BALANCING TAX INCENTIVES WITH OPERATIONAL RISKS IN CAPTIVE OVERSEAS PRODUCTION FACILITIES

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Submitted to the MIT Sloan School of Management and the Engineering Systems Division in Partial Fulfillment of the Requirements for the Degrees of

Master of Business Administration
and
Master of Science in Engineering Systems

In conjunction with the Leaders for Manufacturing Program at the

Massachusetts Institute of Technology
June 2009

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May 8, 2009
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ABSTRACT

Due to the general macroeconomic downturn, many companies have turned to offshoring – sending a function overseas – to reduce production costs. While some companies elect to outsource overseas production to outside companies, many companies choose to keep production in-house and therefore create captive production facilities overseas. In many countries, the government will provide financial incentives (e.g. tax breaks, loans, subsidies) to certain companies in exchange for creating employment opportunities and industry knowledge within their borders. These financial incentives may tempt companies to shift more and more functions overseas; however, in many cases, there are significant operational risks involved with shifting functions overseas.

This thesis uses a six-month project as a case study for discussing ways to weigh financial benefits against operational risks. The project was conducted at the European headquarters of Spirit AeroSystems, the largest independent designer and manufacturer of independent aerostructures for the commercial aircraft industry. Spirit Europe recently launched a greenfield factory in Malaysia. Malaysia was selected as the factory site for a variety of reasons; among which was a long-term tax incentive. This thesis describes the process and tools used to select an optimal transfer pricing relationship (i.e. scope of work to be performed overseas) and transaction methodology that would best monetize the long-term tax incentive without incurring unacceptable levels of operational risk.

A comprehensive functional analysis was conducted to understand operational risk and economic value. Next, a Monte Carlo simulation was created to better understand project profitability. The results from the functional analysis and the Monte Carlo simulation are united to identify the optimal transfer pricing structure and methodology. The unintuitive result is that, for both operational and financial reasons, the scope of work transferred to the low tax jurisdiction (in this case, Spirit Malaysia) should be fairly limited for existing contracts.

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ACKNOWLEDGMENTS

The author wishes to express sincere appreciation to Spirit and its employees for the unfailing support and encouragement over the past year. In particular, the author wishes to thank Andy Leitch, Andy Shact, and Chris Wilkinson for their advice, patience, and friendship.

The author is also grateful to her thesis advisors Don Rosenfield and Dan Whitney for being calming and brilliant sounding boards.

Lastly, the author wishes to thank her parents – Jim and Susan – for their support, mentorship, confidence, and love. Without them, nothing would be possible.

1 Company and Industry Overview

1.1 Company Overview

This company overview is primarily derived from information in the Spirit AeroSystems 2007 Annual Report and June 2008 Investor Day Presentation in Wichita, Kanasas. (Spirit AeroSystems, 2007) (Spirit AeroSystems Holdings, Inc., 2008)

Spirit AeroSystems Holdings, Inc. ("Spirit") is the largest independent non-OEM designer and manufacturer of commercial aerostructures in the world. OEM refers to aircraft original equipment manufacturers such as The Boeing Company ("Boeing") and Airbus S.A.S ("Airbus"). Aerostructures are structural components such as fuselages, propulsion systems and wing systems for commercial and military aircraft.

In June 2005, an investor group purchased Boeing's commercial aerostructures manufacturing operations in Wichita. Boeing Wichita formerly functioned as an internal supplier of parts and assemblies for Boeing's airplane programs and had extremely limited sales to outside customers. Following the acquisition, the Boeing Wichita site became the headquarters for the new company, Spirit AeroSystems. Company operations specifically in Wichita will be referred to as "Spirit Wichita" or "Spirit US."

In April 2006, Spirit purchased a division of BAE Systems located in Prestwick, Scotland and Samlesbury, England – both in the United Kingdom. The Prestwick, Scotland ("Prestwick" or "Scotland") became Spirit's European headquarters. With this purchase, Spirit became a major supplier to Airbus.

Spirit manufactures aerostructures for every Boeing commercial aircraft currently in production, including the majority of the airframe for the Boeing 737. Spirit also makes the majority of the wing for the Airbus 320 family and a major wing component for the Airbus 380.

Spirit's global footprint also includes operations in Tulsa, Oklahoma, USA; McAlester, Oklahoma, USA; Kinston, North Carolina, USA; Moscow, Russia; Xiamen, China; and Subang, Malaysia.

In 2007, Spirit's revenues were just shy of US$4 billion and net income was nearly US$300 million. Sales to Boeing make up the vast majority of revenues. Commercial aircraft market sales account for approximately 99% of revenues. Spirit, Inc. has roughly 14,000 employees worldwide.

1.2 Prestwick Site Overview

Spirit's European headquarters are located in Prestwick, Scotland. The Prestwick, Scotland and Samlesbury, England sites will be collectively referred to as "Spirit Europe." Spirit Europe primarily designs and manufactures wing components for Airbus. Spirit Europe has small operations for Boeing and Hawker Beechcraft as well. Spirit Europe has approximately 800 employees.

1.3 Industry Overview

The following is a summary of recent trends in the commercial aerospace industry, particularly as they apply to Spirit Europe and the recent expansion of its global manufacturing footprint into Malaysia.

1.3.1 General Economic Downturn

The general economic downturn has greatly affected the commercial aircraft industry. Equity analysts at Credit Suisse believe "the lack of commercial aircraft financing and rising airline

bankruptcy risks present the biggest challenges..." In fact, there have been at least eleven airline failures since March 2008 "driven primarily by high fuel prices and weakening demand in the current global downturn." These airline failures represent a growing risk to Boeing and Airbus backlogs, and in turn, represent a meaningful risk to future revenue at aircraft suppliers such as Spirit. Low cost airlines with aggressive expansion plans are the most susceptible to failure. Low cost airlines represent 34% of Airbus' backlog. (Credit Suisse Equity Research, October 13 2008) Airbus accounts for approximately 80% of Spirit Europe's revenues; Spirit Europe's sales are heavily dependent on Airbus' backlog health.

1.3.2 Cost-cutting Pressures

The challenges created by the tough economic environment have been compounded by substantial delays in the A380 for Airbus and the Boeing 787 Dreamliner. Aircraft manufacturers have responded by introducing aggressive cost-cutting measures into existing operations.

Power8 and Power8+

Airbus' response to "the very substantial challenge of the US dollar weakness, increased competitive pressure, the financial burden related to the A380 delays as well as meet its other future investment needs" is called the Power8 restructuring plan. "Power8," launched in early 2007, "provides for strong cost-cutting measures, aims at transforming the Airbus business model and the development of a global network of partners." (Airbus, 2007)

Along with various overhead reductions, divestitures, in-house production improvement initiatives, and organizational changes, Power8 includes a module to reduce the price from suppliers. As part of this module, Airbus has negotiated substantial price reductions on many of its existing programs

with Spirit Europe. For example, revenue on the A320 wing components provided by Spirit Europe to Airbus will decrease by approximately £21 million annually in 2011, approximately 10% of the original price. As this package had already thin margins, the price reduction would have pushed some portions of the package into the red. In response, Spirit Europe has pulled some work from an outsourced supplier (BAE Systems) in the UK and is transitioning the work to a captive, fully-owned, greenfield manufacturing plant in Malaysia. Labor and overhead savings garnered from moving just a small portion of the A320 package are approximately £10 million per year.

Because Power8 was so successful in achieving its targets, Airbus extended the initiative under the name of Power8+. This initiative will force Spirit to accept even further price declines, more risk-sharing, and greater pressures to source from global low cost environments.

1.3.3 Risk Sharing and Outsourcing

The changing environment has quickened the pace of an existing trend – the globalization of the supply chain. "What Airbus and Boeing have in common here is their willingness to transfer part of their risks to partners, and they are doing so to a much greater extent than before. Boeing, for instance, has outsourced as much as 70 percent of the work for the new 787 widebody." (Dubois, 2008) (Dubois, 2008)

Inspired by the successful outsourcing in the car industry, aircraft manufacturers are giving major suppliers much greater responsibility than in the past. There have been "important strategic shifts in supply chain management, driven by the pressing need to reduce cost and spread development costs. Both [Boeing and Airbus] have asked major suppliers in 787 and A380 to absorb non-recurring costs, thus greatly shifting costs and risks to suppliers... Suppliers [have been] delegated much more

responsibility for design, development and manufacturing through closer collaboration, partnerships and integration across supplier networks." (Horng & Bozdogan, 2007)

Tier 1 suppliers have not all reacted well to the increased responsibility. "Latecoere, French supplier to Boeing and Airbus, will no longer invest as a partner in big aircraft projects – a sign that commercial aircraft manufacturers' attempts to shift risks on to parts makers might be hitting the buffers. Francois Junca, chairman of Latecoere's supervisory board, has told shareholders that the group will in future be a simple subcontractor for aircraft manufacturers, which means no longer carrying part of the development and production costs for big projects." (Hollinger, 2008)

In addition to pushing greater risks onto suppliers, both Boeing and Airbus have increased their global outsourcing, particularly in Japan, China, India, the Middle East, and Eastern Europe. Growth in the Asia Pacific region has been particularly notable, driven by strong economic growth as well as fast-growing air travel. Large Asian and Middle Eastern carriers are now major customers (e.g. Singapore Airlines, Emirates). Additionally, a variety of offset arrangements (discussed in greater detail below) have opened up new market opportunities and led to increased sourcing, especially in China. (Horng & Bozdogan, 2007)

Because more and more pieces of an aircraft's supply chain are located in the Asia Pacific region, it is sensible for Spirit and other aircraft suppliers to establish a presence in Asia Pacific as well. An Asian presence allows Spirit to interact closely with other regional aircraft suppliers as well as reduce costs associated with coordination and shipping between the various other suppliers. Spirit's appropriate response to this trend was the formation of Spirit Malaysia. Spirit Malaysia allows Spirit to fully realize the potential of existing suppliers such as SMEA and CTRM in Malaysia and IAE in Indonesia. Spirit Malaysia will likely spearhead the Asia Pacific sourcing and supplier development

for the entire Airbus Supplier Council (comprised of Airbus' major Tier 1 suppliers such as Spirit, GKN, Saab, Latecoere, and others).

1.3.4 Offset Arrangements

As mentioned above, a variety of offset arrangements have opened up new opportunities in the Asia Pacific region. Offset arrangements, sometimes referred to as "offsetting" or "offset obligations," occur when an aircraft manufacturer such as Boeing or Airbus closes the sale on airplanes. In return for a government purchasing aircrafts, the aircraft manufacturer agrees to perform a certain amount of work required to build the aircraft in that specific country. That work can be performed by the aircraft manufacturer itself, or by one of its suppliers (e.g. Spirit).

Spirit Malaysia gives Spirit a significant competitive advantage for winning business from Boeing and Airbus as it helps the aircraft manufacturers fulfill offset obligations in Malaysia. In order to penetrate new markets, aircraft manufacturers like Boeing and Airbus ask their suppliers (e.g. Spirit) to perform work in diverse countries to gain offset credits on their behalf. As Malaysia's economy grows and need for travel increases, Spirit Malaysia is well positioned to help Boeing and Airbus satisfy offset obligations in Malaysia.

1.3.5 Transition to Composites

Aircrafts have long been made primarily from aluminum. However, the industry has taken a determined shift toward using composite materials instead. The A380, Airbus' latest aircraft uses 25% composite material by weight, compared with just 10% in the A320. The Boeing 787 Dreamliner has 50% composite material by weight, compared with just 12% in the Boeing 777. (Horng & Bozdogan, 2007)

Spirit Malaysia helps position Spirit well for this industry trend. By moving composite expertise in-house (out of an outsourced supplier in the UK), Spirit is building composite expertise as a core competency for the future. Additionally, the location of Spirit Malaysia just hours away from at least one major supplier of composite panels/subassemblies in Malaysia (CTRM), Malaysia is set to become a major hub for composite expertise, with Spirit Malaysia pioneering the way.

1.4 Chapter Summary

Spirit AeroSystems is the largest independent designer and manufacturer of aerostructures for the commercial aircraft industry. Five important industry trends have prompted the creation of a new greenfield factory in Malaysia and are thus particularly relevant to this thesis:

1) General economic downturn
2) Cost-cutting pressures
3) Rish sharing and outsourcing
4) Offset arrangements
5) Transition to Composites

Now that the reader is armed with a company and industry overview, he/she is ready to discuss the background and objectives of the project. Following the project description, a brief tutorial on Transfer Pricing is provided in Chapter 3. This chapter includes a presentation of the available options for the solution. Chapter 4 provides detailed descriptions of key functions at Spirit Europe to highlight which are important and why. Chapters 5 and 6 narrow down the options to a solution using a Monte Carlo simulation and some accounting calculations. The thesis ends with a summary in Chapter 7.

2 Project Overview

This chapter clarifies the problem statement for the project, then outlines the approach and organization of this thesis.

2.1 Project Background

As discussed in the previous chapter, the greenfield production facility in Subang, Malaysia ("Spirit Malaysia") was created for multiple strategic reasons. Among those already discussed are:

1. **Increased risk sharing and outsourcing in Asia Pacific**

   As Airbus and Boeing outsource more and more of their production to Asian suppliers, it became clear that Spirit needed a presence in Asia Pacific to effectively interact with these new suppliers.

2. **Rising offset obligations in Asia Pacific**

   Countries in the Asia Pacific region are increasingly active buyers of commercial aircraft. Spirit Malaysia gives Spirit the ability to offer Boeing and Airbus fulfillment of offset obligations in Malaysia.

3. **Transition to composites**

   As the industry moves away from aluminum toward composite materials, Spirit brought the composite process and material technology back in-house by moving production from an outsourced supplier in the UK to Spirit Malaysia. Subang is conveniently located just a few

hours from CTRM, a major supplier of composite panels and subassemblies. Spirit Malaysia is positioned to become a hub of composite expertise in the aircraft industry.

What has not yet been discussed is the financial motivations for the Malaysian factory.

Given the poor macroeconomic environment and the severe pressures to reduce costs from OEMs, Spirit Europe made the decision to utilize more low cost manufacturing. For various strategic reasons – such as building composite expertise in house – Spirit Europe elected to build a captive greenfield facility. As a side note, Spirit Europe does continue to place more work in low cost countries through outsourcing, but those projects are typically simpler projects and/or projects with nearly obsolete technology (e.g. heavy manual processes on an aircraft designed in the 1960s, simple aluminum wing panels).

After evaluating numerous sites in various countries in Latin America, Eastern Europe, and Asia, it was determined that Malaysia offered the best package including a strategic location, an educated workforce, low cost labor, and attractive corporate business environment. The support from the Malaysian government was also a key factor. The Malaysian government agreed to a variety of concessions and subsidies in exchange for the high value work that would be created and core competencies that would be developed within its borders. Among these concessions was a **lucrative long-term tax incentive on profit recognized in Malaysia.**

2.2 Problem Statement

The labor and overhead savings derived from transferring work from the outsourced UK provider to Spirit Malaysia was dramatic and quantifiable. From just labor and overhead, Spirit Europe expects to achieve cost reductions of £10 million to help offset the impact of the price reductions it

has committed to its customer. Government subsidies on land and construction are even easier to quantify. However, the long-term tax incentive is impossible to quantify without understanding how much of a project's profit will be recognized in Malaysia.

This problem is compounded by the fact that a project's profit cannot be understood without first understanding the economic value of the work being performed in Malaysia. Furthermore, at the start of the project, the scope of work to be performed in Malaysia had not yet been decided.

Therefore, there was a **need to determine the optimal method for monetizing the long-term tax incentive without incurring operational risks that outweigh the financial benefit.**

For a more tangible (but hypothetical) example, moving the design process to Malaysia would allow Spirit Malaysia to recognize a significant portion of the profit attributable to the design phase of a project. However, without experienced design and stress engineers, Spirit Malaysia does not currently have design capabilities. Moving design responsibilities there without an adequate supporting infrastructure may cause delays, poor design, loss of customer goodwill, etc. Therefore, the operational risks of moving design most likely outweigh the financial benefit.

2.3 Project Objectives/Goals

This thesis is based on the work during a six-month internship conducted in Spirit Europe. The internship project had essentially **three goals**:

1. **Determine the optimal transfer pricing relationship (i.e. scope of work) between Spirit Europe and Spirit Malaysia**

   This is another way of saying: "Define the **scope of work** to be performed in Spirit Malaysia." The first goal was to define the set of business functions (e.g. sales and

marketing, design, production, finance, supply chain management) to be performed in Malaysia. To do this, the financial benefit and operational risks of each business function must be understood and weighed against each other. This objective is the most difficult and time-consuming of the three.

2. **Determine the optimal transfer pricing transaction methodology**

   Once the business functions to be performed in Malaysia have been defined, the optimal transaction methodology (i.e. *how* Spirit Europe would pay Spirit Malaysia for its services) and margin (i.e. *how much* profit should be recognized in Malaysia) needed to be determined.

3. **Implementation**

   As with most projects, a difficult part of implementation is getting agreement and support from necessary stakeholders.

   After the necessary stakeholders are on board, implementing the tactical items involved (e.g. intercompany agreements, information system tracking ability, modified supplier and customer contracts, customer and government approvals) are more straightforward tasks.

2.4 Approach

The project had three phases – roughly chronologically:

1. **Functional Analysis**

   A comprehensive analysis of all of Spirit Europe's business functions was conducted. The goals of the functional analysis were to identify the core functions being performed and then to **understand the operational risks and the economic value** behind each business function. Included in the comprehensive analysis are strategic (e.g. mergers & acquisitions,

make vs. buy decisions, and global expansion), manufacturing (e.g. design, industrialization, production, supply chain selection and management, compliance, quality, maintenance), and support functions (e.g. information technology ("IT"), finance).

For example, the supplier selection function has significant operational risks. If a poor supplier is selected, there may be significant and costly delays in production, or quality may be adversely affected. These are both grave operational risks in a manufacturing company. Similarly, because supplier selection has significant risks involved, it is considered economically valuable by tax advisors and authorities. Because it is considered economically valuable by tax experts, it is a good candidate to be moved to Malaysia to monetize the tax break.

Phase one was accomplished by conducting approximately forty interviews with employees in various parts of the Spirit Europe organization.

2. Profit and Risk Simulation Model

As the project progressed, it became clear that choosing between the various acceptable transfer pricing relationships (i.e. options for scopes of work to be performed in Malaysia) was dependent upon how profitable a project would be and how much that project's profit would vary over time. At the time, Spirit Europe's methods for predicting project profit were deterministic and therefore inaccurate. The inaccuracy may have been caused by overly specific assumptions and pressures to achieve profitability hurdles whilst also achieving low enough bids to win new projects.

Phase three was completed by building a Monte Carlo simulation model that outputs profit as a probability distribution, thus allowing Spirit Europe to more confidently assess the likelihood of certain profit levels on future and existing projects.

3. **Implementation**

As discussed, the most difficult part of implementation was securing stakeholder agreement. For the author, the most time-consuming portion of phase three was preparing presentations for and frequently interacting with the necessary parties to ensure full cooperation. Once the necessary parties agreed to support the initiative, implementation responsibilities (e.g. writing and executing the intercompany agreements, preparing the financial and IT tracking abilities, preparing the operating plan) were transferred to Spirit Europe's employees for completion.

2.5 Organization of Thesis

This thesis begins (**Chapter 1**) with a company and industry overview to provide readers with the necessary context to understand the purpose of the thesis, as well as many of the challenges faced as the project developed.

Chapter 2 discusses the background and objectives of the project and outlines the chronological approach.

Chapter 3 arms the reader with a basic tutorial on Transfer Pricing principles.

Chapter 4 provides a condensed version of the functional analysis. In particular, this chapter highlights the functions determined to be the greatest value-drivers in the aircraft design and manufacturing process.

After the functional analysis, the reader is prepared to begin considering specific transfer pricing relationships. **Chapter 5** discusses the merits of the Cost Plus Margin relationships versus the merits of the Entrepreneur relationships. The Monte Carlo simulation is utilized here to quantify the financial profit of projects as distributions and to emphasize the vast difference in financial riskiness of the Cost Plus and Entrepreneur structures. The chapter also describes in greater detail the development of the model, including considerations on what uncertainties are truly important to include as inputs, the structure of the model, and the tools used to run the simulation. Chapter 5 concludes with the argument that Entrepreneur options are too risky financially for existing projects and are, therefore, not worth the operational risks incurred. The chapter also includes some other potential business applications of the Monte Carlo simulation at Spirit Europe.

After determining that Cost Plus Margin relationships are the most appropriate, **Chapter 6** is dedicated to selecting the optimal Cost Plus Margin relationship. The chapter begins with a description of the key differences between Consignment Manufacturing and Contract Manufacturing. The chapter concludes with the determination that, given the cost structure of the aircraft manufacturing industry, Contract Manufacturing is significantly more lucrative that Consignment Manufacturing and is also worth the operational risks incurred.

The thesis is concluded in **Chapter 7** with a brief summary of the main points.

2.6 Chapter Summary

Along with a host of strategic reasons and government incentives, one reason for selecting Malaysia as the factory site was the long term tax incentive provided by the Malaysian government. This thesis attempts to address the **need to determine the optimal method for monetizing the long term tax incentive without incurring operational risks that outweigh the financial benefit.**

The project entails understanding the financial benefits and operational risks through a detailed functional analysis and a Monte Carlo simulation of project profit. The project ends with a final recommendation for and implementation of a specific transfer pricing and methodology.

3 Transfer Pricing Theory

3.1Introduction to Transfer Pricing

"Transfer pricing, for tax purposes, is the pricing of intercompany transactions that take place between affiliated businesses. The transfer pricing process determines the amount of income that each party earns from that transaction... Transactions, in this context, are determined broadly, and include sales, licensing, leasing, services, and interest." (Feinschreiber, 2004) "The study of the intra-firm portion of supply chain relationships is a necessity for a proper understanding of cost management throughout the entire supply chain." (Mehafdi, 2002)

"Taxpayers and the taxing authorities focus exclusively on related-party transactions, which are termed *controlled transactions*, and have no direct impact on independent-party transaction, which are termed *uncontrolled transactions*." (Feinschreiber, 2004)

"Transfer pricing can deprive governments of their fair share of taxes from global corporations and expose multinationals to possible double taxation. No country – poor, emerging or wealthy – wants its tax base to suffer because of transfer pricing. The arm's length principle can help." (Neighbour, 2008) For the purposes of this project, the cross-border transactions between Spirit Europe and Spirit Malaysia are in question. With a high-tax environment (Spirit Europe) and a low-tax environment (Spirit Malaysia), the tax authorities will be looking closely at profit recognition and seeking solid evidence that functions justifying Malaysia's profits are (a) actually derived from work being performed in Malaysia and (b) that the work is charged at a fair price.

"Fair" price is, according to the Organisation for Economic Co-operation and Development (OECD), defined using the "arm's length principle." Essentially, the arm's length principle states that a transaction between two related entities should be priced at market value, as if the transaction were priced between two unrelated parties. "The 'arm's-length principle' of transfer pricing states that the amount charged by one related party to another for a given product must be the same as if the parties were not related. An arm's-length price for a transaction is therefore what the price of that transaction would be on the open market. For commodities, determining the arm's-length price can sometimes be as simple a matter as looing up comparable pricing from non-related party transactions, but when dealing with proprietary goods and services or intangibles, arriving at an arm's length price can be a much more complicated matter." (USTransferPricing.com)

"Consider a profitable UK computer group that buys micro-chips from its own subsidiary in Korea: how much the UK parent pays its subsidiary – the transfer price – will determine how much profit the Korean unit reports and how much local tax it pays. If the parent pays below normal local market prices, the Korean unit may appear to be in financial difficulty, even if the group as a whole shows a decent profit margin when the completed computer is sold. UK tax administrators might not grumble as the profit will be reported at their end, but their Korean counterparts will be disappointed not to have much profit to tax on their side of the operation. This problem only arises inside corporations with subsidiaries in more than one country; if the UK company bought its microchips from an independent company in Korea it would pay the market price, and the supplier would pay taxes on its own profits in the normal way. It is the fact that the various parts of the organisation are under some form of common control that is important for the tax authority as this may mean that transfers are not subject to the full play of market forces." (Neighbour, 2008)

In the same way, when Spirit is planning transfer pricing between two related entities – Spirit Europe and Spirit Malaysia, the company must show that the transaction was conducted no differently than it would have been for an arbitrary third party. In simpler words, Spirit Malaysia cannot charge Spirit Europe more or less for services than Spirit Europe would have paid an outside supplier. Nor can Spirit Europe volunteer to pay Spirit Malaysia more or less for its products or services than Spirit Europe would have paid an outside supplier.

The goal of this project is to ensure that the optimal economic relationship – that weighs financial benefits and operational risks – is attained, while still meeting the OECD's requirements for a fair arm's length price between parties.

3.2 Determining the Value of Business Functions

"Arm's length value" is based on the economic value of work; but economic value is difficult to assess. What we are specifically trying to measure here is **what *profit margin* can be recognized for each business function.** Various methods can be employed to estimate economic value.

One method is by comparing the work performed to similar work performed in other companies within the industry. In certain industries, the economic value of specific functions will be highly correlated. In these industries, looking at similar companies is very useful for estimating a fair internal transaction price. For example, in a consumer goods industry such as mobile electronics, marketing is extraordinarily important and likely outweighs manufacturing in economic value.

However, even within an industry, the economic value of functions can vary dramatically depending on individual companies' business models. Mobile electronics may again be a useful example. A company like Apple outsources all manufacturing to external suppliers. Apple carefully controls

their brand image through marketing. For Apple and their business model, marketing provides greater economic value than manufacturing. In contrast, Dell (at least parts of it) focuses on supply chain and manufacturing expertise to deliver low-cost, customized solutions. For Dell, the supply chain and manufacturing functions would be at least as, if not more, economically valuable than the marketing functions.

Because every company has different strategies, determining the profit margin (i.e. economic value) of each business function must start with an in-depth catalogue and analysis of all functions. In transfer pricing lingo, this analysis is called the "Functional Analysis." The Functional Analysis is a comprehensive list of all functions performed by a company.

The Functional Analysis identifies which functions are economically valuable by searching for the "Three R's" – risks, roles, and responsibilities. Those functions with more "R's" are more valuable and can be assigned greater profit. Therefore, if a function has more operational risk (included in the first "R"), it is a signal that it is more economically valuable. Financial risks (e.g. solvency risk, currency risk) are also important indicators of risk. Economic value may also be deduced by roles – the number of people actually located in Malaysia that perform a specific function – and responsibilities – the amount of decision-making authority vested in Spirit Malaysia's employees.

Implications

A potential basis for argument begins to arise. For the purposes of Spirit Europe-Spirit Malaysia transactions, from a **financial perspective**, it would be more lucrative to move the more economically valuable functions (i.e. the most profitable functions) to the low cost tax jurisdiction (i.e. Malaysia). Unfortunately, the most economically valuable functions are by definition (and

logically) the ones that have the risks associated. Therefore, from an **operational perspective**, the most economically valuable functions are the most risky and complicated to transfer overseas.

A full Functional Analysis was performed by the author for Spirit Europe. Excerpts are included in Chapter 4 of this thesis. The Functional Analysis identifies the most economically valuable functions in aircraft manufacturing (and why they are considered such by the author and Spirit Europe's employees) and discusses some of the operational hazards to moving those functions overseas.

3.3 Spectrum of Manufacturing Characterizations (i.e. Options for the Scope of Work)

Because economic value is hard to quantify, transfer pricing regulations in each country provide some guidelines for manufacturing entities. At a high level, there are four basic manufacturing characterizations available for Spirit Malaysia. From left to right, the scope of work performed in Spirit Malaysia increases. The functions marked in red show the additional functions needed to move from one characterization to the next. For example, for Spirit Malaysia to be considered a Contract Manufacturer instead of a Consignment Manufacturer, Production Scheduling and Purchasing & Inventory Planning functions must be performed in Spirit Malaysia.

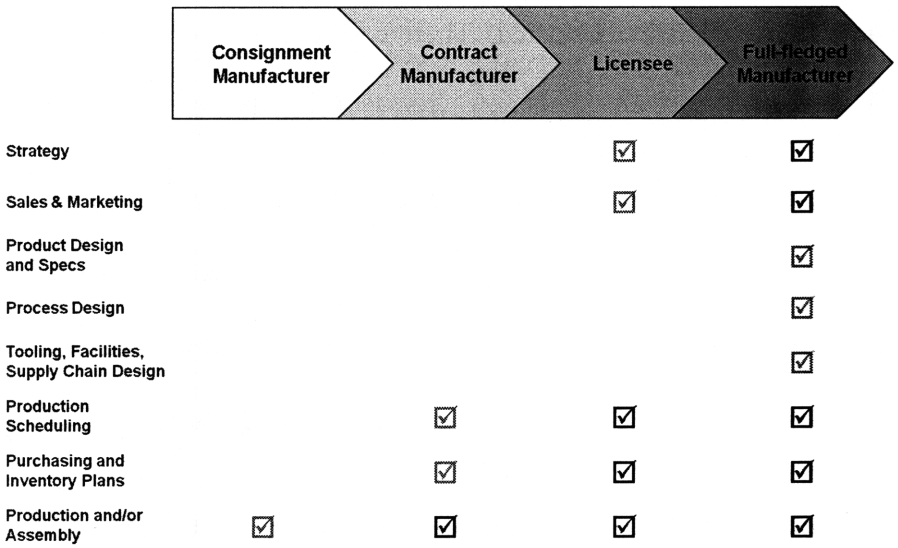

Figure 1 Author's Depiction of the Spectrum of Manufacturing Characterizations

If Spirit Malaysia is designated a Consignment Manufacturer for Spirit Europe, Malaysia's responsibilities extend only as far as production and/or final assembly. As an example, if Spirit Scotland was in the business of making paper airplanes instead of actual airplanes, Spirit Scotland would sell a paper airplane to a customer, design it, purchase raw materials (i.e. paper), schedule production, manage inventory, etc. Spirit Malaysia's only role would be to fold the paper into an airplane shape.

If Spirit Malaysia is designated a Contract Manufacturer for Spirit Europe, Malaysia would still be responsible for folding the paper into an airplane shape. Additionally, Spirit Malaysia would be responsible for purchasing paper, scheduling production, managing inventory. Spirit Scotland would still be the point of sales and interaction with the customer and the designer of the plane and manufacturing process.

The next possibility is for Spirit Malaysia to be a Licensee. In this characterization, Spirit Malaysia would find a customer and complete the sale. Spirit Malaysia would then purchase (e.g. via royalties

or a one-time payment) an airplane design and manufacturing process design from Spirit Scotland. Spirit Malaysia would then purchase supplies and manufacture the product.

In the fourth characterization, a Full-fledged Manufacturer, Spirit Malaysia would have the ability to conduct all functions necessary to sell, design, build, and deliver a paper airplane to a customer.

Implications

In the previous section, the strain between the finance department and the operations department was introduced. In this discussion of manufacturing entities, there is a different way of looking at this conflict. Employees at Spirit Europe, most of whom have worked at the Prestwick or Samlesbury sites for decades, are somewhat reluctant to transfer responsibilities to Malaysia and mindful of Malaysia's inexperience and ability to deliver a quality product. If given the choice, they would designate Malaysia as a Consignment Manufacturer and retain all customer-facing, supplier-facing, inventory and scheduling, and quality responsibilities. Unfortunately, the Consignment Manufacturer designation means that very little economically valuable work would be performed in Malaysia. Thus, very little of the project's profit could be recognized in Malaysia; which means that more taxes would have to be paid in the UK.

Malaysia's employees, however, have the excitement, energy, and optimistic visions typical to a start up environment. They are eager to add value-added responsibilities and desire to be a Full-fledged Manufacturer as soon as possible. While this designation might be a better tax answer (to be discussed further in Chapter 5), the operational risks are significant. It is unlikely that a new facility, in a country with limited prior aerospace manufacturing experience could deliver a timely and quality product as a Full-fledged Manufacturer within 1-2 years. Given the high technology equipment and

processes involved in aircraft manufacturing, as well as the incestuous customer relationships, it may perhaps be feasible in a longer period, but a shorter timeframe would pose significant challenges.

It should be noted that the Europe-Malaysia conflict described here deals primarily with operational and emotional issues. The Finance department's position is less clear and will be discussed in greater detail in Chapter 5.

3.4 Associated Transfer Pricing Transaction Methodologies

Selecting the manufacturing characterization of Malaysia has implications for how and how much profit can be recognized in Spirit Malaysia.

As illustrated in the figure below, the Consignment Manufacturer and Contract Manufacturer designations insinuate that Spirit Malaysia should charge Spirit Scotland on a "Cost Plus Margin" ("Cost Plus") basis. This means that Spirit Malaysia's revenue would be their total costs plus a markup margin. For example, if the appropriate markup margin was determined to be 10%, and Spirit Malaysia spent GB£10 million manufacturing a product for Spirit Europe, then Spirit Malaysia's revenue would be GB£11 million and their profit would be GB£1 million.

If, however, Spirit Malaysia was designated to be a Licensee or Full-fledged Manufacturer, they would be considered the "Entrepreneur" on the project. Therefore, they would be entitled to the full profit earned on a project, and less royalties paid to Spirit Europe for any services or startup intangibles they provided. For example, if Spirit Malaysia sold a program to a customer, selected and managed suppliers, manufactured the product – but purchased the product and process design from Spirit Europe – Spirit Malaysia would be considered a Licensee. Spirit Malaysia would receive the full revenue from the project, pay for any necessary expenditures to complete their business

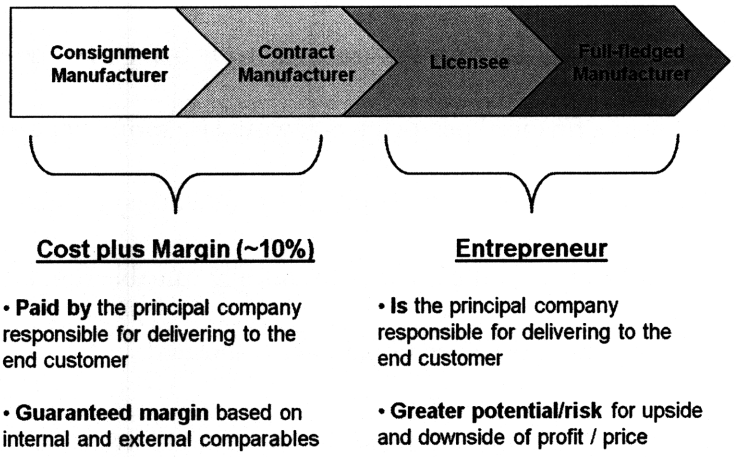

Figure 2 Author's Depiction of Transfer Pricing Transaction Methodologies

functions, and pay Spirit Europe royalties for the design. This model has much greater risk for Spirit Malaysia. On the upside, if the project is a runaway success, Spirit Malaysia would earn much more than just a 10% margin after costs. On the downside, if the project is a disaster, Spirit Malaysia would still have costs to pay to its supplier (including Spirit Europe) and would have to recognize losses. From a tax perspective, it is extremely undesirable to recognize losses in a low tax country. Remember that in this situation, Spirit Europe would be making a profit from the royalties and taxes would be paid to the UK on that profit even though the project as a whole is losing money.

3.5 Chapter Summary

"The choice of the transfer price will affect the allocation of the total profit among the parts of the company. This is a major concern for fiscal authorities who worry that multi-national entities may set transfer prices on cross-border transactions to reduce taxable profits in their jurisdiction." For the purposes of this project, with a high-tax environment (Spirit Europe) and a low-tax environment

(Spirit Malaysia), the tax authorities will be looking closely at profit recognition and seeking solid evidence that functions justifying Malaysia's profits are (a) actually being performed in Malaysia and (b) charged at a fair price. From a financial perspective, it would be more lucrative to move the more economically valuable functions (i.e. the most profitable functions) to the low cost tax jurisdiction (i.e. Malaysia). Unfortunately, the most economically valuable functions are typically (and logically) the ones that have the most operational risks associated.

This thesis selects a transfer pricing relationship from the spectrum of available entities (consignment manufacturer through full-fledged manufacturer) and a corresponding transaction methodology (Cost plus Margin or Entrepreneur).

4 Functional Analysis

4.1Purpose and Methodology

As discussed, assigning economic value and selecting the appropriate manufacturing characterization is specific to each company. To do this, a Functional Analysis of the company must be performed.

This chapter summarizes the Functional Analysis performed by the author for Spirit Europe. The purpose of the Functional Analysis is to **understand the operational risks and financial benefit (i.e. economic value) associated with various business functions**. The Functional Analysis is based primarily on approximately 40 interviews with employees from Spirit Europe and Spirit Malaysia. Some secondary research was performed to supplement the information acquired through interviews.

The official Economic Value Assignment is still being completed by Ernst & Young – Spirit's independent, external tax advisors – at the time of this writing. Ernst & Young will be assigning the *exact* profit margin to be recognized for each business function. However, this Functional Analysis strongly insinuates which functions are the most economically valuable.

4.2 Summary of Functional Analysis

The following is an abbreviated version – with additional commentary – of the analysis of the business processes performed at the Prestwick and Samlesbury sites of Spirit AeroSystems (Europe), Ltd. ("Spirit Europe") in July 2008 and revised in September 2008. The information is derived primarily from a series of interviews of and meetings with employees throughout the Spirit Europe

organization. Primary research was supplemented by secondary research including recent SEC filings, the company intranet, internal process documents, and various public and private company presentations. This analysis excludes various functions that are irrelevant to the purpose of the thesis.

What we do here is review the key functions and assess the economic value and operational risk of each. After reading this section (4.2), the reader should understand the five most critical business functions at Spirit Europe and why they are considered as such. These critical business functions are Sales and Business Development, Procurement and Supplier Management, and Production. Business functions that are critical but not options for full transfer to Malaysia are Strategy & Vision and Design. Less critical business functions are Tooling and Support (e.g. IT, finance, human resources). Each of these functions mentioned is discussed below.

For clarity, currently *all* business functions are performed by Spirit Europe. Spirit Malaysia is still under construction. What we are determining here is which functions Spirit Europe should transfer to Spirit Malaysia in the *near* future.

It should also be clarified that when we discuss operational risk, we are discussing the operational risk of *transferring* the function to Spirit Malaysia. If the function is not transferred overseas, the operational risk of transfer is completely mitigated (and there is no profit recognized in Malaysia and therefore no monetization of the tax break).

4.2.1 Strategy and Vision

Description of Function

Strategic decisions for Spirit Europe are made primarily by the Senior Leadership Council ("SLC") and steer the remainder of the business functions. The Senior Leadership Council consists of the Managing Director of Spirit Europe, his six direct reports, and a project director.

Their decisions dictate which bids are pursued and prioritized, the level of resources committed to which projects, supplier selection, production levels, and much more.

Key strategy responsibilities include:

- Determining which lines of business (e.g. structures, avionics, wings, nacelles) to be in
- Deciding which projects to bid on
- Making make/buy decisions
- Leading global expansion (i.e. where and when to expand geographically)
- Understanding which capabilities to develop for the future (e.g. focus on growing composite experience, predicting technological or structural changes in the industry)
- Supplier sourcing strategy (e.g. decision to single-source components and subassemblies)
- Developing customer relationships (e.g. fulfilling offsetting requirements)
- Identifying mergers and acquisition targets

Assessment of Economic Value and Operational Risk

Clearly, the SLC's decisions are a guide for the decision-making of the rest of Spirit Europe's employees. For example, after the decision has been made to single-source components from suppliers, the procurement team executes that strategy; they do not reinvent the sourcing strategy. Because of the extremely centralized nature of strategic decisions at Spirit Europe, the Strategy and

Vision function is highly critical to Spirit Europe's success and should be considered a major value driver.

Since the General Manager of Spirit Malaysia is a member of the SLC, Spirit Malaysia already has strategy and vision responsibilities. However, it is unlikely that, as a captive facility, Spirit Malaysia will have full control over the company's strategy and vision. Hypothetically speaking, however, wrong decisions would be extremely detrimental to the company. Therefore, moving this function to Spirit Malaysia could pose serious operational risks without sufficient experience and knowledge in Malaysia.

4.2.2 Sales and Business Development

For years, the Prestwick and Samlesbury sites have produced parts for Airbus, Boeing, and Hawker Beechcraft ("HBC"). Since the Spirit acquisition, Spirit Europe has added Cessna to its customer list. Airbus's deep relationship with this site began over 20 years ago. HBC's and Boeing's relationship with the site began around 2000.

Acquire new work packages

Description of Function

Acquiring new work packages is the identification of new work opportunities (i.e. getting a RFP or request for a rough order of magnitude ("ROM") estimate).

There are many barriers to entry for acquiring new work packages:

- Due to government and OEM approvals, as well as the knowledge required to manufacture aircraft components, there are effectively only 5-10 suppliers customers can approach for a single-source, design-and-build wing structure.

- The large upfront capital investment required to achieve economies of scale are also a substantial barrier to entry.
- Another significant barrier to entry is the industry's increasing desire for "risk-sharing partners." This entails suppliers adopting greater risks such as working capital risk (e.g. 787) or risk for future design changes. Smaller suppliers are not positioned financially to absorb the level of risk required. Smaller suppliers also often do not have sufficient flexibility in capacity. Securing approvals and meeting compliance standards of customers and the government is extremely onerous in the aircraft industry and is also a significant barrier to entry.

The first step in the process is to determine whether the opportunity fits with the overall corporate strategy and to decide the amount of resources to allocate to the various opportunities.

Assessment of Economic Value and Operational Risk

There are significant barriers to entry to even be considered qualified supplier for a new aircraft program. These barriers to entry allow Spirit to command a heftier margin than manufacturers in many other industries. By definition, barriers to entry are value-drivers and are strong basis to argue that Acquiring New Work Packages is an economically valuable business function.

At this point, discussing the operational risk of this function is a moot point because it's simply not an option. Until Spirit Malaysia is up and running, it is not a qualified supplier allowed to deal directly with Boeing and Airbus.

Solicit identified target opportunities

Description of Function

After deciding to pursue a bid, the bid process begins. The bid process is an extensive and involved process that requires substantial time, resources, knowledge, and program management. For example, winning the empennage work for Cessna cost Spirit Europe was at minimum US $1.5 million – the approximate cost of 12 full-time Spirit Europe employees working in Wichita for 12 months. The bid team is typically led by a Customer Account Manager and consists of people from engineering, procurement, finance, and other groups as needed. If the business is not won, the time and resources spent on the bidding process are **not** reimbursed by the customer.

The three most critical factors to winning business are:

- Cost/price, and
- Technical innovation, capability, and industrialization (i.e. how robust and confident are the plans for how to manufacture the item).
- Performance (delivery and quality) on, if any, existing projects with the customer

In other words, activities that either reduce cost/price or bolster Spirit Europe's technical innovation, capability, and industrialization are the biggest drivers of economic value.

Assessment of Economic Value and Operational Risk

Actually pursuing bids is a time- and resource-intensive process. The amount of people's time and money invested prior to signing the contract is a large risk for the company that indicates the importance (i.e. value) of this function. Additionally, the fact that the process requires people from nearly all business functions indicates the amount of experience and knowledge required; this task is not an easy task that could be completed by anyone, anywhere. This is another good indicator of

value; but this also makes it clear that the operational risks of moving this function abroad would be very large because so much experience and knowledge is required.

Management existing customer relationships

Description of Function

Displaying good performance on existing work is the best way to win new work. Making sure customers are happy – that they receive quality products and timely delivery – falls more on the shoulders of employees involved in *production* than on account managers.

Assessment of Economic Value and Operational Risk

This statement should not be underestimated. Because the aircraft industry is relatively small – with few Tier 1 suppliers and even fewer OEMs – a bad experience with a supplier can end a relationship. Performing well on quality and delivery on existing work is the best way to guarantee more work in the future. As such, there is both tremendous economic value and operational risk associated with production.

4.2.3 Procurement and Supplier Management

Description of Function

Procurement encompasses all of the buying functions of the organization. At Spirit Europe, procurement is split into three categories owned by different groups: (1) raw materials procurement, (2) direct procurement, and (3) indirect procurement. Generally speaking, direct procurement purchases items that are either incorporated into the airplane or tooling used to make specific products; indirect procurement purchases general equipment (e.g. forklifts, press machines) and manages non-product-related vendors (e.g. utilities, waste management, security). While

procurement is split among three groups, each of the groups uses a similar process for the selection, development, and monitoring of suppliers.

Price often determines whether or not business is won. Selecting and managing low cost suppliers is a key factor in the ability to provide low prices to customers. Because Spirit Europe currently only does final assembly in-house, items purchased through raw materials and direct procurement account for over 80% of the Cost of Production. The majority of this cost is spent on direct purchases.

Develop and maintain supplier relationships

Healthy supplier partnerships are particularly critical to the Spirit Europe business model for three primary reasons: (1) Spirit Europe uses single source suppliers for nearly everything, (2) at least 80% of total costs are outsourced to suppliers, and (3) the nature of the aircraft industry lends itself to long-term supplier contracts (typically 5-6 years). Because of this, Spirit Europe is heavily dependent on its suppliers and the company's success is closely linked with that of its suppliers. Additionally, the complexity and high technical component of aerostructures means that few industries have as deep or complicated a supply chain to manage.

Periodic supplier evaluation

Existing suppliers are proactively managed on an ongoing basis. Periodic business and strategic reviews with the suppliers are conducted to assess each supplier's performance (quality and delivery), overall business health, and avenues for growth with Spirit.

Developing new suppliers

Spirit Europe has invested significant time and resources to developing suppliers, particularly in low cost regions such as Malaysia, South Africa, and Indonesia. It has recently begun developing suppliers in China, Korea, and India. Development of suppliers includes financial assistance or risk mitigation as necessary (tooling, free issue of materials, etc.), and also refers to teaching – teaching engineering, production, and project management skills.

A relatively large portion of this training and guidance occurs during the process of transferring work. However, in some cases, a Spirit Europe employee physically sits in the supplier's offices for 2-3 years (sometimes as many as 7 years).

A few anecdotes indicate dramatic results of Spirit Europe's development efforts. For example, CTRM in Malaysia was essentially an empty building 8-10 years ago and is now a thriving company. Similarly, SMEA (also in Malaysia) was a simple job shop and is now a more sophisticated manufacturer. For Spirit Europe, these efforts have paid off in a few notable ways. One, they have access to low cost suppliers. Two, Spirit Europe has significant buyer power over these suppliers as it typically accounts for 80-90% of these suppliers' revenues. Three, close relationships with these suppliers assist logistics and strategy; these suppliers are more open with sharing information (e.g. other work they are bidding on) so Spirit Europe can assess their capacity how it will affect Spirit Europe's business.

Supplier selection

Identify potential vendors

Spirit Europe has existing relationships with hundreds of vendors that have satisfied its supplier qualification criteria. Additionally, the company is continually searching for potential new partners. After a country or countries are targeted by the SLC for exploration, a market analysis is performed.

The market analysis consists of a conceptual evaluation of the market, country analysis, and company search.

Select supplier

After the market analysis, specific potential vendors are identified and investigated to understand their benefits and risks. At this stage, every potential supplier identified for a new work package must go through a commercial and technical assessment. From this, risk areas and areas that would prevent a placement from occurring are highlighted.

Suppliers are selected by a cross-functional team led by a member of the procurement department. In addition to procurement, the team includes employees from engineering (specialists such as machining, lean/six sigma, design, and quality), estimating (cost), tooling, and supply chain. Selection is based on multiple criteria such as capabilities, cost, geography, and risks.

Supplier selection and management is the core of providing low cost manufacturing. Again, due to the single-sourcing, the high outsourced portion, and the long-term of the contracts, Spirit Europe (and its competitors) are highly dependent on quality suppliers.

This over-dependency on suppliers can cripple project profitability. For example, a major supplier on one specific aircraft program is raising prices and performing poorly. This is partially due to a few external factors outside of Spirit's control such as increased cost of living in Eastern Europe after joining the European Union. As a result, the margin on this project has fallen by millions of dollars in the last 3 years. Those millions of dollars include raised prices, costs to air freight parts to meet deliveries, and more; the figure does not include the costs incurred to source a replacement supplier. The margin may be further reduced due to poor supplier performance.

This project represents a relatively small portion of revenue and this particular supplier represents just 2% of Spirit's spend on suppliers. Even with this small supplier the severe effect on the margin is readily apparent, as is the amount of money in absolute terms. On a larger project or with a more major supplier – the top three suppliers account for over 40% of spending on suppliers, the monetary loss would be more even more remarkable.

Assessment of Economic Value and Operational Risk

Spirit Europe's success is far, far more dependent on the success of its suppliers than in many other industries. Because supplier health and relationships are so important to Spirit's success, the selection, ongoing evaluation, and development of suppliers are extremely critical business functions for Spirit. The failure of one of these functions would have dire effects on Spirit's ability to perform. The failure of one minor supplier can devastate an entire project's profitability.

It is clear that Procurement and Supplier Management are incredibly economically valuable as each project depends so heavily on supplier performance. However, this business function requires less cross-functional resources than acquiring new work packages. This suggests that, while not easy, it is *less* operationally risky to transfer this function overseas than the function of acquiring new work.

4.2.4 Manufacturing

Spirit Europe currently has a portfolio of projects in various stages of manufacturing. Manufacturing can be segregated into (1) Product and Process Design, (2) Tooling, and (3) Production.

Product and Process Design

Description of Function

Spirit Europe projects are either "Design and Build" or "Build to Print." The difference between these two project types is that Spirit Europe is responsible for the product design in the former.

For "design and build" projects, the process is designed concurrently with the product. Theoretically, for "build to print" projects, after the product is designed by the customer and handed to Spirit Europe, the process design begins. It should be noted that even for "build to print" projects, Spirit Europe employees may also be involved in the product design. For example, on the Boeing 747-8 project, a "build to print" project, two Spirit Europe employees are in Seattle working with Boeing designers and providing input on manufacturability.

Because product and process designs happen only at the forefront of a project and require substantial designer manpower (e.g. 80 design engineers on a new project), Spirit Europe believes it cannot financially justify keeping enough designers for a project on staff full-time. Spirit Europe has entered into a strategic partnership agreement with ASSystem to contract design and stress engineers as necessary. Spirit Europe retains about 20 full-time design and stress engineers in-house. These employees work side-by-side with ASSystem contractors on new designs.

ASSystem is not a typical outsourced supplier, nor are they simply a source of low cost engineering or design; they are truly a strategic partner. Spirit Europe interviews and selects the ASSystem engineers working on its projects, and often keeps the same engineers from project to project.

The design process has many elements that can be categorized into two general categories – conceptual design and detail design. These two phases are roughly chronological, but interdependent and iterative in reality.

- Conceptual Design: Conceptual design is when the wing structure begins to take form. General shapes and materials are considered. The customer provides guidelines for the

structure's surface; the interior ribbing, thickness of the skin, weight, materials used for various components, connections, modularity, etc. of the product are up to Spirit's design team. During conceptual design, understanding and flushing out the product's requirements from the customers, who often do not fully understand their needs, is extremely difficult and requires significant experience and skill.

- Detail Design: Detail design is when the concept is finalized. For example, while the number of ribs may have been determined during conceptual design, the exact configuration, thickness, weight, spacing, use of fasteners, etc. still needs refining. Substantial creativity is required to meet the customers' requirement while minimizing weight and cost.

Much iteration between design and stress testing are required during this phase. Stress testing determines whether a proposed structure is too weak to bear the loads required by the customer. While 90% of the testing and analysis of designs are related to stress, other factors such as weight, propulsion, acoustics, fire safety, anti-icing and more are also considered. Similarly, significant time must be spent documenting the design into 3-D computer drawings.

In the late stages of conceptual design, representatives from tooling, supply chain, and manufacturing engineering are brought in to issue preliminary opinions. During detail design, these items are finalized along with the product design.

An important skill in both of these phases is the ability to efficiently manage change. New requirements from the customers, airlines, airports, etc. emerge everyday and result in major or minor design changes. The ability to incorporate these changes in a cost-effective and timely manner has a tremendous effect on maintaining the schedule and budget. Managing changes is

crucial to enabling continuous improvement, maintaining the traceability, complying with certifications, etc.

While design is clearly an integral part of Spirit Europe's manufacturing, it has substantial strategic implications as well. Having design capabilities in addition to production capabilities is essential for being a Tier 1 supplier for some OEMs. Additionally, for many OEMs, including Boeing and Airbus, the wing is a major competitive differentiator for aircraft performance and aesthetics.

Assessment of Economic Value and Operational Risk

Design was the most controversial business function when discussing economic value with Spirit Europe's employees as well as with the tax advisors. Spirit Europe's employees believe that design is extremely valuable. This is because design requires advanced degrees and specific aircraft experience and industry relationships. Furthermore, some OEMs require design capabilities to be considered a direct supplier. These are all indicators that design is an important value driver.

There is, however, some support to argue that design is less critical. The fact that Spirit outsources design – albeit to a close, long-term, strategic partner – greatly weakens the argument that design is critical. Much of the design process (such as the man-hours required to document the design into 3-D drawings) does not require tremendous skill or experience. In the eyes of the tax advisors, Spirit's decision to outsource the design activity is enough to prove that the design function is not a critical business function.

There is truth in both arguments. Some parts of the design process are not that difficult and can be outsourced; these elements are not that economically valuable. Other aspects of the design process are extraordinarily difficult. For these aspects, it is not likely that Spirit Malaysia can develop sufficient skill and proof of skill to be approved by the OEMs anytime in the next few years.

Therefore, Spirit Malaysia cannot be a Full-Fledged Manufacturer in the near term. As this project focuses on a short term (2-3 years) recommendation, whether or not design is critical is a moot point.

As a side note, Spirit Malaysia can assist with the non-critical aspects of design process immediately and charge for that work separately.

Tooling

Description of Function

Tooling refers to product-specific equipment such as jigs. "Tooling" does not include non-product-specific equipment such as drilling machines and press machines; these are referred to as "equipment." The tooling design, manufacturing, and installation are outsourced to ASSystem. Because ASSystem is involved in the product design and controls the tooling design, the two designs are worked on simultaneously, which harmonizes the product and process.

Assessment of Economic Value and Operational Risk

Because tooling is completely outsourced by Spirit Europe, it is considered less economically valuable. There is little or no operational risk in transferring this oversight of tooling to Spirit Malaysia.

Production

Description of Function

After the product and process design are finalized, and the component and subassembly suppliers are selected and in place, the product is ready for production. At Spirit Europe, the production

lifecycle is separated into roughly three phases. Each phase relies progressively less on engineering and progressively more on logistics.

- Industrialization: During this phase, the product and process design become a reality. This phase irons out the major kinks in the product and process design and incorporates changes where necessary. It occurs over the building of approximately the first ten sets. This phase involves many engineering changes, which equates to multiple redesigns and stress retesting. Engineers involved in this phase are generally university graduates with engineering degrees from accredited programs.

- Getting up to Peak Rate: After the first ten sets are built, the major design flaws have been resolved. However, there is still room for incremental improvements to reach the peak build rate. Within Spirit Europe, the internal rule of thumb is that it takes 50 sets to get down the learning curve for a new product.

- Steady State Production: When the bulk of major and minor incremental improvements have been made, production reaches a steady state level, which is limited by supply and demand, not on process ability. During this stage, engineering plays a lesser role. Success is determined primarily by the ability to manage suppliers' quality and delivery, as well as scheduling production to meet the customers' fluctuating demands. Meeting the customers' schedules and constant cost-cutting are of primary importance during this phase. Small gains in time savings are still made through continuous improvement initiatives but the progress is less remarkable than in the first two stages.

Each of the three phases above requires engineering, logistics, and final assembly. The success of the first phase relies more heavily on engineering while the third phase depends more on vigilant logistics.

Logistics

Managing logistics is particularly critical to the Spirit Europe business model because 80% of the product's worth is fabricated or assembled outside, prior to final assembly.

Production scheduling

Customer scheduling

The customers' desired deliveries often fluctuate widely. The Customer Scheduling team smooths out the demand to provide steady workflow for production and account for variations such as holidays and vacations.

Vendor scheduling

The new production schedule is then received by the Vendor Scheduling team who use backward induction to build schedules for the suppliers. The backward induction process starts with the production date and works backward by adding in days for lead times, shipping transit times, and buffer periods. The amount of days added is fixed based on past experience (i.e. trial-and-error) and distance from the supplier. For example, items from the UK are scheduled to arrive 5 days earlier than necessary; items from Asia are scheduled to arrive 2 weeks earlier than necessary.

For products such as the Prestwick A320 line with a fast rate (about 40 per month) and multiple suppliers, making sure components arrive on time is imperative to production. On-time delivery is the greatest pain point for the A320 line (i.e. number one cause of production delays); thus Vendor

Scheduling requires significant time and resources. For products with a slower rate such as the A380 line (currently 14.5 per year) and fewer suppliers, on-time delivery is easier to manage and Vendor Scheduling is less important. For the A380 line, the quality of supplied parts is the largest cause of production delays.

Physical logistics

The Logistics team manages the physical logistics – booking supplies into the system when received, moving parts throughout the factory (e.g. craning a product from one station to the next), packaging and shipping products to customers, and checking that products are received by the customer. This team also deals with customs when importing supplies and exporting finished goods.

Inventory management

The vendor scheduling team is primarily responsible for inventory management. Inventory management consists of quarterly physical stock checks, calculating reorder and buffer amounts, and periodically reviewing inventory strategy (e.g. ship vs. air freights, reorder and buffer amounts). Because inventory is a significant use of cash, this is an important function in the aerospace industry.

Assembly

Final assembly is a labor-intensive process. Manual employees are needed to drill holes, place fasteners, fit components and subassemblies together, apply sealant, and paint. As process improvements are made over time, the processes become more robust and error proof. For example, metal templates that fit over spars were created to ensure holes are drilled in exact locations; this led to a significant reduction in errors versus the pen and hard media formerly used to

mark locations. As processes have become more error proof, workers have become more versatile, able to switch from product to product, allowing for greater flexibility and easier capacity planning.

Assessment of Economic Value and Operational Risk

Often, "production" is cast aside as low-margin, simple work with little economic value. This is because "production" is often pictured as simply the labor required in the final Assembly. It is true that the labor required in this last stage of Manufacturing are fairly simple and economically invaluable.

However, in aircraft production, "production" encompasses much more than just final assembly. The industrialization and process improvement phases are extremely difficult and valuable; they require experience, education, and excellent management. Similarly, the scheduling – particularly for fast buildrate programs – is complex and extremely integral to the project's success.

Lastly, it cannot be overemphasized how important the performance on the Production function of existing projects is to winning future work. The future ability of the company to win new work lies primarily with the people that deliver on current projects.

The operational risks of moving production are, of course, very large given that Spirit is a manufacturing company; it is Spirit's defining core competency. In the case of this project, moving the assembly portion to Malaysia was predetermined. However, just moving assembly, which is not very economically valuable is a bad tax answer. It would be financially beneficial to move the surrounding scheduling and logistics functions to Malaysia as well. These two functions are fairly isolated; they do not require much cross-functional experience but bear significant risk. As financially beneficial, but less operationally risky functions, they are good candidates to be moved overseas.

4.2.5 Support Functions

Description of Functions

Human resources

Generally speaking, the HR department at Spirit Europe is similar to HR departments at most companies. Benefits, wages, recruiting, and employee development at Spirit Europe are fairly standard. However, given the heavy labor component and unionized workforce, two functions – union relationship management and capacity planning – need greater emphasis at Spirit Europe.

Capacity planning

Internal labor capacity influences significant strategic decisions such as whether or not to outsource work packages and how to structure bids for new opportunities. Given the relatively large impact of each new project and the expense of terminating employees, careful management of labor capacity is critical for business continuity. Considerations include any major initiatives that will affect labor capacity such as new bids on the horizon, Power 8, and other improvement initiatives, as well as guidance from the SLC on the company's growth strategy.

Finance

A few factors make finance support at Spirit Europe more complex.

The parent company is a US public company; therefore Spirit Europe is subjected to Sarbanes-Oxley, the Foreign Corrupt Practices Act, and various similarly onerous SEC control and reporting requirements.

The long-term contractual nature of the business requires more judgment and risk adoption when accounting.

The complexity of projects including complicated contracts with customers and suppliers, the long lifetime of the projects, the variety of overhead costs that need to be allocated, the difficulty in tracking physical inventory, etc. makes understanding profitability very difficult in this business.

General finance functions include financial accounting, employee expense administration, control and compliance. In addition to daily support, the finance team actively participates in the business by helping to win business and manage ongoing projects.

Facilities

Many aspects of facilities at Spirit Europe are standard cleaning, maintenance, repair, utilities and workspace setup activities. Much of these standard activities are outsourced. However, the building construction and planning is an integral part of the manufacturing process. Ensuring that buildings are tall enough, are large enough, have appropriate doors, have sufficient foundation, and have enough floor space for the product and tooling meant for the facility is inseparable from production.

Information Technology

Information technology ("IT") is fairly standard at Spirit Europe. IT includes servers, network security, personal computing, communication systems, ERP systems, desktop support, etc.

Compliance

Spirit Europe is subject to an extraordinary amount of regulations. As an aviation company, there are stringent Federal Aviation Administration ("FAA") and European Aviation Safety Agency ("EASA") regulations. Furthermore, Boeing and Airbus have extensive internal standards for quality that must be followed. As a subsidiary of a US public company, Spirit Europe must comply

with Sarbanes-Oxley ("SOX"), GAAP, and other SEC regulations. Additionally, there are substantial health & safety and environmental regulations.

Compliance with the multitude of regulations requires significant time and resources. Each department internally ensures its compliance. They are then subject to audits from the internal audit team as well as external audit teams. Audits may be as simple as a few days with accountants or as onerous as six months of Boeing or Airbus employees observing work processes.

Demonstrating rigorous compliance is imperative for winning new business and maintaining status on OEM's approved supplier lists. Similarly, being able to evaluate compliance is critical for selecting quality suppliers.

Proof of compliance, approvals, and designated authorities are the indications of company's know-how, experience, and ability.

Assessment of Economic Value and Operational Risk

In general, the support functions at Spirit Europe are fairly standard, with the exception of Human Resources and Compliance. In general, the support functions are standard and can be easily outsourced. They are not considered critical to economic value.

Additionally, because most of the functions require local presence and knowledge, Spirit Malaysia will undoubtedly create, develop, and staff these functions locally; therefore, it is not relevant to this project how economically valuable these functions are.

The above excerpts from and commentary on the Functional Analysis have argued that the following functions are the three most critical value drivers for Spirit Europe:

1) **Acquiring new work**

2) **Selecting, maintaining, and developing suppliers**

3) **Production (including assembly, quality, industrialization, scheduling, etc.)**

Note that Strategy & Vision and Design are also critical, but because full transfer of these functions is not an option for the near future, they are not considered for transfer in this thesis.

4.3 Public Opinion of Critical Functions

While every company function is important to providing quality and timely delivery of aircraft components, the Functional Analysis suggests that three functions are the most critical value-drivers for Spirit and other similar aerostructure suppliers. Review of various public documents (SEC filings, analyst reports, trade websites, etc.) support these findings. These three functions are the most important value drivers because they have the most impact on managing working capital and winning new business, the two most critical elements for survival in this industry. Public documents do not mention strategy, most likely because it is so difficult to define. The author contends that the "Strategy" function as defined in the Functional Analysis above includes the major strategic decisions necessary to execute on the following critical functions and should be considered critical.

The three functions most critical value-drivers for Spirit Europe according to outside documents are:

1) Manufacturing (Design and Production)

2) Evaluating and Managing Suppliers

3) Winning and Negotiating New Business

These are the same three functions as identified in the internal Functional Analysis.

Manufacturing

At its heart, Spirit is a manufacturing company. Spirit is one of less than a dozen manufacturers in the world that can confidently design and produce aircraft components to the required standard. The vast majority of Spirit employees are manufacturing employees (whether in design, industrialization, or mass manufacturing), with the remainder of the employees (human resources, IT, finance, administration) supporting these functions.

"Spirit relies on its technical skills and factory performance to sell its product, not fancy marketing." (Jefferies & Company, August 1, 2008) Manufacturing and design skills are critical to winning business. People in the business often say the best way to win new business is to perform well on existing business. As such, timely, cost-efficient, quality products are the most important factor to winning new business and therefore keeping the business operating and growing. Excellent manufacturing also lightens the load on working capital. SG&A is just under 4% of sales because of the company's short customer list and ability to rely heavily on performance to sell new business.

Evaluating and Managing Suppliers

Evaluating and managing suppliers is increasingly important for Spirit and the aircraft industry in general. On average, Spirit Europe outsources approximately 80% of the value of the components it manufactures. When so much of the company's costs are due to purchasing from suppliers, evaluating and managing suppliers is crucial to performance and financial health. Additionally, because most items are single sourced, Spirit is heavily reliant on each supplier and developing and maintaining supplier relationships becomes even more important. Anecdotes from poor suppliers in Spirit's past show the dramatic detrimental effects of poor performing suppliers.

The importance of supply chain management is evident in other experiences from the aircraft industry. Because of the deep supply chain and trend toward outsourcing, supply chain evaluation and management is an increasingly important issue industry-wide. "Supply chain oversight has been a thorny issue for both Airbus (on the A380 notably) and Boeing." Boeing 787 Dreamliner delays have been primarily due to supplier evaluation and monitoring problems. "Italy's Alenia appear to have realized too late that their workshare was too complex, given the timetable. Boeing saw the predicament late as well." This has caused 787 delays of at least 15 months. (Dubois, 2008)

The ability to accurately assess the financial health and technical capability of suppliers is critical to project success. " 'Initially, some suppliers did not have the technical capabilities they claimed,' Oliver Wyman management consultant Rémi Cornubert told AIN... Morever, 'the way work was shared was relatively unclear,'... This led to shadow engineering, a situation where the OEM and the supplier duplicated design efforts." (Dubois, 2008)

Winning and Negotiating Business

The third critical factor for an aircraft manufacturer's success is the ability to win and negotiate new business. Winning business is particularly important for building a strong backlog to whether economic downturns such as the current one. For Spirit, winning business is also specifically important as it attempts to diversify its customer base away from Boeing, which accounted for 91% of revenue in FY2007.

Boeing and Airbus have largely similar contract processes. The selection of a supplier typically follows a competitive bid process. Boeing retains a unified list of pre-qualified suppliers and vendors. Airbus does not yet maintain such a unified list, but is moving in that direction. Both have major suppliers participate early in design and development process, often before the actual bid is

won. Supplier partnership typically limited to suppliers that continuously show excellence in performance, demonstrate credible long-term business interest, and back it up with their own development and investment. Typically both OEMs use life-of-program fixed-cost contracts, though not always.

There are four critical arguments for the value of winning and negotiating business: (Horng & Bozdogan, 2007)

First, the bid process is a long process that typically requires months of effort, a full-time dedicated team at Spirit, as well as contributions from many functions across the organization such as procurement, estimating, manufacturing engineering, design, finance, and more. Having and retaining qualified vendor status is an important barrier to entry for servicing Airbus and Boeing.

Second, the summary mentions that suppliers participate early in the design and development process. This indicates that the design team is integral to winning business, not just to executing it. Much of the conceptual design of a product happens before the contract is signed with the supplier, illustrating the amount of time and money Spirit must invest to win new work.

The third point is the importance of excellent performance to maintain customer relationships, as well as the idea of more development and investment on the part of the supplier.

Lastly, because contracts are typically life-of-program, the supplier is heavily dependent on the customers' health. For example, Spirit has suffered severe cash constraints due to delays on the 787. During the negotiation of this contract, Spirit agreed to own the fully stuffed cockpit until the aircraft was delivered to the customer. However, due to Alenia's delays, the aircraft has not been delivered yet. Therefore, Spirit continues to manufacture and hold these products in inventory. The Boeing machinists strike was another example of Spirit's dependency on customers. Spirit has gone

to 3-day work weeks in Wichita as Boeing was not accepting deliveries during their machinists' strike. Negotiating portions of future customer contracts to protect against such issues can make millions of dollars of difference on the bottom line.

4.4 Chapter Summary

The above excerpts from and commentary on the Functional Analysis have argued that the following functions are the three most critical value drivers for Spirit Europe that are available for transfer:

1) Acquiring new work
2) Selecting, maintaining, and developing suppliers
3) Production (including assembly, quality, industrialization, scheduling, etc.)

Secondary research confirms this view. These three functions would be the most profitable to move to Malaysia. Much of production is already being moved to Malaysia. Moving the second function (the supplier-facing responsibilities) would transition Malaysia from a Consignment Manufacturer into a Contract Manufacturer. Then, moving the first function (the customer-facing responsibilities) would make Malaysia a Licensee. We must now examine more closely the financial benefits of moving the first two functions to Malaysia in addition to the third.

5 Cost Plus versus Entrepreneur

In the case of this project, financial benefit is derived from tax savings. Tax savings are derived from recognizing profit in the low tax jurisdiction (i.e. Spirit Malaysia) instead of in the high tax jurisdiction.

While the exact amount of the Malaysian tax break is confidential, to walk through a hypothetical example, let us assume the low tax rate is 5% (discounted from Malaysia's regular 25% tax rate). For ease of calculation, assume the corporate income tax rate in the United Kingdom is 30%. Again, for ease, let us assume that a project would cost the exact same amount whether it was performed in Scotland or Malaysia. (This is clearly not the case as Scotland would likely be more efficient from experience and Malaysia has much cheaper labor and overhead.) If a project made $100 in pre-tax net income (i.e. profit) it would pay $30 in taxes in the UK, resulting in a net post-tax profit of $70. That same project would only pay $5 of tax it if was completely performed in Malaysia, resulting in a net post-tax profit of $95. The tax savings are tremendous.

Now imagine if something went wrong in the project and the pre-tax profit was $0. The tax in both countries would then be $0, with a resulting post-tax profit would be $0. In this case, the financial benefit was nil, but the company incurred significant operational risk by transferring all the functions to Malaysia from Scotland.

From this simple example, it is clear that it makes a difference how profitable a project will be. If it's very profitable, the tax savings effect will be very large. If the tax savings is very large, it is worth it to incur some operational risk to transfer functions to Malaysia. If a project is not very profitable,

break even, or even negative, the tax savings (i.e. financial benefit) will not be worth the operational risk. This chapter provides a tool for Spirit to predict (very roughly) how profitable a project will be, and how much that profit level will vary. In other words, this tool provides a rough way to estimate the financial benefit.

5.1 Key differences between Cost Plus and Entrepreneur Transaction Methodologies

Let us revisit a couple figures from Chapter 3. In Chapter 3, four possible manufacturing characterizations were introduced.

For a quick review, remember that a Consignment Manufacturer is responsible only for production or final assembly. A Consignment Manufacturer is typically *not* responsible for production scheduling, purchasing, or supply chain management. To become a Contract Manufacturer, a Consignment Manufacturer must add supplier-facing and material management activities such as production scheduling, purchasing, inventory, and supply chain selection and management functions. To move further along the spectrum to a Licensee, a Contract Manufacturer must add customer-facing activities (i.e. sales & marketing) and strategy. Finally, a Full-Fledged Manufacturer has all capabilities required to sell, make, and deliver a final product.

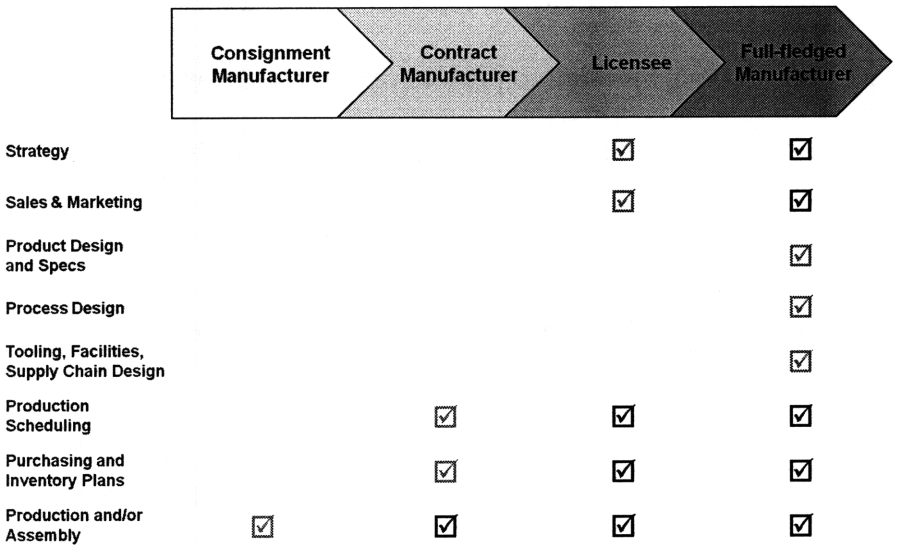

Figure 3 Author's Depiction of the Spectrum of Manufacturing Entities

As discussed above, Consignment and Contract Manufacturers are typically paid on a Cost Plus Margin ("Cost Plus") basis while Licensees and Full-Fledged Manufacturers own the risk for the entire project.

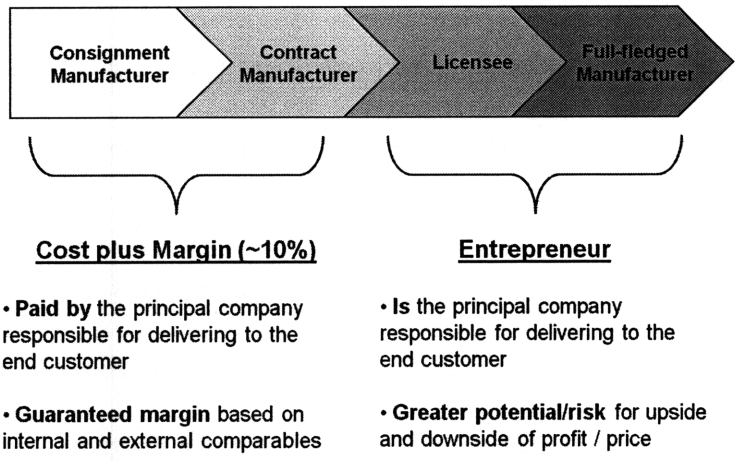

Figure 4 Author's Depiction of Transfer Pricing Methodologies

For the purposes of transfer pricing planning, the most important distinction is that Cost Plus entities will generally earn a profit; they will earn a set margin on all expenditures. Entrepreneurs, on the other hand, must manage the risk of a project's profit.

From a transfer pricing perspective, it is difficult to ascertain which designation is more lucrative for a company. If a project is a tremendous success (e.g. earns a 20-25% margin), it would be much more profitable for the entity in the low tax environment (i.e. Spirit Malaysia) to be the Entrepreneur. This way, the company as a whole would have to pay less tax on the project's profit. However, if the project's profit is low or nonexistent, it would be preferable to have the entity in the low tax environment (e.g. Spirit Malaysia) designated a Cost Plus manufacturer. If, for example, Spirit Malaysia was a Licensee and the project was not profitable, Spirit Malaysia would still have to pay royalties to Spirit Europe for the product and process design. Spirit Scotland would pay taxes on these royalties in the UK, while Spirit Malaysia recognized no profit and therefore made no use of the tax reduction.

5.2 Problem Statement

If the profit level of a project is clear, it would be easy to calculate whether it is more lucrative to designate Malaysia a Cost Plus manufacturer or Entrepreneur from a tax perspective. However, the problem with aircraft programs is that, as will be proven in this chapter, profit levels are often not clear; they are unpredictable and highly variable. Spirit typically commits to building a component for the lifetime of an aircraft (20-30 years). However, its supplier contracts are typically only 5-6 years. Costs of suppliers can change dramatically over the life of a program. Similarly, changing commodity prices, wavering demand from the customer, foreign exchange rates, and many more factors can vary wildly and greatly affect the profitability of a program.

Today, Spirit's view on project profitability is incredibly deterministic. Profit forecasts – for both new and existing projects – are calculated and communicated as averages, without confidence intervals, standard deviations, or any other contextual clues to express the variability of the profit.

Without a true understanding of a project's profit, it is impossible to determine whether a Cost Plus or Entrepreneur designation is more appropriate for the entity in the low cost tax environment.

5.3 The Flaw of Averages

The "Flaw of Averages" states that "Plans based on the assumption that average conditions will occur are usually wrong." (Savage, 2000) A humorous example is the statistician who forded a river that was, on average, only three feet deep:

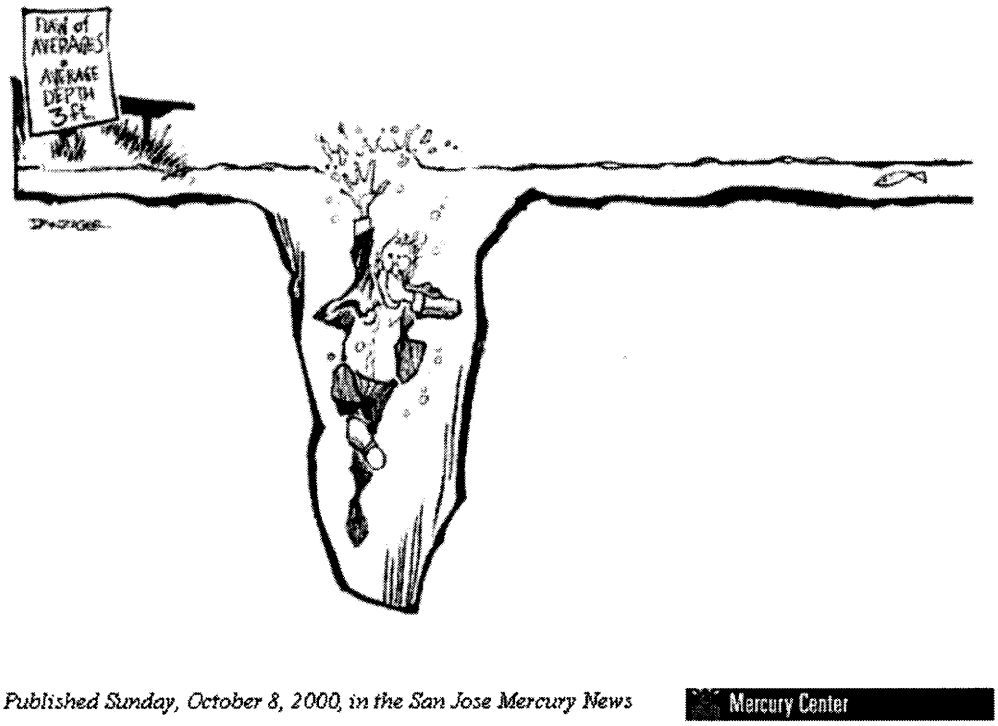

Figure 5 The Flaw of Averages

Unfortunately, the Flaw of Averages manifests itself in many aspects of real life such as investment management, production planning, and more.

> *Consider the hypothetical case of a Silicon Valley product manager who has just been asked by his boss to forecast demand for a new-generation microchip.*

``That's difficult for a new product,'' responds the product manager, ``but I'm confident annual demand will be between 50,000 and 150,000 units.''

``Give me a number to take to my production people,'' barks the boss. ``I can't tell them to build a facility with a capacity of between 50,000 and 150,000 units!''

So the product manager dutifully replies: ``If you need a single number, the average is 100,000.''

The boss plugs the average demand and the cost of a 100k capacity fab into a spreadsheet. The bottom line is a healthy $10 million, which he reports to his board as the average profit to expect. Assuming that demand is the only uncertainty, and that 100,000 is the correct average, then $10 million must be the best guess for profit. Right? Wrong! The Flaw of Averages ensures that average profit will be less than the profit associated with the average demand. Why? Lower-than-average demand clearly leads to profit of less than $10 million. That's the downside. But greater demand exceeds the capacity of the plant, leading to a maximum of $10 million. There is no upside to balance the downside.

This leads to a problem of Dilbertian proportion: The product manager's correct forecast of average demand leads to an incorrect forecast of average profit, so he gets blamed for giving the correct answer. (Savage, 2000)

While both of the examples above may seem overly simplistic, they are excellent illustrations of the Flaw of Averages and the extremely negative results that can occur from making plans based on averages.

The Flaw of Averages can also be stated mathematically:

$$E[f(x)] \neq f(E[x])$$

The expected value of a function of x is not equal to the function of the expected value of x.

Unfortunately, when it comes to profit prediction, Spirit Europe suffers from the Flaw of Averages. The following chart shows the profitability over time on Spirit Europe's current projects. Please note that project names, 2008 information, and the numerical scale have been deleted to protect confidentiality. While Spirit expects stable double-digit profitability on every project, it is clear that few projects achieve the target level of profitability. Some projects even lose money. Most project profitability declines over time. In the cases shown, Spirit Europe both (1) overestimated profit and (2) failed to capture the decline in profitability over time.

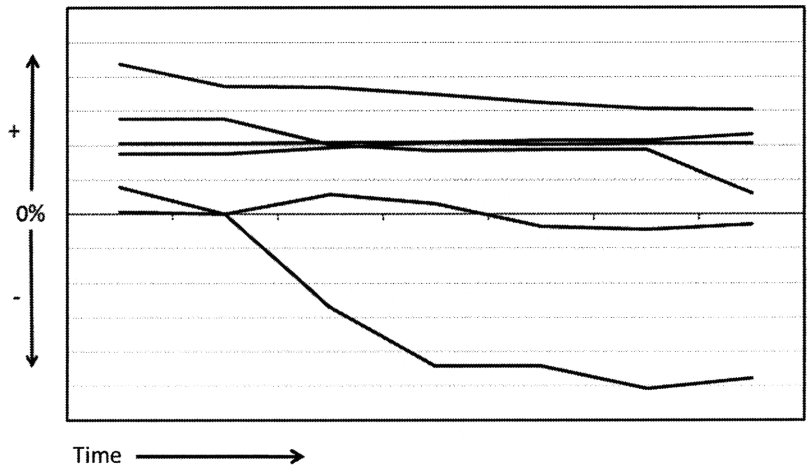

Figure 6 Spirit Europe Profitability by Project

Spirit's problems are reminiscent of our microchip factory example above. One contributor to this problem might be the perils of basing planning on average assumptions.

5.4 Understanding Profit Risk using Monte Carlo Simulation

Fortunately, there is a remedy for the incorrect inferences from Flaw of Averages; and with today's computing power, the remedy is fairly easy to implement. This remedy is Monte Carlo simulation.

Monte Carlo simulation "involves the random sampling of each probability distribution within the model to produce hundreds or even thousands of scenarios (also called iterations or trials). Each probability distribution is sampled in a manner that reproduces the distribution's shape. The distribution of the values calculated for the model outcome therefore reflects the probability of the values that could occur." (Vose, 1996)

Today, Spirit Europe uses a deterministic model to calculate profit. A deterministic model will produce the same results every time. The outputs, y_1 and y_2 in the figure below, will always be the

same and will are based on *average* assumptions for x_1, x_2, and x_3. As discussed, results based on average assumptions are likely to be incorrect.

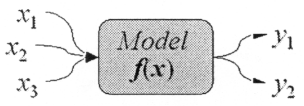

Figure 7 Diagram of Deterministic Model (Wittwer, 2004)

Instead, Spirit Europe should consider using a Monte Carlo simulation model to calculate profit.

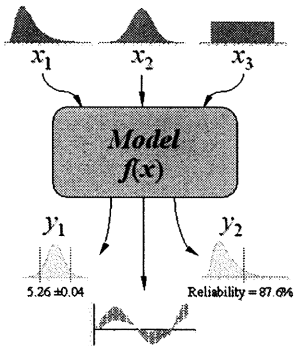

Figure 8 Diagram of Model Using Monte Carlo Simulation (Wittwer, 2004)

Monte Carlo simulations use inputs randomly generated from probability distributions to simulate the process of sampling from an actual population. Attempting to select distributions for inputs that most closely match the actual population can be extremely difficult, especially when there is limited actual data on the population. The good news is that even guesses at probability distributions will likely be an improvement over using deterministic averages.

5.5 Monte Carlo Simulation applied to Profit in Aircraft Manufacturing

The following is a case study of one of Spirit's new projects. This project was recently won and is currently in the design phase. For confidentiality purposes, the customer, aircraft model, and aircraft component to be manufactured are not revealed here. This project can be considered representative of Spirit Europe's other projects. This section discusses how to transform Spirit Europe's currently deterministic profit prediction model for new projects into a Monte Carlo simulation that accepts probability distributions as key inputs and outputs the profit as a distribution. For the purposes of this project, profit is defined as positive pre-tax net present value.

This case study takes one of Spirit's existing deterministic models and converts it to a model with a Monte Carlo simulation. Later in this chapter, the author compares the results from the version with the Monte Carlo simulation to the original deterministic version. The calculations are identical, the Monte Carlo simulation is simply a representation of 10,000 of those calculations based off of probability distributions instead of just one based off of average assumptions.

Note that Spirit Malaysia can carry a different designation for each project so this tool can be used on a project-by-project basis.

5.5.1 Inputs

There are numerous input assumptions that go into a profit prediction model on a new aircraft. These range from internal variables (e.g. wages, slope of learning curve, rate of continuous improvement) to external variables (e.g. currency exchange rates, demand, supplier pricing and performance).

The author's philosophy on modeling is that a model should be detailed enough to be meaningful, but not so complex as to be rendered incomprehensible or burdensome. As such, through a series of discussions with Spirit employees, we were able to determine the key inputs that affect profit and should be transformed into probabilities. **Inputs were identified as either "key" or "not key."** Variables that were designated as "not key" if they either did not vary much historically (and were thus not expected to vary much in the future) – and therefore not seen as a meaningful risk – or are of low absolute value. This means that adding complexity to the model by varying the inputs for the "not key" variables would not have much impact on the ultimate project profitability. To keep the model simpler, for these "not key" values, the original average deterministic values were used.

Here is a summary of the decisions:

Exchange Rate

Exchange rate is a **key** variable: The US$-GB£ exchange rate fluctuated dramatically during the six and a half months of the author's internship – decreasing from over 1.8 US dollars per GB pound to under 1.5. This input should not be deterministic because it both varies widely and greatly affects profit.

Learning Curve and Continuous Improvement

The learning curve and continuous inputs are mostly **key** variables:

1) Basic curve: This is the assumed rate that the man-hours required will be reduced with each additional aircraft. Spirit employees assume that an aircraft component will be built using approximately 85% of the man-hours required to build the previous one. In reality, this is a rough estimate and actual results fluctuate dramatically. Sometimes an aircraft can improve much faster from one set to the next and sometimes, perhaps due to customer modifications, a set can take longer than a preceding set to build.

2) Basic unit: Similarly, the basic unit also can vary dramatically from project to project. The basic unit is the inflection point of the learning curve from the steep slope to the soft slope, the point at which dramatic improvements from set to set cease to occur and any further rate improvements are derived from smaller continuous improvement efforts from employees. According to various interviews with Spirit employees, the basic unit can range from the 20^{th} to the 70^{th}, primarily depending on the complexity of the project.

3) Continuous improvement rate: The rate at which the program improves following the basic unit. Because this rate does not vary much (single-digit improvement rates from year to year), transforming this input into a variable is not as critical for the model.

Labor

Labor inputs include the baseline salary (for direct and indirect employees), pension contribution, overtime premium, shift premium, annual salary increases, and indirect-to-direct employee ratio of Spirit Europe employees. Labor inputs were categorized as **not key** because they are generally long-term contractual obligations. At first, it seemed somewhat surprising to categorize labor inputs as "not key" because of the amount of people involved and time and energy spent handling and negotiating with the unions. However, upon closer inspection, negotiations with the union only happen every few years, and even after negotiation when contracts change, these values typically do not change by much. Furthermore, this category includes only the labor of Spirit Europe employees. As the majority (80%) of most projects is outsourced, internal labor is a relatively small component of cost. As such, these inputs remain as deterministic numbers in the Monte Carlo simulation.

Recurring Costs

This is one of the two **most key** categories to transform into probability distributions. The inputs are primarily the baseline estimated cost and predicted annual escalation of supply prices (e.g. prices for composite materials, metals, aircraft general supplies, treatments, shipping, subassemblies, and other outsourced costs). These prices can vary over the life of a project based on any number of events such as natural swings in commodity prices, renewed contracts, or something as

unpredictable as a country joining the EU and immediately enjoying a higher quality of life. Over a 20-30 year period, almost anything can happen.

Non-Recurring Costs

For this project, non-recurring costs are **not key**. This is because many of the non-recurring cost inputs are enumerated in the contract with the customer. If they are exceeded, the customer will bear the cost. As such, much of the risk from non-recurring costs has been removed and these inputs are kept as static numbers in the model. To be clear, these are huge costs that affect the profitability of a project. In that sense, they are "key" to project profitability. However, for the purposes of this simulation model, they are "not key" to transform into variables because they have low variability.

Overhead and Allocations

Overhead and allocations includes inputs such as site support overhead, assumed non-labor as a percent of labor, and SG&A. These costs are (1) not that large, (2) not very variable, and (3) fairly controllable. As such, these are considered **not key** for variation in the simulation model.

Demand

Along with recurring costs, inputs in this category are the **most key** to transform into variables. At this point, it is nearly impossible to guess whether an aircraft will be wildly popular and sell for 40 years (such as the Hawker Beechcraft program) or if demand will die within a decade. To make it more complex, programs may be given a second life seemingly out of the blue. For example, currently, the build rate for the wing components on the Boeing 767 is one per month at Spirit Europe. However, if Boeing wins the government contract to transform that commercial aircraft

into a military transporter, the build rate will increase dramatically. While it is already clear that finding the right probability distribution and amount of variation for the number of aircrafts demanded per year and the number of years of demand will be extraordinarily difficult, it is also easy to see why leaving those inputs as deterministic guesses would be even worse.

Discount Rate

Spirit Europe uses a set discount rate dictated by Spirit headquarters in the US. While the author contends that Europe should have its own discount rate due to its different cost of debt and since discount rates should change from project-to-project to reflect the riskiness of each individual investment, we assume the fixed rate dictated by Spirit US. As such, the discount rate is accepted as a static number and is categorized as **not key** in this simulation model.

5.5.2 Data

After categorizing the inputs as either "key" or "not key" for variability, we are left with the four categories of **key variables**. In its current form, the model has approximately 70 input cells with probability distributions, all of which are from the following four categories of key variables (in rough order of importance):

1) Demand (e.g. number of aircraft demanded in future years, number of years of demand)
2) Recurring costs (primarily baseline cost estimation of supplies and rate of escalation in future years)
3) Currency exchange rate (US$ vs. GP£)
4) Learning curve and continuous improvement (e.g. basic curve slope, basic unit, continuous improvement rate after hitting the bottom of the learning curve)

For some variables, finding data with which to approximate probability distributions is fairly easy. For example, the currency exchange rate has daily average exchange rates recorded for decades. Using a 5 years of daily data and fitting that to a Weibull distribution provides an excellent approximation of the probability distribution for the last 5 years of currency fluctuations. The Weibull distribution was used as it is a good distribution for skewed data; and recent exchange rate data is clearly skewed. "Sometimes the [Weibull] distribution is used as an alternative to the normal distribution in the case of skewed data." (Simple Interactive Statistical Analysis) We assume that the last 5 years are indicative of the future. Because we cannot predict the future, we rely on historical values here.

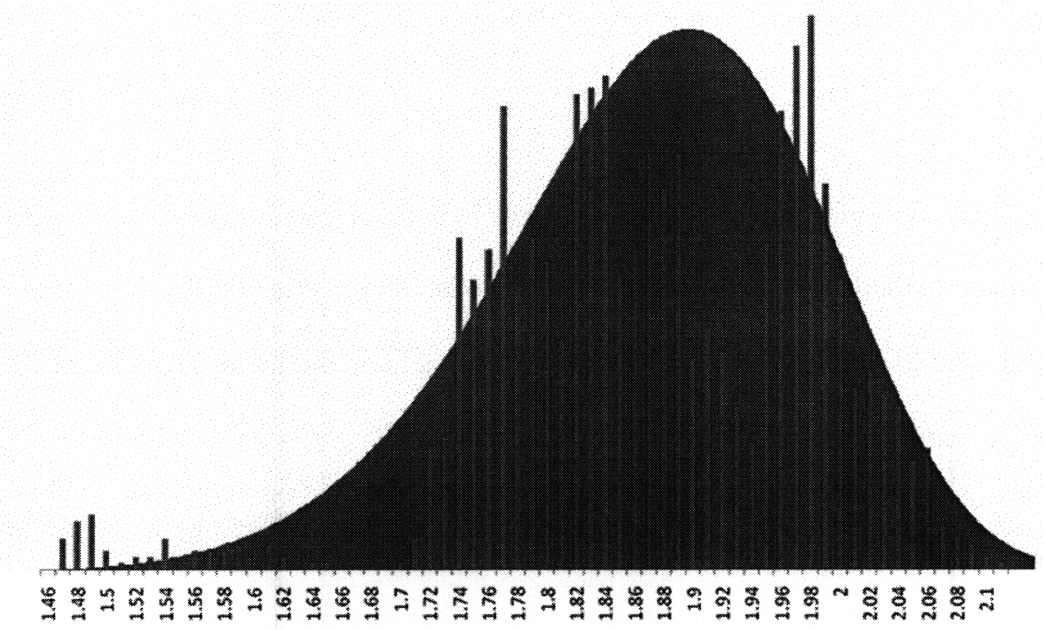

Figure 9 Actual Historical Exchange Rates Histogram (Red) vs. Weibull Distribution Used in Model (Green)

For other variables – recurring costs and demand in particular – it is virtually impossible to create accurate probability distributions for these inputs. There are only a handful of programs happening currently at Spirit Europe, and less than a dozen in the last few decades. Because of this, unlike currency exchange rates, there is simply a **lack of data** on how supply prices have fluctuated.

"The Strong Law of Large Numbers… says that the larger the sample size, the closer their distribution will be to the theoretical distribution." (Vose, 1996) Because there have been so few aircraft projects, the distribution resulting from this small sample size may not be that close to the theoretical distribution.

If you estimated based on current projects only, there is a 1 in 5 chance that a program will have a supplier from a country that joins the EU and thereby drastically increases prices as their quality of life improves. Clearly, there is not enough data to conclude that there is a 1. In 5 chance of this happening; but what is the probability of this or a similar event? 1 in 10? 1 in 1,000,000? Similarly, what are the chances this aircraft will be extremely popular? At this point of the design phase, 2-3 years before production begins, there is not much of a backlog to provide hints at customer demand. The only information is the OEM's predictions, which they have incentives to be overly optimistic about when providing information to suppliers.

Fortunately, just because an *accurate* probability distribution is nearly impossible to derive, it does not follow that a *useful* probability distribution is also impossible.

As an example, let us attempt to estimate a *useful* probability distribution to represent the annual escalation in the price of supplies. Given the lack of data, the best source of information is human experience. From human experience (i.e. the author's interviews with Spirit Europe's employees), it is clear that the price of supplies rarely decreases from the original negotiated price. There may be

small decreases over time, but these will be incremental. There may also be small incremental increases over time. This would suggest a normal distribution for the price of supplies. However, this would be naïve. It is clear from experience that every so often, the price of supplies can skyrocket on any given project. The best current example is the current difficulties with the Eastern European supplier on the aircraft mentioned previously. This and other anecdotal examples gives an understanding that the probability distribution for the price of suppliers has a long tail representing the small probability that prices will be far higher than expected. Note that there is *not* a long tail in the direction of price decreases because large price decreases do not happen.

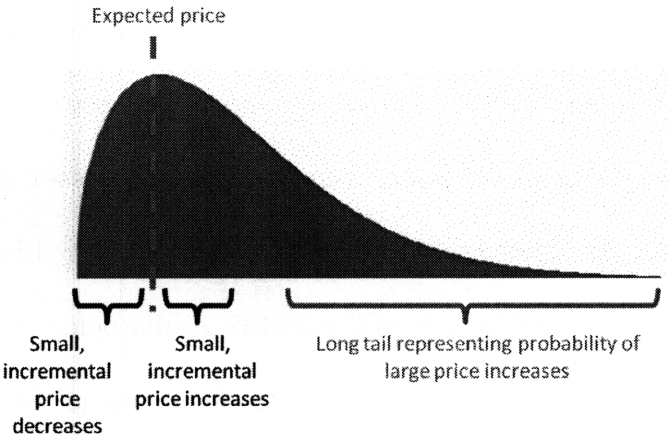

Figure 10 Probability Distribution for Price of Supplies

Using this method, rough – and useful – probability distributions can be derived for the other input variables with limited available data such as demand and learning curve assumptions. The probability distribution for demand looks quite different. For one, the demand for airplanes is a discrete variable; you cannot sell half of an airplane. At these low volumes, it is necessary to use a discrete variable to simulate aircraft demand. Again, using interviews and anecdotal evidence, a

probability distribution for aircraft demand each year can be derived. Using the deterministic expected demand given from Spirit's original model as a base, a normal distribution might be an obvious assumption. While it is probably fair to assume that the customers' demand and the general macroeconomic environment are fairly normally distributed, there are a number of other possible events that can hinder demand. Thus, a conservative approach would be to place a slightly larger possibility that demand will be lower than expected.

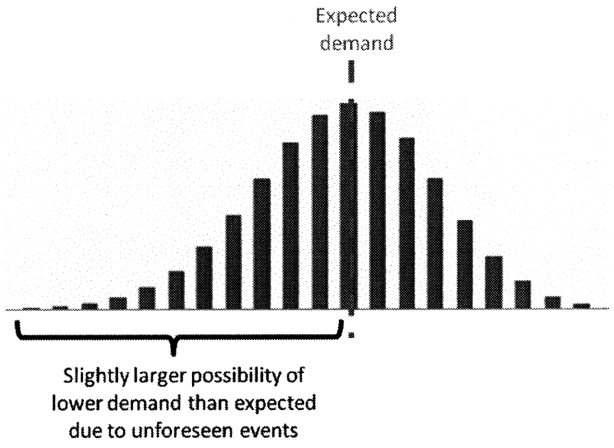

Figure 11 Probability Distribution for a Given Year's Demand

5.5.3 Output / Results

In general, there is much more downside to building aerostructures than upside. This was hinted at by the chart showing project-by-project profitability above. When discussing the appropriate inputs for probability distributions, the logic begins to take shape. Now, looking at the results of the simulation, it becomes even more lucid.

Using the original deterministic model's inputs as averages or medians (as appropriate) and estimating probability distributions for the key statistics yields the following result for pre-tax net present value (NPV): (This model uses 10,000 runs. Actual numbers have been removed for confidentiality.)

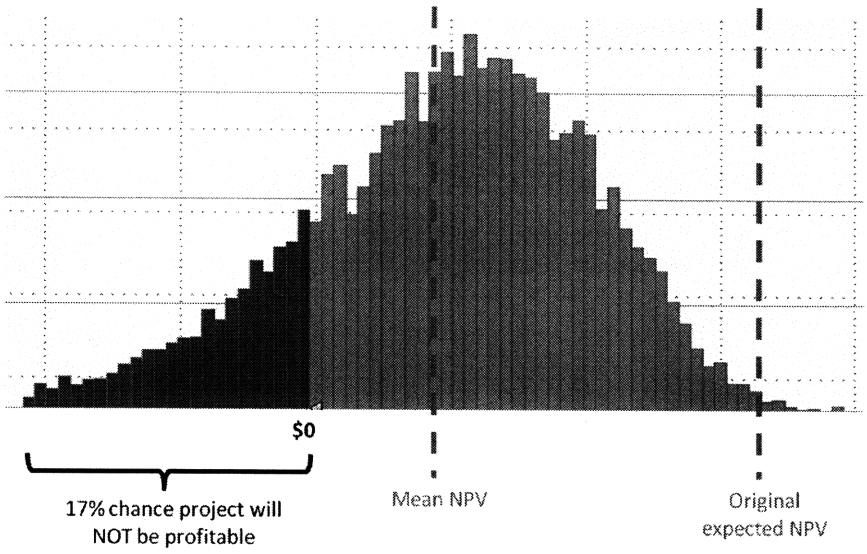

Figure 12 Distribution of Profit Output from Monte Carlo Simulation Model

There are a few aspects that should be immediately pointed out:

1) Profit is extraordinarily variable; this is extremely different from Spirit's current deterministic views on profit.

2) There is mostly downside – there is very little chance (less than 5% chance using this set of inputs) the project will meet the original expected pre-tax NPV.

3) The mean pre-tax NPV is much, much lower than the originally expected pre-tax NPV.

4) There is as much as a 17% chance that a project will *not* be profitable.

These observations fit perfectly with the graph of Spirit Europe's project-by-project profitability – repeated here for convenience:

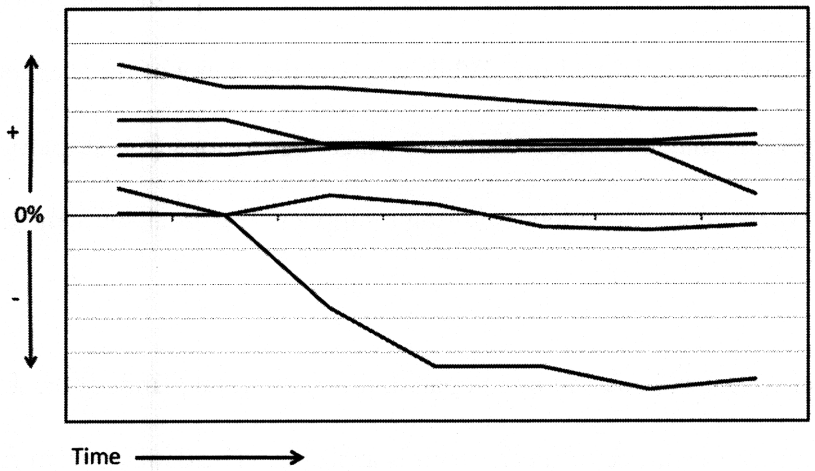

Figure 13 Spirit Europe Profitability by Project

Few projects meet the original expected profit level. Two of the six projects depicted here are no longer profitable. Project profitability tends to decrease over time. This last phenomenon is due to the fact that, as time goes on, it is more and more likely that one of the harmful "long tails" from the input distributions will hit.

Though a long tail on a distribution here or there doesn't seem like it would make much difference, when there are long tails on multiple inputs (price of labor, price of commodities, man hours required, etc.), the likelihood of one of those long tails occurring in a given project is actually fairly high. This is consistent with anecdotal evidence. Major customer modifications slowed A380 production, a troublesome supplier harmed the aforementioned project, customer demand did not meet expectations on Boeing 767/777, issues with other suppliers slowed Boeing 787 Dreamliner

production, the Boeing machinists' strike forced Wichita to go to 3 day work weeks – the list goes on and on.

My perception is that these events tend to be viewed as one-off, unpredictable, uncontrollable external events that cannot be planned for. While it is true that many of these events are external and uncontrollable, some may be mitigated with contract negotiations (e.g. stoploss clauses on supplier prices) or by reducing dependence on single suppliers (e.g. dual-sourcing some components).

Either way, whether or not the risk can be mitigated, the risk can be planned for. Using this simulation model, a better estimate of mean profit is available. The damage from future risks can be budgeted for, thus smoothing out project profitability in a more realistic manner.

At this point, this model is merely a demo. Refining the inputs would require additional effort. However, testing slightly different shapes on the estimated distributions (demand, recurring costs, and learning curve) shows us that the results are robust. Perhaps the scale changes, but the model still shows that there is much more downside than upside available.

5.6 Other potential applications of Monte Carlo simulation

There are numerous other potential business applications for this Monte Carlo simulation. As discussed briefly, the Monte Carlo simulation could be used to improve contracting with customers and suppliers. By changing inputs (based on different contract clauses such as a stoploss clause), the Monte Carlo simulation could help quantify the benefit of such a clause and therefore how much effort/negotiation should be applied toward achieving it. It could also assist with basic contract negotiation (e.g. how much does a 1% supplier price increase affect the distribution of profit?).

For a more tangible example, we ran the model again as if the variability of baseline supply prices was cut in half of the original assumptions (using the same median values), the standard deviation of final profit would decrease by almost 45%. Additionally, instead of a 17.8% chance that the project pre-tax NPV would be less than 0, with the reduced supply price variability there is only a 8.8% chance that the project would lose money. While the mean and median average profit would decrease (by 15% and 20% respectively), that might be an acceptable cost for the greater predictability and reduced chance of negative earnings.

Another useful business application might be for risk mitigation. By playing with the inputs and their sensitivity, multiple runs of the model can demonstrate which factors have the most impact. Which of these should be prioritized for risk mitigation? How much would it improve profitability if that risk was halved?

5.6.1 Implications

The results of the Monte Carlo simulation have clear implications for transfer pricing planning between Spirit Europe and Spirit Malaysia. Clearly, the range of profit on a typical Spirit Europe project is widely variable, far more so than previously believed and than previously represented by a single number.

Given the high variability of typical project's profit, it is very possible that a given project will have low or negative profits. Furthermore, there is a low probability that profit will be so high that the benefits far outweigh the stable margin available from the Cost Plus model. As such, from a tax perspective, the financial benefits of designating Spirit Malaysia an Entrepreneur are very risky.

From an operational perspective, there is mainly downside. The risks of transferring customer-facing activities to Spirit Malaysia are great. The cross-functional nature of the bid process and long-term relationships with Spirit Europe are difficult to replicate in Malaysia in the short term.

Because of the volatile nature of project profit and the high operational risks associated with moving customer-facing functions to a location with little experience, ***the Entrepreneur model is not, for the time being, a viable option for Spirit Malaysia on existing programs.***

5.7 Chapter Summary

This chapter began with a brief tutorial on Monte Carlo simulation and how Spirit Europe suffers from the Flaw of Averages. It then described the inputs, data, and results of the Monte Carlo simulation as applied to Spirit Europe's profitability. It then touched upon ways the model might be used to budget for or mitigate risk of future profit-harming events.

Most importantly, for the purposes of this thesis, this model demonstrated that the variability of profit on Spirit Europe's projects is too high. Furthermore, the chance of losing money is quite high. While the expected value of the Entrepreneur model and Cost plus 10% margin model may be similar, the Entrepreneur model is far too risky financially. The financial risk does not merit incurring the operational risk of adding customer-facing responsibilities to Spirit Malaysia. As such, Spirit Malaysia should, for now, be confined to Cost plus Margin structure options for existing programs.

6 Consignment Manufacturer versus Contract Manufacturer

6.1Key differences between Consignment and Contract Manufacturing

The Monte Carlo simulation demonstrated that the Entrepreneur model was too risky financially; the financial benefits were not enough to justify the added operational risks of adding customer-facing functions to Spirit Malaysia in the near term on existing programs.

That leaves Spirit Europe to select from the remaining Cost Plus designations – Consignment Manufacturer and Contract Manufacturer – for Spirit Malaysia for existing programs. As discussed, the primary difference between the Consignment and Contract Manufacturer is the ownership of supplier-facing and material management functions. Supplier-facing functions include supplier selection, supplier management, supplier development, etc. Material management functions include purchasing, inventory management, production scheduling, logistics, etc.

What do these functional differences mean from a financial perspective? What is the financial benefit – from a tax and transfer pricing perspective – gained from shifting supplier-facing and material management functions to Spirit Malaysia?

The Cost Plus Margin method of payment inherently has two primary factors – cost and margin. The margin is difficult to change dramatically. The margin is determined by independent outside economic advisors. It is easy to understand why tax authorities would insist on an independent opinion. Imagine the types of margins companies would use if they could determine the margin themselves.

Because the margin is hard to affect, the main factor that determines profit recognition using the Cost Plus Margin model is cost.

6.2 Contract Manufacturer is Significantly more Lucrative

From a cost perspective, the Contract Manufacturer designation is significantly more lucrative than the Consignment Manufacturer designation. This is due primarily to the high percentage of costs going to outside suppliers in Spirit's business model.

Let's consider some straightforward calculations. The following numbers represent a hypothetical project.

If Spirit Malaysia was purely a Consignment Manufacturer, they would only be able to recognize the costs of the labor and overhead on this project. Let's say these costs total roughly GB£7 million pounds. Assuming a 10% margin, the profit in Malaysia would be GB£700 thousand. Spirit Europe's profit – total project revenue minus payments to suppliers and Spirit Malaysia – would be approximately GB£5 million. Assuming a roughly 30% - it's actually 28% – income tax rate in the UK, the UK would pay GB£1.5 million in taxes in 2010.

If, however, Spirit Malaysia was the Contract Manufacturer on this same project, they would, in addition to production, also be responsible for purchasing from the supplier, ongoing supplier evaluation, production scheduling, logistics, etc. With these added functions they would be justified in recognizing the costs on all items purchased from suppliers. In this case, the total costs recognized by Malaysia would be approximately GB£50 million. Using the same 10% markup assumption, the profit in Malaysia would be GB£5 million. Spirit Europe would still retain ownership of the project's profit as a whole. After paying Spirit Malaysia (who would in turn then

pay the suppliers), Spirit Europe's profit would be just GB£1 million. Again assuming a 30% tax income tax rate, Spirit Europe's tax payment in 2010 for this project would be approximately GB£300 thousand.

In just one year, a relatively small (hypothetical) wing component package could create tax savings of approximately GB£1.2 million.

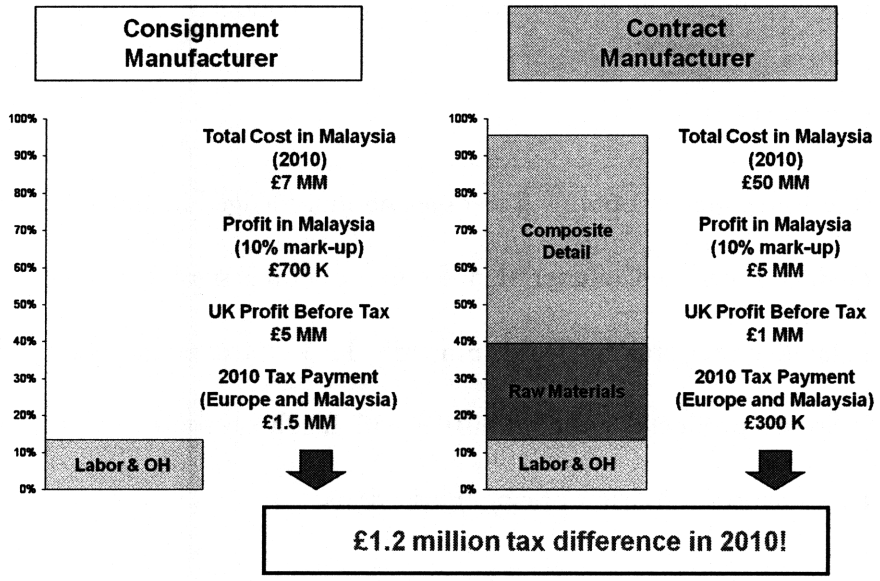

Figure 14 Tax Savings from Consignment Manufacturer and Contract Manufacturer

It should be noted that the package used in the example here is actually the subset of a larger wing package. While the proportions are representative of many of Spirit's projects, the absolute value of money involved is, comparatively, quite small compared to Spirit's typical projects. When applying this framework to a larger package, the tax savings will be even more significant. It should also be noted that these savings are for just one year of tax payments. The lifetime of an aircraft component is typically for the life of the aircraft it's going into. The savings over this 20-30 year

period, even at this relatively small annual amount, are very significant for a low margin manufacturer.

The financial benefits of designating Spirit Malaysia a Contract Manufacturer instead of a Consignment Manufacturer – and of course arming them with the ability to perform the additional functions – are significant. When considering this framework in the context of all the future programs that will be moved to Spirit Malaysia for production from the US and UK and the many years these programs will run, the additional tax benefit is tremendous.

6.3 Chapter Summary

After eliminating the Entrepreneur options (Licensee and Full-Fledged Manufacturer) in Chapter 5, this chapter demonstrated that the Contract Manufacturer option is significantly more lucrative than the Consignment Manufacturer option. This is primarily due to the extremely high proportion of outsourced cost in Spirit's products. Other industries with highly outsourced cost structures would likely have a similar scenario for transfer pricing transactions.

7 Conclusions

7.1Transfer Pricing Relationship (i.e. Scope of Work)

Multiple factors should be considered for transfer pricing. Among them is the financial benefit to be gained from moving certain functions overseas. Companies should resist the temptation to move everything overseas to increase profit without first understanding the amount and variability of the profit available. Similarly, companies should not underestimate their overseas counterparts and assume that operational risks are too great; there may be large amounts of tax savings to be had for minimal operational risk. It is important to fully understand the tradeoff between financial benefit and operational risks before making a final decision. For high outsourced cost structures and highly variable project profitability like Spirit Europe, the Contract Manufacturer option provides the least risk and the most profit.

While tax incentives initially suggest that companies should opt for an Entrepreneur model when possible, this project indicates that the Entrepreneur model may be too risky financially; companies should opt for the safer, steady (yet still significant) tax savings available from the Contract Manufacturer relationship.

7.2 Monte Carlo Simulation

Even in slow clockspeed industries like aircraft manufacturing – where copious data for inputs is not available – Monte Carlo simulation can be extremely valuable for providing at least some context for risk. Even without perfect information, useful out puts can be generated; outputs that more closely resemble reality than those generated by deterministic models.

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