. Revenues not only come from overhaul and repair services provided but also from spare parts repaired and replaced. Due to the strategic position of these services to the engine life, it may be a way of controlling the aftermarket business.

5. Marine and Industrial Turbine Applications

With some reconfiguration, jet engine platforms can be converted to power generating turbines for marine and industrial applications. This business puts jet engine manufacturers head to head in competition against power generating equipment manufacturing companies and has different dynamics as compared to the jet engine business. This business can be run separately and generate additional revenues. All three major engine manufacturers have business units in this sector where GE Power Systems (GEPS) holds world leadership in industrial turbine technology. GEPS has actually built a successful high-margin business in this business.

D. A Political Business

It is common knowledge that the US aerospace industry dwarfs any other industry in terms of balancing the trade of the US with other countries. It is a very important industry both for the exports it produces and the new technology that it generates to maintain US leadership in commercial and military aviation. A major part of this industry is the development, manufacture and sale of jet engines to the world's commercial airlines. Approximately 25% of the value of a commercial plane is accounted for by its engines.

Due to the importance of the aerospace sector both in the US economy as well as in its defense, the industry is easily affected by political events. One recent example is China shifting a part of its commercial aircraft orders from Boeing to Airbus just because it wanted to warn the US government against meddling in its internal affairs especially the human rights issue. This may not be detrimental to jet engine manufacturers because their engines are also on Airbus planes but this shows how politics play an important role in this business. Furthermore, many countries that the US export aircrafts to may have imports and foreign exchange controls. It is therefore critical for manufacturers in the aerospace industry to understand and know the politics and regulations of each country that they sell to.

E. New Trends

Despite the critical nature of the aerospace industry for the US balance of trade, a new trend has emerged. Partnerships in the development and manufacture of parts of airplanes and engines are increasing. This is brought about by various reasons.

First, partnerships spread the risks in developing and manufacturing new products. For example, the development of a new jet engine can take up to \$2 billion in development costs. This is excluding the fact that it may be years after a new jet engine is sold before the company breaks even on its investments let alone make a profit. This is one of the

reasons why General Electric Aircraft Engines (GEAE) and Pratt & Whitney (P&W) have established a joint venture specifically to develop the next generation of jet engines.

Second, many of the parts of the jet engine as well as the technology for development and manufacturing may not be in-house. Parts sub-contractors and partners are normally more efficient in manufacturing a particular part versus a jet engine maker as a whole.

Finally, with world wide partnerships come reciprocity in terms of entry into foreign markets. It would be easier for example to sell jet engines to Japan Airlines just because Pratt & Whitney may have manufacturing or technology partnerships either with them directly, their subsidiaries or even other Japanese businesses that they deal with. This also helps in the politics of trade.

F. Customers

Before the advent of dual or multiple engine sourcing, the customers of the jet engine manufacturers were the airframe manufacturers only. In the earlier years, decision making was made by aerospace engineers as well as pilots who wanted the best that technology can offer on the jet engines. Since engine manufacturers were run by the same types, it was easy to sell the latest and the greatest.

When dual and multiple sourcing happened, the customer base of the engine manufacturers grew multiple-fold overnight now to include not only airframers but also airline companies who made choices as to which engines go on their airplanes. First, the engine manufacturer had to sell to an airframer to put his engine on a particular aircraft most probably with another competing engine manufacturer. After that process, the selling to the airlines begins to make them choose a particular engine maker over another. These decisions are based on many factors but eventually boiled down to price when engine performance and reliability improved so that no engine had a distinct advantage over another.

In addition, in the developing world for example, airlines are either state-owned or had exclusive flying rights in a particular country or both and are considered national treasures. To this end, the selling process also involves selling to top government officials which of course would have differing sets of interests of their own. Selling jet engines therefore is a highly complicated process of balancing interests of various constituencies involved in the buying process.

It is also a fact that there are airlines that other airlines look up to in terms of their choices of airframes and engines. In the Asia-Pacific for example, Japan Airlines and Singapore Airlines hold that honor. Both are considered strategic "must wins" for the manufacturers. This is therefore where competition is at its fiercest since any win could affect future sales to other airlines as well.

III. Competitive Environment

There are three major competitors in the jet engine business who have the capability to design, develop, build, sell, and support commercial and military jet engines. Pratt & Whitney (P&W) is by far the leader in terms of a 54% market share in installed commercial engines world wide. The other two are General Electric Aircraft Engines (GEAE) and Rolls-Royce Aerospace (RR). GEAE however is fast catching up as a result of its being the sole engine source for the Boeing 737 aircraft, one of the largest selling commercial aircraft in the world today. In 1996, GEAE accounted for 44% of all Asia-Pacific commercial engine deliveries, about half of which was for the CFM56 engine for the 737 aircraft.

A. Backgrounds of the Majors

1. Pratt & Whitney

Pratt & Whitney has the largest installed base of all three major engine manufacturers due to its leadership in applying military derivative engines into the commercial aircraft arena after World War II. Due to some historical missteps, P&W has allowed encroachment by GEAE to the extent that in 1996, both companies' market shares in terms of aircraft deliveries were almost even. In addition, the recession in the airline industry starting in 1990 also drastically affected P&W's profitability so that it continues to downsize its work force until now. P&W is part of United Technologies Corporation, a diversified technology company with strong roots in aerospace.

2. General Electric Aircraft Engines

General Electric Aircraft Engines is a formidable player in the jet engine business today. This is due to various factors but primarily resulting from CFM56 becoming the largest selling jet engine in history. CFM56 is the exclusive powerhorse for the popular Boeing 737 aircraft. Furthermore, as part of a world class company that is General Electric, GEAE's cost structure is still considered to be lower than that of P&W. GEAE seemed to have taken advantage of partnerships in the development and manufacturing of its jet engines more than P&W so that more of its engine development and manufacturing are out-sourced rather than done in-house. Finally, GEAE has as its captive customer the biggest aircraft owner in the world and the largest aircraft leasing company as well, GE Capital Aviation Services, Inc. (GECAS).

3. Roll-Royce Aerospace

Roll-Royce Aerospace is the third of the majors. It is majority owned by institutional shareholders but is one of a few privatized British companies that the British government has perpetual rights to. This gives the company tremendous leverage in terms of less financial constraints as well as political backing in obtaining customers for its jet engines. RR is based in the UK which has a different way of accounting for R&D expenditure, for example, that allows RR greater flexibility not available to both P&W and GEAE. It also does not hurt RR that the British Prime Minister sometimes "closes" deals for them compared to maybe a Secretary of Commerce of the US for P&W and GEAE. RR is currently considered the loose canon in the jet engine oligopoly because of its perceived strategy of "buying" market share at all cost since it does not have the installed base of the other two majors.

B. Market Shares

Table A illustrates the respective market shares in terms of engine deliveries of each manufacturer for 1996 in the Asia-Pacific region. See Exhibit 1 for engine delivery market shares from 1986-1996 in the Asia-Pacific.

Table A - Asia-Pacific Orders Market Share (1996)

Manufacturer	% Market Share
CFM (JV between GEAE and SNECMA)	22%
GEAE	22%
IAE (JV between P&W, RR and others)	4%
P&W	42%
RR	11% [

C. No More Sole-Source

In the 1950's and 1960's, commercial aircrafts were offered with essentially one engine choice. However, with the coming of widebody aircrafts in the 1960's, all three major engine manufacturers developed their own high-thrust turbofan engines. Since these engines were a significant leap in technology, technical and performance issues arose which resulted in competitor engines being allowed on previously exclusive aircraft platforms. Airframe manufacturers found that it was advantageous to have multiple engine types on a particular aircraft because competition by the engine manufacturers lowered engine prices. This in turn lowered aircraft prices accordingly. Consequently, lowering of aircraft prices as a whole allowed airframe manufacturers to sell more aircrafts to their airline customers.

D. Unstable Oligopoly

With only three major jet engine manufacturers in the world the industry is oligopolistic. However, due to two major factors, the trio in the market has actually engaged in a brutal price war to gain a significant installed base. These factors are as follows:

1. Difference in Installed Base

The difference in the position of each company in the jet engine business does not allow for a stable oligopoly. While P&W established a massive installed base early on by successfully securing key applications of its engine on the first two US commercial transports and therefore established its leadership, RR has remained a small player while GEAE was still concentrating on the military side of its business. Due to the Razor and Razor-Blade framework that these manufacturers compete in, it is critical for the followers to gain market share to establish that installed base to guarantee their future survival. RR for example has been labeled as a company that is "buying" market share by basically giving away its engines.

Whether or not this is an accurate description of RR's strategy remains to be seen. To illustrate this, some believe that RR won Singapore Airlines's Boeing 777 orders by basically giving away its engines, in essence promising free spare parts for a certain period when the engines mature, and the understanding that Singapore Airlines' application for more gates at London's Heathrow airport will be looked at favorably. At first glance, this seems to support the idea that RR is "buying" market share. However, some circles think that RR did not expect to win this order. Evidence to support this contention was in RR's announcement a week after winning the deal that it would demand a 30% price reduction over the 1996-1997 period from its suppliers.

2. Industry Overcapacity

The massive overcapacity in manufacturing facilities resulting from the boom years before 1990 has created pressure on engine manufacturers to increase shop utilization through increased sales of engines. This created competition for what little orders were available in the market that rational pricing practices had to give.

Overcapacity is also apparent in the overhaul and repair business especially in the Asia-Pacific region where the major airlines want their own engine shops. Their governments also encourage the trend for the technology transfers that can be derived from such operations. This compounds the problem by adding another

"requirement" in an engine sale to have a certain number of engines go through particular overhaul and repair shops.

IV. Changing the Rules of the Game

The way the game is played right now allows for tremendous buyer power under an extremely competitive environment where jet engines are becoming a commodity and price is the only differentiating factor. For the engine manufacturers to prosper, the rules have to be changed. For P&W to regain its leading position in the market, it has to lead the change.

A. *Industry Rationalization*

To be able to compete profitably in the jet engine business, P&W needs to lead the rationalization of the industry. The current overcapacity in engine manufacturing as well as overhaul and repair facilities world wide is putting pressure on all players to lower prices just to maintain shop load levels. If this continues, the overcapacity in the industry will eventually be trimmed but at extremely high costs to engine manufacturers. This will result from price wars that nobody can get out of because by then, customers' expectations about the level of pricing may have already been set. It is only therefore through proactively lowering capacity across the industry that another price war can be avoided.

The key to being able to lead the rationalization of capacity is cost competitiveness of P&W's operations. As a lower cost operator, P&W can set the tone in engine competition by bidding only up to where it can either break-even on a deal or make reasonable profits. P&W may lose business but then the competitor who obtained the business will lose money. In the long-run, with this discipline, only a profitable company will survive, be able to finance new engine development and differentiate its product offering that could give it a competitive edge against the competition.

Of course, one strategy to becoming a low cost leader is to improve efficiency and productivity of P&W's operations as currently being done. It would take a cultural shift for all of P&W employees as well as good execution by its management for this strategy to be successful.

Another avenue worth exploring to lower cost is outsourcing of non key activities both in the development of an engine as well as in its manufacturing. Some criteria for non key activities are: (1) P&W does not have or cannot maintain a competitive advantage in that activity (for example parts of an engine that do not have proprietary high technology content that can be manufactured by a third party more cost effectively); and (2) P&W services that its customers do not perceive to add value to their operations.

In growing the overhaul and repair business to capture more of the value adding work for P&W, it should concentrate in identifying key facilities world wide and purchase them

instead of building new ones. Not only does P&W identify key facilities to own and operate but also some to take out to rationalize overcapacity in the business. Hopefully, P&W can then capture the business of the closed facilities to increase shop load for P&W's other facilities.

Partnership with another jet engine manufacturer in developing and manufacturing new engines would also improve the competitive environment in the industry. In fact, GEAE and P&W are already in the process of finalizing their partnership to develop an engine for the future versions of the Boeing 747 jumbo jet. Whether this partnership succeeds will remain to be seen especially when there is so much mistrust between GEAE and P&W.

B. Value Added Work

To be successful and profitable, a company can only cut so much of its costs. To grow, it would have to increase its revenue line as well. For P&W, this would mean being able to deliver value to its customers that they are willing to pay for. An anecdote in a Boeing company video captures the concept of value adding work to the customer. It tells of a manager of Boeing who told Bob Crandall (CEO of American Airlines) that it is very expensive to develop a new aircraft. Bob Crandall responded: "here's a quarter, call someone who cares." At the end of the day, P&W can only sell what the customer is willing to buy at a certain price.

With the advent of competition in the Asia-Pacific airline industry, adding value means lowering the cost of ownership of engines to airlines. This does not necessarily mean lower priced engines or cheaper spare parts which means lower margins on spare parts to P&W. An analysis of an airline's cost structure shows that only 3% of it is accounted for by engine maintenance. P&W can therefore keep the margins on spare parts without upsetting a customer but P&W has to work on helping customers address their top priorities. These priorities are reducing cost of the airline's engineering and maintenance staff as well as its financing expenses. These costs account for a bigger share of the pie than just engine maintenance.

To this end, P&W should develop the capability to offer flexible plans and packages that would suit individual airline needs. These packages can range in how all-encompassing they are from a power-by-the-hour package to just managing inventory of used and refurbished spare parts that airlines can use at lower costs. The power-by-the-hour concept is very similar to car manufacturers who lease a fleet of cars to rental companies as well as corporations who do not want to own nor maintain the assets themselves. Airlines, especially the smaller and newer ones may take advantage of this and only do what their core competencies are, like providing passenger reservation system, flight crew and cabin attendants and route systems.

It may be difficult however to offer a package only on the engines since airlines normally buy aircrafts as a whole. In this regard, P&W may be at a disadvantage compared to

GEAE. Unlike GEAE, P&W does not have an aircraft leasing company as a sister company. Nevertheless, P&W could still partner with the other aircraft leasing companies such as the International Leasing and Finance Company (ILFC), the second largest aircraft leasing company in the world, second only to GECAS. Or, it may want to buy the smaller players in the aircraft leasing business should the industry trend require this.

Another aspect in lowering the cost of ownership of jet engines to airlines is continually improving the engines' reliability. This will allow airlines to avoid costly delays and airport charges when a plane cannot leave on time due to engine trouble. Since reliability of engines always improves over time after its introduction into service, the competitive advantage that can be gained here is to be able to introduce engines that are reliable starting from day one. The PW4098, a P&W engine on the Boeing 777, obtained 180 minutes ETOPS (Extended-range Twin-engine Operations) certification on its first commercial flight. This is a historic achievement since the Federal Aviation Administration (FAA) normally only grants 60 minutes ETOPS certification in the first year of a twin-engine aircraft. This allows aircrafts to only fly routes that at any point in time are only one hour away from the nearest airport. With 180 minutes ETOPS, a twin-jet is reliable enough to virtually fly anywhere in the world.

C. Change Customer Perception

Not only should P&W provide value added work for its customers, but it should also be able to communicate this value to them. Since airlines are now very financially driven, the way to communicate P&W's value proposition in selling its engines is to quantify the bottom line effects to the airlines in purchasing a P&W engine as compared to say GEAE. This quantification may include less maintenance time for more reliable engines which means the planes fly more often and therefore generate revenues for the airline.

In addition, P&W should enhance its customer service to all the constituents of its selling process with its airline customers. It will have to be responsive, and perceived as so, by the different people in the airlines. To be able to do this, P&W has to first segment its airline customers according to their strategic objectives, financial resources, mode of operation as well as its needs. The next step is then to understand the goals and interests of each constituent clearly and address them individually. For example, the finance department will be more concerned with the return on assets figures while the engineering and maintenance department may be more concerned with availability of spare parts when required. These constituents are rewarded differently and the sales people at P&W should be aware of this.

In most Asian countries, relationships hold a significant role in any transaction. These relationships cannot be developed overnight and therefore to succeed, P&W should be able to put in place a structure that addresses this character of doing business in the Asia-Pacific. One way of doing this is to transfer decision making authority, up to a certain

extent, into the region. P&W, like GEAE is now in the process of appointing General Managers for each of the major airlines in the region as well as General Managers responsible for smaller airlines in a particular country or group of countries. The key to success in implementing this change in organization is for these General Managers to be perceived by their customers as having enough power and clout to obtain what they need from headquarters to delight their customers. Moreover, these General Managers will have to be well liked by their airline customers as well as the government officials that have any role in a particular country's airline industry.

Finally, this will not come easy for organizations the size of P&W with all its internal politics and so this structure has to be *continually championed by the company's top executives* and reinforced accordingly by realigning the reward system of the whole organization. Precursor to delighting one's customers is *delighting one's employees* for they are the voice of the organization. With the current reorganization and downsizing of P&W's work forces, this will be a difficult feat but nonetheless will have to succeed for P&W to become a world class company. Asians are very "face" conscious that for them to know that they are dealing with a world class company (strong brand image, professional management, and reliable products and services) goes a long way.

Pratt & Whitney has to go back to its roots as captured by its logo that says "Dependable Engines" and interpret that beyond technology to encompass all concerns of its customers.

V. Asia-Pacific Market Overview

The Asia-Pacific market is currently the fastest growing region in the world and is projected to remain that way in the next decade. There is a rapid expansion of the middle class as well as the generation of new wealth. Table B illustrates a sampling of growth figures of various Asia-Pacific countries.

Table B - Country GDP and Growth Rates

Country	Per Capita GDP (1993)	Real Growth Rate (1993)
China	\$2,200	13.4%
Japan	\$20,400	0%
Malaysia	\$7,500	8.0%
Singapore	\$15,000	9.9%
Taiwan	\$10,600	6.0%
Thailand	\$5,500	7.8%

For a comparison to the rest of the world, see Exhibit 2 for the regional economic growth rates and Exhibit 3 for a comparison with world GDP growth rates.

A. *Developments in the Asia-Pacific Airline Industry*

Historically, the Asia-Pacific airline industry has been dominated by country flag carriers normally owned by the state. These airlines had virtual monopoly of the air traffic in their particular countries and were treated like another type of utility company. They provided air travel access to everybody in their respective countries even to destinations their governments claim to be unprofitable, much like the justification why telephone and electric companies were monopolies. As a result, most of these airlines were unprofitable and were only prop up to serve the national interests.

Due to changes in the world economy and trade as well as the burden that these airlines imposed on their countries' governments, more and more of the region's airlines are being privatized while their airline industries are being deregulated. Take the case of the Philippines as an example. While Philippine Airlines (the country's flag carrier) was undergoing privatization, the skies were also opened up to new competition. Now, there are four other airlines which fly "real"⁵⁹ airplanes between high traffic destinations particularly between Manila and Cebu.

Of course there are exceptions to this situation as well. Singapore Airlines and Cathay Pacific Airways (Hong Kong) are world class airlines which do not have domestic markets to serve and had to compete to a greater extent with foreign airlines. Due to these

airlines' emphases on courteous customer services, they have become world class airlines that continue to grow by competing for other global players' passengers.

With competition brings pressure on airfare pricing. This in turn encourages airlines to become more efficient to survive and prosper. With lower prices, demand for air travel increases. As a result of more airline operators and more passengers flying, demand for new and better aircraft that suits the region and the routes well increases. Countries like China, South Korea, Japan and Indonesia are now planning to be the first to launch their own homegrown regional twinjet (100-120 seater) that would efficiently serve many destinations in the region.

Despite these positive trends however, the selling process to the airline industry in the Asia-Pacific is still very complicated compared to what companies may be used to in the West. This is mainly driven by a few factors. First, since aircrafts are expensive capital items, selling a few to a small developing country affects the balance of trade and exchange rates significantly which may lead to some disruptions in its economy. As a result, in some countries, import restrictions are imposed on airlines which pressures airframe and engine manufacturers wishing to sell to those countries to provide counter-trade arrangements for those countries' products. Second, the airline industry in many Asia-Pacific countries are still highly politicized because most of the flag carriers are still state-owned enterprises. Even if an airline is not state-owned, due to its nature, politicians still do meddle in their affairs.

B. Future Growth Drivers

Besides the demand drivers mentioned earlier, the Asia-Pacific market has its own specific future growth drivers for its airline industries and thus airframe and engine sales.

First, there is the ***growing affluence of the population*** who can now afford to travel for leisure. This leisure travel may be overseas travel to visit relatives and friends. Second, there is a ***limited choice of transportation*** in the region. The road systems are not as extensive and good as they are in the US for example. Furthermore, due to the terrain of the region (mountains, jungles and islands), air travel, when available at an affordable price, would be the preferred choice because of convenience and speed. Finally, the ***increase in regional trade*** and business due to opening up of markets increases the demand by business travelers.

See Exhibit 4 for the Asia-Pacific aircraft seat mile projections, Exhibit 5 for revenue passenger mile projections compared to that of the world and Exhibit 6 for the Asia-Pacific aircraft demand projections. See Exhibit 7 for the Asia-Pacific engine forecast from 1995 to 2014.

C. Overview of Aerospace Industries in Selected Asia-Pacific Countries

1. China

In China, rapid economic growth has caused an undersupplied market. For example, growth in the airline industry is limited primarily by shortage of pilots to operate a greater number of airplanes. The break-up and newly granted autonomy of China's airline industry and emergence of new airlines stimulates demand further. US aircrafts have excellent track records in the country. Nevertheless, US exporters should show creativity in financing, including leasing to be able to tap this market. Most promising subsectors as identified by the US Department of Commerce (USDOC) are aircraft sales and spare parts sales with 1993 estimated market size of \$2.4 billion and \$600 million respectively.

2. Hong Kong

Hong Kong is situated at the geographic heart of the southeast Asia region. Most of the aircraft coming through this area makes Hong Kong a stop-over point, not only for sight-seeing and cargo transshipment but also for maintenance at the excellent facilities available in Hong Kong at the Hong Kong Aircraft Engineering Company (HAECO), the sole vendor of such services at present. When the new airport at Chek Lap Kok comes on line, the airport authority envisions 2-3 suppliers of these services, thus creating more opportunities for sales. Most promising subsectors as identified by the USDOC are airplanes and helicopters, and their parts with 1993 estimated market size of \$545 million and \$157 million respectively.

3. Indonesia

Along with the vital role played by sea transportation in national economic development, civil aviation is also critical to linking the country's widely separated islands. In recent years, the government has been very active in the modernization of older airports and in building new ones throughout the country. PT Garuda, a state-owned company is the national flag carrier. Historically, only Sempati Air was allowed to use jet aircraft on domestic routes. Starting in 1992 however, other private domestic airlines were permitted to operate jet aircraft for domestic operations. Presently, three domestic airlines already operate jet airplanes in their fleets. One of the most promising subsector identified by the USDOC is aircraft engines with 1993 estimated market size of \$50 million.

4. Japan

While the US still maintains a commanding lead in aircraft and components demonstrated by the US bilateral trade surplus, Japanese aircraft exports have been expanding in recent years, and European manufacturers have started entry into the Japanese market. Cooperative ventures among US, European and Japanese firms have increased markedly in recent years. Most promising subsectors as identified by the USDOC (with their estimated market size in 1993) are civil aviation jet aircraft (\$2.7 billion), aircraft engines and parts (\$2.1 billion), and general aviation aircraft such as helicopters and executive jets (\$90 million).

5. South Korea

The Korean civilian aircraft market seems to have taken off in 1993, due to increased demand from the two national carriers, Korean Air Lines (KAL) and Asiana Airlines (AAR). AAR plans to procure 51 aircraft from 1993 to 1998. KAL will also procure 63 aircraft by the year 2000. The government is also expected to approve the creation of regional commuter airlines. Most promising subsector identified by the USDOC is general aviation aircraft with estimated 1993 market size of \$ 1.8 billion.

6. Malaysia

Malaysian Airlines is undertaking a multi-billion dollar expansion program in the next ten years in an effort to meet the rising demand for air travel. The expansion will see the airline acquiring several Boeing 747-400 aircraft. Most promising subsectors identified by the USDOC are commercial airplanes and helicopters with 1993 estimated market size of \$1.2 billion and \$150 million respectively.

7. Pakistan

There are good prospects for increased sales of aircraft and parts to Pakistan. The government recently has allowed the private sector to own and operate airlines on both domestic and international routes. Pakistan International Airlines continues to be a major buyer of aircraft and related equipment. The drop in imports from the US in 1993 is attributed to aircraft rather than parts, imports of which increased at about 10% annually.

8. Philippines

Philippine Airlines' new management is now focusing its efforts on boosting the flag carriers' performance in the aviation industry. PAL management plans to purchase new aircrafts both to supplement its current fleet as well as replace old airplanes. Other airlines financed by local tycoons are also entering the deregulating market which bodes well for new as well as used aircrafts and engines. The new airlines are Pacific Air, Cebu Pacific, Grand Air, and Star Asia.

9. Singapore

The aerospace sector continues to be one of Singapore's major industries. In 1992, output in the aerospace sector rose by 8% to \$ 731.25 million. Singapore is evolving into a world-class aero-component manufacturing and overhaul center for the world market. The aircraft component overhaul and manufacturing industry has grown steadily at 10% annually over the last five years and is expected to continue growing at an accelerated pace well into the 21st century. Singapore Airlines expanded rapidly over the past two decades and currently maintains a fleet of 55 aircraft. It expects to continue expanding to meet growing passenger demand in the Asia-Pacific region and beyond. Most promising subsectors as identified by the USDOC are aircraft and helicopters with 1993 estimated market size of \$893 million and \$ 137 million respectively.

10. Taiwan

Taiwan seems to have one of the most number of airlines among all Asia-Pacific region countries. These airlines include Eva Airlines, China Airlines (flag carrier), Great China Airlines, Mandarin and Far East. All have plans to procure new aircrafts in the next few years. Most promising subsector as identified by the USDOC is general aviation aircraft with 1993 estimated market size of \$1.2 billion.

11. Thailand

Market demand for aircraft and aircraft spare parts is based entirely on imports. US firms are the main suppliers for inter-continental aircraft. Airlines covering regional routes are supplied by both France and US firms, while domestic flights use aircrafts from US, France, and the UK. For aircraft spare parts, US firms account for about 70-80% of the import market. Since the Royal Thai Government plans to develop Thailand as a regional aviation hub, the future import market for both aircrafts and aircraft parts are promising. Thai Airways

International is the only major national airline. Bangkok Airways on the other hand has a very small annual procurement program of only a few planes per year. Thailand's demand for commercial aircraft is therefore based mainly on Thai Airway's development plan. The most promising subsectors as identified by the USDOC are aircraft and aircraft parts with 1993 estimated market size of \$425 million and \$150 million.

VI. Significance of the Asia-Pacific Region

The Asia-Pacific region is not just another fast-growing market to broaden the demand base of P&W. The region presents a unique set of challenges and opportunities that will allow P&W to change the rules of the game that would essentially achieve three things.

- Take the engine competition from the commodity game where sales successes are highly and inversely correlated with price.
- Reduce the buyer power that currently exists in the market for jet engines.
- Put P&W in a bandwagon to reinvent itself from a jet engine manufacturer to something else. This something else will depend largely on the evolution of competition that ensues after P&W attempts to change the rules of the game.

Discussed below are some of the unique challenges and opportunities presented by the Asia-Pacific region and their significance to P&W.

A. Demand for Engines

Based on the largest P&W customers for the PW4000 engine series, the Asia-Pacific seems to be the only region in the world that is actively placing orders. Table C below lists the largest P&W PW4000 customers in order of size of ordered engines.

Table C - PW4000 Customer Ranked by Size of Order (3/31/96)

Customer	Region
Singapore Airlines	Asia-Pacific
Korean Airlines	Asia-Pacific
United Airlines	Americas
Delta Airlines	Americas
Northwest Airlines	Americas
International Leasing and Finance Company	Americas
Malaysian Air System	Asia-Pacific
Air China	Asia-Pacific
Japan Airlines	Asia-Pacific
China Airlines	Asia-Pacific
All Nippon Airways	Asia-Pacific
Ansett	Asia-Pacific
Japan Air System	Asia-Pacific

This demand results from the growth of the airline industry in the region as well as its profitability. With the advent of new start-ups in the market financed by some of the wealthiest individuals and family groups in the region, this demand would continue to grow. This demand helps to alleviate the production overcapacity of P&W specifically and the other major engine manufacturers generally. Moreover, as a result of a dynamic market, the Asia-Pacific will present a good opportunity for P&W to try out new strategies and study the evolution of competition in responding to those strategies to see what works for it and what does not.

B. Very Different Sub-markets

The Asia-Pacific region consists of many countries with different stages of economic development as well as different cultures. Goals and needs of individual countries vary tremendously which are also reflected on the goals and needs of their airline industries. Consequently, this presents a tremendous opportunity for market and airline segmentation which results in P&W being able to address each airline's needs individually and thus be more successful in differentiating its "products." One model for segmentation has been developed by the Boston Consulting Group (BCG) and this is illustrated in Table D below.

Table D - BCG Airline Segment Model

Airline Segment	Description	Examples
Weak small airlines	<ul style="list-style-type: none"> • regional players and route specific airlines • meager financial resources • prefer to lease assets • some financing required from manufacturers 	Air Europe Reno Air Cebu Pacific Pacific Air
Virtual airlines	<ul style="list-style-type: none"> • large players with strong franchise and customer base • only want assets that directly touch their customers • lease assets 	British Airways
Fleet cost reducers	<ul style="list-style-type: none"> • they are also known as cost minimizers • fly fleet at lowest costs • low downside residual risk 	Korean Air Northwest Airlines Delta Airlines
Service expanders	<ul style="list-style-type: none"> • diversify into ancillary services such as overhaul and repair services, food catering, and aircraft leasing 	Singapore Airlines Lufthansa

Understanding of the various segments and what is required to be successful in serving their needs would allow P&W to develop a competency to differentiate a package of

services to its customers. The end result would be that engine price on its own will not be a significant criterion in the engine selection of its customers, both the airlines as well as the aircraft leasing companies that are developing in the region such as Singapore Aircraft Leasing Enterprise (SALE).

Based on the different segments, P&W can consider various service options and packages for its customers such as straight lease, equity stake, joint-venture, and power-by-the-hour packages. Since the current trend in the region is service expansion, as part of a package, P&W may opt to develop joint-ventures with the airlines or their parent companies in parts manufacturing, overhaul and repair services, and other services.

C. Low Labor Costs

Some countries in the region have skilled workforces that can be easily trained and costs less than their counterparts in the US. Since there is pressure from various countries in the region for local parts sourcing as well as technology transfer requirements when importing capital goods, this will be a good opportunity for P&W to both get into favor with the region's trade politics while at the same time gain cost advantages in parts of its business.

D. No Dominant Regional Airline Yet

Unlike North America or Europe, there is still no dominant regional airline in the Asia-Pacific region. With continued deregulation as well as the continued evolution of ASEAN and the Asian Free Trade Area, this regional airline concept may become a reality. This will provide tremendous opportunities for up-and-comers to leapfrog the current contenders or to take up profitable niches in a rapidly evolving market. If P&W plays its cards right, it may be able to partner with an up-and-comer so that it becomes the engine of choice for an airline with good growth potential.

Moreover, with new airlines starting up, P&W has the opportunity to extend the lives of its older engines by fitting them on to the aircrafts of start-ups who may not be able to afford to buy new. This will in turn assure P&W a longer stream of spare parts revenues.

E. Bream of a Regional Jet

As mentioned earlier in this paper, countries such as China, South Korea, Japan and Indonesia are racing to develop their own homegrown regional twin-jet that fits well with the route structures in the Asia-Pacific region. With this comes the opportunity to become the exclusive provider of jet engine on the most successful of these ventures. The challenge of course is to identify the one that is most likely to succeed given the right support from P&W. This again can change the rules of the game to the extent that P&W

does not just supply the engine but also evolves into an organization that supplies technology and other services as well.

F. Source of Financing

With the tremendous cost in developing and manufacturing of jet engines, P&W can avail, through partnerships and joint-ventures, of the financial capability of various corporations and institutions in the region who are supported by their governments to develop their countries' aerospace industry. Not only does P&W share the risk of development, with the right partners, it could even minimize the risk by the assurance of a ready market for its engines and services.

VII. Conclusion

Like many other companies before it, P&W (or any of the other contenders in the jet engine war) will have to change the way it looks at its business and change the rules of the game to succeed. It will have to evolve from an engine manufacturer into something else. Right now, this something else is not yet apparent. It could evolve into a propulsion marketing company, a propulsion manufacturing integrator, a propulsion solutions provider or an aerospace service engineering company that supplies its own jet engines as well. There are various companies out there which have reinvented themselves that can serve as models for P&W's evolution.

One thing is for certain though, P&W has to differentiate itself as a company from its competition to get itself out of a "commoditizing" business by changing the rules of the game. It cannot afford not to change the game anymore mainly because its customers have become used to the fact that for all its worth, jet engines are basically commodities and price is the determining factor in a successful sale.

Despite the global nature of the jet engine business, the Asia-Pacific region provides fertile grounds to sow a different strategy to change the nature of competition mainly because it is a growth market compared to that of the mature markets of North America and Europe. In addition, its idiosyncrasies as described above also provide opportunities for differentiation which will manifest itself in terms of (1) changing (usually enlarging) the strategy space for each player; (2) changing the set of attainable prospects; and (3) changing the payoff functions. Referring back to game theory, these manifestations may be the key to allowing the three major players the opportunity to develop their dominant strategies to be different from each other to achieve a Nash Equilibrium or a stable oligopoly through differentiation.

In "In the Neolithic Age" by Rudyard Kipling, the poet wrote about differentiation as follows:

There are nine and sixty ways
of constructing tribal lays,
And every single one of them is right.

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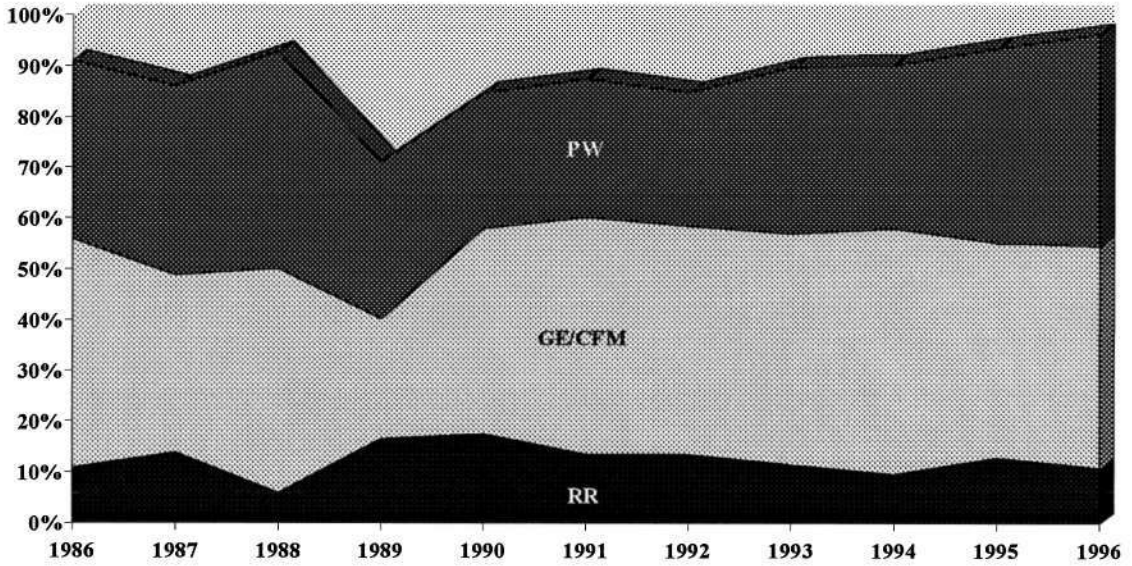
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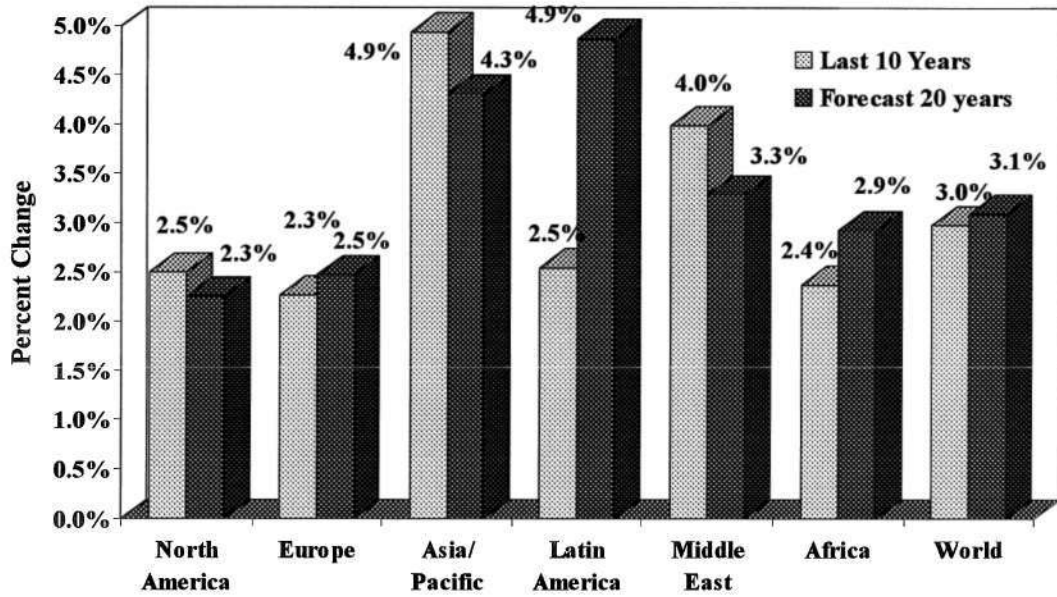
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IX. Exhibits

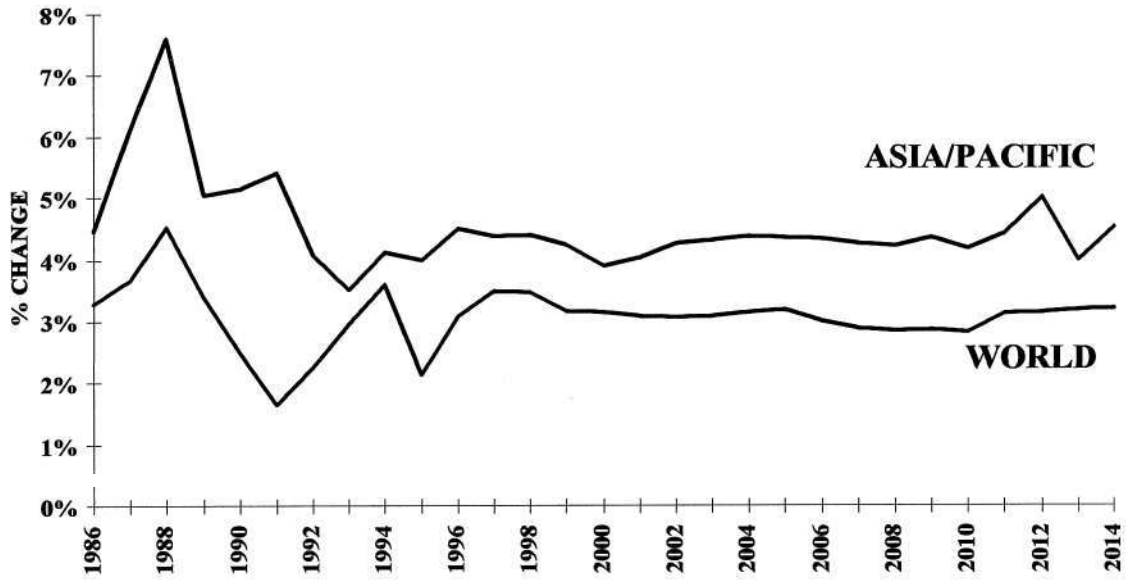
A. *Exhibit 1 - Engine Delivery Market Shares (1986-1996)*



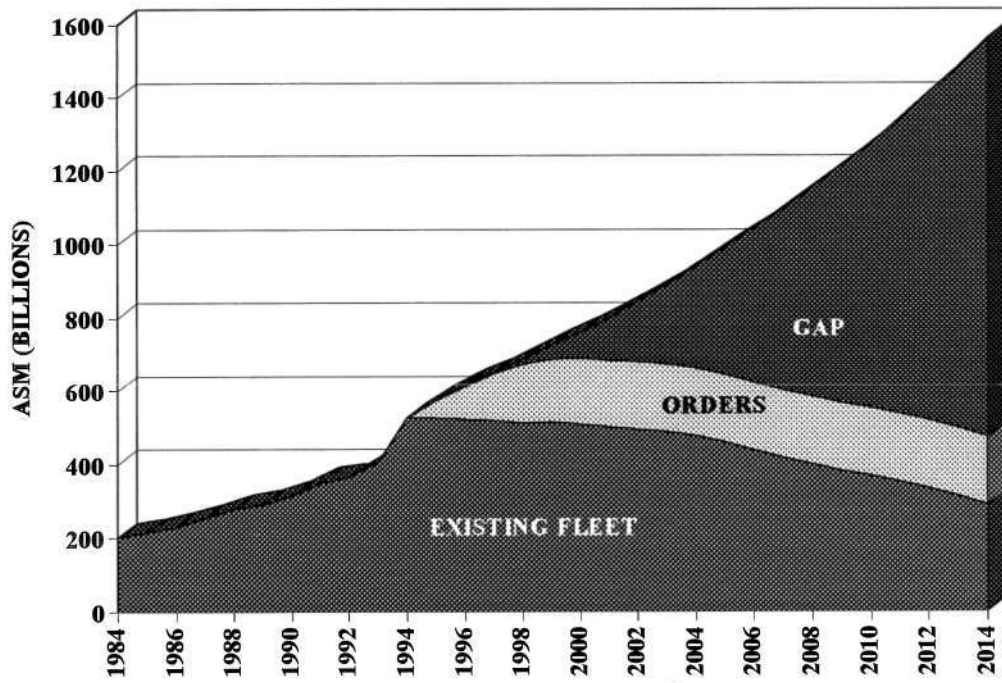
R. *Exhibit 2 - Regional Economic Growth Rates*



C. *Exhibit 3 - World GDP Growth Rates*



D. *Exhibit 4 - Asia-Pacific Aircraft Seat Mile Projection*



G. *Exhibit 7 - Asia-Pacific Engine Forecast (1995-2014)*

