FRAMEWORK FOR THE SELECTION OF ACQUISITION TARGETS APPLIED IN THE COMMERCIAL AEROSPACE INDUSTRY

By

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B.S. Mechanical & Aerospace Engineering
Cornell University, 2005

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

Master of Science in Management
and
Master of Science in Mechanical Engineering

In conjunction with the Leaders for Global Operations Program at the

Massachusetts Institute of Technology
June 2010

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ABSTRACT

Acquisitions are costly, even the ones that never happen. They require a significant commitment of resources involving multi-disciplinary teams examining all aspects of a business. This can come at a significant cost if either the acquisition does not produce the value that was originally expected or if the acquisition process is aborted all together.

Clearly, it is critical to be confident in the initial selection, when investing capital and resources to carry out the lengthy investigation process. However, while there is exhaustive research on the detailed evaluation of a target, there is very little published about the preliminary selection process.

In this thesis, we demonstrate a methodology for acquisition target selection. We propose a method of metric-based ranking of targets for criteria defined in 3 dimensions. The first is a measure of how a target meets the Strategic Goals of the acquiring company. This is critical not only to measure a target, but to clarify and create alignment among the leadership of the company for the purpose of the acquisition. The second dimension is a measure of Acquisition Fit. This represents a rough measure of likelihood of integration success of a target. The metrics in this dimension are based on research into attributes of acquisition failures. The final dimension is a Financial Impact measure, which represents a rough business case for the acquisition.

In the second half of this thesis, we introduce a case study of this methodology being applied in the large commercial aircraft (LCA) industry at Spirit AeroSystems, Inc. This case study demonstrates the application of this methodology with the necessary industry analysis, internal and external technology evaluation and implementation challenges. During this case study, the LCA industry is undergoing a period of technological disruption and re-distribution of engineering responsibilities. These shifts in the industry structure require additional rigor in evaluation of technological and engineering needs and capabilities.

Experience is statistically a strong indicator of success in M&A. We hope to lower the learning curve costs and associated risk by capturing research of best practices in a manageable process for M&A target selection.

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ACKNOWLEDGEMENTS

This thesis is the culmination of a significant portion of my experience at MIT and I would never have been able to get to this point without the help of many others.

I would like to thank Spirit AeroSystems for their support of my internship. I appreciate the kindness and hospitality of everyone I met while at the Prestwick site. In particular, I would like to thank the leadership of Spirit Europe. Neil McManus, Scott McLarty, Andy Leitch, Chris Wilkinson, David Stewart, and Simon Foster were all substantial contributors as well as mentors during my time at Spirit. Special thanks go to my company supervisor, Nicola Spence, who has been a resource, mentor, and a friend.

I also would like to acknowledge MIT, the Sloan School of Management and LGO program for the privilege of this opportunity. Thank you to the LGO program staff for making the program possible and helping us navigate this internship process. Another special recognition goes to my advisors, Vah Erdekian and Hank Marcus, who contributed guidance and insight.

Thank you to the LGO Class of 2010. I could not ask for a more capable and caring group of friends to go through this program with.

Finally, I need to thank my family and friends for their encouragement and understanding. Most of all, I would like to thank my wife Stephanie whom has been a source of constant support through this program.

Thank you.

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1 Introduction

"Having the senior management of the company agree on the goals of the acquisition early on is critical to success"

Acquisitions are costly, even the ones that never happen. Consult nearly any work on mergers and acquisitions (M&A) and it will discuss the need for a significant commitment of resources involving multi-disciplinary teams examining all aspects of a business. This can come at a significant cost if either the acquisition does not produce the value that was originally expected or if the acquisition process is aborted all together.

Clearly, it is critical to be confident in the initial selection, when investing capital and resources to carry out the lengthy investigation process. However, while there is exhaustive research on the detailed evaluation of a target, there is very little published about the preliminary selection process.

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In the second half of this thesis, we introduce a case study of this methodology being applied in the large commercial aircraft (LCA) industry at Spirit AeroSystems, Inc. This case study demonstrates the application of this methodology with the necessary industry analysis, internal and external technology evaluation and implementation challenges. During this case study, the LCA industry is undergoing a period of technological disruption and re-distribution of engineering responsibilities. These shifts in the industry structure require additional rigor in evaluation of technological and engineering needs and capabilities.

Experience is statistically a strong indicator of success in M&A (Hitt, et al. 1998). We hope to lower the learning curve costs and associated risk by capturing research of best practices in a manageable process for M&A target selection.

While the objective analysis of the M&A process, the company and industry are all fully disclosed, some specifics of the company strategy and activities are 'masked' to protect Spirit, Inc. Representative examples have be used for some parts of Chapter 4.

1.1 Problem statement

a. *The acquisition process is costly in terms of time, resources, capital, managerial distraction from operations, and missed opportunities in other areas.*
b. *There is a significant risk of failure either in deals that end prematurely, or deals that fail after acquisition.*
c. *These risks are further heightened when there is additional uncertainty due to exterior supply chain, macro economy and technological disruptors.*
d. *The process for selection of acquisition targets is for the most part unpublished.*
e. *Acquisition success is highly dependent on experience.*

1.2 Research goal and research questions

Research goal:

Develop a low investment methodology to make optimal acquisition target selection decisions for firms that have decided to use acquisition as a growth or investment strategy. Focus is on strategic, not purely financial, acquisitions in slow clockspeed heavy manufacturing industries where technological or supply chain industry disruptors are present.

The following are central questions to the research in this thesis.

a. What factors make an acquisition successful because of the inherent traits of the target rather than the actions of the acquirer during the process?

   Excellence in the management of the acquisition process is critical to success, and is also heavily researched. It is simply not the focus of this research.

b. How can the strategic needs of the business be connected with measurement methods and available data sources?

Strategic needs are often broad goals that can be misconstrued. This research will focus on how to transform these broad goals in to simple measurable characteristics.

c. How can this selection processes effectively be implemented in a real business setting?

   The granularity of analysis must be matched with the ability to execute in a business context and convey results to an executive audience.

d. How is it possible to minimize the learning curve associated with proficiency at successful acquisition?

   There are best practices that can be drawn from research of successful and unsuccessful acquisitions. This thesis will focus on capturing these best practices in a usable framework.

1.3 Hypothesis

1. *A process-based methodology for the acquisition selection process will improve the outcome of the selection.*

2. *It is possible to create a quantitative measurement system to capture the critical decision making factors necessary to select an optimal acquisition target.*

3. *Selection of an optimal acquisition target depends primarily on the target's likelihood to successfully meet the goals of an acquisition and its likelihood for successful integration.*
   a. *Successfully meeting the goals of an acquisition requires a clear definition of what success means in the specific acquisition setting.*
   b. *Assessment of the probability of successful integration is dependent on many factors that are common in M&A research.*

4. *By selecting through this methodology the probability that the acquisition will still be attractive at the point of making the deal should be higher than if a target was chosen by other methods.*

5. *The application of this theory is appropriate in slow clockspeed heavy industries such as the commercial aerospace industry.*

1.4 Research methodology

The research for this thesis was conducted using four types of sources; literature research on M&A, the aerostructures industry, and current targets as well as company research carried out at Spirit Aerosystems. We outline each of these below.

Literature research on M&A and Business Strategy

- This research was conducted using text books, academic journal articles and M&A consulting reports.

Literature research on the Aerostructures Industry

- This research was conducted using operations textbooks, academic journal articles, industry analyst reports, and aerospace consulting reports.

Literature research on Target Companies

- This research was conducted using analyst reports, news articles and trade journal reports.

Company research at Spirit AeroSystems

- This research was conducted using formal and informal interviews, working meetings, and company documents. All proprietary information from these sources have been stripped or masked from this thesis.

1.5 Chapter overview

This thesis will present the hypothesis, fully explore the theory behind the hypothesis, introduce the setting of the case study, and describe the implementation of the hypothesis on the case study. This structure is outlined in greater detail below.

Chapter 1 – Introduction and hypothesis

- The challenges around effectively selecting an acquisition target are significant and not well explored. In this thesis we present a framework to assess and evaluate multiple acquisitions targets at the early phases of the process and select the best prospects to advance to later stages of evaluation and engagement.

Chapter 2 – Acquisition selection framework theory

- We developed the Acquisition Selection Framework (ASF) theory for the early phase selection process. In this chapter, we discuss the appropriate scope of the ASF, the process by which it is developed and its primary components.

Chapter 3 – Case Study Background: Spirit (Europe) and the LCA industry

- In this chapter we introduce the case study. The company is Spirit AeroSystems (Europe) and they are aerostructure manufacturers, a subset of the commercial aircraft industry. We analyze the industry dynamics which are in a period of flux due to new players, consolidation, shifts in supply chain responsibilities and technological disruptors.

Chapter 4 – Application of the ASF on the Spirit (Europe) case study

- In this chapter we discuss the actual implementation of the ASF. This chapter primarily discusses the methodology, results, manifestation of the framework as a database, and implementation challenges we faced in this process.

Chapter 5 – Conclusion

- We conclude with our final thoughts on the subject as well as a critical assessment of the hypothesis and opportunities for improvement.

2 Acquisition Selection Framework Theory

The Acquisition Selection Framework (ASF) is a tool we have developed for the very preliminary selection of an acquisition target. The ASF is a process that involves a base structure that is customized for a given company's needs. The customized framework can then be utilized through either a onetime application or a continuous industry monitoring methodology.

In this chapter we introduce the overall ASF structure and then defend the theory by analyzing each of its components. Finally, we discuss the appropriateness of the application context for the ASF. This methodology is by no means appropriate for all businesses in all industries and indeed would inhibit the M&A operations of some businesses.

2.1 *Scope of ASF in overall M&A timeline*

The Acquisition Selection Framework (ASF) can be used to select a single target or simply narrow the field to a shortlist of targets that should be further investigated. It should be applied as a very preliminary filtering device prior to the due diligence phase. However, it is also by no means the start of the process. The process must start with clear definition of the goals of the acquisition long before the filtering and comparison process begins. While the final stages of the acquisition process are very well documented, there is very little description in the public domain on the methodology by which a candidate company is selected for further assessment.

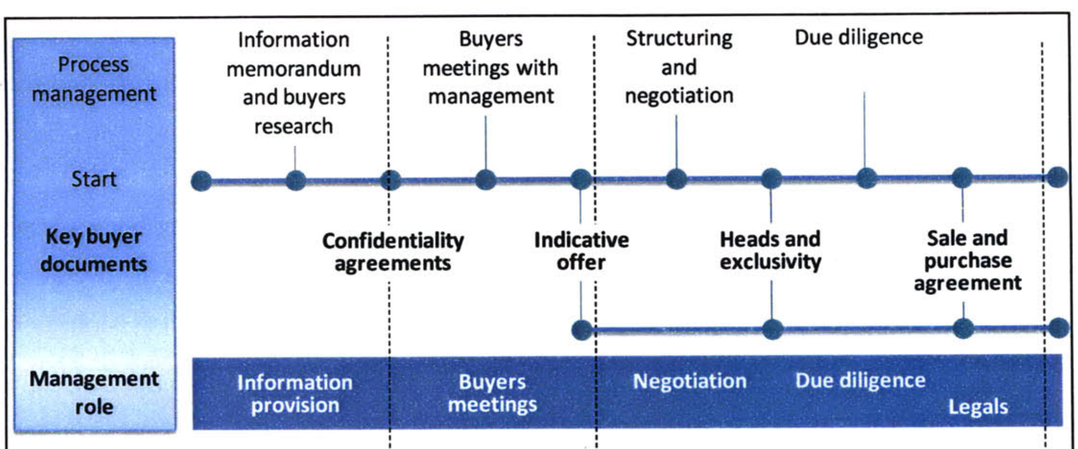


Figure 1 – "The acquisition process" (Rakine, Bomer and Stedman 2003)

The M&A process generally focuses on the activities between first contact and integration. The process generally includes contacting bankers to determine availability of targets, due diligence assessments of the company, negotiations with the target management and owners, a full disclosure period, valuation and concluding with the finalized deal. After a deal has been brokered, the significant work of integration and management begins, which involves consideration of the balance between independent management and level of integration. This balance should depend on the original purpose of the acquisition.

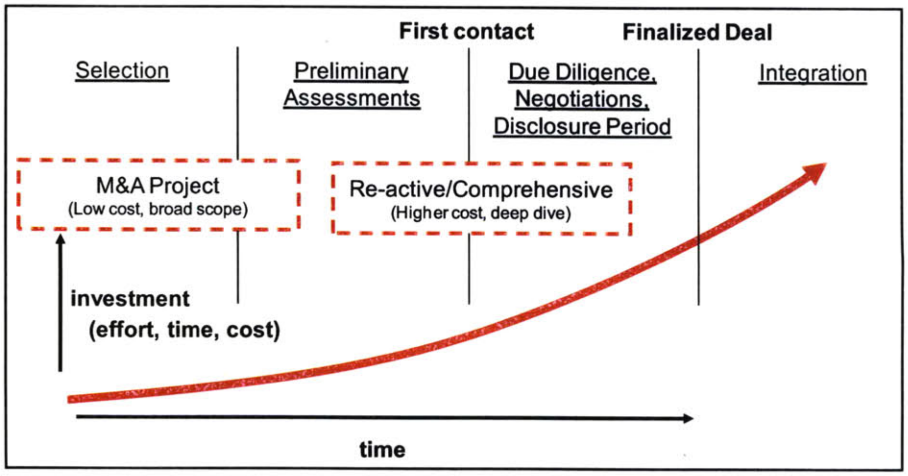


Figure 2 – Diagram of investment over M&A timeline

The level of investment increases significantly with each phase of the process. In the due diligence period, cross functional teams from the acquiring company must analyze every aspect of the target's business. This may include but is not limited to internal finances, ownership structure, legal obligations, financial obligations, operations, IP ownership, supply-chain structures, company culture, leadership reputation, labor relations, product portfolio, market share, geographic location, national stability and more. Clearly, this can require experts from a variety of areas and be costly in both cash and resource allocation.

There must be a way companies select the target that they will invest such heavy resources on. However, a thorough literature search of public documents revealed no description of the overall process by which firms select acquisition targets. Aspects of the decision are described such as strategy drivers and attributes of success and failure. Many works on the topic stress the importance of thorough development of strategy.

> *"An effective M&A process begins before any deal is considered – with senior management setting out a road map for future growth. This road map is not only a traditional long-term strategic plan, but rather a detailed set of proposed milestones toward the strategic goals of the company integrating mergers and acquisitions, organic growth investments and alliances"* (Adolph and Pettit 2009)

Other works such as the Brealey, Myers and Allen finance text (Brealey, Myers and Allen 2006) list possible strategies and attributes of successful acquisitions. A common approach is a documentation of cases of both successful and unsuccessful acquisition experiences (Boeh and Beamish 2007).

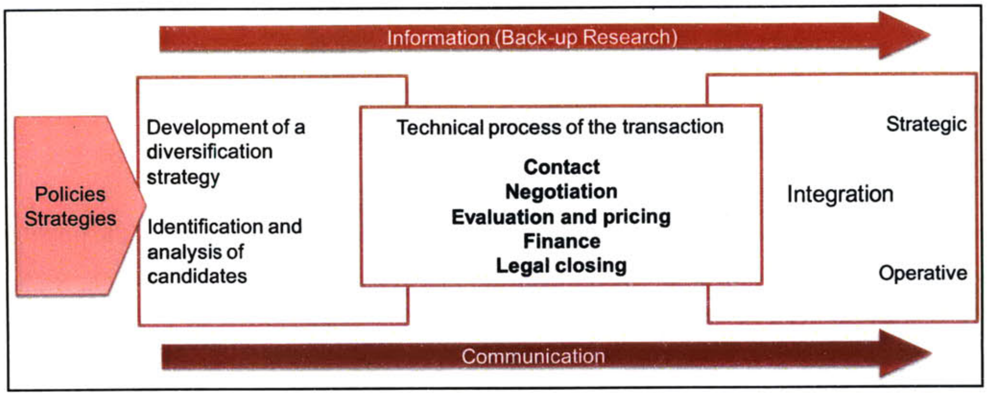


Figure 3 – "The Acquisition Process" (Kruger and Muller-Stewens 1994)

However, in either case there is no methodology presented in the reviewed literature for how to turn a general strategy into specific criteria by which potential acquisition targets can be compared and analyzed. Informal conversations with individuals experienced in the M&A industry reveal a variety of methodologies employed by firms. There seems to be four very common methodologies by which a firm is selected for further evaluation.

1. Proprietary process
   - Large firms such as M&A consulting firms have their own propriety processes by which they make these selections. Unfortunately, none of this documentation is in the public domain.
2. Single source
   - Very commonly in high-tech and pharmaceutical industries when the core goal of an acquisition is IP, there may be only one company with the desired technology. In these cases, the target has no reasonable substitute and is assessed on its own merits.
3. Reactionary
   - When a firm announces its intention to sell, the other players in the industry are forced to evaluate this company as quickly as possible to react with speed. In this case the choice to evaluate a target is made by the market and not by the acquiring company.
4. Intuition

- Surprisingly common is the response that there are members of the M&A department who simply know the industry and the M&A process with such expertise that they can make an intuitive judgment of the best target to pursue. This methodology should not be underestimated, due to the significant experience captured in the mental models of these senior employees. However, for firms with less expertise and confidence in the M&A process, we try to capture this intuition into a more scientific framework. In addition, for any company, a more structured process is easier to follow and the results are easier to defend.

The ASF theory is intended to capture the decision making process to narrow the possible acquisition targets. The ASF is not a substitute for company strategy or capital allocation though. Rather, it is a tool where the company strategy can drive acquisition selection. In the following sections the process by which the ASF is structured will be described.

2.2 Process description

The ASF is a process based on a simple framework that is customized by the acquiring company to suit its needs and goals. The base structure is a methodology to consolidate relevant data about an acquisition into three primary measurements. This structure is then customized to the given company and acquisition by defining specific metrics related to each of the three primary measurements. Finally, the process is applied in either a one-time method where a target is selected and the acquisition process continues, or in continuous monitoring modalities.

2.2.1 Base Structure

The ASF is based on the hypothesis that the many quantitative factors that contribute to the selection decision can be captured in a measurable and comparable framework. Target companies are assessed for a variety of metrics that are consolidated into three primary measures or "dimensions." These dimensions are "Strategic Goals", "Acquisition Fit", and "Financial Impact."

1. Strategic Goals

   The first dimension is a measure of how well a target matches the strategic purpose of the acquisition. It is defined based on the acquiring company's strategic vision and capital planning.

   For example, the Strategic Goals for an acquisition could be to acquire a company with competency in a specific technology. The metrics in this dimension would all be based on measures of proficiency at this technology. In this example the goals are singular. However, there may be a number of reasons for acquisition such as access to a particular market, market share growth, or economies of scale.

This dimension is particularly important in both defining the criteria by which a target is selected, but also in clarifying the purpose of the acquisition so it can be clearly communicated and assessed throughout the acquisition process.

2. Acquisition Fit

The second dimension is a measure of the likelihood of integration success. The metrics in this dimension are based more heavily on research of factors for failure of an acquisition.

While achieving the core goals of the acquisition are important, the long term success of the acquisition may be defined by this measure. In the example above, a certain target's proficiency at the desired technology might be perfect. However, if this represents only 5% of a much larger business that has large barriers to integration, the success of an acquisition could be in jeopardy.

A key aspect of this dimension is its usefulness in identifying potential roadblocks to the acquisition process. By analyzing the reasons a target is unattractive in the Acquisition Fit dimension the acquisition team could perhaps identify the "deal breaker" items and address such issues first in the downstream acquisition processes. An exit criteria strategy can be developed early on in the process to identify the indicators that signal when the acquirer should walk away from the deal.

3. Financial Impact

The final dimension is a measure of the ideal financial impact of the acquisition. It needs to be based on the specific acquisition goals, because not all acquisitions seek the same financial ends.

For instance, one goal may seek an immediate top line revenue growth, while another does not stress immediate revenue growth in favor of long-term bottom line profit increases. In technology-based acquisitions, affordability may be the only critical financial measure.

While these definitions may be less ideal than a clear NPV assessment of the value of the firm, a realistic assessment of NPV would not be available at this point in the acquisition process. Such assessments would only come out during the valuation phase at the final end of due diligence. An accurate assessment would just not be feasible at this point in the process.

By assessing a company on these three dimensions we can plot targets as seen in the figure below. This plot represents a variation of a risk vs. reward chart. In this case we can consider the Acquisition Fit as a measure of minimizing risk, while the Strategic Goal axis can be considered a measure of strategic success. Clearly, optimal targets would be found in the top right quadrant, while the least attractive targets would be found in the bottom left quadrant. The top left quadrant would represent targets that are good integration targets, but offer little to achieve the given strategic goals. Targets in the bottom right would represent options that achieve strategic goals, but are major integration challenges. These targets may represent areas where an alternative strategy such as alliances or greenfields may be more effective than an acquisition.

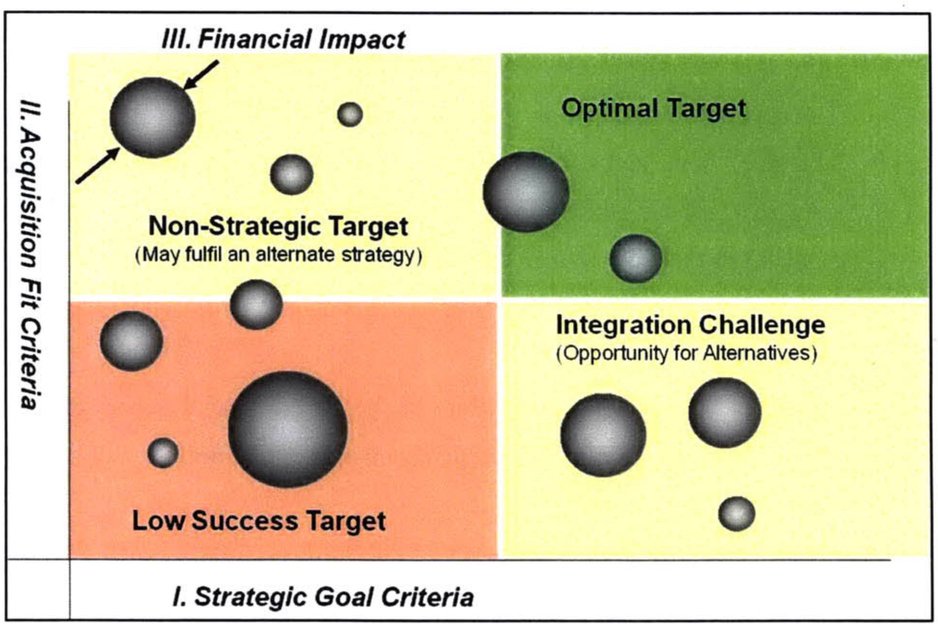


Figure 4 – ASF conceptual four quadrant plot

2.2.2 Customization and development

The three dimensions of the ASF are customized by defining metrics and weightings within the dimensions. The framework is based on both a "top-down" and a "bottoms-up" approach to defining the critical areas of the acquisition. The top-down approach is meant to be a means for the company leadership to steer the purpose and vision of the acquisition. The bottoms-up approach is meant to be a means for the experts and functionally experienced employees to define the specifics of what makes a strong target.

This is achieved by a two tier weighting and scoring system. Each of the Tier 1 metrics is defined by the company leadership. This is critical because of the need to match the purpose of the acquisition with the philosophy of the company and the existing portfolio of investments. Once the Tier 1 metrics are defined, the Tier 2 metrics can be defined to create clear concise criteria by which the target company can be assessed.

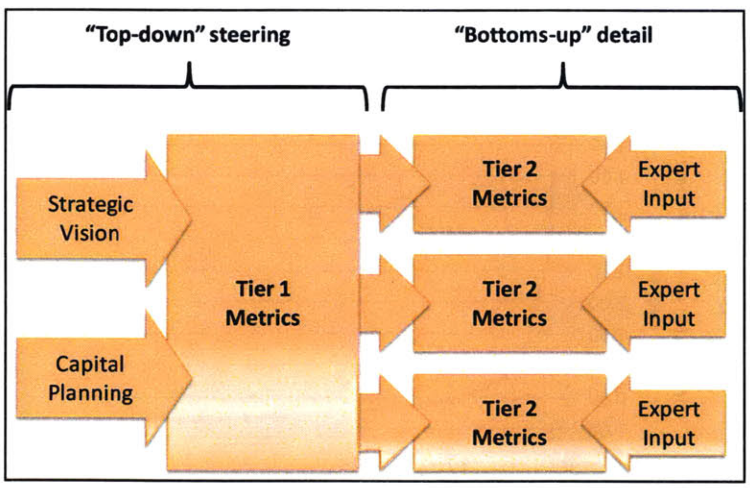


Figure 5 - Dual level metric structure, customization phase

Since each metric in a dimension may not carry the same importance as the others in the dimension, we employ Multi-Attribute Utility Theory or MAUT (Von Neumann and Morgenstein 1953). MAUT is a tool commonly employed in engineering design tradeoffs that has been adapted for this application. Here, MAUT allows the acquisition team to define relative importance of each metric in the scoring.

In the dual level metrics system we actually need to employ a dual level utility weighting. The equation employed is below.

$$U_{c,d} = \sum_i \left(W_i \sum_j (w_{ij}\, s_{ijcd}) \right)$$

1. $U_{c,d}$ = Utility score for each company, c, and dimension, d
2. W_i = Weighting for Tier 1 Metrics
3. w_{ij} = Weighting for Tier 2 Metrics
4. s_{ijcd} = Score for Tier 2 Metrics for each company, c, and dimension, d

It is important to note the limits of this methodology. One of the major limits is the dilution of impact that occurs with increasing numbers of attributes. A simple demonstration of this is captured in the graph below. If there are a number of evenly weighted metrics that are scored on a scale of 0 to 5, the impact of an individual single metric decreases with number of metrics. If there are only 5 metrics each metric can impact the cumulative score by a range of up to 1.0 out of 5. This is a significant impact that could change the overall decision. However, if there are 50 total metrics each can impact the decision by only 0.1 out of 5. This is not likely to impact the overall decision.

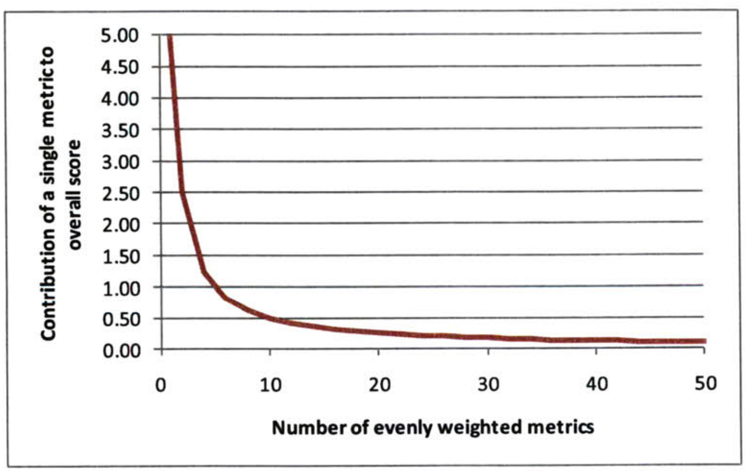


Figure 6 – Dilution of metric impact with increasing attribute numbers

This issue is further compounded by the limits to useful information. Obviously, at the early stages of assessment the precision of the measurement is dependent on accurate assessments of imperfect information. Since the information is likely to be quite imperfect, several of the metrics may have a significant error tolerance associated with them. If a heavily weighted metric has significant inherent error, it could impact the decision far more than an accurately assessed, but low weight metric.

However, there are a few advantages that this dilution provides. The first is that if management understands this dilution, they should be much more careful in what they consider as decision factors. The second is that the dual level system of weighting allows the acquisition to consider a few critical factors at a time in each level. The first level may contain only five critical metrics. In the second level again only 5-10 metrics might be considered. While this may result in an expansion of the total number of metrics, the top level metrics will have some quantitative methodology supporting their scoring, rather than a purely subjective score. This should increase the robustness of the overall assessment even if an individual factor may not have a significant impact.

2.2.3 Application and maintenance

After the base framework has been customized with the necessary metric definitions and weights, the process of applying the ASF can begin. The first time that the ASF is applied, each possible target company is scored for each metric and the resulting dimensional score is calculated. The acquiring company can act on the output of this single analysis, or it may enter into other modes of operation of the ASF such as strategy re-evaluation or industry monitoring.

The scoring occurs in the opposite direction of the customization of the framework. The experts or acquisition team will evaluate each target for the tier 2 metrics that are defined during the customization process. Then a total dimensional score is calculated for each company based on the weightings that are also defined during the customization phase.

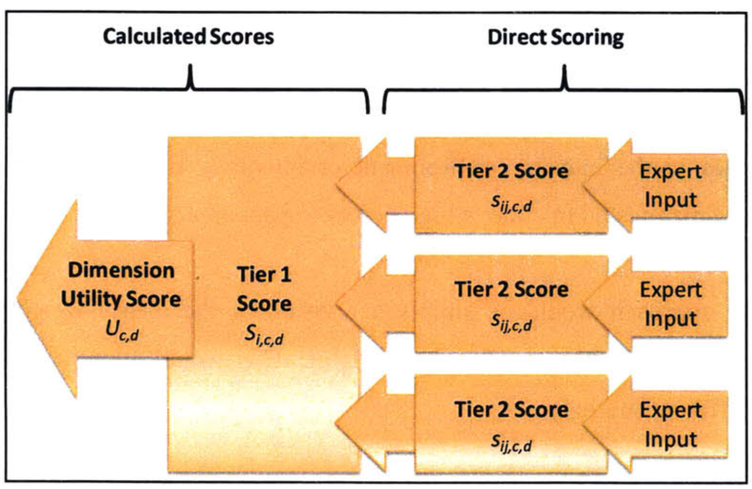


Figure 7 - Dual level scoring structure, scoring phase

Once scored the output of the ASF can be evaluated. At this point the acquisition team must decide whether to proceed to the next phases of the acquisition process with a selected target, pursue an alternative option, or remain in the pre-selection acquisition phase. Alternative options could include joint ventures, alliances, or greenfields and while there are many insights that could be drawn from the ASF for these options, that is not the focus of this thesis.

An acquiring company may choose to remain in this pre-selection phase if there are no targets that seem optimal from the ASF output analysis. There are two primary modality options that are available to an acquisition team at this point, industry monitoring and strategy re-evaluation.

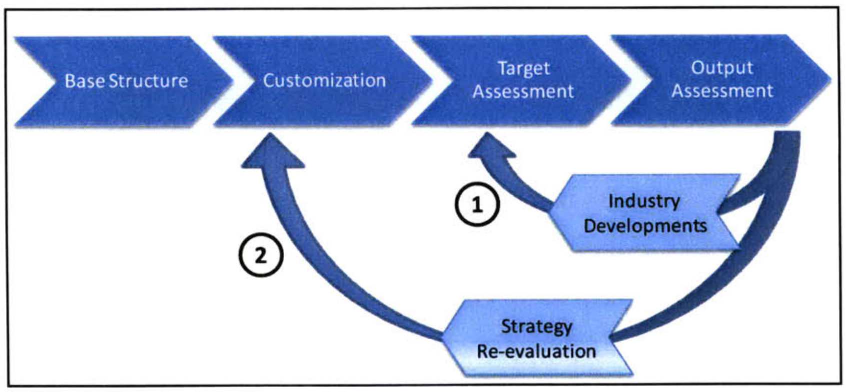


Figure 8 - Industry monitoring and strategy re-evaluation modes

The first modality is industry monitoring, which is a "wait and see" tactic. The acquisition team monitors the industry for new targets and changes to the existing targets and updates the assessments periodically. If there are changes that shift a target into an optimal zone, the acquisition team can then act and proceed with the acquisition target.

The second modality of the ASF is a strategy re-evaluation method. This could be prompted externally by changes in the industry environment or internally by shifts in needs of the acquiring company. This can be manifested in either a high or low impact approach.

The low impact approach would be simply a revision of the metric weightings. By shifting the weightings new results would be immediately available. This would allow a certain amount of "war-gaming" to assess different strategies.

The high impact approach is depicted in Figure 8, where the strategy revisions change the metrics or introduce new metrics. In this approach, all updated metrics would need to be re-customized and re-assessed.

2.3 *Component analysis*

In this section we demonstrate the importance of each of the three ASF dimensions and discuss common attributes of the dimension. The first two dimensions, strategic goals and acquisition fit, draw heavily on research of acquisition successes and failures respectively. The third dimension, financial impact is developed from both of these areas, but draws out those attributes specifically associated with the financial impact of acquisitions on the buying company.

2.3.1 Strategic goals

The strategic goals of an acquisition are critical to define because of the ambiguity that surrounds the measurements of success. In defining these goals there are many common drivers of acquisitions that should be considered for their history of success and failure.

Even a cursory investigation into research on acquisitions shows a wide variety of success rates quoted. One report quotes that in a study of 131 deals of $500 million or more from 1994 to 1997,

> "in 59% of the deals, total market-adjusted return of the acquiring company went down on announcement... Returns for 71% of those deals were negative over the next 12 months." (Eccles, Lanes and Wilson 2001)

Another study claims,

> "Most acquisitions and alliances fail... Companies' share prices fall by between 0.34% and 1% in the ten days after they announce acquisitions...Acquiring firms experience a wealth loss of 10% over five years." (Dyer, Kale and Singh 2004)

However, studies on the other side of the argument claim that low success rates are a normal part of business.

> "I have lost count of the references... to this 20% success rate: Much is made of how small it is, though it would dwarf the success rates of other business activities frequently lauded including new business start-ups, new product introductions, expansions to new markets, and investments in R&D" (Burner 2005)

They continue by undermining the arguments of those with a negative view of acquisitions.

> "...the losses from 1980 to 2001 were concentrated in just 87 deals, out of a total sample of 12,023; without these deals, the whole sample would have showed a significantly positive dollar return." (Burner 2005)

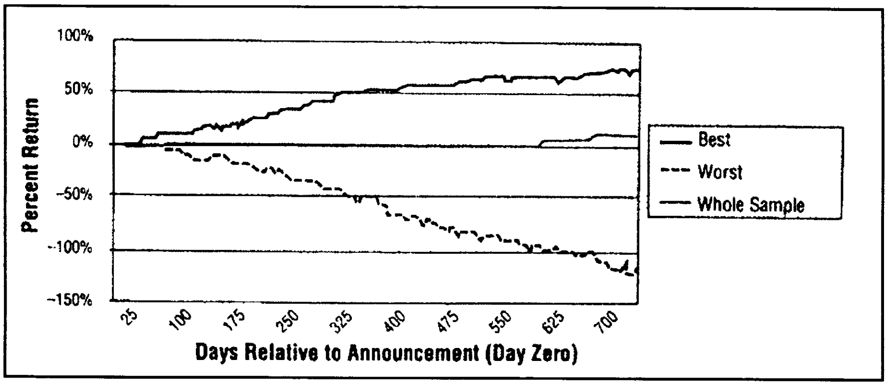


Figure 9 - "Cumulative Adjusted Returns for Whole Sample, Best and Worst from Day -5 to Day 756" (Burner 2005)

Clearly, we can assume that there is both a significant amount of risk and uncertainty that surrounds acquisitions. Despite this, there are firms that consistently grow through acquisition and see on average positive value creation. How should a company properly select an acquisition strategy in the face of such uncertainty? What should be considered success and in what timeframe? Should success simply be dependent on the external assessment by financial markets? Alternatively, should success be measured by how well the acquisition met specific internal strategic goals?

Our advisor posed the question, "A year from now when you sit at this table, how will you know if you have succeeded?" (Erdekian 2009) It is a fact that the management of the acquiring company has a legal fiduciary responsibility to its shareholders to create/protect/grow shareholder wealth (Brealey, Myers and Allen 2006). However, a goal of "creating value" is ambiguous to the point of irrelevance when making specific business decisions. This needs to be clarified to specific motivation for the acquisition. Higgins describes the issue well,

> "One problem is the difficulty of specifying precisely how operating decisions affect stock price. If we are not certain what impact a change in, say, the business strategy of a division will have on the company's stock price, the goal of increasing price cannot guide decision making. A second problem is that managers typically know more about their company than do outside investors, or at least they think they do. Why, then, should managers consider the assessments of less informed investors when making business decisions?" (Higgins 2009)

Strategy in itself is a wide topic and beyond the focus of this paper. However, we stress the importance that the M&A strategy be properly aligned with the strategy, capabilities and resources of the company as a whole. The M&A strategy could be a functional strategy that fits within the corporate and business unit strategies (Beckman and Rosenfield 2007).

We propose that since a strong strategic motive is a common theme among successful acquisitions (Burner 2005), the management should create clear definitions to assess strategic success in specific timeframes. A clear definition of why the buyer is acquiring the target has several beneficial aspects that contribute to positive returns. First, it allows examination of the assumptions involved with the acquisition. Management overconfidence and optimism are common pitfalls of acquisitions. Explicit goals make "devil's advocate" arguments easier to illuminate poor assumptions. Second, it provides common instructions for the subsequent members of the acquisition and integration team. These teams quickly grow through the M&A process and defined goals will improve the decision making processes of those involve in designing the new combined entity.

There are many literature reviews of common strategic drivers of the acquisition process. In this section, we will outline some of the major "sensible" and "dubious" drivers and their effects on acquisitions. For a more in depth review of strategic drivers, we recommend Gaughan 2007, which analyzes many of these factors in detail.

As the first step in understanding what makes a "sensible" motivation for acquisition, we must understand the value of acquisitions. The value in acquisitions is only present if there is more economic value in the two companies combined rather than as separate entities. In addition, this synergistic gain must outweigh the cost of the acquisition which generally includes an acquisition premium, the cost of executing the acquisition, and the present value of the target company (Brealey, Myers and Allen 2006). Buyers generally pay too much for their acquisitions, which creates significant pressure to realize the synergistic gains which can be a major challenge for the post acquisition management (Eccles, Lanes and Wilson 2001). It is important to note that simply acquiring a target to capture their portion of the value chain without creating any synergistic value will erode the buyer's value because there is no return on the acquisition costs. Below is an example of firm A acquiring firm B to become firm AB

(1) Gains = $PV_{AB} - (PV_A + PV_B) = \Delta PV_{AB}$ = synergy
    a. This is the "synergy" or the increase in value of the two firms as a single entity over the sum of the independent parts.

(2) Cost = cash paid – PV_B = acquisition execution costs + acquisition premium

$+$ market value$_B$ - PV$_B$ = execution costs + premium

a. Assuming market efficiency the market value of a target should equal the present value of the forecasted returns so this cost and potential return should net out. The significant acquisition premium and execution costs represent the value that has to be recaptured through synergies.

(3) $NPV_{Acquisition}$ = gains – cost = synergies – execution cost – premium

(Brealey, Myers and Allen 2006) (Gaughan 1999)

With this understanding of the value of acquisitions we can further discuss the motivations that would make sense in this context. Below is a compilation of motivations from a variety of texts. The first three are commonly cited as either "sensible" or as having a track record of success. Motivations in the lower half of the list are commonly cited as either "dubious" or as having a track record of failure.

Motivation	Reasoning	Risk
Economies of scale, Cost-reducing synergies	Incorporating redundant resources or capabilities allows elimination of one set. Based on the economic theory of an average cost per unit, there is an optimal minimum value that is a balance of the economies of scale from spreading overhead costs and diseconomies of scale that come with organizational complexity.	1. Economies of scale require integration and elimination of redundancies. In acquisitions of human capital there is risk that over-zealous integration can drive human talent out the door. 2. Optimistic managers tend to rationalize acquisition premiums through economies of scale that never materialize. The post-merger companies end up working as completely separate entities. 3. The effort to capture economies of scale may be outweighed by the diseconomies of scale from organizational complexity. A company optimized for a particular market or product segment may be more inefficient when acquired by company

		with a different focus.
Economies of scope, Revenue enhancing synergies, Complementary resources	Incorporating complimentary resources and capabilities of each business will allow increased revenue opportunities. For instance a better combined product or cross-market access. In cases of small company acquisitions, often the small company has a product of value and the large company has market access or capital resources of value.	1. Estimation and quantification of these unknown revenue streams can be difficult. Similarly, co-ordination costs of executing on these proposed synergies may be underestimated and may exceed the potential revenue gains. 2. The same issues of integration and optimistic rationalization are present.
Economies of vertical integration	A company might pursue backward or forward vertical integration for several reasons. *Lower transactional costs* can be achieved through integrating systems and stable long-term supply agreements. A *dependable supply source* in terms of availability, quality, and delivery can be critical in just-in-time manufacturing. *Specialized inputs* may require high-cost tooling, which increases switching costs. This can leave the buyer exposed to price inflation without vertical integration. *Competitive drivers* can be motivators, such as forward integration to increase pull through of the acquirer's product.	1. Vertical integration by its nature is highly correlated to fluctuations in the buyer's existing business. In industries with high demand fluctuation this can increase exposure and is a common driver for the converse, outsourcing. 2. A common misperception of this goal is the plan to capture the profits of a supplier. This is an incorrect train of reasoning because it does not increase the value of the combined entity and the value of the supplier's future profits will be eliminated in the cost of the acquisition.
Surplus funds	A mature company with limited growth opportunities and excess cash may seek to invest in cash poor companies with growth potential. This can be a strategy to avoid corporate raiders and as an alternative to repurchasing shares	1. This strategy is only effective if the acquisitions are independently sound. If a company uses surplus cash in ineffective acquisitions rather than dividend payouts, it will most likely prompt a corporate takeover.

	or dividend payouts.	
Diversification	Diversification provides a means to increase reward or decrease risk. It can be used to enter a more profitable/ higher growth industry. To decrease risk a company can diversify into a negatively correlated company to create a more stabilized earnings stream.	1. The empirical evidence is consistent in the negative effects of diversification and that specialization is consistent with shareholder wealth maximization. The first major wave of diversified conglomerates in the 1960's was followed by an equally sizeable wave of divestments in the 1970's. More recent efforts of diversification result in average losses of 13-15% of firm value. The only companies to effectively diversify, such as GE, are large enough to acquire market leaders in each new industry.
Increasing earnings per share, "the bootstrap game"	By acquiring a company with higher earnings per share (EPS) the new entity will immediately have a higher EPS than the original acquirer. This can be attractive to managers that are measured on their ability to increase EPS.	1. The increase in EPS is simply financial manipulation and does not reflect real growth in value. In fact, there should be a net decrease in value due to the acquisition premiums.
Lower financing costs, Financial synergies	The degree to which financial synergies can be realized is a matter of dispute. The proponents of financial synergies claim access to lower cost of capital. Opponents of the theory claim that this lower cost of capital comes at the expense of investors having to co-insure the two firms, with no net value gain. Agreed upon "sensible" financial synergies include capture of unused tax shields, net increase in borrowing limits or economies of scale through the fixed	1. The gains in lower cost of capital may not be real growth in value, but a re-distribution of risk from debtors to investors.

	costs of issuing debt.	
Monopolization, Increased market power	The goal of increasing market share and therefore increasing market power and the ability to set prices is based on classic economics. However, Porter argues that in market equilibrium, if a player eliminates its competitors through acquisition, new players will enter to fill this new void. Since markets are rarely in equilibrium though, they often go through periods of expansion and consolidation, with roll-up acquisitions.	1. Estimating the economic benefits of increased market power are difficult to weigh against the cost of an acquisition. 2. Overconfidence in the barriers to entry could lead to an acquisition of a competitor that would be negated by new entries to the industry.
Superior management skills	A bidding firm may pay a premium for a target on the premise that the skill of the acquiring company will be able to extract greater returns out of the target than the current management.	1. The success of the management team and their managerial policies may be more attributable to fortuitous circumstance than deliberate action. In such cases their actions may not be as successful in another business endeavor.
Hubris	A commonly debated hypothesis is that executives seek out acquisitions for their own personal stature, reimbursement, and motives rather than the firm's or the stockholder's economic gains.	1. There is not a convincing body of evidence for this motive. However, intuitively it seems like a very human bias to engage in activities that are viewed to have a personal gain.

(Brealey, Myers and Allen 2006) (Gaughan 1999) (Higgins 2009)

It is important to note that the first three items, which are considered "sensible," all require some level of integration of the target and acquiring firms. This is because these strategies have been based on the theory that the value of an acquisition must come from the synergistic gains of the combined entity. This is inherently a theory biased for "strategic" rather than "financial" acquisitions.

Financial acquisitions, those commonly executed by private equity firms, are speculative in nature. They are based on the theory that markets are inefficient in practice. Therefore, target companies that are undervalued by the market can be identified, purchased and resold for a profit. This theory requires no synergy between the buyer and seller. Instead, profit is derived from the inefficiencies in markets and the degree to which a target is undervalued. Furthermore, financial portfolio theory is employed which encourages diversification. This thesis is not intended to address the speculative aspects of identifying undervalued targets.

2.3.2 Acquisition Fit

The "risk" side of these dimensions, Acquisition Fit can be captured primarily by the barriers to successful integration. It is important to note, that these metrics also need to be customized for each acquisition since some goals require very low levels of integration and others require very high levels of integration. The metrics for these dimensions are commonly cited factors in the cause of failed acquisitions.

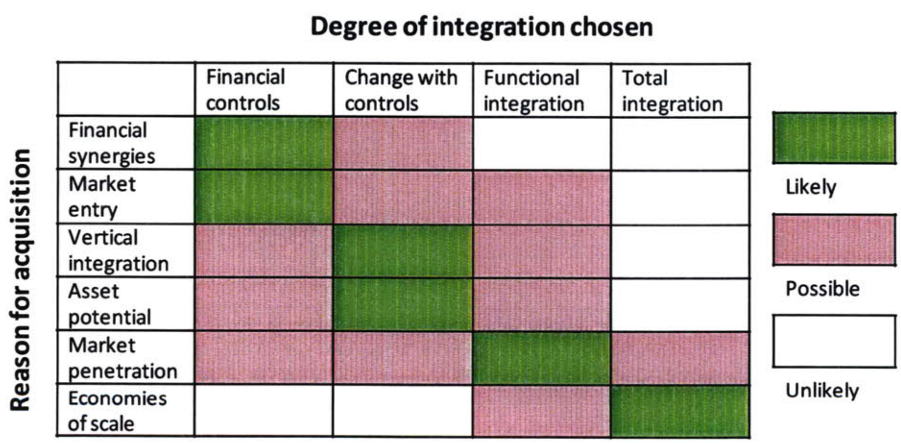


Figure 10 – "Acquisition objective and required degree of integration" (Hubbard 2001)

Hubbard presents a good framework to first assess the level of integration for a given acquisition. This framework considers the type of acquisition that is appropriate and the risks associated with integration. One of these risks is employee attrition. The perceived changes in autonomy by the acquired firm and imposed controls can have a negative impact on employee attrition, especially the senior management. With deeper levels of integration the level of imposed control, disruption and upheaval to the target company's employees reaches more and more of the functional areas and levels of the organization. Ideally, the acquisition will require the minimal amount of integration to meet the goals of the acquisition (Hubbard 2001).

Target companies that are a poor acquisition fit because of the level of integration required may be candidates for a staged integration approach. In the execution of the acquisition, the degree of integration may begin with financial controls and progress over time towards a functional or total integration. These types of execution strategies are delicate and often benefit from previous experience. It is important to consider this option though, because it may improve the Acquisition Fit score if immediate full integration is not required.

It is important to note in this assessment of Acquisition Fit that we are looking at traits of the target and not the actions of the acquiring company. There are plenty of areas for managerial mishandling of the acquisition process that can turn a high potential acquisition into a high profile disaster. This is the subject of extensive cognitive science and acquisition implementation research. The research of this thesis focuses on the traits of the target as they fit with the acquiring company.

In the following list we try to capture some of the most commonly cited risks for success of an acquisition.

Non-goal related products

- Ideally, all products and services of the target company will fall within the goals of the acquisition. However, it is very likely the portion of the business being evaluated in the Strategic Goals is only a small portion of an indivisible business. In these cases the remainder must be evaluated for their fit with the organization. This can either be a positive or a negative to the Acquisition Fit. This category is very similar to the Strategic Goals, just focused on the non-goal related products. Some of the key traits in this area are reviewed below.
    - *Targets with related products and capabilities*. Significant diversification is commonly cited as an indicator of failure of acquisitions.
    - *Acquiring from a position of strength rather than need.* Companies that choose targets that could benefit from the expertise of the acquiring company rather than the reverse often are more successful at M&A.
    - *Management bandwidth.* If the size of the target is too large, or the number of acquisitions occurring concurrently is too high, the management's attention will not be adequate to drive success in all investments.

  (Burner 2005)

Restructuring distance

- The restructuring distance is a function of the level of restructuring required for the strategic goals and the inherent barriers to restructuring.
    - *Restructuring required.*
        - The restructuring required will depend heavily on the amount of integration planned. If significant economies of scale, transfer of technology, relocation of sites, or layoffs are required as part of the plan, these costs can increase significantly. This also is dependent on the size of the company. This is probably the most important area for the acquiring team to think creatively about the target and lean on those with experience in implementation of acquisitions. A poor assessment could lead to the assumption of a higher level of integration than is necessary.
        - In addition, some level of investment may be necessary with no amount of integration. After Airbus failed to sell Premium Aerotec, its the fully owned subsidiary, the management of Premium Aerotec requested €500M from Airbus for necessary technology and infrastructure upgrades (Flottau 2009). An acquiring company should do everything possible to uncover possible investment needs.
    - *Barrier to restructuring.*
        - Unions, management and national labor laws vary from company to company and they all can pose a barrier to implementing changes at a target firm. These must be considered when designing the level of integration and assessing the restructuring distance.

Overcapacity risk

- The overcapacity risk will depend significantly on the assumptions of the Strategic Goals. If there are assumptions of a need for capacity or a high risk of overcapacity they should be outlined explicitly so that these assessments can be made. Capacity changes due to an acquisition can also be either a positive or a negative factor in the success of an acquisition.
    - *Flexible capacity.* It is possible that the nature of the capacity and product lines that are acquired are fairly interchangeable with the acquirer's current capacity. If this is the case, one could argue that by portfolio theory the total variance in workload should be reduced by utilizing the capacity flexibly.

- *Correlated demand.* The caveat to flexible capacity is that the demand for the acquired product lines and the current product lines must be uncorrelated. This may be a poor assumption in the aircraft industry which cycles in unison. In a highly correlated demand scenario the acquirer only compounds their risk with acquisition.

Alternatives to acquisition

- The acquisition is only one tool along a spectrum of strategic options that can be employed to achieve the same ends. It is important to check that investment in the given target is not more appropriately deployed as a different investment. Some of the best firms at acquisitions are also the best at alliances. For instance Cisco, known for their rapid growth through acquisitions, acquired 36 firms in 10 years. In the same time period they entered into more than 100 strategic alliances (Dyer, Kale and Singh 2004).
    - *Alliances and Joint Ventures.* Factors that drive the decision between acquisitions, joint ventures, and alliances can include the modularity of synergies, human to hard asset ratio, redundancy of resources, degree of target potential uncertainty, and level of competition for resources (Dyer, Kale and Singh 2004).
    - *Greenfields.* Not surprisingly, the value of an acquisition as compared to a greenfield decreases with the level of integration. Slangen and Hennart present a framework for understanding this relationship, based on the cost of conforming to the external environment (technological, local geographic markets, local culture, etc.) and the cost of conformance to the acquiring company's culture. As the acquiring company already is aligned with the local externalities, it only incurs the cost of integrating with the acquiring company's culture. At some point, with significant levels of integration, these costs outweigh the alternative costs of a greenfield (Slangen and Hennart 2008).

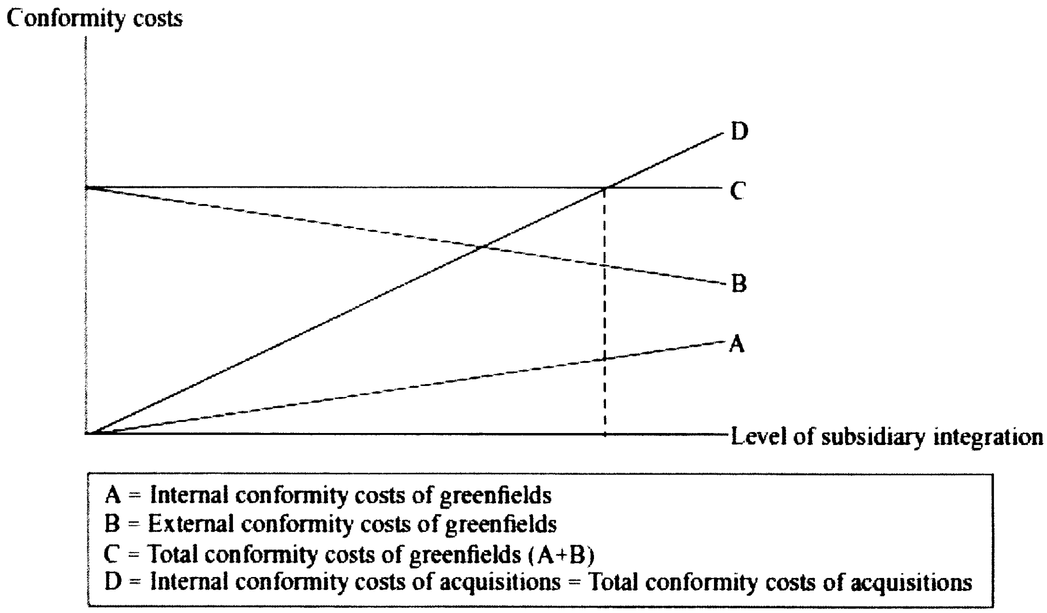


Figure 11 "Relationship between the level of subsidiary integration and the conformity costs incurred by greenfields and acquisitions" (Slangen and Hennart 2008)

Cultural fit

- Cultural mismatch presents perhaps the most nebulous metric to measure and also the highest potential to create disastrous results. On the other hand some claim that the diversity in cultures can generate learning and value creation. The degree to which cultural differences impact the resulting financial measures of performance is statistically questionable. However, the "ability to manage the integration process – particularly the sociocultural aspects – in an efficient manner is a key factor in determining the extent to which synergies are realized" (Stahl and Voigt 2008).

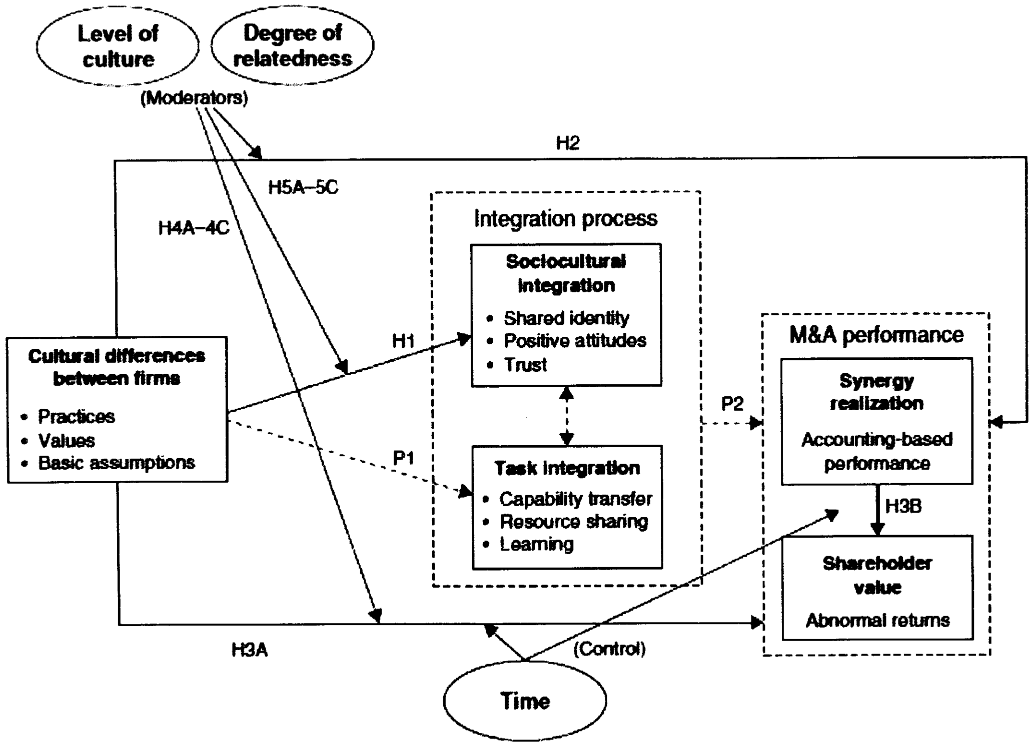


Figure 12 – "Hypothesized impact of cultural differences on M&A performance" (Stahl and Voigt 2008)

- *Acquisition culture.* Many studies have indicated that the returns from friendly acquisitions are higher than those of hostile takeovers (Burner 2005). Part of this success can be attributed to the level of buy-in and engagement of the existing management during negotiations. This ability to integrate cultures can be enhanced by experienced integration teams from the acquiring company (Hitt, et al. 1998).

2.3.3 Financial impact

The financial goals of a strategic acquisition can be surprisingly varied. All acquisitions should strive for the goal of "increasing shareholder value." However, as we have discussed, this sort of goal is vague when making specific operational decisions. The most common financial goals for strategic acquisitions are top-line growth, bottom-line growth and affordability. Whichever financial goals are chosen they must align with the strategic goals of the acquisition. If there is poor alignment between the designs of these two sets of goals, a sub-optimal target may be selected and incentives will be misaligned.

There are other financial goals for M&A such as lower cost of capital, capital restructuring, access to capital markets and the use of excess cash to avoid raiders. It is our opinion that this second set of goals pertain to deals that are primarily financial in nature, rather than primarily strategic. In this thesis we will be reviewing the first set of goals as they are the goals of a strategic acquisition.

Top-line growth can be a measure of growth by revenues or earnings per share. This motive could be described as the "bigger is better" approach. There are only a few cases where this should be the primary financial metric. In industries where strong network effects are the dominant indicator of success, absolute size is an important metric. Similarly, if negotiating power is critical to market dominance, absolute size could be critical. In either of these cases, the acquisition premium must be paid for by the synergies that arise from consolidating the fragmented players into a single larger player. However, simply chasing top-line revenue growth simply for the sake of growth is a dubious strategic plan (Brealey, Myers and Allen 2006).

Bottom-line growth strategies are accretive and can be a measure of absolute profits or profit margins. A critical variable in bottom-line growth is timing. Targets that are accretive in the near term can be very different than those in the long term. Immediate bottom line growth can clearly be extrapolated from the target's current profits and margins. However, any value captured by this growth should be part of the cost of the acquisition and so additional value from synergies must be accounted for. Developing an assessment for long term accretive profit growth can be challenging. To do this accurately would require significant valuation of the firm and assessment of the value of the combined entity in the long term. However, at this early selection phase, an accurate business case would be challenging to defend due to imperfect and lacking data.

Affordability as a primary financial measure is based on the expected price of the acquisition target and the financial capacity of the acquirer to purchase the target. The price can be determined in several ways, although at this early phase using industry multipliers is a reasonable approach. Acquirers should not expect that a price based on a multiplier is what the final price will actually be, but rather an order of magnitude comparison of the various targets. Multiples for the aerospace industry fell from nearly 12x to 5x EBITDA in 2008 (Grant Thornton Corporate Finance, Mergers and Acquisitions 2009). Price can significantly be affected by the way the acquisition occurs. Acquisitions that occur through public auction rather than the private purchase of a target have significantly lower success rates (Burner 2005). This is most likely due to price inflation during the auction process that makes the acquisition a negative NPV investment.

The second part of affordability, financial capacity of the purchasing company, can be a function of the size of the target, the existing capital structure of the acquirer and external capital markets. During the financial crisis in 2008, the external capital markets collapsed limiting access to debt and, therefore, limiting the capacity for companies to acquire (Grant Thornton Corporate Finance, Mergers and Acquisitions 2009). When debt markets are liquid, companies often utilize debt to finance acquisitions. The ability to maintain an average to low debt to equity ratio has been shown to be statistically significant in successful acquisitions. There are a number of theories on the reasons for failure with high debt ratios including higher cost of capital, higher risk of default and lower investments by management in long term projects and R&D in high debt environments (Hitt, et al. 1998). These issues can be alleviated if the acquiring company takes on debt for the purchase, then sells unwanted assets of the acquisition to immediately reduce the debt.

The definition of high debt to equity ratio is highly dependent on industry. A table of debt as a percentage of equity ratios for the aerospace industry is shown below. Spirit's debt ratio is actually quite low for the aerospace industry, indicating that they have significant capacity to increase their leverage. It is not that surprising that the aerospace industry has such high leverage, considering the amount of capital investment and long development periods required bringing a product to market. Debt is not the only method of payment for an acquisition. Some firms use stock to pay for an acquisition, although this has been shown to be an indicator of unsuccessful acquisitions as compared to using cash (Burner 2005).

Benchmarking

	Spirit Aerosystems	Aerospace & Defence Industry	Industrials Sector	GKN plc	Latecoere S.A.	Bombardier
LT Debt to Equity (%)	53.11	689.78	68.93	80.33	137.69	136.55
Total Debt to Equity (%)	53.57	735.67	98.31	112.04	165.46	136.55

Figure 13 - Debt to equity ratios in the aerostructures industry (Reuters 2009)

2.4 Appropriate application setting

This framework was designed to be used in the commercial aerospace industry. While it should be applicable in many industries, it may require different levels of granularity depending on the needs of the acquisition, acquiring company, acquisition team, and industry. There are clear cases when this framework may not be appropriate. However, it is our assertion that in general this should be a successful decision making framework in acquisitions where the rate of similar investments is slow enough to consider each deal as a single event rather than as a portfolio of investments.

The purpose of the customization phase of the framework is not only to tailor the framework to the strategic needs of a given industry, but also the operational needs of the acquisition team. In some cases either a very high number of possible targets or limited time and human resources of the acquirer may require the framework to be customized in fewer total metrics. Conversely, in cases of just a few targets where a final selection must be made, much higher levels of detail should be employed. It is very reasonable to use the framework in several iterations for a single acquisition beginning with general analysis of a breadth of targets and ending with a focused analysis of a few targets. However, a reminder from our advisor was the adage, "the devil is in the details." The analysis will get exponentially more complex and non-linear with increased level of detail, revealing oversimplifications in the assumptions of less rigorous analysis (Marcus 2009).

This framework would not be appropriate in high clockspeed industries such as biotech and high-tech. While we stress that the acquisition must be aligned with the overall company investment strategies, the ASF theory does not account for any aspect of portfolio theory. In the case of the commercial aerostructures industry, companies with aggressive acquisition strategies may acquire an average of one company a year. (GKN Aerospace Services, Ltd. n.d.). Especially for companies with even lower rates of acquisition, it would be inappropriate to apply strategy based on portfolio theory, which places more importance on negative correlation of investments than on low risk. Due to the infrequency of these investments, it is more appropriate to consider each investment as a single event where risk and return are considered for their own merits. If a company's position were to change to one where such investments occurred at a more rapid rate, portfolio theory would be a critical decision factor.

3 Case Study Background: Spirit (Europe) and the LCA Industry

The application of the acquisition selection framework theory for this case study was at the European business unit of the Spirit AeroSystems company. Spirit's primary business is in the production of aerostructures, the frame of the aircraft, in the large commercial aircraft (LCA) industry. In this chapter we will explore this industry in terms of its competitive dynamics, industrial dynamics and technological dynamics. We demonstrate that the industry is in a period of considerable flux, driven by significant changes in each of these three interdependent industry characteristics. The industry inflection point that Spirit is experiencing brings significant uncertainty to any investment decisions. Spirit AeroSystems (Europe) is responding to these shifts through a low vertical integration strategy, along with investments in R&D and technology integration.

3.1 Company background

Spirit AeroSystems has been described as "a four year old company with 80 years of history." In 2005, the airframe production sites in Wichita, Kansas and Tulsa, Oklahoma were purchased by Onex Corporation from Boeing Commercial Aircraft for $900m and rebranded as Spirit AeroSystems (Karp 2005). In 2006, the BAE aerostructures division in Prestwick, Scotland was acquired for £80m (GBP) or $142m (USD) to form the Spirit Aerosystems (Europe) business unit. In June of 2006, Onex announced the IPO of Spirit which raised $1.65bn (Wall St. Gets Spirit 2006).

Today Spirit AeroSystems is the largest independent supplier of aircraft structures (Counterpoint Market Intelligence Limited 2009) with revenues of $3.77bn USD (Spirit AeroSystems Holdings, Inc. 2009). Their headquarters is in Wichita, KS and have operations in the Oklahoma, North Carolina, Scotland, England and Malaysia (Spirit AeroSystems (Europe), Ltd. 2009). Spirit Inc.'s primary products are aircraft structures, known as aerostructures, for the LCA OEMs such as Airbus and Boeing.

Spirit (Europe) consists of the Prestwick, Scotland and Samlesbury, England sites. It is part of the Wing Sector business group which also includes Tulsa, Oklahoma and the new sites in North Carolina and Malaysia. Spirit (Europe)'s current business focuses on supply chain management and assembly of large wing sub-assemblies such as fixed leading and trailing edges. Some of the products Spirit (Europe) produces are shown below (Spirit AeroSystems (Europe), Ltd. 2009).

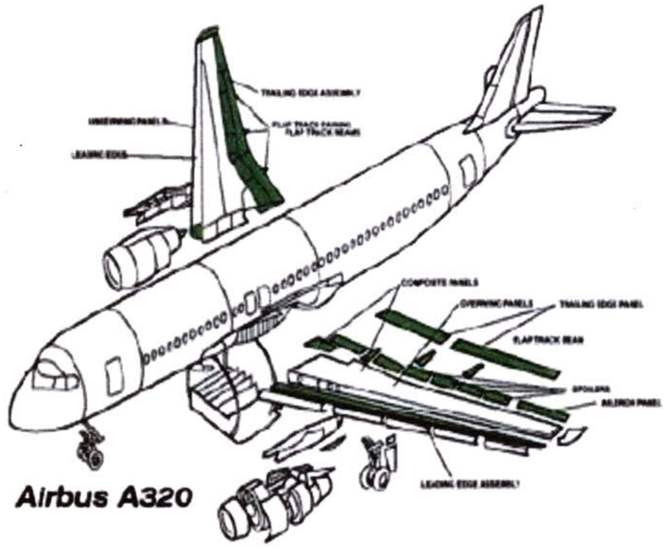


Figure 14 – Example of parts from Spirit (Europe) external presentation (Spirit AeroSystems (Europe), Ltd. 2009)

3.2 Current industry structure and competitive dynamics

The best way to begin an industry analysis is to precisely define the company's industry. Spirit AeroSystems is in the aerostructures industry, which is a subset of the aircraft industry. Aerostructures generally includes the manufacture of structural components but not other subsystems such as hydraulics, electronics, engines, interiors or avionics. At higher levels of integration the aerostructures are integrated with these other subsystems to create equipped or "stuffed" structures. These equipped structures are then integrated with each other and with more subsystems in final aircraft assembly. Historically, the equipping has primarily occurred at the OEM level. However, the line between the aircraft industry and the aerostructures industry is being blurred as more equipping work is being placed into the supply chain.

The aerostructures industry can be further sub-divided by product, tier level, and segment. These divisions and the areas that Spirit contributes can be found in the table below.

	Product		Tier level		Segment
SA	Fuselage		0 – OEM	SE	Large commercial aircraft
SE	Wings		1 – Final assembly		Regional aircraft
SA	Nacelles & pylons	SA	2 – Equipped assemblies	SA	Business/private jet
SA	Empennage	SE	3 – Structural assemblies	SA	Military
		SA	4 – Detail components		Rotorcraft
			5 – Materials		

Key:

SA – Built by Spirit AeroSystems, Inc but not by Spirit (Europe)

SE – Built by Spirit AeroSystems (Europe)

3.2.1 Rivalry forces

The aerostructures industry is currently at a very mature stage and industry growth is minimal. The aerostructures industry is estimated to be $35.9 billion in 2008 with CAGR 2.5% over the next 10 years (Counterpoint Market Intelligence, Ltd. 2009). Spirit (Europe) competes specifically in the wing sector and is responsible for about half of Spirit AeroSystems revenue in wing products.

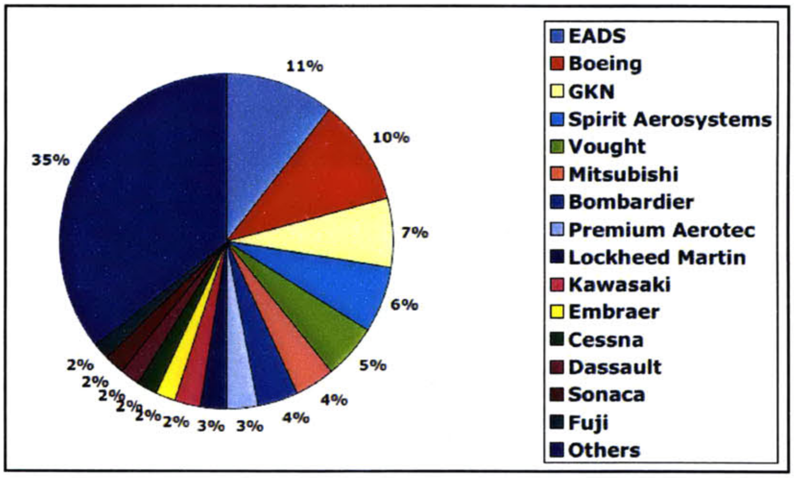


Figure 15 - Wing sector market shares (total $15.9 B) (Counterpoint Market Intelligence, Ltd. 2009)

It is clear that the wing segment of the aerostructures market is particularly fragmented. The top four market leaders capture only a third of the market, the top 15 players capture less than two thirds and over a third is captured by sub 2% market share players. If we compare this to the nacelles segment of the aerostructures industry we get a very different picture.

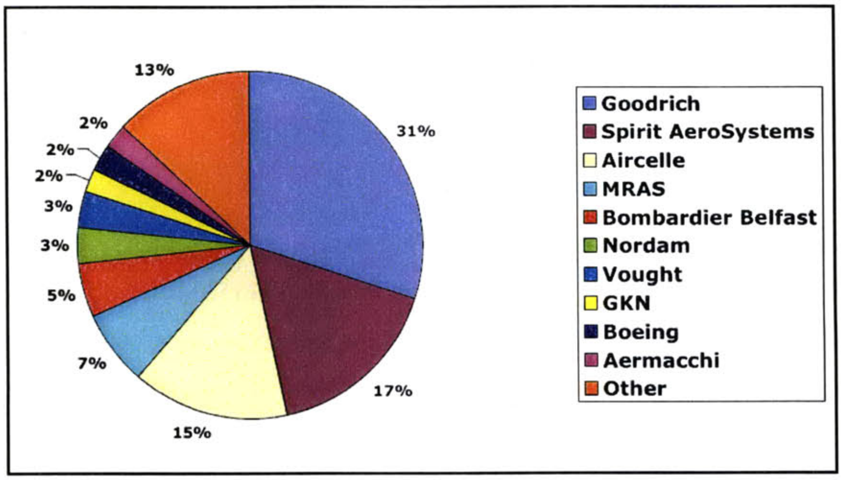


Figure 16 - Nacelles market shares (total $5.5B) (Counterpoint Market Intelligence, Ltd. 2009)

The nacelles market is significantly different than the aerostructures market. Nacelles are the shell or casing that surrounds the aircraft engines. They are more heavily integrated with the engines than the specific aircraft. Note that the top four firms account for 70% of the market and just 10 firms account for 87% of the market. Clearly the market leaders have a much stronger position in this market.

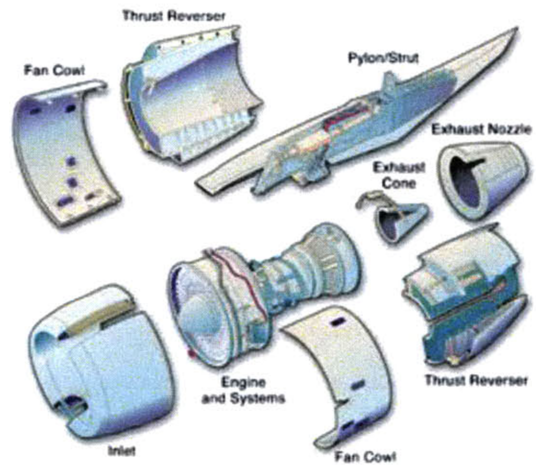


Figure 17 – Nacelle components, including inlet, fan cowl, thrust reverser and exhaust nozzle (Black 2004)

What accounts for the drastic difference between these two sub-divisions of the same industry? A closer analysis of the wing sector reveals that 7 of the top 15 players in the wing market are OEMs. This indicates that a significant amount of the wing has been historically kept in-house by the OEMs. This may be due to factors including decomposability of the wing and nacelle as independent products, the view that the wing is a strategic value-add product, or the logistics and supply chain considerations of transporting a piece part as large as a wing.

In addition to the OEMs that compete in this space are the newly independent competitors created by the OEMs. In the case of Airbus, as part of their Power 8 program they have divested manufacturing sites such as Premium Aerotec as wholly owned subsidiaries with the intention to divest or sell. Boeing's obvious example of similar divestment would clearly be Spirit Aerosystems. In addition to divestment Boeing has created new players in the wing industry by a reversal of their vertical integration strategy with the outsourcing on the 787. This has created new players in the supplier tier such as Mitsubishi Heavy Industries and Kawasaki Heavy Industries.

All of these factors have contributed to a highly fragmented industry and subsequently increased expectation of a period of industry consolidation. This is compounded by rumors that Boeing and Airbus will want to work with only a few suppliers of major subsections of the plane (such as an entire wing). The suppliers of this industry are beginning to position themselves as either integrator-supply chain managers or component suppliers. Those seeking to be integrator-supply chain manages are seeking out the necessary capacity, technology, and capability to meet this perceived need.

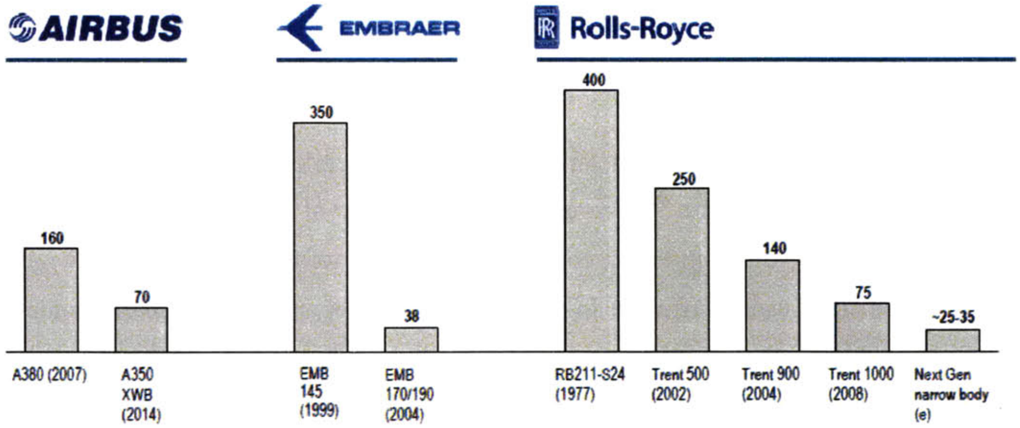


Figure 18 - Consolidation of prime suppliers engaged by OEMs (Thomson and Sczcudlik 2008)

3.2.2 Entry-Exit barriers

Current rivalry driven competition aside, we should consider the entry-exit barriers to the industry. The industrialization costs and equipment are extremely significant in this industry and increase dramatically as the level of integration increases. This is partially due to the challenges of scale that come with the size of large commercial aircraft. For instance, these costs of scale pose real trade-offs in terms of automation. Even in high cost countries, companies have adopted strategies of both high automation and low automation. Since the cost of highly specialized automation equipment at this scale is so significant, volumes are so low, and demand is highly cyclical there are real trade-offs in terms of leveraging your operations for automation. These produce high fixed costs to reap maximum profits on low variable costs, but risk higher losses due to unused capacity. SAAB was forced to lay-off 300 employees in 2009 after pursuing a high cost automation strategy on production lines that saw demand far below the customers forecast (Saab AB 2009).

Compounding this problem is the fact that the equipment (especially in a high automation strategy) and skills involved (especially in a low automation strategy) are not transferrable across product groups. This means that manufacturers cannot gain economies of scale through utilizing their resources on both fuselage and wing products. The manufacturing sites are generally specialists in a particular product, especially at the higher levels of integration. This is partly due to the political environment in which most of these organizations were built, but also partly due to the significant differences in required resources.

The entry-exit barriers to the industry are magnified by the sector. The military aviation sector has enormous entry-exit barriers on a global scale often tied to national security. Both established and emerging countries heavily invest in military aviation and impede exit from the industry to maintain capability for military production. In addition, many nations will stifle competition by preventing foreign suppliers from competing on particular aspects of military aircraft.

The split between business jets and large commercial aircraft in the civil aviation world also contributes to the entry-exit barriers. This comes back to the issues of size of the components. A business jet with a wing that is 20-30 feet in length compared to the wing of the A380 which is 4 to 5 times the size and weight are significantly different. In one case the complete parts or purchased equipment could easily be transported by truck. In the other, the equipment would need to be built on site and the complete structure cannot be transported easily by either truck or rail. These barriers are clearly evident in the OEM level competition. For large commercial aircraft (LCA) there are two dominant competitors. Just one sector smaller in the regional jet space there are now over six players currently in the market or trying to enter, three times the number of competitors in the LCA space. In the business jet arena there are even more competitors. The increased competition at the smaller sized aircrafts will minimize profits.

3.2.3 Buyer-Supplier power

Currently, there is a significant amount of power both in the buyer and supplier sides of the equation. This leaves Spirit in an unfortunately squeezed position. However, these dynamics are changing as consolidation is expected to occur at Spirit's level and new players are entering at the OEM level.

Traditionally there have been two primary players in the LCA market, Airbus and Boeing. These players generate a significant portion of their revenue from their highest volume products, the single aisle jets, the 737 and A320 families. This space is changing rapidly though with the announcements of the Chinese C919 and Russian MS-21 single aisle jets both targeting market entry in 2016. In addition, there are competitors for the lower end of the single aisle space with the Bombardier C series and the Kawasaki YPX.

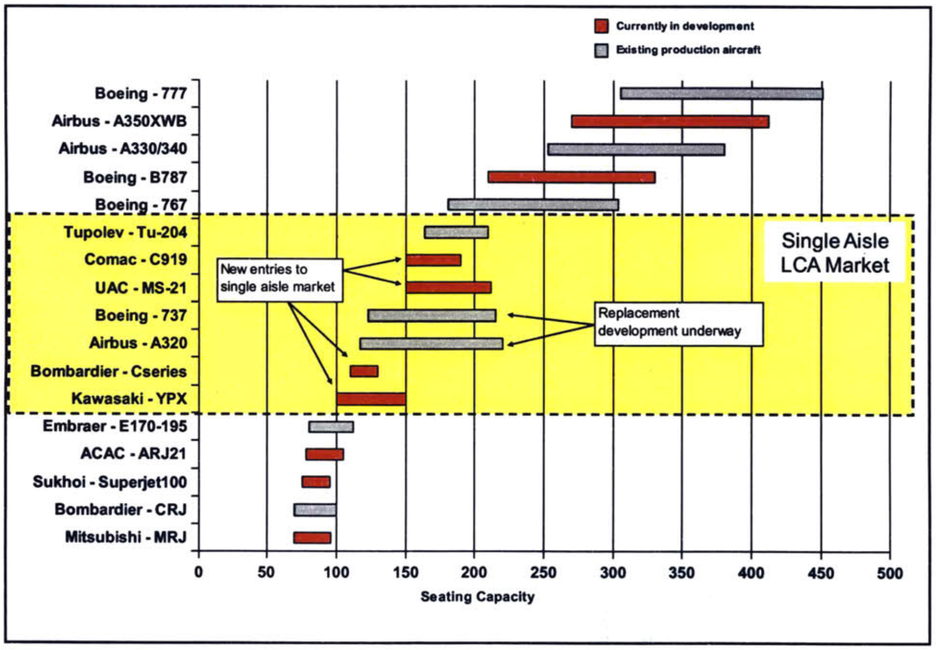


Figure 19 – New entries by seating capacity

This is particularly significant when we consider the forecasts by both Boeing and Airbus for future growth. Each company projects Asia as the primary driver for growth in the next 10 years. Neither forecast includes comments on the impact of these new nationally backed players developing competition in the very market they are targeting.

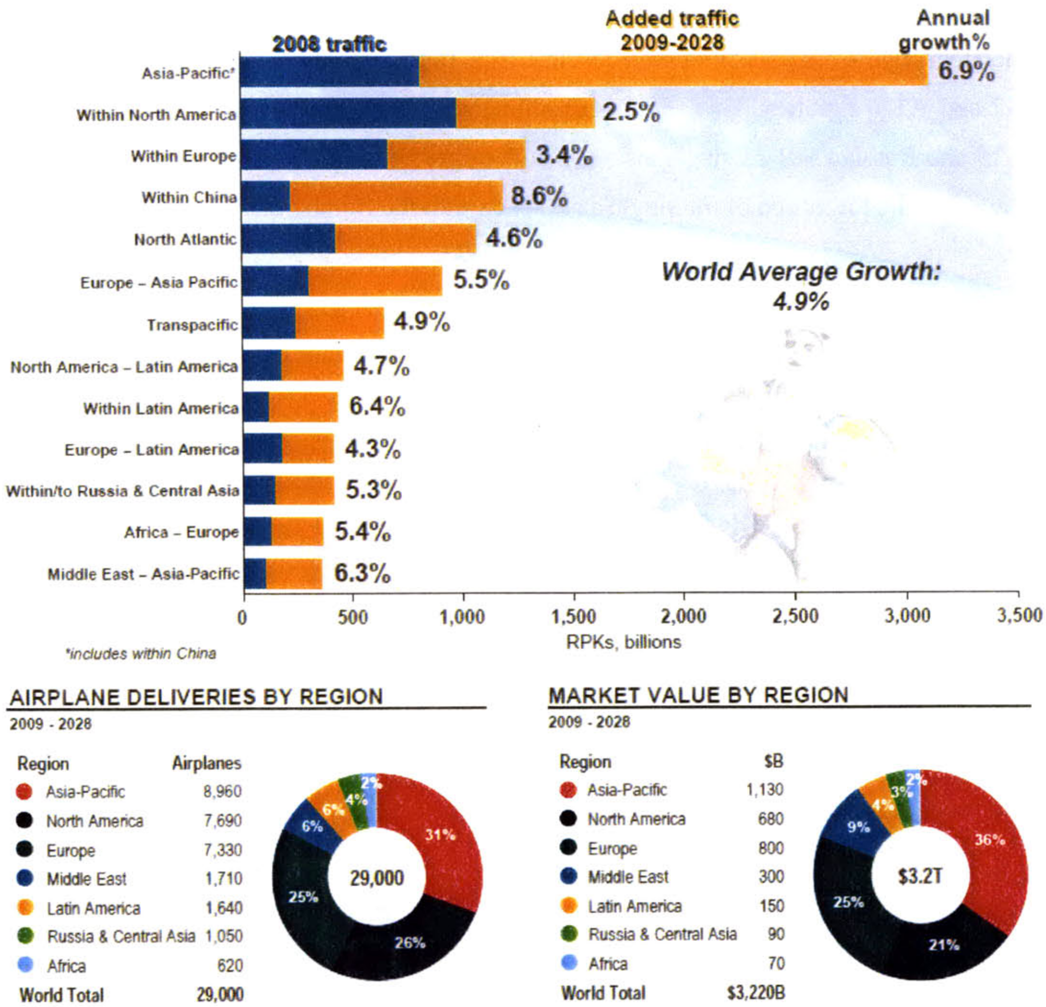


Figure 20 – Boeing projections for aircraft demand 2009 to 2028 (The Boeing Company 2009)

Top ten countries (2007-2026)

	Passenger aircraft demand		By US$ value (billions)	
1	United States	6,579	United States	547.4
2	People's Republic of China	3,238	People's Republic of China	391.2
3	United Kingdom	1,307	United Kingdom	159.7
4	Germany	1,069	Germany	118.9
5	India	986	India	118.7
6	Russia	921	Japan	111.6
7	Mexico	661	UAE	91.7
8	Japan	608	Russia	78.7
9	Ireland	538	Australia	62.5
10	Canada	528	France	59.2

New and recycled passenger aircraft ≥100 seats (excluding freighters)

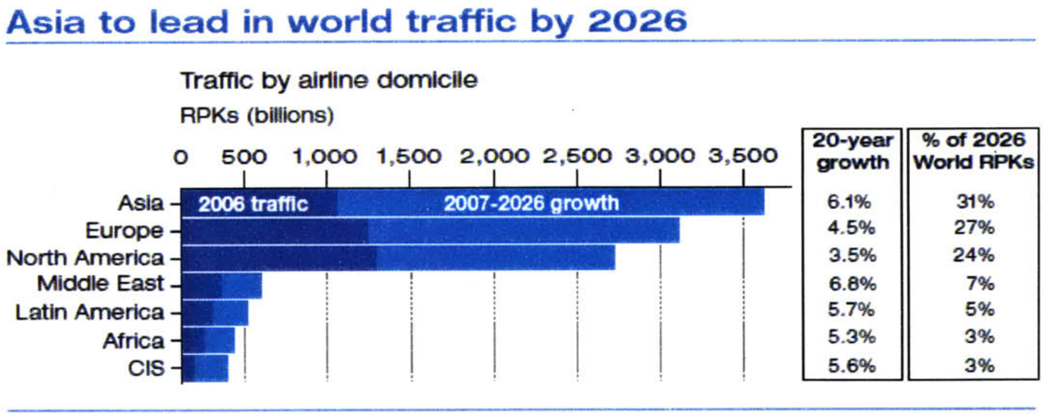


Figure 21 – Airbus projections for aircraft demand 2007-2026 (Airbus S.A.S. 2007)

3.3 Industrial dynamics

In addition to the changing horizontal competitive dynamics, the vertical supply chain dynamics are significantly reshaping the industry value capture proposition. The current status of the supply chain shows the very position that Spirit (Europe) has chosen as the lowest value-add point of the value chain. However, disintegration by the OEMs is pushing more value into the value chain and has already begun to change this landscape. Much of the initiative for this value shift is for the goal of cost reduction and managing the cyclical nature of the industry. The disintegration is occurring in two forms, the distribution of more design work and equipping work packages into the supply chain by the OEMs and the divestment of plants by the OEMs.

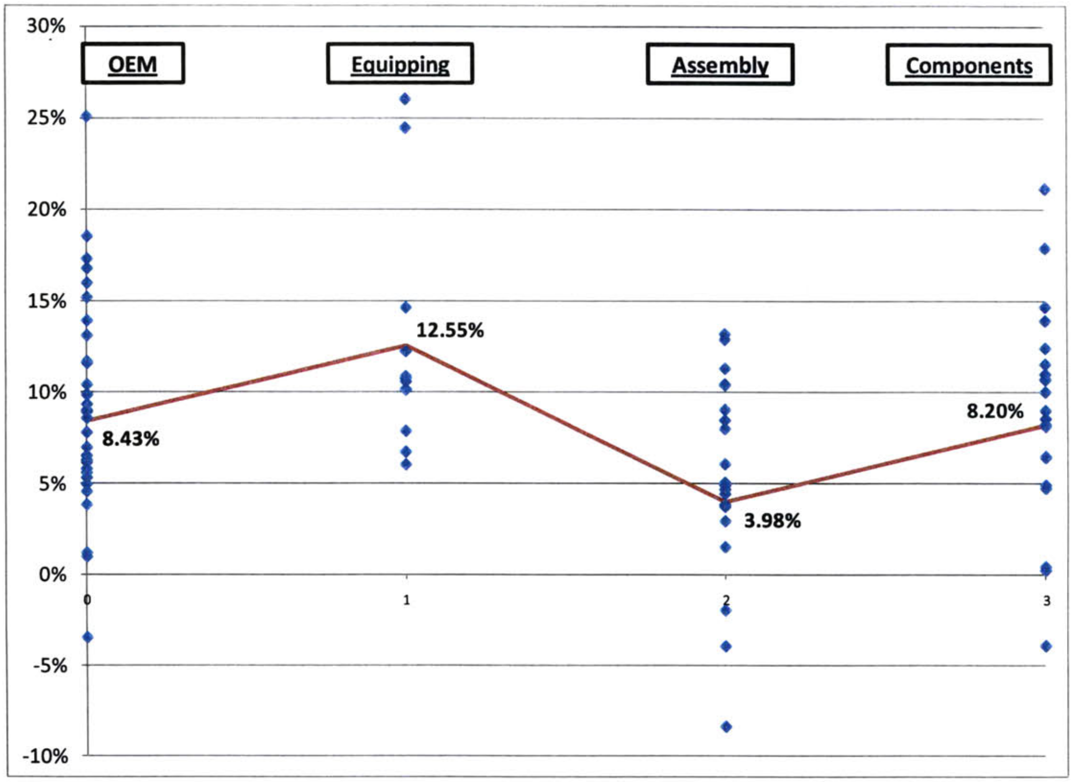


Figure 22 - Return on sales for the aerostructures supply chain

This figure depicts a sampling of return on sales numbers for companies at various points in the supply chain. Each blue diamond data point represents a single company's return for a single year. The companies were categorized by their highest level of integration work. For instance, a company that engaged in some amount of equipping, assembly and component manufacturing was categorized as an equipping company. The red line and percentage values are the average value of return for each tier in the supply chain. There are several caveats to this graph such as the sampling is only of those companies that provide financial data publicly and the financial measures are not perfectly equivalent. It is also important to note that this chart is incomplete. It would be best to include equipment, fasteners/stock parts, and materials suppliers. Unfortunately, these players have a big impact on the aerostructures industry, but the aerostructures industry is only a small portion of their business. Financial data from these companies would not be representative of this industry. A full table of every data point and caveats can be found in the appendix.

Despite the imprecise nature of the data, certain information can be drawn from this analysis.

- For instance, currently the assembly tier of the supply chain is the lowest value-add. This is the area of activity that Spirit (Europe) is primarily engaged in.

- The component suppliers unsurprisingly have the most significant spread. At this level, the manufacturing activities are fairly varied and while some may be much more commodity services, others are more specialized.
- The OEMs are quite spread, however they are not all comparable. These represent manufacturers of small trainer aircraft, business jet, regional jet, large commercial aircraft, military jets, and commercial and military rotorcraft. Airbus has an average 6.0% EBIT margin for the 10 year period from 1999 through 2008.
- Companies that engage in equipping, but are not OEMs are uncommon. They primarily are companies that produce nacelles or equip full wings for the business jet market. Note that two of the highest outliers are both in equipping and are the nacelles market leader Goodrich in 2007 and 2008.

The most critical point to note about this graph is that it represents the past, not the future. Each of the areas discussed in this chapter, competitive dynamics, industrial dynamics and technology dynamics can and will drastically change the distribution of this graph. The critical part of developing strategy in this industry will be to determine where the value will be for the next generation of aircraft. Mistakes in such a judgment can be catastrophic for a business. Consider the classic example of IBM and the disintegration of the personal computer value chain.

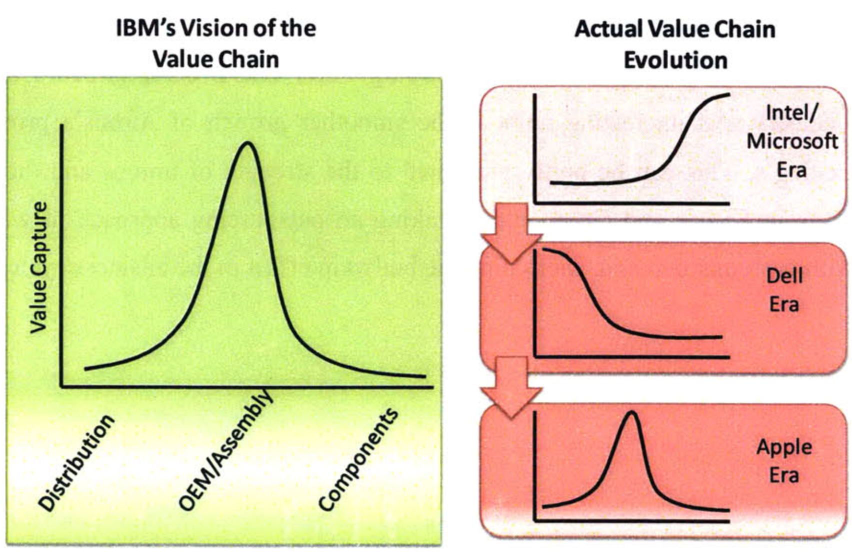


Figure 23 - Value chain disruption example

This figure is exaggerated for example purposes. However, it exemplifies the significant impact that disruptors can have on the value chain and the perils of misinterpreting where the future value will be captured. IBM controlled the entire PC supply chain at the beginnings of this industry in the 1980's. When the company disintegrated their vertical supply chain, they believed that the real value was in the system architecture and the components and distribution were commodities. In actuality, the software and hardware components became the most profitable and powerful tier in the supply chain. However, this power distribution was also transient and in the 1990's Dell became a major power by revolutionizing the distribution channels. In the 2000's the value chain was again disrupted as Apple emerged as the system architect player that IBM had intended to remain.

In this example, there is a theme of integration and disintegration of the vertical supply chain. Charles Fine of MIT presents a model describing this cycle of integration and disintegration. Currently, the aircraft industry is in a period of disintegration (Fine 1998). There are several key examples of this trend including the outsourcing and divestment activities of Airbus and Boeing. Each manufacturer has divested major operations, Boeing with Spirit and Airbus with Premium Aerotec and Aerolia.

In addition, on the 787, Boeing has outsourced unprecedented amounts of the design work to contractors. Airbus has made similar changes through its Power 8 and Power 8+ risk sharing programs. These decisions have been driven by a variety of factors. Nations seeking to develop industrial capability have created significant national grants to fund development for work packages. The offers from governments to pay for development and capital investment are a significant cost reducer for the OEMs. This type of subsidy can also take the form of offsets or trade agreements. The cyclical nature of the aircraft business is also a major driver for outsourcing work. The two charts below show the cyclical nature of the industry. An interesting point is the smoother growth of Airbus's production levels as compared to Boeing's. This can be partly attributed to the strength of unions and the difficulty of re-allocating workers in France and Germany. By taking an outsourcing approach, it would be easier to match output with customer demand, shortening the bullwhip effect in the business cycle.

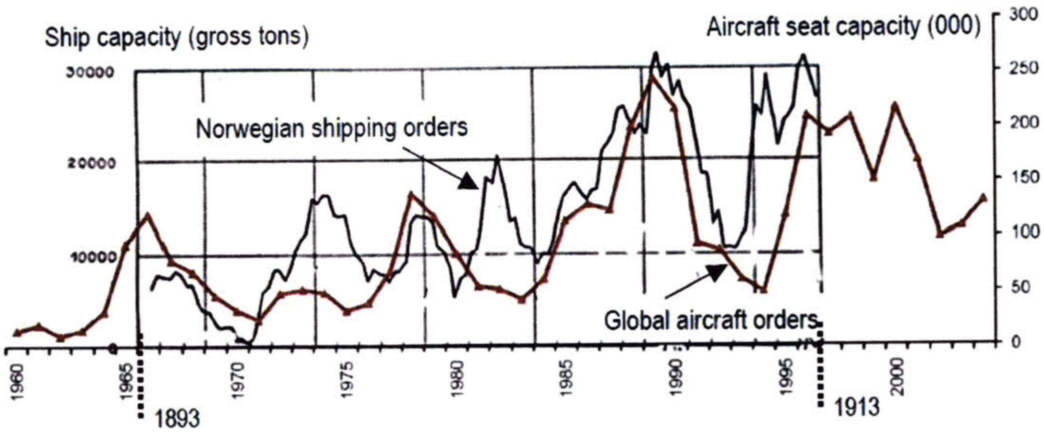


Figure 24 – "Illustration of similarities in the cyclical behavior of the shipping ordering cycle in Norway between the years 1893-1913 and the global aircraft ordering cycle" (Sgouridis, et al. 2008)

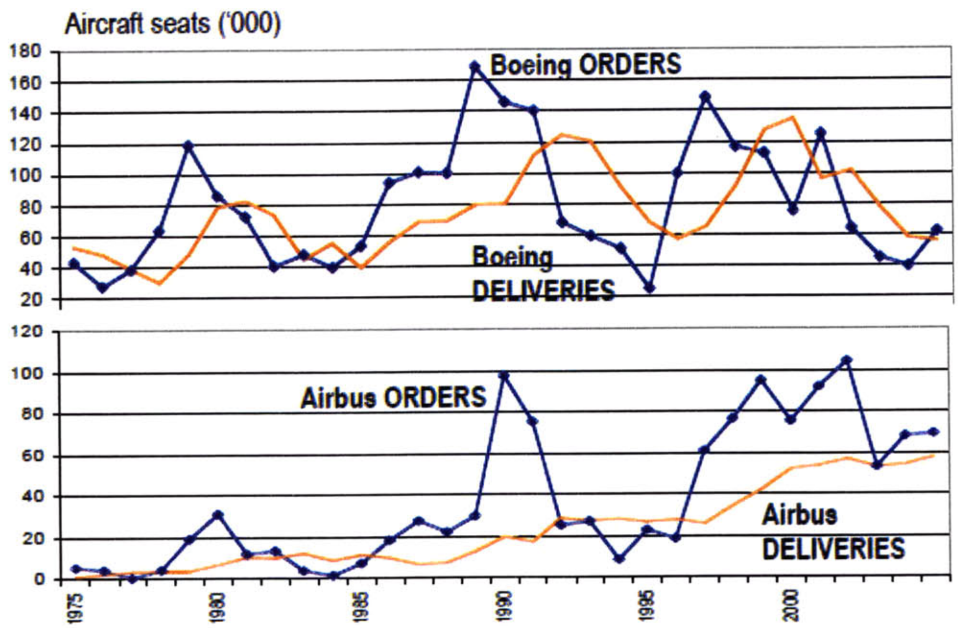


Figure 25 – "Juxtaposition of Boeing and Airbus order and delivery data in total number of seats" (Sgouridis, et al. 2008)

The shift to have complete sub-sections of the aircraft, such as wings, designed and built by the current suppliers could significantly shift where value is added in the supply chain. This could completely shift the current value capture chart depicted at the beginning of this section. The question is how will it shift, and how can a company best position itself for the next generation of the supply chain?

3.4 Technology dynamics

As we have shown in the previous two sections, the industry is in significant upheaval due to the introduction of new players and consolidation of old players as well as redistribution of design and manufacturing responsibilities. However, if the most significant impact on the value chain could be the technological dynamics that occur. There has been a demand for planes to be made of increasingly high percentages of carbon fiber reinforced polymers (CFRP). CFRP materials have a much higher modulus to density ratio than traditional metallic structures and so have the potential to create much lighter more efficient aircraft. The impacts of a shift to CFRP could have significant ripple effects by completely restructuring the value chain in this industry. However, the evidence is not entirely compelling that CFRP will be the definitive solution for the future generations of aircraft.

3.4.1 Technology demands

The trend towards higher percentage composite content of commercial aircraft is not new, however it has been rapidly accelerating in the past 15 years. In recent years, the percentage of an aircraft structure that is made from CFRP has drastically increased to over 50% by weight of the Boeing 787. The reason for this shift is to create lighter, more efficient aircraft. It is assumed that the next generation of plane will have even greater efficiency expectations by the market place and therefore even greater percentages of CFRP. These demands may be even further enhanced by the possibility of a new level of product differentiation in the aircraft industry that has not existed previously.

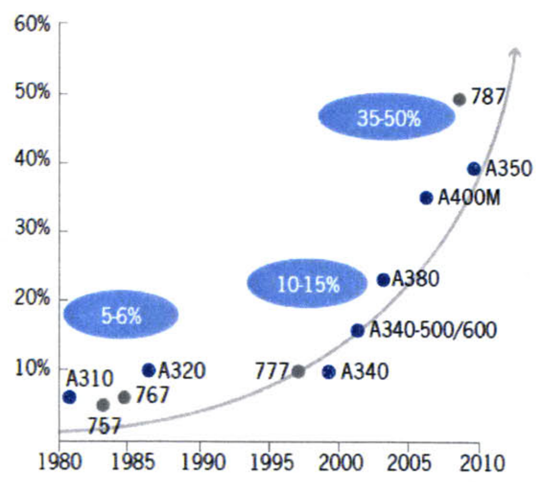


Figure 26 - Composite content in aircraft over time (Grant Thornton Corporate Finance, Mergers and Acquisitions 2009)

While the development of a CFRP aircraft is considerably more expensive and risky than a traditional metallic one, the potential benefit is significant weight reductions and therefore fuel efficiency. This creates a product that has a higher initial purchase price, but a lower overall cost of ownership due to gains in operating efficiency. This trade-off is due to the extremely high percentage of operating costs that are associated with fuel consumption as seen in the chart below. In addition, composite aircraft are also claimed to have lower maintenance costs, because CFRP structures do not corrode like their metallic counterparts.

Fill 'Er Up and Up

Fuel costs are eating up a huge portion of plane tickets. Here are estimates of current fares and fuel cost per passenger between New York and Los Angeles.

Airline	Route	Aircraft	Est. current average fare	Est. fuel cost per passenger	Share of ticket paying for fuel
American	JFK-LAX	767-200	$671	$488	72.7%
JetBlue	JFK-LGB	A320	$414	$292	70.5
Delta	JFK-LAX	737-800	$442	$299	67.6
United	EWR-LAX	757-200	$493	$314	63.7
Continental	EWR-LAX	737-800	$495	$293	59.2
United p.s.	JFK-LAX	757-200	$972	$520	53.5

Source: WSJ estimates based on airline filings of Form 41 data at U.S. Department of Transportation.

Fares are based on fourth quarter 2007 averages for those routes, raised 10%. Per-passenger rates are based on average domestic load factor for each airline.

Figure 27 - WSJ estimate of fuel costs for 2007

It is expected that the next aircraft to be produced by Boeing and Airbus are the replacement aircrafts for their legacy single-aisle aircrafts, the 787 and A320 respectively. These new aircrafts are commonly referred to as the next generation single-aisle aircraft (NGSA). Boeing and Airbus have been rumored to be referring to their projects as "Project Yellowstone" or "Y1" and "A30X" respectively. We will refer to them both as the NGSA aircraft. To overcome the significant price-tag associated with a new aircraft, the product analysts and aircraft operators expect that a 30% increase in fuel savings would be required (Walker 2009). To put this in comparison, the Next-Generation 737 was Boeing's update to the legacy 737 first flown in 1998 which achieved an 11% fuel reduction over its predecessor (Wilhelm 2008).

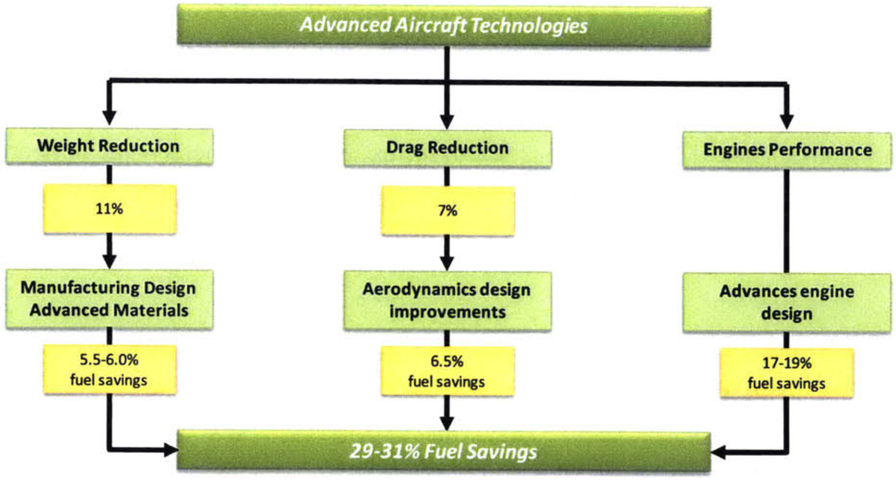


Figure 28 – Fuel saving expectations from analysts and aircraft operators (Walker 2009)

A significant amount of this is expected to come from improved aerodynamics and advanced engine designs, however 6% fuel efficiency is expected to come from weight reduction. In the analysis above it is important to note that weight reductions provide an approximately 2:1 reduction in fuel consumption. Using other estimates weight reduction based on the existing designs could provide a 1.4-1.75:1 reduction in fuel consumption. In any analysis, there is a significant multiple of weight reduction to get the necessary fuel savings. This results in a weight reduction requirement of over 10,000 lbs from the current single aisle aircraft.

These significant demands for fuel efficiency may be compounded by the emerging competitive dynamics. There is a possibility for a new dimension of product differentiation in the LCA space with this new plane. For the NGSA there may be a competitive landscape that would offer the choice of low purchase cost, but high operating cost legacy metallic aircraft or high purchase cost, but low operating cost advanced composite aircraft. In addition to the incumbent 737 and A320, the Chinese built COMAC C919 aircraft projected to fly in 2014 is a metallic structure single aisle competitor. All three of these aircraft use more traditional designs. Furthermore, the design costs for all these aircraft are either already paid off or been sponsored by national governments. Finally, the Boeing and Airbus aircraft have advantages of significant learning curve progress and the Chinese aircraft has the advantage of low cost manufacturing.

This market will be characterized by commodity and premium products. This puts additional pressure for the NGSA to have significant technological advantages to differentiate it as a premium product.

Therefore, there will be an increasing demand for advanced CFRP structures to minimize weight and fuel consumption.

3.4.2 Potential for CFRP aerostructures

Composite aerostructures have the potential to completely restructure the value chain. In this section we analyze the potential and impact of composites on the value-chain using a 3-D Concurrent Engineering model of the product, process and supply chain (Fine 1998). The material characteristics of composites could drive revolutionary rather than evolutionary change of aerostructures design. However, the volume of the single aisle aircraft business would demand significant developments in the manufacturing processes. There are many technologies being developed. However, the scale and performance requirements for aircraft present far more significant challenges than other industries. Finally, the supply chain impact would be most severe. Perhaps most significant, the traditional metallic capabilities of companies in this industry will be immediately made obsolete.

Composite materials are quite clearly an attractive alternative material for an advanced new product. They present a clear trade-off of cost for performance. The performance can easily be measured by traditional Ashby material selection charts. The density of CFRP is approximately 1/3 that of titanium and almost ½ that of aluminum, with similar Young's modulus. A purely performance based materials decision would indicate that CFRP is a significantly better alternative.

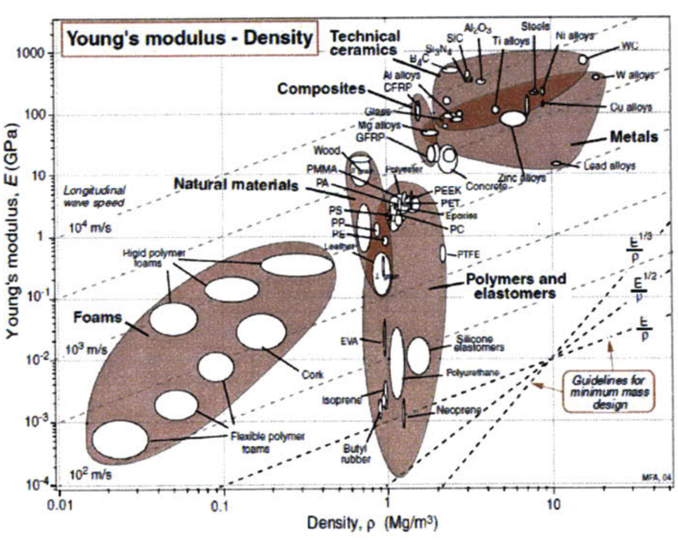


Figure 29 – Ashby chart for Young's modulus-density (Ashby 2005)

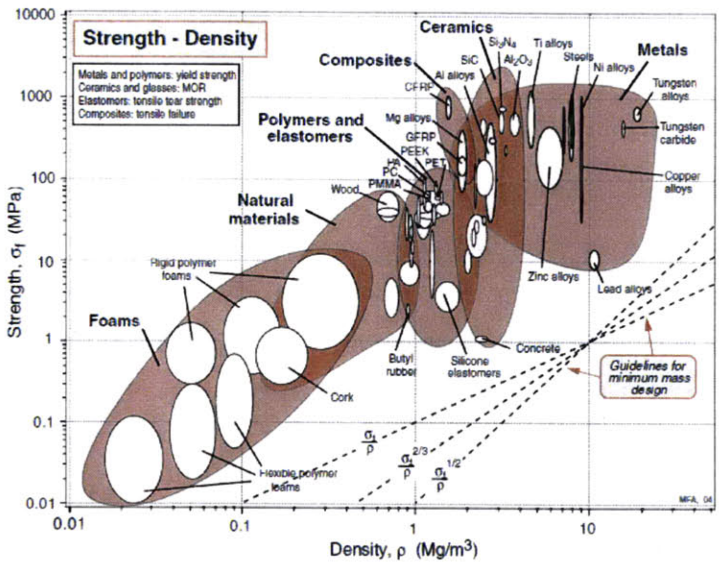


Figure 30 – Ashby chart for strength-density (Ashby 2005)

Fiber reinforced composite materials are composed of long continuous fibers bonded together into a matrix. The earliest composites included straw-mud mixtures used to make huts and dwellings. Modern composites generally refer to fiber glass or carbon fiber type materials. Carbon reinforced plastics are some of the highest stiffness and strength to weight materials available. The continuous carbon fibers have extremely high tensile strength, 4300-6200 MPa, and tensile modulus, 220-300 GPa. Aerospace aluminum alloys, in contrast, have tensile strengths of 250-570 MPa and stiffness of 72 GPa. The fibers are bonded together using an epoxy resin to create a single composite material. The stiffness of the composite material is generally much lower than the strength of an individual fiber, but still has better stiffness to weight ratios.

		UNITS	FIBRES: E-GLASS		ARAMID		HIGH STRENGTH CARBON		INTERMEDIATE MODULUS CARBON	
t 90°, ℓ 0°; Volume content of fibres : - 60 % (Carbon) - 50 % (E-glass - Aramid)			UD	Fabric	UD	Fabric	UD	Fabric	UD	Fabric
Tensile	$\sigma\ell$ ‖‖	MPa	1100	600	1100	500	2000	800	2400	900
	σt ≡	MPa	35	550	35	450	80	750	80	850
	$E\ell$ ‖‖	GPa	43	20	60	30	130	70	170	90
	Et ≡	GPa	8	19	8	30	9	65	9	90
	Poisson's ratio $\upsilon\ell t$		0.28	0.13	0.34	0.2	0.25	0.05	0.27	0.05

Figure 31 – "Typical mechanical values on epoxy prepreg laminates" (Hexcel Corporation 2005)

Another unique feature of composites is the proliferation of end materials. New materials are made with every combination of fibers, resins, and the ratio of fibers to resin, or fiber content. Each combination provides tradeoffs in terms of manufacturing, storage, strength, stiffness, peel strength, high temperature strength, cost, and other characteristics. Furthermore, a single fiber resin system can be assembled into a variety of materials based on the orientation of the fibers. Below is a depiction of two layups of carbon fiber sheets. The layup on the right is unidirectional (UD), where all the fibers are aligned in a single direction. This material would have extremely high strength and stiffness in one direction and not the other as seen in the chart above. The layup on the left varies the direction of the layup to create a "quasi-isotropic" material. These have more uniform longitudinal and transverse strength and stiffness. The design of the layups can be tailored to create a material for a specific design purpose that takes advantage of the non-isotropic capabilities of carbon fiber.

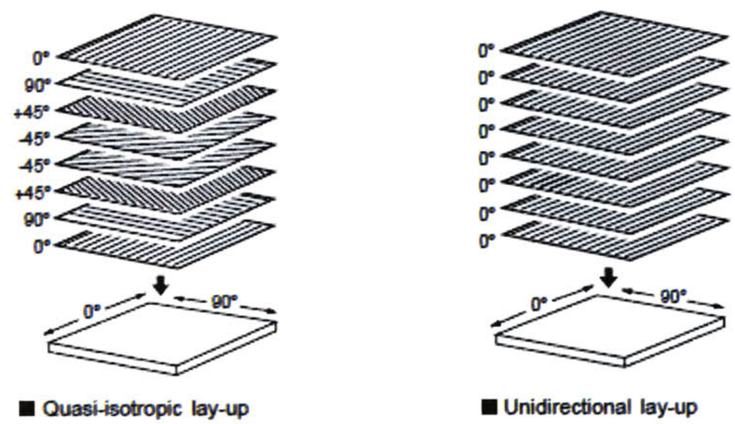


Figure 32 – Example of layup designs (Hexcel Corporation 2005)

Initially, LCA planes introduced composites to replace small surface panels and non-load bearing structures. In these structures, composites offer a clear advantage in performance and weight savings. With the more current aircraft designs, major load bearing structures and high wear components such as spars and fuselage components are being replaced with composite structures. These types of applications do not have as clear an advantage and this is leading to a phenomenon referred to as the "black-metal" problem.

The composites have been used in the structural load bearing components as a direct material replacement for their metallic predecessors. However, due to several characteristics of the material, the weight advantages are showing diminishing returns in this area. The venerability to fracture and de-lamination lead to the components being heavily over-designed and the need for increasing numbers of metal fasteners. In some of the modern planes it is questionable whether there has been a real net weight savings due to these factors. In the period from 1998-2010, the composite content of aircraft increase from 10% to 50%, the weight per passenger revenue mile hardly changed.

In the chart below, we compare composite content to weight per passenger revenue mile. This is a good metric, because it normalizes planes for the number of passengers and range. Clearly, a small plane would weigh less than a large plane. Similarly, a plane design to carry enough fuel for a long haul trans-continental flight would need to be heavier than a short haul aircraft. By normalizing for these factors we can look at trends in the efficiency of aircraft design. It is important to note, this metric will be affected by changes in aerodynamic and engine efficiency, since range is a function of these factors. Despite this it is clear that through the period of significant increases in composite content, there is minimal effect on the effective weight reduction of these aircraft.

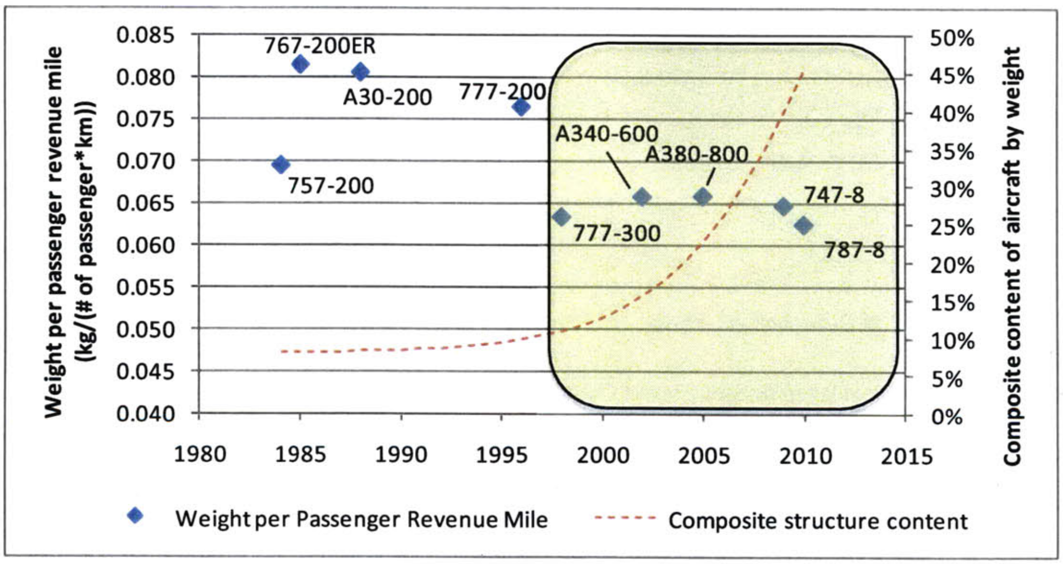


Figure 33 - Comparison of weight to passenger revenue mile

However, the true potential of CFRP has not been achieved. A completely revolutionary structural design needs to take advantage of the non-isotropic strength of the material rather than use it as a metal replacement. Composite assemblies lose their weight advantage with a proliferation of piece parts, because of the need for fasteners. To fully take advantage of CFRP, structures need to be designed completely differently. Design of the sub-assemblies would shift from assemblies with hundreds of small brackets, braces and structures to assemblies of just a few monolithic large structures. Good examples of this include the Airbus A400M cargo doors and the Bombardier C-series wing.

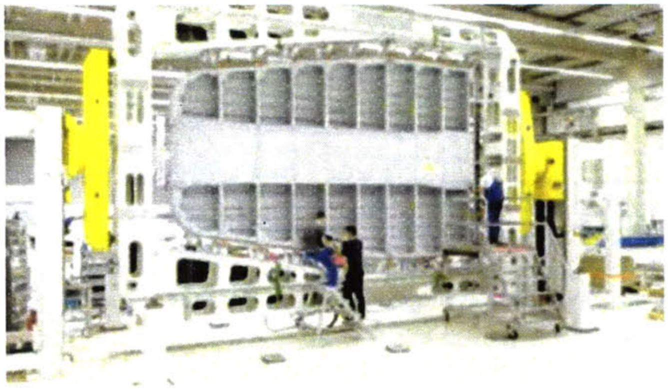


Figure 34 – A400M cargo door manufactured at Premium Aerotec (Plastics Technology 2009)

Figure 35 - Bombardier C-Series wing skin (Bombardier Aerospace, Belfast 2009)

Large monolithic structures in CFRP are significantly advantageous for two reasons. First, they lend themselves to the strength of composite fiber materials. CFRP's primary advantage is stiffness which is due to the continuous fibers that make up the material. If the assemblies are broken into substructures with metallic fasteners, the assembly will only be as stiff as the metallic joints. The C-Series wing takes advantage of these traits by designing with a U-box style structure rather than the traditional wing box design. Second, designs that incorporate unidirectional stringers as co-cured parts to a monolithic structure, such as the A400M cargo door, not only enhance the stiffness, but eliminate the need for rivets, fasteners, and brackets that all add weight. Future designs that start to take advantage of these features of CFRP will avoid the "black metal" problems.

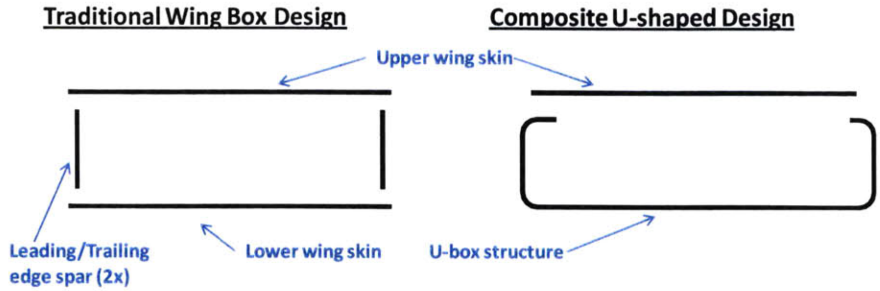


Figure 36 - Traditional and advanced wing box designs

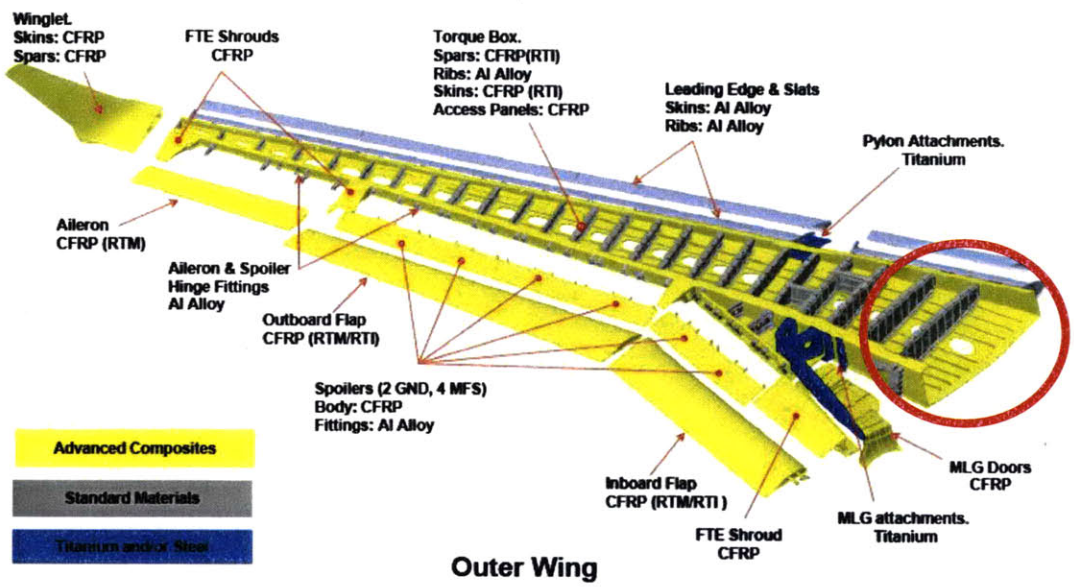


Figure 37 – C-Series U-shaped wing box design (Bombardier Aerospace, Belfast 2009)

The potential for these structures to revolutionize this industry's product is significant. However, there is a major bottleneck in process. The manufacturing technology is currently not sufficient to meet the demands of "high-volume" production of single aisle aircraft. The current leader in composite LCA is the 787, which is intended to be produced at a rate of 10 per month by 2013 (Thomas 2009). In contrast, Airbus was producing A320s at a rate of 36 per month in 2009 (Airbus S.A.S. 2009). By the time a NGSA aircraft was introduced, technology to produce greater than 40 per month would most likely be needed.

The process to manufacture traditional composite structures is limiting. However, new materials and processes are being developed. The traditional method for aircraft composites involves laying unidirectional, sheets of carbon fiber pre-impregnated with resin matrix (prepregs) on a mandrel, then curing the structures to harden the resin in an autoclave. Each layer has a specific orientation, which provides optimal strength to the material. However, each layer is also only 0.00025" to 0.0005". Clearly, to create structures that are several inches thick could take a significant amount of time. To overcome these limitations, expensive automation equipment has been employed for the layup processes. In addition, massive autoclaves have been produced to accommodate the large aircraft structures. One approach to meeting the high volume needs of a composite NGSA would be to invest in many sets of mandrels, automated ply laying machines, and autoclaves. This approach is massively capital intensive and considered to not be cost effective.

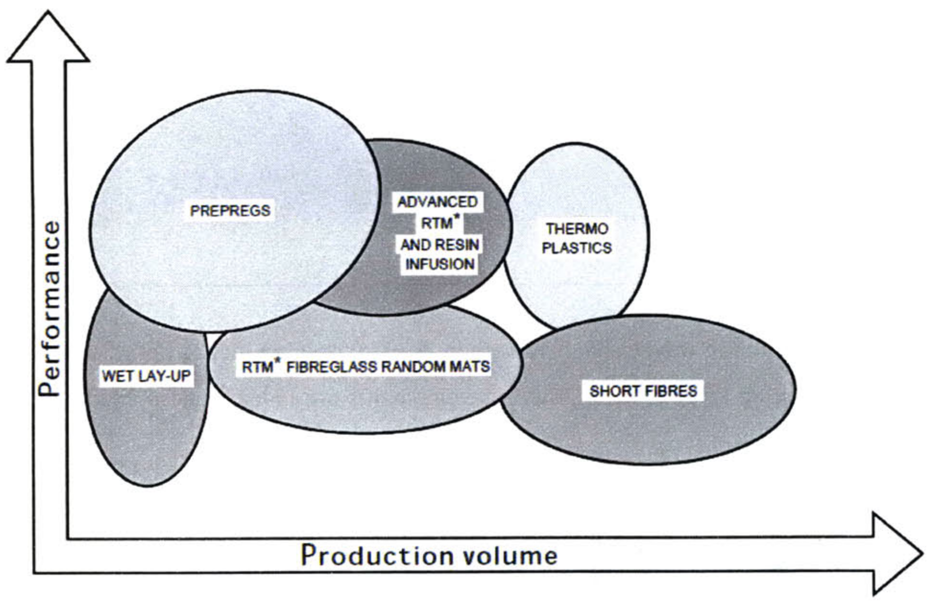


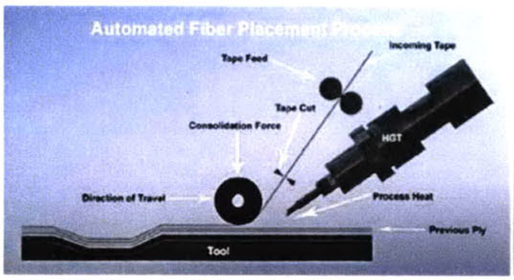
Figure 38 – Composite material processing techniques (Hexcel Corporation 2005)

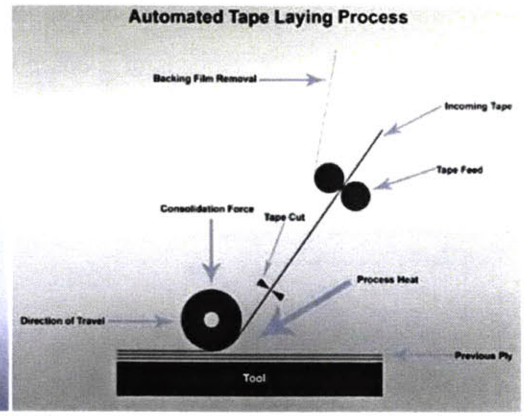
Autoclave cured prepregs have been the traditional choice for aircraft manufacturing because of their extremely high performance characteristics. However, significant investments are being made into exploring ways to produce high performance, high volume, low-cost structures. A key component of these process developments are advancements that reduce the need for high capital intensive equipment such as the aircraft sized mandrels, autoclaves and automated machinery. The goal of all these technological developments is to achieve "autoclave" performance materials, in ways that are either less expensive or higher volume. The table below provides an assessment of some of these emerging technologies.

Automated Tape Laying (ATL) and Automated Fiber Placement (AFP)
• The most conservative approach is to simply automate the autoclave composite process. • AUTOMATED TAPE LAYING is a mature process and is currently being used in both commercial and military aircraft applications. It uses robotic deployment of pre-impregnated

sheets of carbon fiber to create structures on a mandrel.

- AUTOMATE FIBER PLACEMENT is the same concept as ATL, but uses much narrower strips of composite fiber to accommodate complex geometries.

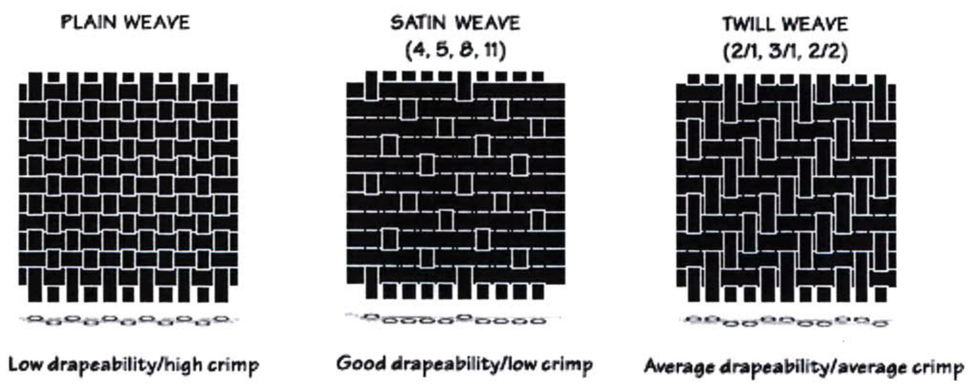




(Automated Dynamics 2010)

Textile Composites

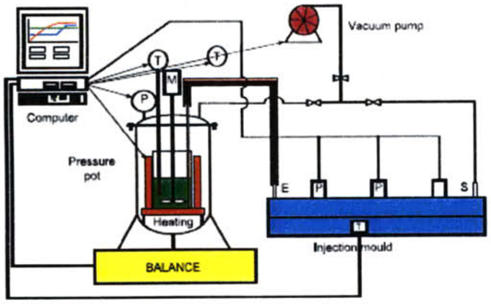
- These techniques utilize woven sheets of carbon fiber to allow the deposit of thicker layers thereby speeding up layup process. These developments are being made primarily by the material manufacturers.

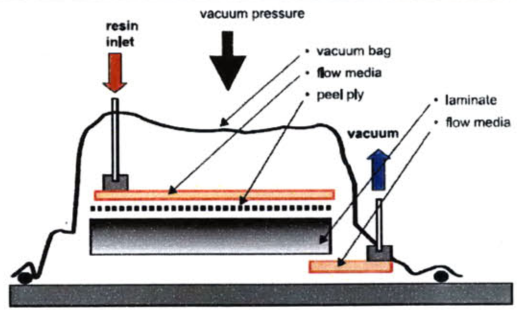


(Hexcel Corporation 2007)

Resin Transfer Molding (RTM) and Vacuum Assisted RTM (VaRTM)

- RTM is a process in which catalyzed resin is pumped into dry fiber structure called a preform that is compressed by a matched, positive and negative mold.
- VaRTM is a variant where there is only a positive mold and a vacuum bag is used to compress the resin into the preform. Its primary advantage over RTM is less expensive tooling because of the single sided mold.





(Hexcel Corporation 2007)

Resin Film Infusion (RFI)

- RFI is a process in which sheets of resin film are interleaved between the layers of the dry fiber preform. The advantage of RFI is the ability to achieve full infusion of resin on very thick composite structures. This is particularly critical in primary load bearing aircraft structures.

(Hexcel Corporation 2007)

Quickstep

- Quickstep is a proprietary technology that has not scaled to aircraft size parts, but is being used in several academic institutions. It uses liquid filled bags to transfer heat to the preform. This provides both faster and more accurate heat transfer and is used to maintain the resin in its most fluid state for the longest period possible. Primary advantages are speed and control of cure properties.

(Quickstep Technologies 2005)

Finally, the most significant impact of these new products and processes will be their ripple effects on the supply chain. There are two major effects of these changes, a vertical contraction of the supply chain and a horizontal shift of the supply chain.

The vertical contraction is due to the design changes to produce the large monolithic composite structures. These large CFRP structures are effectively the same level of integration as the "Assembly" tier of metallic structures. Essentially, the supply chain for a wing would be shortened to just component suppliers and equippers. There would be no intermediate step of integrating components into larger structural assemblies. Firms with activities in this area would need to develop capabilities upstream as the CFRP component suppliers or downstream as the system integrators.

The horizontal shift in supply chain is due to the new skill sets required for the production of these new aircraft. In the traditional LCA supply chain there was a proliferation of sub component suppliers that focused on a particular manufacturing capability. This could range from working with a type of material like titanium or aluminum, cheap commodity manufacturing of small brackets, high tolerance stretch forming of sheet metal, 5-axis machining of large structural beams, surface treatments, and more. In the new design far fewer parts will require any of these metal manufacturing capabilities. What firms will be best placed to move into the new large CFRP production space? Will it be the companies with significant composite expertise, but on a small scale such as automotive and space applications? Or will it simply be the firms with access to capital to invest in the massive equipment required for these projects? It is clear, however, that there will be a shift if CFRP designs move to this next level of integration.

3.4.3 Uncertainty about CFRP adoption

Clearly, there is great promise in the possibilities for CFRP if designs are fully optimized. However, this future is far from certain because of several key factors. First, there is a fundamental lack of understanding about composite failure modes. Second, there are significant alternatives that capture similar efficiencies at far less cost. Third, there has been a resurgence of metallic aircraft designs in a reverse trend against CFRP technology. Fourth, the aftermarket repair and manufacturing costs of damage and defects is significantly higher than metals.

In the previous section, we assert that part of the reason aircraft have not seen a significant weight reduction despite the use of composites is that they are used in sub-optimal designs as replacements for metal components rather than designs optimized for composite material. This is only part of the story. CFRP components are also often overdesigned and overweight because of a fundamental lack of understanding of the material. Hundreds of years of metallurgical science and nearly 100 years of the use of metals in aircraft design have led to a deep understanding of the materials. This allows an entire aircraft to be designed using analytical software and upon construction and test it will behave almost exactly as expected. The same is not true for composites. Not only are modern composites in general a much younger science, every new formulation, resin-fiber system design, and fiber lay-up design leads to a brand new material that needs to begin from scratch with brand new testing and analysis.

A series of international exercises known as the "World Wide Failure Exercise" that began in 1995 has been testing our understanding of composite failure mechanisms. Nearly every year a paper is published on the results. In the test, 14 to 15 of the world's leading theoreticians present their predictions for a series of tests of composites under various configurations and loading. The theories are ranked for the effectiveness at predicting the failure results of these conditions in comparison to the actual results. An assessment in 2003 noted that, "the predictions of the four most highly ranked theories, which included two of the new approaches were within ±50% (i.e. a factor of 2) of the experimental results in more than 75% of the test cases" (Hinton, Kaddour and Soden 2004). Due to this fundamental lack of understanding in composite failure mechanisms, designers cannot be as aggressive as possible in the design optimization. Large safety factors must be employed to protect against such failures.

A perfect example of this shortcoming was experienced by Boeing in 2009. At the very end of its development, after many test configurations, analysis, and design, the first plane failed its final loading test just before first flight. The failure was a major composite joint, the structural connection between the plane and the wing (Gates 2009).

In addition to the uncertainty around composite design capability, there are low cost and higher confidence alternatives that are being employed to increase the efficiency of legacy aircraft. The metals industry is developing new lightweight lithium-aluminum alloys to compete with the performance of composites. In addition, winglet designs are driving significant fuel savings without the cost of a redesign of an entire new aircraft. These devices minimize the wingtip vortices that create significant amounts of drag. Airbus announced in November of 2009 that it would launch new "sharklets" that could achieve 3.5% fuel savings over longer distances (Airbus S.A.S. 2009). One of the forerunners of winglets, Aviation Partners has claimed a possible 10% fuel efficiency gain from their new Spiroid winglets (Goold 2006). If these types of reductions are possible, they seem to dwarf the benefit/cost analysis of redesigning an entire aircraft for 6% fuel savings in weight reduction and 6% fuel savings in aerodynamics. To compound this issue, the fuel savings from improved engine performance could be fitted to almost any aircraft.

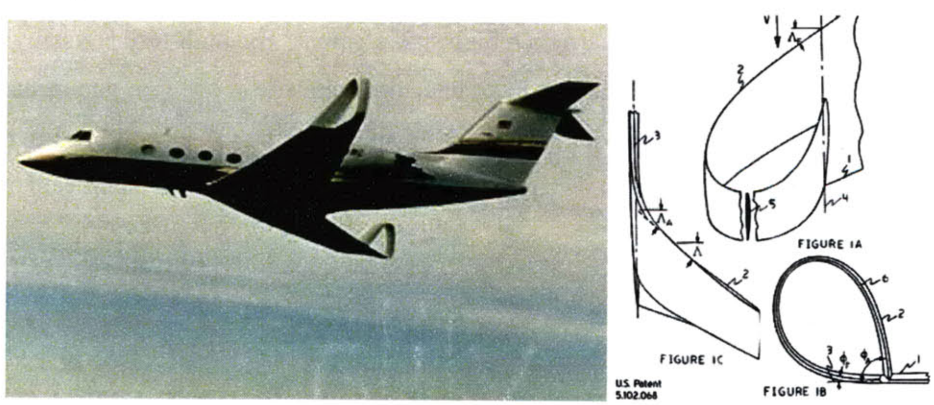


Figure 39 – Aviation Partner's spiroid winglet design

There is now even some degree of confirming evidence against CFRP designs in the investments of new aircraft. Mitsubishi Heavy Industries, supplier of significant CFRP components on the Boeing 787, initially announced their first independent jet, the Mitsubishi Regional Jet (MRJ) to be made of a majority of composite materials. However, in September 2009 they announced a decision to rely on aluminum for the majority of the airframe. China's COMAC C919 is intended to be all metallic. Even Airbus's new A350XWB has experienced this backward trend. Aerolia, the manufacturer of the nose fuselage, announced in June 2009 the construction of a €224 million, 18,000 m^2 Composites Unit in Méaulte (Aerolia 2009). This unit was specifically intended for the construction of the all composite nose fuselage. However, in September 2009, just three months later, the Aerolia company magazine announced the decision to make the nose fuselage entirely of metal, citing material strength against bird impacts, existing capabilities, and existing expertise. (Aerolia 2009)

Finally, there are significant tradeoffs in considerations of damaged parts due to the expense of composite parts. Composite parts can be as much as an order of magnitude more expensive than their aluminum counterparts. When one of these parts is damaged, either during the manufacturing process or in operational use, there is a significant desire to repair the parts rather than replace them. However, repair of composite parts is a highly complex and expensive process that has given significant rise to the maintenance, repair and overhaul (MRO) business. In addition, OEMs need to have the same MRO capabilities on site to actively repair parts damaged in production.

All of these uncertainties about the adoption of a new level CFRP aircraft design complicate the task of creating a focused strategy for acquisitions. At one end of the spectrum, CFRP technology has the potential to completely restructure the value chain and where value is captured. At the other, if traditional techniques prove dominant, the firms that invested in alternate technologies could be at a disadvantage. This is why slow clock speed industries are such high stakes games. The high-tech company Intel can pursue a "tick-tock" approach, where changes in architecture are made in one year and manufacturing technology the next. In the aerostructures industry it is an all or nothing game, where a firm must be perfectly positioned for the next product, because there will not be another for a significant amount of time.

4 Application of the ASF on the Spirit (Europe) Case Study

In the previous chapter, we discussed the industry analysis and case background for the application of the framework. In this chapter, we will present how the ASF was applied and the structure of the databases utilized for this purpose.

4.1 Implementation approach and results

The development of this approach followed three stages. The first was theory development and engagement. As with any model, engagement of your customer in the model development process is critical. We worked with the management and employees throughout the process to develop an accurate model. The second stage was target research. Once the model was developed we had to identify and research every target. This further fed back into the model because there were desirable metrics, but no access to realistic data. This lack of data, fed back into the model to re-design it for more concrete data. Finally, we developed a set of results with a full spectrum of target companies. This is where the effectiveness of the model came through. At this point we were able to have productive discussions about the traits that made particular targets more attractive than others and the traits that were barriers to desirability of marginal candidates.

4.1.1 Methodology

Engagement was the critical aspect of model development. Since an acquisition target could be measured by many functional areas, there are many stakeholders all with valuable input. We followed the "top-down / bottom-up" customization approach described in Section 2.2.2. We began with site leadership engagement through a number of sessions to define the strategic goals of the acquisition. We drew the acquisition goals from a variety of sources including the CEO brief to Morgan Stanley, executive committee mission statements, CTO mission statements, direct management interviews, and group working sessions. These goals were a subset of the overall company goals that were both specific to this site and fitting with internal investment strategies.

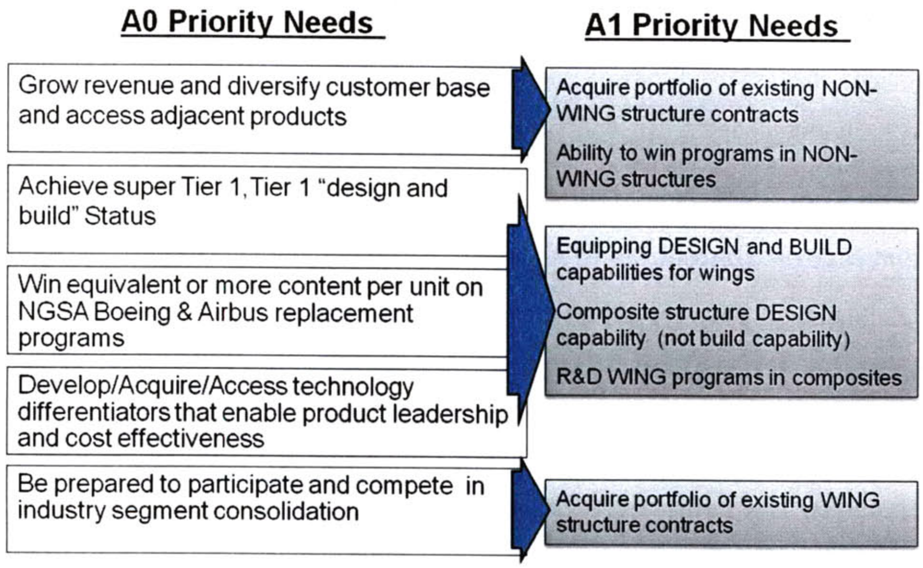


Figure 40 – Acquisition project strategic goals of the Spirit (Europe) business unit

A colleague, Jeremy Pitts, LGO Class of 2010, was involved in the development of R&D capital investment project selection at Spirit AeroSystems in Wichita, KN. Working collaboratively with the US site, we developed a model for acquisitions specific to R&D. Though this specific acquisition project did not focus on R&D, this a framework by which suitable acquisition targets can be selected.

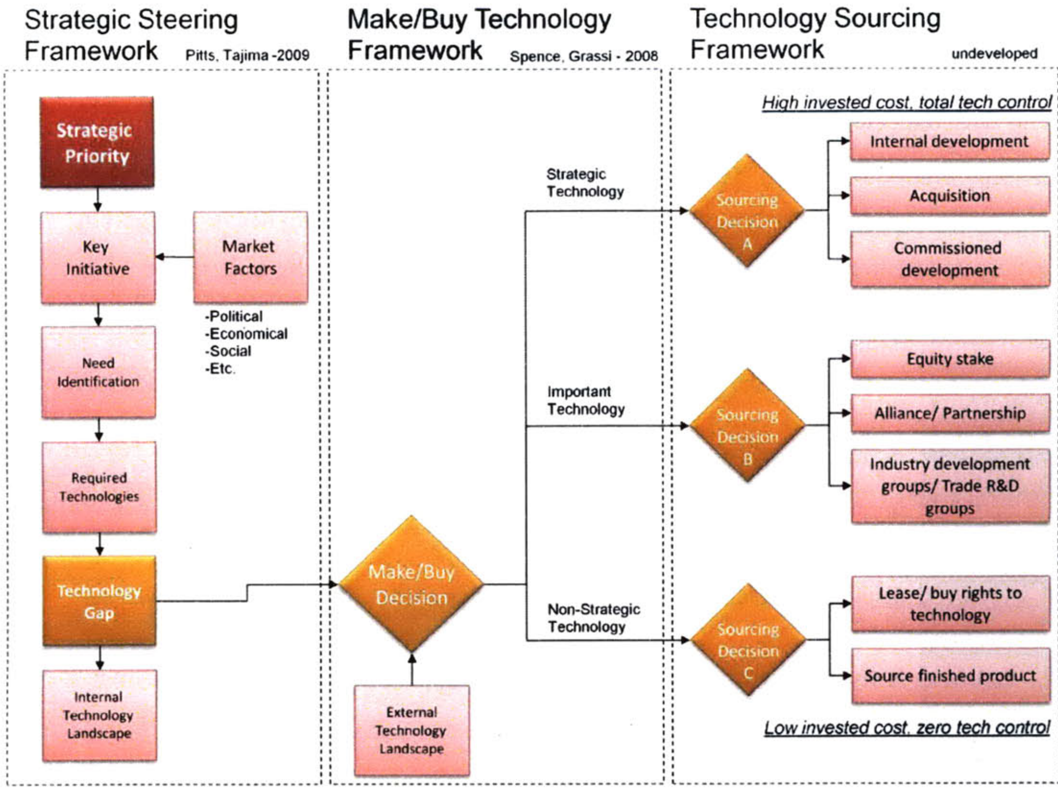


Figure 41 – R&D technology acquisition framework

In this framework, the first step is to identify your "technology gap" that is driven by your strategic goals and current capabilities. These needed technologies are then assessed through a "Make/Buy" decision framework that had previously been established at Spirit. This framework is used to determine which products, capabilities, and technologies are core and critical to the strategic advantage of the firm. The final section of the framework is used to determine the best strategy to acquire the necessary technology. There are a number of options that represent a spectrum from high invested cost with high control over the technology to low invested cost with limited technology control. Acquisition would clearly be found towards the top of this spectrum.

Another tool used to help define the strategic goals was a "why" framework. A strategy involves much more than a one line title. There are inherent assumptions, reasoning and drivers that lie behind the goal. To effectively clarify the purpose of the acquisition we used this framework. It is a simple worksheet to be filled for each top level goal. The first critical area that needs to be defined is the purpose of the acquisition strategy, why this capability or capacity will drive to the company's strategic goals and ultimately shareholder wealth. The second definition is the need assumption. This clarifies what the leadership is assuming about the changes in the market. This is critical especially in the current aerospace industry, because there are many viewpoints of where the value will be in the next generation of aircraft structure production. Finally, there may be assumptions specific to this acquisition rather than the general goals. This may indicate the importance of certain traits of the target or how the acquisition would need to be executed to benefit the company. For instance it is important for everyone involved to know if the assumption is to capture value through economies of scale and, therefore, heavy integration. This would lead to a very different evaluation and integration execution than a differing assumption.

Strategic Goal	**Equipping DESIGN and BUILD capabilities for WINGS**
WHY?	To win full-wing, equipped, design and build packages for LCA -(Boeing and Airbus NGSA) To win equipped decomposed sub-sections of the wing NOT for business jet or military
Need Assumptions	Boeing and Airbus will want full wing packages. Spirit currently lacks reputation in equipping systems. This hurts ability to win full wing. There will be equipped sub-assembly packages that can be decomposed from a full wing.
Acquisition Assumptions	Does not need to be Broughton. Airbus will deal with the overcapacity at Broughton if they gave equipping to Spirit. Will increase profits beyond those from equipping and structures independently to justify acquisition premium. Wing history not required. Knowledge gain from target equipping skill is primary goal. (can be other structures)

Figure 42 - "Why" framework

The real value of this upfront definition of goals is to create alignment of the leadership. Acquisitions can be executed for many different reasons and the various stakeholders in the company may have very different goals for an acquisition. Getting all members aligned for a given acquisition project is critical for success in this process. One method to get better focused alignment is to lay out several independent acquisition projects with separate goals that address the different stakeholders. Concurrently addressing separate acquisition projects that address market expansion, product differentiating technology, consolidation for economies of scale, and access to national funding may be much more successful than seeking out a single target that meets all of these needs.

Once the "top-down" portion is fully developed, entering into the "bottom-up" development requires engagement of functional experts. We approached this by presenting the functional groups most appropriate for a given goal with a scorecard to create. It is built on specific metrics developed by this group. It is important to keep the feedback channels open at this portion of the project. The "why" framework may be helpful in communicating the leadership's thought process in the directive. However, the functional experts will likely have valuable feedback about some of the feasibility of some of these goals. It is crucial to keep an open mind and open lines of communication through this process.

4.1.2 Target and Competitor research

The data collection and scoring phase of this project exposed some of the peculiarities of the aerostructures industry that made it challenging to gather data in a traditional methodology. This industry is made up of very large public companies and smaller private companies. The large public companies generally have a portion, or even a small division of their company associated with the aerostructures industry. These companies are only required to provide significant data about their top level business and so there may be very little financial and public data about their aerostructures specific activities. The small private companies similarly have very little public data about their activities.

However, informal sources of data are much stronger. Since these businesses are all a combination of suppliers and customers to each other, they have many points of contact at all levels throughout the companies. Examples of these informal sources include, business, commercial, and engineering meetings as well as conventions and personal networks. It was our experience that these informal knowledge sources preceded formal press releases by as much as a year and were more accurate and detailed.

These sources of knowledge are a strategic company resource that should be pooled to a company's advantage in developing policy. To aid in this and create a more accurate analysis, we created a market research database to specifically be a repository for both formal and informal knowledge about target companies and competitors.

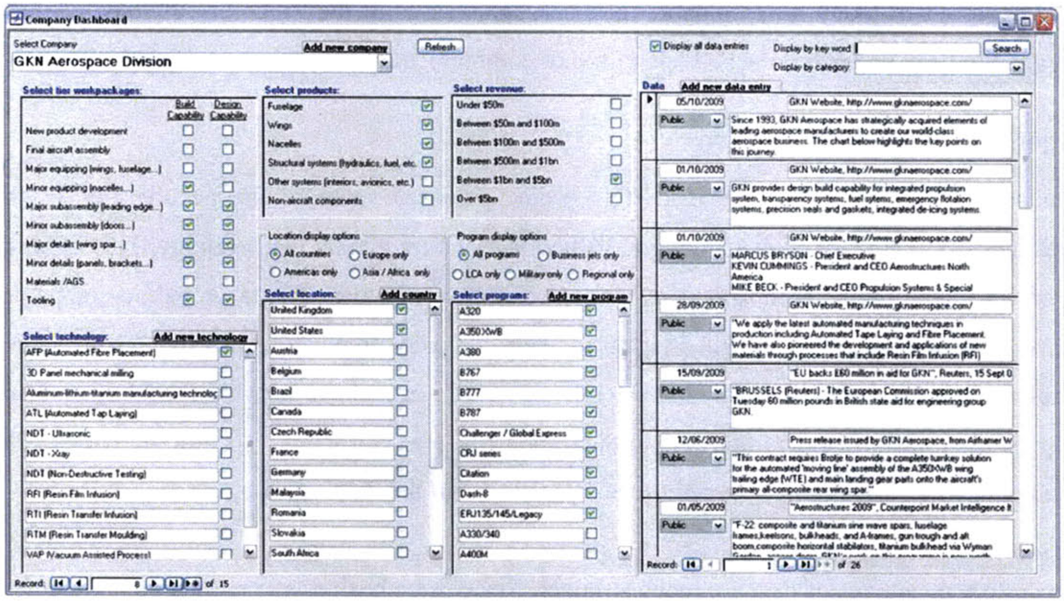


Figure 43 – Market Intelligence database

4.1.3 Results

Our research grouped targets in two key areas, the big ticket items and the integration challenges. Based on the goals of this particular strategy there was a significant overlap of top competitors and top targets. Since design and build capability associated with integration and equipping was the most significantly weighted goal of the strategy, companies with any amount of experience in this area were very strongly weighted. However, at this point there are no companies with experience in equipping of LCA structures other than nacelles and only a few with primary composite fabrication experience.

In the following two charts we depict the results of the ASF. In the first chart, the size of the bubbles associated with each company is based on absolute current profitability (not a ratio of profitability) of that target. In the second chart, the size of the bubbles is based on a scale of expected affordability. Both of these factors are not exact, however, they depict an order of magnitude difference between possible investments.

In the top right quadrant we can see the top prospects for acquisition. These targets have all of the capabilities and qualities that Spirit is seeking in this strategic acquisition. They also have the highest current profitability and not surprisingly are some of the least affordable targets. Very close to these targets are the targets in the lower right quadrant. These targets are not expected to be quite as expensive, but have significant barriers to integration. However, if these companies can be approached and these barriers addressed, there may be the potential to be a top tier acquisition target.

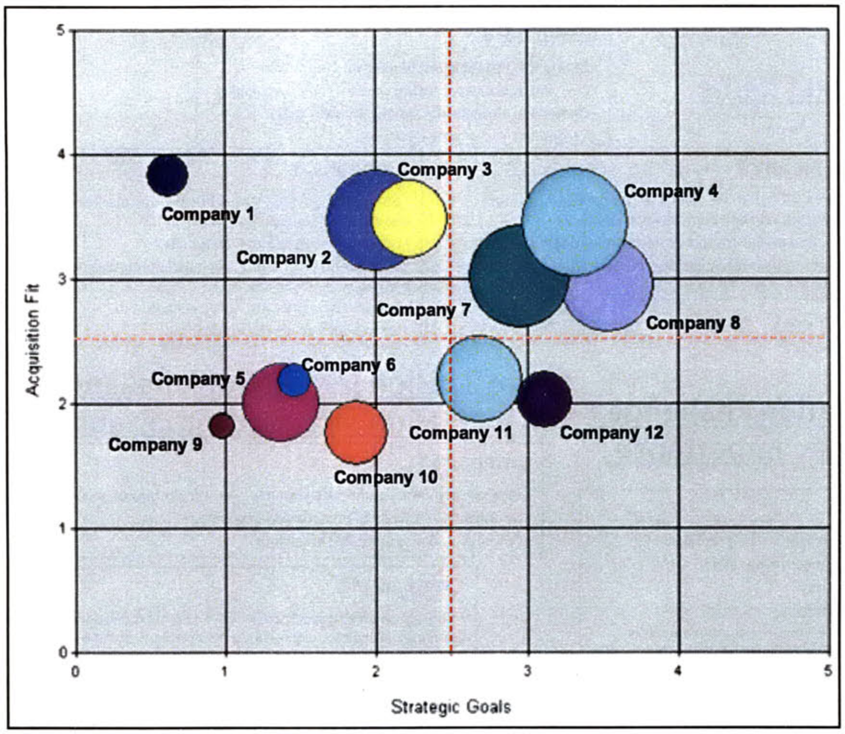


Figure 44 – Acquisition results, size based on current profitability of target

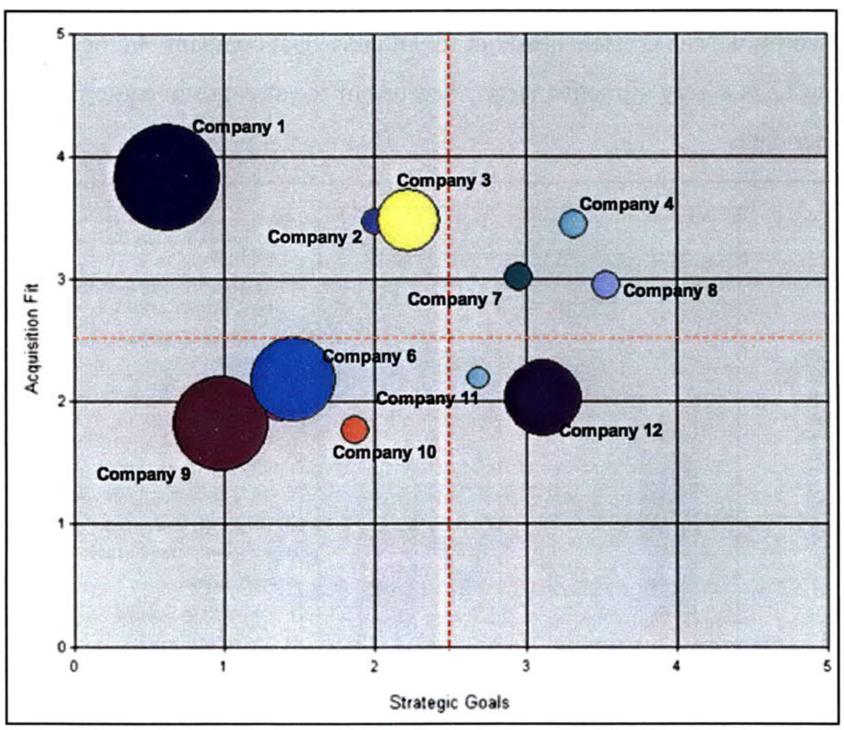


Figure 45 – Acquisition results, size based on affordability of targets

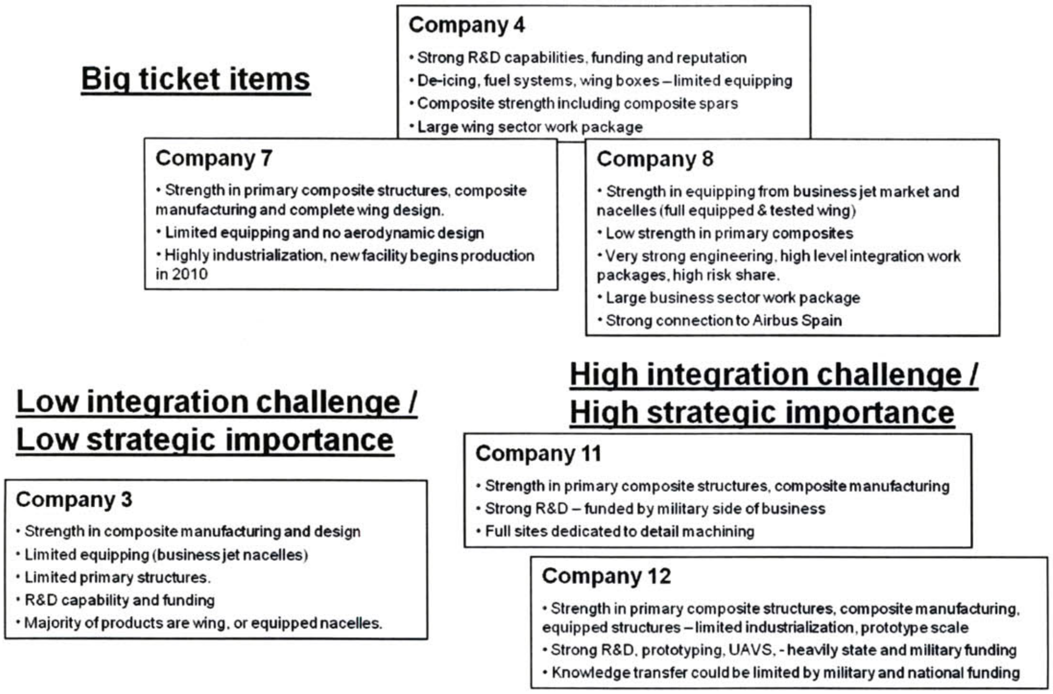


Figure 46 – Breakdown of top acquisition targets

To look into exactly what areas are causing the low score on Acquisition Fit, or the drivers for strong Strategic Goals scores, we can create a breakout for an individual company. In the breakout below we can see that Company 12 is a very attractive target, because of the strength in equipping design and build as well as R&D experience.

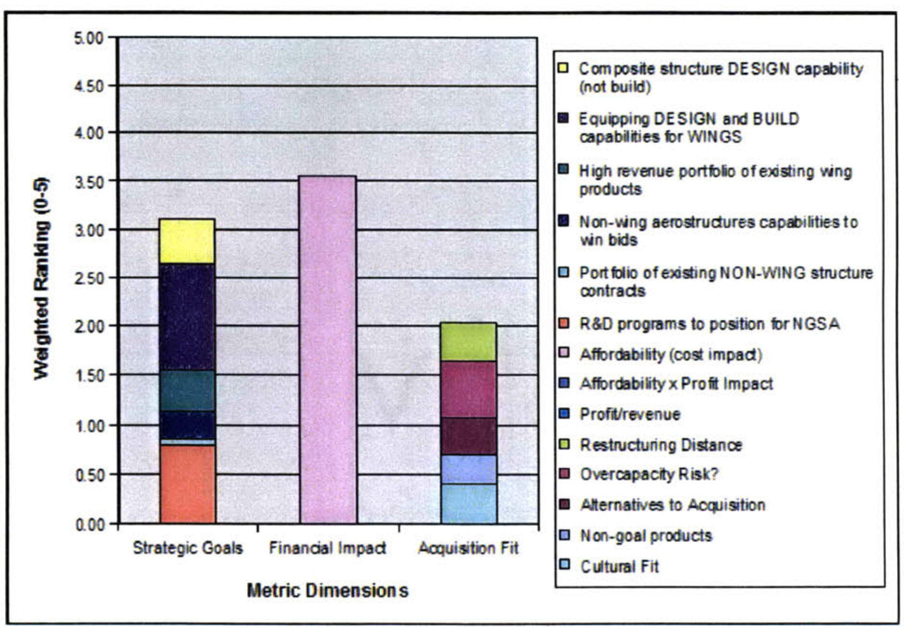


Figure 47 – Company 12 individual company results breakout

4.2 Database design

To implement this procedure at Spirit we created a database to facilitate the process and manage and record the data. The structure was built off a MS Access platform and utilized the programs graphic interfaces to create user forms and reports. The database was a key part of this project. However, there is certainly room for improvement and further work on this database.

4.2.1 Database description

The database is structured in the same methodology as the development process. First, the framework is customized by entering companies, strategic goals, and developing scorecards. Second, the database has and execution phase, where weightings and scorings are added. Finally, the user can look into results and create reports for each company.

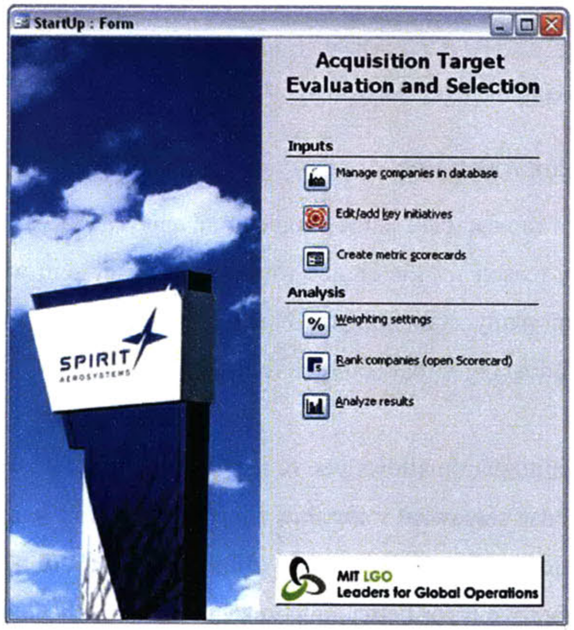


Figure 48 - Acquisition database main menu

A key aspect that the database introduces that has not been thoroughly introduced is the concept of scorecards. These were employed to give a universal format to the Tier 2 metrics that are developed by functional experts. Shown below is an example of the scorecard. In the scorecard customization the functional experts can define both the metric, the definitions by which to score each level and the weightings to define importance of each metric.

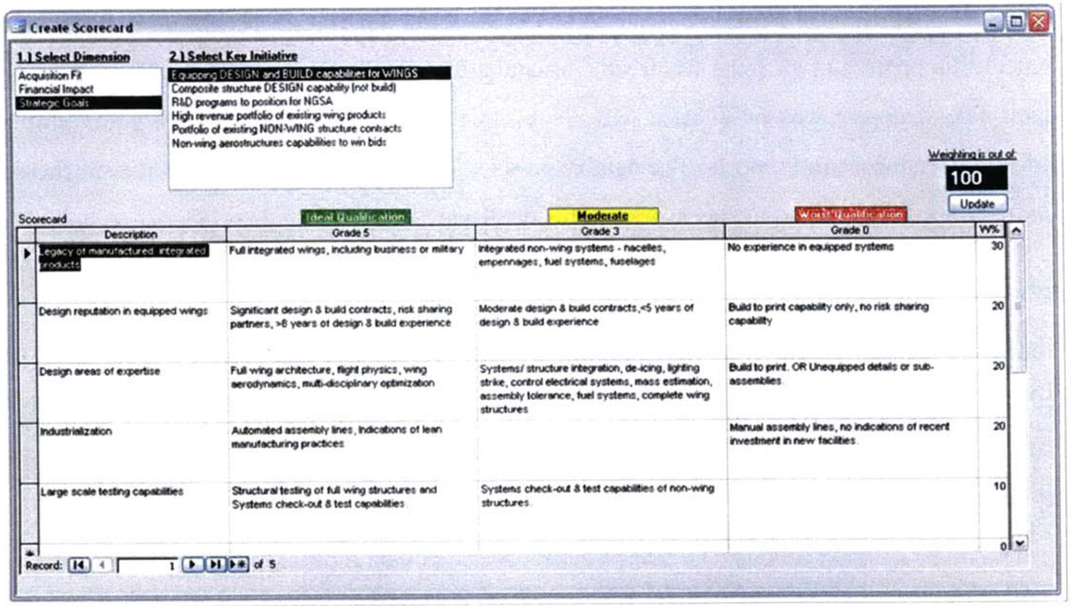


Figure 49 - Acquisition selection database scorecard

4.2.2 Opportunities for improvement

One of the drawbacks of the database is the choice to develop in Access rather than a spreadsheet tool such as Excel. The primary reason for the choice was to create a system with a "program" like feel and database style access from many stakeholders. For these reasons the choice of platform is sound. However, there are certain advantages that could be found in Excel.

There is a saying that "automation allows you to make your mistakes more efficiently." The choice to use Access makes the database somewhat inflexible. Since this process is newly developed it would have been advantageous to develop in Excel. This would allow more users to be able to modify and alter the program to continuously improve it for better function. For instance the addition of new features such as head to head comparison of two companies in detail would be helpful. The creation of charts and graphs for presentations is slower and less adaptable in Access.

The choice of platform is debatable and the product produced has been used and is effective,; however, new features and analysis options should be considered. We will look into this area more in Chapter 5.

5 Conclusions

The Acquisition Selection Framework is a way to provide increased structure to the task of early stage acquisition down selection. In particular, in the aerostructures industry there is a significant need for rigorous evaluation of strategy in these significant investments. There is both opportunity and peril in the next generation of aircraft production that could shift where value is captured and who is capturing it. This could have huge ramifications on the firms, nations and thousands of employees involved in this industry. That makes accurate analysis and assessment of these strategic decisions all the more critical.

5.1 Future work on Acquisition Selection Framework

There are major shortcomings in this framework. We strove to capture as much as possible into this framework, but M&A is simply a massive undertaking. For instance this framework does not indicate anything about the timing of the acquisition being optimal (i.e. buy low and sell high) or how it fits in with alternatives such as greenfields and strategic alliances. Future work could address any of following shortcomings.

Expansion of scope

- Incorporate the importance of timing of the acquisition based on optimality in market prices of acquisitions, company capacity requirements, or technology development.
- Incorporate the possibilities of strategic alternatives. Mergers and acquisitions are only two tools in a range of options of alliances, contracts and joint ventures that can be creatively and profitably designed.
- Expand the focus beyond the single investment strategy to be more appropriate in other industries. If considered as part of a portfolio of investments internally and externally, the metrics and criteria may change to create an optimal portfolio over an optimal single choice.
- Consider the impacts of the choice to be internal strategy driven rather than market opportunity driven. This process is based on developing strategy internally and applying to possible targets. An alternative of surveying targets to identify opportunity and potential may yield different results.

Improve robustness of framework

- Improve the structure to avoid double counting of a single trait. A single trait, such as size of the organization, could be used in evaluating several metrics. There is the possibility that this biases the evaluation in undesirable ways.

- Build in objective data to minimize confirmation bias. A primary purpose of this framework is to force clarification of the drivers of the acquisition to avoid emotional or subjective decisions. However, the flexibility in rankings and weightings can create the ability to shift the results by those seeking confirming evidence of a preconceived decision.
- Develop sensitivity and uncertainty analysis into the database. Many of the rankings in the metrics must be made on imperfect information. Methods to capture this uncertainty and determine if the most uncertain factors are a significant contributor to the overall score would improve the robustness. In addition, running sensitivity analysis to see the leverage of various aspects of the rankings would provide valuable data to the acquisition team.

Finally, further work could be done on assessing the efficacy of this process. This would require many acquisitions using this framework and determining the correlation between its use and successful outcomes or at least successful deals. This sort of analysis would require a long term analysis especially if only used in slow clock speed industries.

5.2 Business strategy implications

"This is not a tool to replace thinking, but a tool to enhance it"

The primary potential for the Acquisition Selection Framework is a methodology for incorporating the many aspects of a decision into a single framework. We experienced the power of this framework specifically when communicating the final results. The ASF was easy enough to communicate to top-executives who had never seen it in a few minute pitch, yet could stand up to rigorous questioning, because of the layers of analysis below the surface.

The power of this tool is a methodology to force the designers of an acquisition to explicitly state their goals on paper and face the scrutiny and "devil's advocate" analysis. This explicit communication of purpose, assumptions and reasoning should improve the understanding of the acquisition for all parties involved, both at this early stage and downstream as the acquisition progresses.

6 Appendix

Example of effects of quantifying the qualitative

There are a number of issues that can arise in the process of quantifying the qualitative attributes of target companies. This example uses a simplified version of an ASF with a single tier of metrics. We demonstrate the issues of uncertainty, inconsistent data, and subjective criteria. Consider the scorecards below.

Metric Name	Rank 5 Definition	Rank 3 Definition	Rank 0 Definition	Weight A	Weight B
1.) Composite design capability	Established capability to design and integrate composites primary aerostructures assemblies based on core proprietary product definition and manufacturing technology	Capability to mature design of composites primary aerostructures based on OEM product definition and limited integration into large assemblies	Understanding of composite design principles for secondary parts with traditional hand lay-up processes for supply chain package management	30%	10%
2.) 2008 contract revenue	Contract value >$300M	Contract value >$150M	Contract value <$30M	40	10
3.) Contract lifespan	Less than 10% of contracts are up for renewal in the next 5 years.	More than 20% of contracts are up for renewal in the next 5 years.	Greater than 30% of contracts are up for renewal in the next 5 years.	10	40
4.) Contract renewals	High probability of recapturing all contracts	Good probability of recapturing most contracts	Poor probability of capturing any contracts	10	20
5.) Culture	Culture is very similar	Culture is somewhat similar	Culture is significantly different	10	20

In this example there are some good and bad lessons to be learned. We analyze each metric below.

1. This is a good example of taking a qualitative aspect of a technology capability and turning it into a quantitative metric. Since the majority of contracts are public and the major technologies used are highly publicized the data for this metric will also be available.
2. This is a clear and discrete metric, however, there may be an issue with scaling. If all target companies had revenues in the range of $150-200M last year, there will not be much spread

in the data, especially under weighting option A. If the targets really do range from <$30M to greater than $300M this would be an appropriate metric.

3. This metric demonstrates the issue of inconsistent data. This is a clear metric and would be an excellent measure. However, the necessary data might not be available or it may be available for some targets, but not others. If some targets can be ranked with 100% certainty, but others have error bars of ±2 points the end result could be very misleading. This can be seen in the table below.
4. This metric has several issues, but uncertainty is a major one. This metric requires the person scoring to guess a future state with very little structure.
5. This metric has an issue of subjective criteria. With the exact same available information, two users of the system may score this metric differently. A better alternative would be to use specific traits or simply referring to another framework for cultural assessment.

In the table below, we demonstrate how the uncertainty associated with the various criteria could affect the overall score. In particular we demonstrate how well intentioned weighting may have an adverse effect if kept divested from the realities of the assessment and metrics.

Metric Name	Example Uncertainty	Weight A	Weight B	Weighted Error for Weight A	Weighted Error for Weight B
1.) Composite design capability	±0	30%	10%	±.15	±.05
2.) 2008 contract revenue	±0	40	10	0	0
3.) Contract lifespan	±2	10	50	±.2	±.8
4.) Contract renewals	±3	10	20	±.3	±.6
5.) Culture	±2	10	20	±.2	±.4
			Total	±.85	±1.85

This indicates that for the exact same metrics, the final answer could vary by as much as 3.7 out of 5.0 or 1.7 out of 5.0. While neither is ideal, clearly intelligent weighting can drive more accurate analysis. Ideally, more accurate metrics would be used to have more accurate results.

Values for Figure 22

Company	Teir	Year	Cur.	Revenue	EBIT	EBIT %	Note
AgustaWestland	OEM	2008	Euro	3,035.0	353.0	11.6%	EBIT
Finmeccanica - Aeronautics	OEM	2008	Euro	2,530.0	250.0	9.9%	adjusted EBITA
Finmeccanica - Aeronautics	OEM	2007	Euro	2,306.0	240.0	10.4%	adjusted EBITA
BAE Systems	OEM	2008	GBP	4,638.0	291.0	6.3%	EBITA
BAE Systems	OEM	2007	GBP	5,327.0	456.0	8.6%	EBITA
Bell Aircraft Corporation	OEM	2008	USD	2,827.0	278.0	9.8%	Operating profit
Bell Aircraft Corporation	OEM	2007	USD	2,581.0	144.0	5.6%	Operating profit
Bombardier Aerospace	OEM	2008	USD	9,965.0	896.0	9.0%	EBIT
Bombardier Aerospace	OEM	2007	USD	9,713.0	563.0	5.8%	EBIT
Cessna Aircraft Company	OEM	2008	USD	5,662.0	905.0	16.0%	Operating profit
Cessna Aircraft Company	OEM	2007	USD	5,000.0	865.0	17.3%	Operating profit
Dassault Aviation Group	OEM	2008	Euro	3,748.0	434.0	11.6%	Operating profit
Dassault Aviation Group	OEM	2007	Euro	4,085.0	477.0	11.7%	Operating profit
Embraer	OEM	2008	USD	6,335.0	389.0	6.1%	Net income
Embraer	OEM	2007	USD	5,245.0	489.0	9.3%	Net income
General Dynamics Aerospace (Gulfstream)	OEM	2008	USD	5,512.0	1,021.0	18.5%	Operating income
General Dynamics Aerospace (Gulfstream)	OEM	2007	USD	4,828.0	810.0	16.8%	Operating income
Hawker Beechcraft	OEM	2008	USD	3,546.5	135.5	3.8%	Operating income
Hawker Beechcraft	OEM	2007	USD	2,793.4	148.3	5.3%	(9 months only)
Hindustan Aeronautics	OEM	2008	INR	10,260.0	1,559.0	15.2%	Profit before tax
Hindustan Aeronautics	OEM	2007	INR	8,625.0	2,164.0	25.1%	Profit before tax
Kawasaki Heavy Industries	OEM	2008	Yen	238,993.0	10,876.0	4.6%	Operating income
Kawasaki Heavy Industries	OEM	2007	Yen	270,795.0	13,400.0	4.9%	Operating income
Korea Aerospace Industries	OEM	2007	USD	852,952.0	7,881.0	0.9%	EBIT
Korea Aerospace Industries	OEM	2006	USD	751,035.0	8,617.0	1.1%	EBIT
Pilatus Aircraft Ltd.	OEM	2008	CHF	661.0	92.0	13.9%	EBIT before R&D
Pilatus Aircraft Ltd.	OEM	2007	CHF	656.0	86.0	13.1%	EBIT before R&D
Saab Aeronautics	OEM	2008	SEK	7,269.0	-1,508.0	-20.7%	EBIT
Saab Aeronautics	OEM	2007	SEK	6,510.0	454.0	7.0%	EBIT
Sikorsky	OEM	2008	USD	5,368.0	478.0	8.9%	Operating profit
Sikorsky	OEM	2007	USD	4,789.0	373.0	7.8%	Operating profit
Airbus	OEM	2007	Euro	25,126.0	-881.0	-3.5%	EBIT
Airbus	OEM	2008	Euro	27,453.0	1,790.0	6.5%	EBIT
Goodrich Nacelles and Interior Systems	Equipping	2008	USD	2,485.6	647.5	26.1%	Operating income
Goodrich Nacelles and Interior Systems	Equipping	2007	USD	2,169.0	531.0	24.5%	Operating income
Spirit AeroSystems	Equipping	2008	USD	3,771.8	405.7	10.8%	Operating income
Spirit AeroSystems	Equipping	2007	USD	3,860.8	419.2	10.9%	Operating income
Vought	Equipping	2008	USD	1,796.6	108.6	6.0%	Operating profit
Vought	Equipping	2007	USD	1,625.5	109.5	6.7%	Operating profit
Aernnova	Equipping	2007	Euro	396.0	58.0	14.6%	EBITDA
Aernnova	Equipping	2008	Euro	490.0	60.0	12.2%	EBITDA
GKN Aerospace	Equipping	2008	GBP	1,002.0	106.0	10.6%	Operating profit
GKN Aerospace	Equipping	2007	GBP	820.0	83.0	10.1%	Operating profit
SABCA	Equipping	2008	Euro	133.2	10.5	7.9%	Operating profit
SABCA	Equipping	2007	Euro	126.1	12.8	10.2%	Operating profit
Bombardier Aerospace Belfast	Assembly	2008	USD	947.4	125.0	13.2%	Operating profit

Bombardier Aerospace Belfast	Assembly	2007	USD	859.9	32.9	3.8%	Operating profit
Fuji Heavy Industries	Assembly	2008	Yen	99.7	4.4	4.4%	Operating income
Fuji Heavy Industries	Assembly	2007	Yen	94.0	5.7	6.1%	Operating income
Mitsubishi Heavy Industries Aerospace	Assembly	2007	Yen	512,300.0	-10,300.0	-2.0%	Operating profit
Mitsubishi Heavy Industries Aerospace	Assembly	2006	Yen	500,500.0	14,600.0	2.9%	Operating profit
Heroux Devtek	Assembly	2008	CAD	307.9	27.8	9.0%	Operating income
Heroux Devtek	Assembly	2007	CAD	283.3	14.3	5.0%	Operating income
Kaman Aerostructures	Assembly	2008	USD	147.6	-5.9	-4.0%	Operating income
Kaman Aerostructures	Assembly	2007	USD	102.4	13.2	12.9%	Operating income
Spirit AeroSystems - Wing Systems	Assembly	2008	USD	955.6	99.7	10.4%	Operating income
Spirit AeroSystems - Wing Systems	Assembly	2007	USD	985.5	111.3	11.3%	Operating income
Aero Vodochody	Assembly	2007	CZK	4,307.0	364.0	8.5%	Operating profit
Aero Vodochody	Assembly	2006	CZK	2,942.0	-667.0	-22.7%	Operating profit
Latecoere	Assembly	2008	Euro	683.9	31.9	4.7%	Operating profit
Latecoere	Assembly	2007	Euro	489.3	39.1	8.0%	Operating profit
Ruag	Assembly	2008	CHF	1,536.0	57.1	3.7%	Operating profit
Sonaca	Assembly	2007	Euro	304.2	14.9	4.9%	Operating profit
Sonaca	Assembly	2006	Euro	268.7	-22.7	-8.4%	Operating profit
Stork Fokker	Assembly	2008	Euro	597.0	62.0	10.4%	EBITDA
Stork Fokker	Assembly	2007	Euro	543.0	8.0	1.5%	EBITDA
Air Industries Machining	Components	2007	USD	34.1	3.4	10.0%	Pre-tax income
Air Industries Machining	Components	2006	USD	33.0	1.6	4.7%	Pre-tax income
Albany Engineered Composites	Components	2008	USD	46.7	3.0	6.4%	Gross profit
Albany Engineered Composites	Components	2007	USD	33.0	2.7	8.1%	Gross profit
Avcorp	Components	2008	CAD	128.9	0.5	0.4%	Operating profit before tax
Avcorp	Components	2007	CAD	110.3	0.2	0.2%	Operating profit before tax
CPI Aero	Components	2008	USD	0.0	0.0	10.7%	Operating profit
CPI Aero	Components	2007	USD	0.0	0.0	10.7%	Operating profit
Ducommun Aerostructures	Components	2008	USD	252.2	35.1	13.9%	EBIT
Ducommun Aerostructures	Components	2007	USD	219.1	27.2	12.4%	EBIT
Brookhouse Holdings PLC	Components	2007	GBP	27.7	2.4	8.5%	Operating profit
Brookhouse Holdings PLC	Components	2006	GBP	24.7	1.2	4.9%	Operating profit
FACC	Components	2008	Euro	251.9	-10.0	-4.0%	Net profit
Gardner Group	Components	2008	GBP	66.2	7.3	11.0%	Operating profit
Gardner Group	Components	2007	GBP	55.4	4.6	8.2%	Operating profit
Hampson Industries	Components	2008	GBP	157.9	18.2	11.5%	Operating profit
Hampson Industries	Components	2007	GBP	138.0	12.4	9.0%	Operating profit
W&J Tod Ltd.	Components	2008	GBP	10,890.0	705.0	6.5%	Operating profit
Asian Composite Manufacturers	Components	2008	USD	27.9	5.9	21.1%	Net income
Asian Composite Manufacturers	Components	2007	USD	30.2	5.4	17.9%	Net income
Boeing Tiajin Composites	Components	2007	USD	32.7	4.8	14.7%	Net income

7 Table of Figures

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