SUPPLIER RELATIONSHIP MANAGEMENT BEST PRACTICES APPLIED TO THE MANUFACTURE OF A HELICOPTER AIRFRAME IN CHINA

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B.S. in Mechanical Engineering, Georgia Institute of Technology, 2000

Submitted to the MIT Sloan School of Management and the Department of Mechanical Engineering
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ABSTRACT

Sikorsky's recently begun program to manufacture the S-76 helicopter airframe at a supplier in China is examined as a case study of supplier relationship management. Best practices and key principles from the literature and other industry case studies are identified. Key concepts covered include: importance of product architecture and supplier strategic role on the appropriate type of supplier relationship to develop; the different stages of relationship management; the concept of making investments in a supplier relationship as a way of achieving desired relationship closeness; the importance of geography and culture on foreign supplier relationships.

The best practices and principles are then used to analyze Sikorsky's performance in the China S-76 airframe program to date. It is found that while Sikorsky is engaged in several key supplier relationship management activities, significant improvement could be made by more carefully considering how to overcome geographic and cultural distance and by making decisions about relationship investments in a more analytical way, with a focus on bottom-line financial impact. Finally, a generalized process for managing supplier relationships is developed. The six steps are:

- Determine the appropriate relationship to develop with the supplier
- Determine current supply chain proximity with the supplier
- Determine stage of supplier relationship management and appropriate type of investments
- Develop menu of relationship investment options
- Determine the attractiveness of investment options
- Select, prioritize and make investments

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INTRODUCTION

The author spent the second half of 2008 conducting his *Leaders for Manufacturing* internship at Shanghai Sikorsky, Sikorsky Aircraft Corporation's (Sikorsky) joint venture in China, as a member of their procurement team as they ramped-up production of the airframe of their S-76 helicopter by a Chinese supplier. One of the internship's major goals was to develop insight for Sikorsky into how it could better manage its supplier relationships, with a specific focus on its relationship with its Chinese supplier, Changhe Aircraft Company (Changhe). The method followed was to gather information on supplier relationship management best practices and principles from the literature and company case studies while at the same time determining Sikorsky's current state of supplier relationship management with Changhe through direct observation. The next steps were to utilize frameworks from the literature to analyze Sikorsky's current performance, develop specific recommendations for improvement of their relationship with Changhe and develop a generalized process that could be used to manage other supplier relationships.

CHAPTER 1: CONTEXT & PROBLEM

SIKORSKY COMPANY OVERVIEW

Sikorsky Aircraft Corporation ("Sikorsky"), a United Technologies (UTC) company, is a Stratford, Connecticut-based designer, manufacturer and servicer of military and commercial-use helicopters. Founded by aerospace pioneer Igor Sikorsky in the early 1900s, the company built the world's first practical single-main-rotor helicopter in 1939 (Sikorsky Aircraft Corporation), and today is one of the world's largest helicopter manufacturers with revenues of $5.4B in 2008. Sales have grown an average of 16% annually since 2002, when revenues were $2.2B. Commercial-related revenue growth has been particularly strong, up from $70M in 2002 to $1B in 2008, an average of 56% annual growth. Sikorsky has an approximately two year order backlog as of the end of 2008. (United Technologies Corporation)

Sikorsky traditionally performed most helicopter assembly operations in-house and produced most airframe components in house as well. Since around the year 2000, however, it has moved to more outsourcing of both component manufacturing as well as various amounts of assembly for certain aircraft. Along with the move to outsourced production has a come a push to also offshore work. Until relatively recently, all of Sikorsky's manufacturing facilities were located in the U.S. and most airframe components, whether manufactured in-house or outsourced to suppliers, were also fabricated in the U.S. By the mid-'90s, though, Sikorsky began to expand its manufacturing activity globally.

Today, in addition to five manufacturing locations in the U.S., Sikorsky in total also has wholly-owned manufacturing facilities in Poland, joint-venture manufacturing facilities in Turkey and China and major integration suppliers in the Czech Republic and China. Sikorsky also owns service and support facilities in seven countries outside the U.S. (Sikorsky Aircraft Corporation).

Sikorsky's involvement in China began relatively early, in the mid-'90s, when it selected Changhe to participate in the design and manufacture of the tail pylon of the S-92 commercial helicopter. Changhe continues to produce S-92 tail pylons and in 2007 was also chosen to serve as a second-source supplier for the S-76 helicopter's airframe. Production of S-76 airframes by Changhe began in 2008.

S-76 PRODUCT OVERVIEW

"An intermediate class, twin-engine commercial helicopter, the S-76 helicopter was originally intended for the offshore and executive marketplaces. The S-76 helicopter program was announced in February 1975 as the first strictly commercial production program in Sikorsky's history. The first production aircraft was delivered in February 1979." (Sikorsky Aircraft Corporation) The S-76 is Sikorsky's best selling commercial aircraft, with current annual deliveries of about 50 units and a lifetime delivery volume of over 700 aircraft to date. The S-76 sells for between $8M and $12M depending on equipment and interior options.

Production of an S-76 helicopter happens in five main stages: component manufacture, airframe assembly, final assembly, completion and testing. Component manufacture is done primarily by suppliers. In the case of airframe sheet metal and composite components, much of the work is sometimes done in-house by the supplier who also serves as the airframe assembler. Airframe assembly includes not only assembling the sheet metal and composite body components that are primarily riveted together, but also installing most of the avionics, electronics and hydraulic system. Final assembly involves installing all critical moving components such as the engines, gear box, rotor hub and main and tail rotor blades. Completion consists of installation of interior components like seating and cosmetic panels, as well as custom painting of the exterior of the airframe. The final stage, testing, consists of a series of ground and flight tests that confirm the proper functioning of all the aircraft's systems.

The S-76 was largely manufactured in-house by Sikorsky from its inception 30 years ago until 2002, when it selected Aero Vodochody (Aero) in the Czech Republic as a sole-source supplier to produce the airframe. Since that time, Aero has produced over 200 S-76 airframes for Sikorsky. (Lake 22) In 2007, Changhe entered into an agreement with Sikorsky to serve as a second-source supplier for the S-76 airframe. Airframes produced by both Aero and Changhe are shipped to a Sikorsky facility in the U.S. for final assembly, completion and testing. Sikorsky pays between $2M and $3M for each airframe from Aero or Changhe.

The airframe of the S-76 consists of about 4000 different part numbers of various types: sheet metal structural parts, composite structural parts, rivets, adhesives, electronic components, hydraulic components, etc. The supply chain for the airframe includes over 200 component suppliers, primarily in the U.S., with a few dozen European suppliers and a few Asian suppliers.

China's current total civil helicopter fleet numbers only 150 helicopters, of which about two dozen are S-76s. China is not expected to be a significant market for the S-76 until the government loosens regulations to allow more private aviation, a change which is expected to occur at some point in the future.

PROBLEM & METHODOLOGY

Sikorsky's supply chain has undergone several significant changes in the last 10 to 15 years. It now outsources significantly more work than it previously did. It also now has more complex integration work done by supplier in some cases, rather than just production of individual components or systems. Finally, its manufacturing is spread across a wider geographic area, including Asian locations with cultures that are very different from the U.S./West.

These changes amount to a significant change in, and complexity of, Sikorsky's supply chain. These types of changes have required the company to address a number of supply chain management questions. First there is the question of asset ownership – the "make vs. buy," or vertical integration decision. Answering this question requires analyzing a number of strategic, market and technology factors such as: the firm's core competencies, internal and supplier capabilities, urgency of capacity and

capability needs, economies of scale and intellectual property protection. (Beckman and Rosenfield 45-57) For those items for which the decision is "buy" rather than "make," there is the question of where to buy from (both supplier and geography selection). Answering this question requires performing Total Landed Cost analyses; assessing geographic-specific and supplier-specific risks; and considering market access and other strategic factors. Finally, once decisions about what is to be outsourced and where to source from have been made, companies must answer the question of how to work with, or manage, their chosen suppliers. This final question of how to manage supplier relationships is the focus of this paper.

This paper attempts to address what any company can do to manage suppliers more effectively, but given the specific situation of Sikorsky, focuses on issues particularly relevant to companies that are undergoing or have undergone the transition from primarily internal manufacturing to increasing amounts of outsourcing and off-shoring. The supply chain management literature, the culture literature and industry case studies will be used as sources of principles and best practices. Sikorsky's relationship with Changhe will be analyzed to serve as a case study of how to apply these principles.

The application case companies, Sikorsky and Changhe, are in the aerospace industry, and many other aerospace companies are undergoing or have undergone similar evolutions in supply chain architecture. The application case also deals with an American company souring from a Chinese supplier. It is important to note, however, that the principles highlighted, analysis conducted and improvements recommended have applicability in any business operation, regardless of industry or geography. With that in mind, a generalized process for managing supplier relationships is presented as the final result of this analysis.

CHAPTER 2: CONCEPTS & PRINCIPLES FROM THE LITERATURE

DEFINING SUPPLIER RELATIONSHIPS

Before examining the topic of supplier relationship management, it is helpful to define what is meant by supplier relationships in the context of this thesis. Beckman and Rosenfield present a spectrum of supplier relationships that is defined by ownership of both assets and responsibilities. The spectrum, arranged according to increasing levels of vertical integration, ranges from "arm's-length relationships" to "full ownership." (Beckman and Rosenfield 224) (Table 1)

Table 1: Spectrum of Relationships with Suppliers or Customers, Beckman and Rosenfield

Type of Relationship	Description
Arm's length relationships	• Traditional, cost-based, free-market, short-duration, purchase-order-driven relationships
Modified vendor relationships	• Value-added services (e.g., supplier managed inventories)
Long-term contracts	• Long-term supply contracts
Non-equity-based collaboration	• R&D consortia • Cross-marketing agreements • Cross-production agreements • Joint purchasing activities
Minority equity investments	• Invest in a supplier
Licensing arrangements	• Provide license to supplier in technology that host firm develops, but in which it wants to limit investments
Investment integration	• Coordinate investment jointly
Joint ventures or strategic alliances	• Allow firms to exchange certain goods, services, information, or expertise while maintaining a formal trade relationship on others
Asset ownership	• Host firm retains ownership for critical assets in adjacent stages of the industry chain but contracts out all other aspects of ownership and control
Full ownership	• Host firm fully owns activity

Supplier relationships, however, consist of more than just assets and lists of responsibilities determined by contracts. Information sharing is another crucial aspect of supplier relationships because it ultimately is what enables work to occur. People relationships are also a critical component of supplier relationships because interaction of customer and supplier personnel is required for information to be exchanged. Interaction between people can be done via a variety of modes (face-to-face conversation, email, etc.) and in a variety of formats (formal meetings, memos, physical tasks). How much and what

information is shared between customer and supplier as well as how and when information is shared are all things that in part define the relationship a customer has with its supplier.

For the purposes of this thesis, "supplier relationship" is broadly defined to include all of the aspects of relationship mentioned above. A reasonable working definition of supplier relationships, then, might be: "actions and conditions that connect a customer and supplier, including specific investments, assigned responsibilities, exchange of information and interaction of people, as well as the norms for, or means of, determining these actions and conditions." Table 2 lists these aspects along with some examples of how they might be manifested differently in "arm's length" and "close" supplier relationships.

Table 2: Supplier relationship aspects and examples

Action or condition	**"Arm's-length" relationship example**	**"Close" relationship example**
Specific investments	• No specific investments	• One or both parties invest in custom tooling
Assigned responsibilities	• Supplier supplies • Customer purchases	• Supplier takes responsibility for managing sub-tier suppliers • Customer responsible for managing design changes
Interaction of people	• Purchasing agent interacts via email and telephone with supplier's salesman	• Customer quality and engineering staff jointly located at supplier
Exchange of information	• Purchase order and product specifications are only shared information	• Integration of ERP/MRP systems between customer and supplier • Formal, regular progress meetings
Means of determining relationship aspects	• Purchase-order based	• Long-term contracts and incentives • Face-to-face, multi-round negotiations • Informal joint problem-solving

SUPPLIER RELATIONSHIP MANAGEMENT FRAMEWORK

Over the last few decades, supply chain management has grown both in importance and complexity as companies have realized the strategic and competitive importance of the supply chain and as industry has trended towards more outsourcing and global sourcing. It is now important to be more nuanced and sophisticated in architecting the supply chain, and accordingly, supplier relationship management has also become more complex. Given this increased variety in the type of suppliers and

types of cooperation with suppliers, it may be helpful to utilize some type of theoretical framework to assess how a company should manage each individual supplier in its supply chain.

One such framework was developed by Moeller et al., and draws from Customer Relationship Management (CRM) concepts as well as supplier management literature to develop the Supplier Relationship Management (SRM) framework. SRM seeks to map actions across different types of suppliers and different stages of supplier relationships. The SRM framework, in part, is derived from customer-centric CRM principles turned on their heads so as to be supplier-centric:

- The main task of SRM is to optimize the portfolio of suppliers.
- Investments in new supplier relationships can be valuable and necessary.
- New supplier acquisition costs exceed supplier maintenance costs.
- The potential lifetime value of a supplier relationship to the customer varies by supplier, and relationships should be invested in accordingly. (Moeller, Fassnacht and Klose 69-78)

In the SRM framework, supplier management is divided into three sequential phases:

- Out-Supplier Management
- In-Supplier Management
- In-Supplier Dissolution Management

Out-Supplier Management involves evaluating potential future suppliers as replacements for current suppliers. Given the high costs of supplier acquisition, a key task in this phase of SRM is assessing whether the investment in acquiring and developing a new supplier is justified by the potential payoff. In-Supplier Management consists of "building up and maintaining relationships with [current] suppliers to enhance value creation." In-Supplier Dissolution Management deals with ending supplier relationships. (Moeller, Fassnacht and Klose 73)

Given this thesis's focus on analyzing the ongoing supplier relationship Sikorsky has with Changhe, the "In-Supplier Management" phase is the most relevant to consider. In-Supplier Management's focus is on building and maintaining relationships with current suppliers, with the recognition that each supplier must be treated according to its value-enhancing potential. There are four sub-elements of In-Supplier Management: Set-Up Management, Development Management, Contract Management and Disturbance Management. (Moeller, Fassnacht and Klose 75-76) Figure 1 illustrates both the phases of Supplier Relationship management and the sub-elements of In-Supplier Management.

Set-Up Management argues that, as with CRM, the costs of acquiring new suppliers are greater than the costs of maintaining them, but that these investments can be "valuable and necessary." (Moeller, Fassnacht and Klose 76) It involves making investments by both the customer and supplier, especially ones that are valuable only in the context of the specific customer-supplier relationship. These "specific" investments serve to enhance the capabilities of the supplier as well as build trust and signal commitment by both parties. Moeller et al. cite a study by Jap and Ganesan (2000) where they conclude that "specific investments especially in the set up phase are a powerful signal for relationship

commitment. The signal provides confidence for the partners, because each will sustain economic consequences in case of relationship termination..." The level of investment made by the customer depends on how strategic, or value-enhancing, the supplier is expected to be. (Moeller, Fassnacht and Klose 76-77)

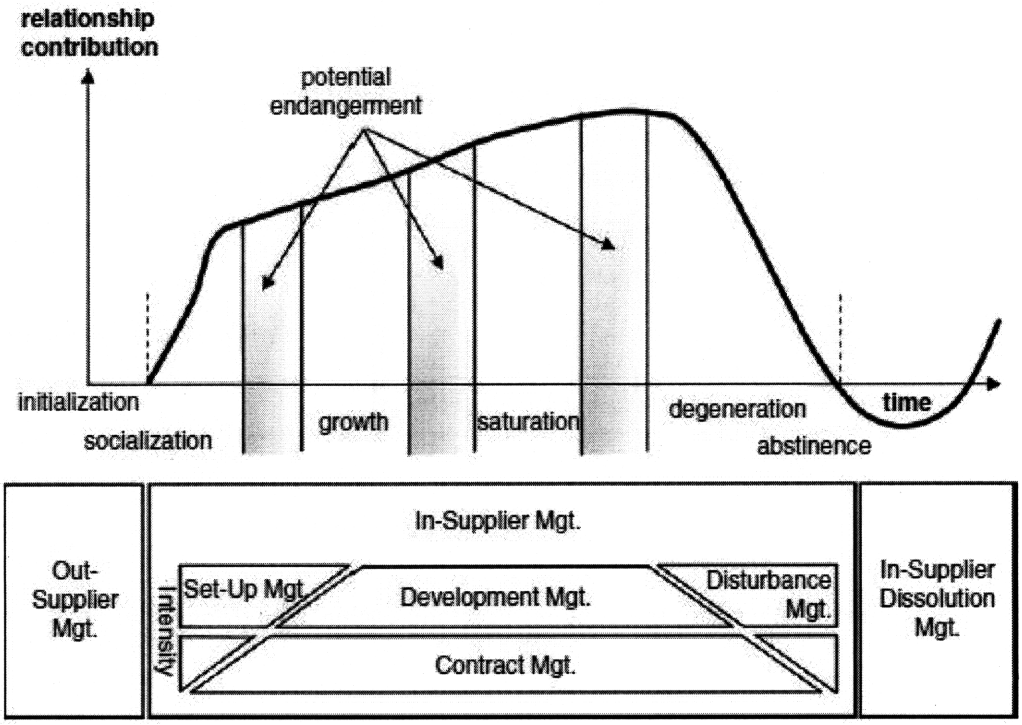

Figure 1: The Supplier Relationship Life Cycle and Corresponding Management Tasks (Moeller et al.)

Development Management consists of identifying opportunities for improvement and undertaking activities to capture those opportunities. As in Set-Up Management, these activities may involve making more specific investments. But during this phase it is important to balance the cost of improvement with the expected lifetime value of the supplier relationship. Moeller presents a matrix for mapping suppliers' potential value as a combination of their strategic importance and relationship contribution (Figure 2). Suppliers that have a high strategic importance and high relationship contribution are labeled as "Real Value Enhancers," and deemed worthy of higher levels of Development Management effort than other suppliers. (Moeller, Fassnacht and Klose 79-80)

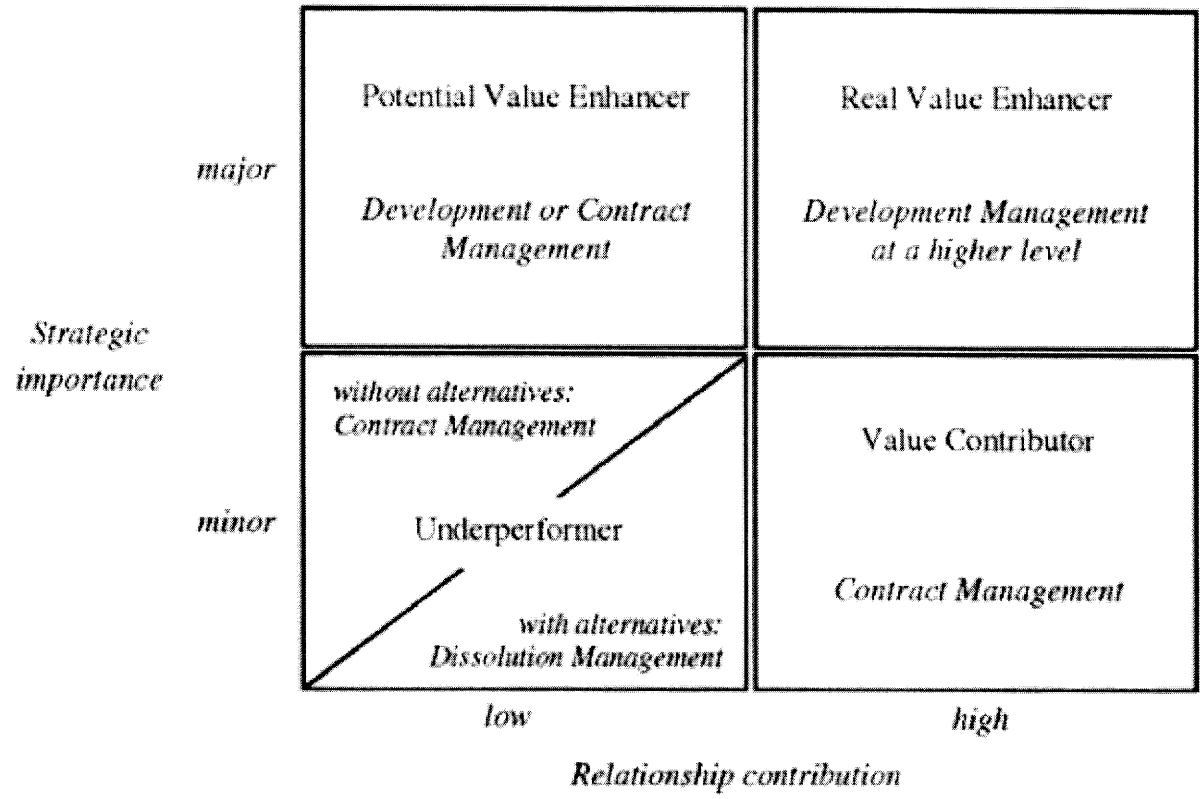

Figure 2: Managing the Supplier Portfolio within SRM (Moeller et al.)

Contract Management is a sub-element of In-Supplier Management used with those suppliers deemed unworthy of significant Development Management or specific investments. Relationships with these suppliers are managed primarily through contracts. (Moeller, Fassnacht and Klose 80)

The final sub-element of In-Supplier Management, Disturbance Management, involves preventing "breakdown of continuous relationships...The identification of potentially problematic aspects within the relationship allows the proactive and careful management of these disturbance aspects and an early employment of de-escalation instruments like cooperative meetings or renegotiation of contract conditions." (Moeller, Fassnacht and Klose 81)

STRATEGIC ROLES OF FACTORIES

Per Moeller et al., knowing what kind of relationship to pursue with a given supplier is contingent upon the expected strategic value of that supplier. One way to go about determining the expected strategic value of a supplier is for the customer to think about the supplier's factory as part of its own factory network, and consider what strategic role it should play within that network.

Ferdows defines six potential strategic roles that a foreign factory can play. These six strategic roles represent a kind of continuum from low strategic value where the objective is cost minimization, to high strategic value, where the goal is access to markets and exploitation of global knowledge and talent. The type of capital and managerial investments made vary according to strategic role. These six strategic roles and corresponding investments are summarized in Table 3. To categorize a factory, "start by answering two basic questions...What is the primary strategic reason for the factory's location? What is the scope of its current activities?" (Ferdows 76-77)

Table 3: Strategic Roles of Foreign Factories

Factory Type	Factory's Strategic Role	Required Investments
Offshore factory	• Access to low factor costs • Manufacture for export • Little or no product development work • Little or no supply chain management	• Minimum level of investment
Source factory	• Access to low factor costs • Manufacture for export • Supply chain management • Product modification	• Supply chain management skills • Low level of product engineering skills & resources
Server factory	• Access to local markets • Limited product modification	• Low level of product engineering skills & resources
Contributor factory	• Access to local markets • Product and process development • Supply chain management	• Skilled engineering and management talent & resources • Supply chain management skills
Outpost factory	• Gather strategic lead market information • Secondary role as another type of factory	• Market intelligence gathering skills & resources • Skills required for secondary role
Lead factory	• Development of products and process for company globally • Gathers and exploits market information • Customer interface	• High level of management skills • High level of engineering skills & resources • High level of sales and CRM skills & resources

In Table 3, factory roles are listed in order of increasing strategic importance. Higher strategic importance corresponds with higher necessary levels of investment in the supplier relationship. In the case of an internally-owned factory, the source of investment is obvious. In the case of a supplier, the customer's decisions about investments can be less clear. If a supplier already possesses the necessary skills and resources to perform the strategic role required by the customer, difficult decisions about investments may not be necessary. But in the case where a supplier's skill and resource base requires upgrading in order to be able to fulfill the strategic role desired by the customer, decisions must be

made about which party will make which investments. According to Moeller et al., the higher the strategic value of a supplier, the greater the need for shared, mutual specific investments. (Moeller, Fassnacht and Klose 76-77)

The strategic role desired of a supplier's factory has at least three implications for supplier relationship management. First, the greater the strategic role required of the supplier, the greater the complexity of interaction required between the supplier and customer, which in turn necessitates development of a closer relationship with the supplier. Second, the greater amount of investment required to enable a supplier to fulfill the desired strategic role for the customer, the greater the need for relationships capable of making joint decisions about responsibility for each specific investment. And the investments themselves are part of the relationship. Third, necessary investments may be of a tacit nature – technical or managerial skills, for example – and therefore require close interaction between customer and supplier personnel in order to successfully "invest" in the supplier.

SUPPLY CHAIN ARCHITECTURE

Supplier relationships are one aspect of supply chain architecture, and so it is important to understand the concept of supply chain architecture to understand how managing supplier relationships can be used to achieve optimal supply chain architecture. Optimal supply chain architecture, in turn, is dependent on product architecture, and so the concept of product architecture must also be understood and considered when determining supplier relationships.

Architecture is a term most frequently associated with the design of buildings. But more generally, architecture can be defined as "formation or construction resulting from or as if from a conscious act;" or "a unifying or coherent form or structure." (Merriam-Webster, Incorporated) Anything then, whether an object, system or even an idea that exhibits some coherence or existence of structure has architecture, whether by accident or by design; hence the use of terms like "computer architecture," "network architecture," and "organizational architecture."

Product Architecture

Manufactured products thus, by their very nature, must have architecture. Ulrich defines product architecture as "the scheme by which the function of a product is allocated to its constituent components." (C. H. Fine, Clockspeed 134) Determination of product architecture is a major outcome of product design, and involves addressing the following questions:

- "What sub-functions are needed to carry out each function or sub-function?
- What technology will be used to implement each function or sub-function?
- How should each physical embodiment be divided into chunks (also called modules) within the constraints imposed by choice of technology?
- How should the chunks be arranged with respect to each other in space?
- How will they need to interact?

- How should the interfaces that provide these interactions be defined and implemented?" (Whitney 342)

Supply Chain Architecture

Supply chains, too, have architecture. Supply chain architecture is "a richer concept than that of traditional make/buy or vertical integration," (C. H. Fine, Clockspeed 136) and consists of addressing, among others, the following questions:

- Which components should be bought and which made in-house?
- How many sources should each component be supplied by?
- Who owns inventory in each part of the chain?
- When and how much inventory is needed?
- What geographies should production occur in?
- How should the different parties in the supply chain interact and collaborate?

Supply chain design is the conscious process of deciding on supply chain architecture. Fine defines supply chain design and emphasizes its importance to the manufacturing firm this way:

"Supply chain design ought to be thought of as assembling chains of capabilities, not just collaborating organizations, in the quest for a series of temporary advantages. Since no advantage lasts forever, these design activities must be ongoing and therefore constitute the 'core' capability of a firm in a dynamic economy. " (C. H. Fine, Clockspeed 76)

Modularity and Integrality

One attribute of architecture that is highly relevant to discussions of both product and supply chain architecture is "the degree to which functional elements are intended to be independent of each other, and similarly the degree to which physical chunks are designed to be independent of each other as they carry out their assigned functions." At the independent extreme, referred to as modular architecture, "each function and sub-function [is] assigned to its own individual...element...Each element could be designed and manufactured independently of all the others, and the product could be produced simply by plugging these elements together at their predefined interfaces." At the interdependent extreme, referred to as integrated architecture, a product "would have a single part that performs all the functions." That is, all features and functions of architecture would be integrated into a single component. Most architectures lie somewhere in between the two extremes of modularity and integrality. (Whitney 345)

Product architecture and integrality

Applied to product architecture, the concept of modularity and integrality refers to a product's individual components and sub-assemblies, and their interactions with each other. "An integral product architecture might feature, for example,

- Components that perform many functions
- Components that are in close proximity or close spatial relationship
- Components that are tightly synchronized

In contrast, a modular architecture features separation among a system's constituent parts, whereby

- Components are interchangeable
- Components are individually upgradeable
- Component interfaces are standardized
- System failures can be localized." (C. H. Fine, Clockspeed 134-5)

Looking at the S-76 helicopter airframe as an example can be illustrative (Figure 3). Consider first the Fuel Cell. This sub-assembly serves as the aircraft's fuel tank as well as providing a portion of the airframe's structural strength and aerodynamic outer surface. Consider also the Upper Cabin Assembly. This subassembly serves both as a structural component and aerodynamic component, but also houses portions of wire harnesses and hydraulic systems and provides volume for passenger seating. Analysis of many of the remaining sub-assemblies of the S-76 airframe would yield similar results. Many of the airframe's sub-systems are custom-designed and have custom interfaces with other components. The fact that the total weight of all the helicopter's components is a critical design requirement is also a characteristic of integral product architecture. (C. H. Fine, Clockspeed 135) At the airframe level of assembly or higher, one must conclude that a helicopter has a highly-integrated product architecture.

By contrast, printed circuit boards, consisting of a board with standardized holes mated with "pluggable" resistors, capacitors and other standard components (Whitney 346); or bicycles, with uni-functional, interchangeable components exhibit more modular product architecture. (C. H. Fine, Clockspeed 136)

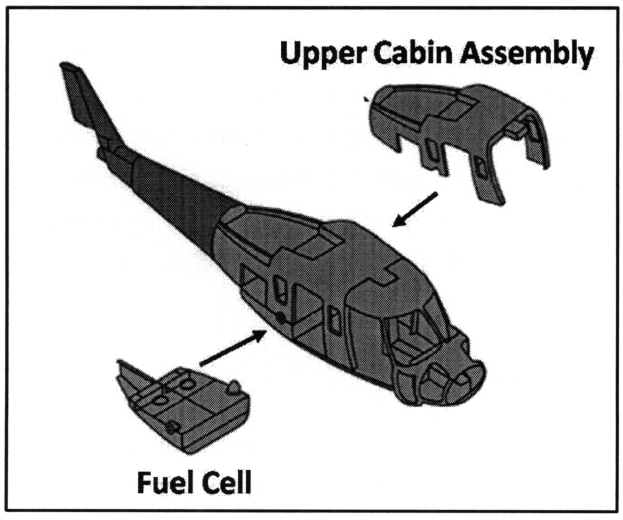

Figure 3: Product architecture example - Sikorsky S-76 airframe

Putting it all together: architecture, integrality and supplier relationship management

Supply chain architectures also have characteristics of modularity or integrality. In his book "Clockspeed," Fine introduces the concept of using "proximity among its elements" as a measure of supply chain integrality, where proximity is measured along four dimensions: geographic, organizational, cultural and electronic. (C. H. Fine, Clockspeed) A depiction of this framework can be seen in Figure 4. The four dimensions can be described as follows:

- Geographic: actual physical distance, although electronic means of communication can in some cases serve as a form of geographic proximity even when physical separation might be large.
- Organizational: "can be approximated by constructs of ownership, managerial control, and interpersonal and inter-team dependencies." (C. H. Fine, Clockspeed 137)
- Cultural: language, ethics, business and management norms, relational norms, risk and uncertainty avoidance, etc.
- Electronic: communication technologies, design software, ERP/MRP systems, etc.

"A supply chain with a high degree of integrality, therefore, is one in which a manufacturer and its principal suppliers are concentrated in one city or geographic region, have common or interlocking ownership, share a common business and social culture and are linked electronically." (C. H. Fine, Clockspeed 138)

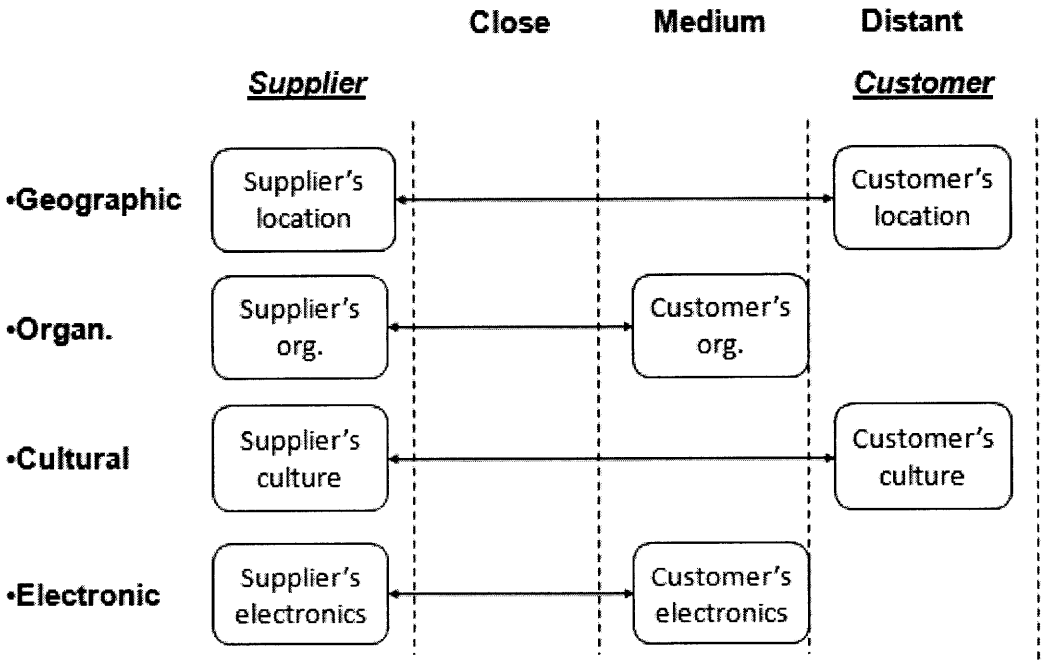

Figure 4: Supply chain proximity framework depiction

Deriving implications for supplier relationship management from the concepts of architecture and integrality/modularity first requires understanding that,

> "To a significant degree, product and supply chain architectures tend to be aligned along the integrality-modularity spectrum. That is, integral products tend to be developed and built by integral supply chains, whereas modular products tend to be designed and built by modular supply chains. In essence, product and supply chain architectures tend to be mutually reinforcing." (C. H. Fine, Clockspeed 140)

The logical extension of the mutually reinforcing nature of product and supply chain architectures is that the supply chain architecture best-suited to deliver a particular product closely mirrors the product's architecture in its degree of integrality. That is, a product with highly integrated product architecture is best-delivered by a highly-integrated supply chain.

Where each of the four dimensions of supply chain proximity "rank" in "closeness" is directly a result of the type of supplier relationships that exist. For example, a customer that requires a supplier to use the same CAD design software it uses internally, provides visibility into its inventory by linking of ERP systems and hosts frequent video or teleconferences is managing its supplier relationship such that it results in close proximity along the electronic dimension of supply chain proximity.

How a company chooses to manage its supplier relationships determines the integrality of a company's supply chain architecture. And since the supply chain architecture it seeks to construct should be driven by the architecture of the product it is trying to deliver via the supply chain, it is important to consider product architecture when managing supplier relationships.

GEOGRAPHIC PROXIMITY: THE EFFECT OF PHYSICAL SEPARATION ON COMMUNICATION

The geographic dimension of supply chain proximity is largely determined by the distance of physical separation between two companies' people and facilities. Normal intuition is that "the closer, the better" when it comes to the appropriate physical distance separating collaborators; the idea being that closer physical proximity will result in better and more frequent communication. But just how close is "close enough," or at least sufficient, for effective collaboration is important for organizations with multiple locations and external suppliers to consider. One way to quantify the relationship is to look at the affect of physical separation on likelihood of communication.

Frequency of communication versus physical separation

Research on this subject was pioneered by MIT's Thomas Allen in the 1970s as he studied the effect of organizational architecture on innovation. In his research, Allen and his colleagues plotted the physical distance between offices in an organization and then assessed whether each pair of individuals communicated on technical matters at least once a week. Data was collected for multiple organizations

and plotted. "Plotting these results produces a curve that to no one's surprise shows probability of communication declining with distance." In one set of data collected from seven laboratories, "communication probability declines to an asymptotic level within the first 50 meters of separation...Computations were made for pairings in which the distance is much greater, including distances between sites in hundreds or even thousands of kilometers. The results are unchanged. There is only a modest drop in probability after the first 50 meters." (Allen 26) Figure 5 below is a plot of this data.

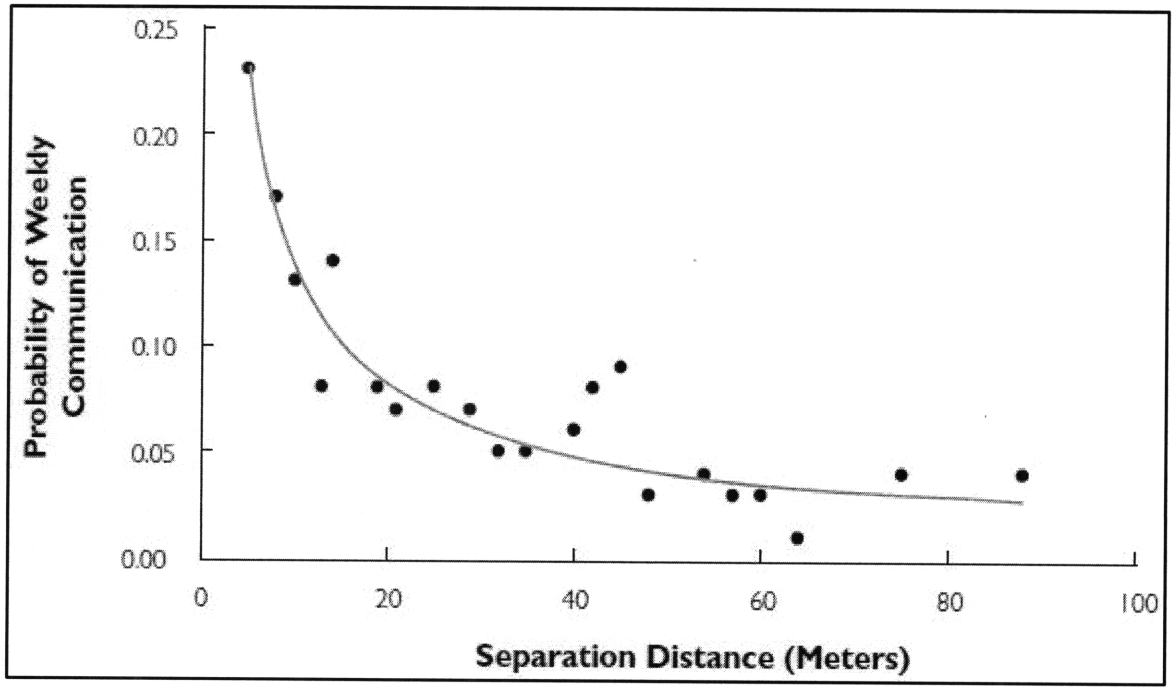

Figure 5: Probability of Technical Communication as a Function of Distance Between Work Stations (Allen)

One reaction to this data might be to assume that the data merely reflects an efficient placement of workers by their managers; that people who need to communicate frequently with each other have been seated more closely together by their managers than those who don't need to communicate frequently. To test for this dependency, Allen looked specifically at pairs of communicators who were members of the same department or the same team. He found that the plot of communication probability versus separation distance retained the same shape, although with an upward shift that remained constant with respect to separation distance. (Allen 27)

The clear implication of this phenomenon with respect to the Supply Chain Proximity framework is that very "close" geographic proximity might need to be measured on the order of meters rather than kilometers; and minutes of travel rather than hours.

Telecommunication frequency versus separation distance

Perhaps counter-intuitively, this same relationship holds even for telephone and email communication. Allen cites numerous studies indicating that most telephone calls are made to people with close physical proximity, and that probability of face-to-face communication and electronic communication tends to be the same. There are a number of reasons why this may be the case:

- Communication frequency in general is naturally inversely correlated with separation distance. People just communicate more frequently with those nearby than those faraway.
- Communication of complex information often needs to be done through multiple mediums, such as a combination of drawings, gestures and words.
- Written communication (i.e., email) is asynchronous, leading to time delays versus verbal communication.
- The necessity of scheduling teleconferences and videoconferences means that they are primarily used only for communicating formal information. (Allen 30)

Allen also cautions managers not to generalize from their experience to the work of their engineers. He argues that managers typically communicate much less complex information than do engineers, and therefore may benefit less from face-to-face interaction with their counterparts than do engineers or others communicating complex information. (Allen 32) While managers certainly communicate complex information, it is more of an organizational nature rather than a technical nature, and this may be what Allen was getting at: managers should refrain from assuming the tools and means of communication they employ for the type of communication they engage in are also the best fit for their engineers.

Information types and proximity

When assessing the importance of physical proximity amongst collaborators, it is important also to consider the type of communication that needs to occur. Allen defines three types of technical communication, the communication of which are affected to varying degrees by physical separation (Table 4). (Allen 23-24, 39)

Table 4: Types of communication and vulnerability to separation distance

Classification	Description	Vulnerability to separation distance
Type I	Communication to coordinate the work. (**Coordination**)	Least vulnerable
Type II	Communication to maintain staff knowledge of new developments in their areas of specialization. (**Information**)	Moderately vulnerable
Type III	Communication to promote creativity. (**Inspiration**)	Most vulnerable

The takeaway here is that acceptable physical separation distance between communicating pairs might vary by the content of their work. Engineers collaborating on new designs would have a smaller maximum acceptable separation distance than would a project manager and his counterpart at a supplier, for instance.

Separation distance in cross-cultural environments

For companies engaged in international collaboration, it is also important to consider the implications of cross-cultural situations for the importance of physical proximity. First, it is important to recognize that cultures vary in the value they place on "face-time" and the value they place on relationships with business or work partners. Allen states that the same communication probability drop-off with separation distance occurs in Europe although no data for Asia is cited. (Allen 27) In China, for instance, the development of individual relationships is more critical to successful business collaboration than in the U.S. This might mean that U.S. companies might have to locate their teams that are collaborating with Chinese teams physically closer together than they have to when working with U.S. partners.

Second, it is important to realize the elevated importance of non-verbal, non-written communication when dealing with language barriers. For example, even though suppliers in China may have English translators or speak English themselves, they are communicating in a second language when using English and will often have difficulty both fully expressing what they wish to communicate and fully comprehending what is being communicated to them. In these types of situations, being able to rely on gestures, sketches and viewing of the physical objects being discussed greatly enhances communication efficiency and accuracy. Face-to-face communication also allows the individual with a trained eye to assess from non-verbal cues whether he is really being understood or whether a "Yes" actually means "I don't understand, but I'm embarrassed to admit it," or similar.

Third, it is important to realize the fact that in some cultures where the concept of "face" is strong, East Asia among them, bad news, dissatisfaction and disagreement tend to be communicated very indirectly in order to prevent "loss of face" by one or both parties. In fact, unpleasant news (e.g., about production delays or quality problems) is often hidden and not communicated at all until discovered by the other party. Individuals with cross-cultural experience can become savvy detectors of this type of indirect communication by reading body language, assessing tone of voice and speech patterns, talking with multiple individuals about the same topic, visiting the worksite for direct observation or conducting communication in non-threatening social environments. In fact, in East Asia, it is not uncommon for some of the most frank business discussions to occur under the influence of alcohol! But when relying on remote communication (telephone & email), one must rely on explicit words only to try and ascertain the true and full meaning of what is being communicated. This may work well for communication with Germans, but is not as ideal for communicating with Chinese people.

CULTURAL PROXIMITY: ASSESSING CULTURAL DIFFERENCES

The Supply Chain Proximity framework discussed above includes culture as one of the four dimensions of supply chain proximity. Culture itself is determined by multiple factors, and assessing the proximity of a customer with its suppliers along this dimension of supply chain proximity requires analysis of the various factors. Not only is geographic location, or "nationality," a determinant of culture, but so are home market characteristics and the individual experiences of firms.

Analyzing how a supplier's culture differs from the customer's can give the organizations insight into how best adapt their inter-company interactions to more closely match that of each other or at least take into account cultural differences, resulting in closer proximity along the culture axis of supply chain proximity. This is most important when an integral supply-chain architecture is indicated by the integrated nature of the products being produced by the supplier for the customer.

Nationality and culture

Dr. Geert Hofstede of The Netherlands conducted what is widely considered to be the seminal research on the topic of ethnicity-based cultural differences, beginning as a psychologist working for IBM in the 1960's and 1970's, and continuing for several decades afterward. Hofstede identified five dimensions of "national cultural difference," summarized below:

1. **"Power distance**, that is the extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally. This represents inequality (more versus less), but defined from below, not from above. It suggests that a society's level of inequality is endorsed by the followers as much as by the leaders. Power and inequality, of course, are extremely fundamental facts of any society and anybody with some international experience will be aware that 'all societies are unequal, but some are more unequal than others.'

2. **Individualism on the one side versus its opposite, collectivism**, that is the degree to which individuals are integrated into groups. On the individualist side we find societies in which the ties between individuals are loose: everyone is expected to look after him/herself and his/her immediate family. On the collectivist side, we find societies in which people from birth onwards are integrated into strong, cohesive in-groups, often extended families (with uncles, aunts and grandparents) which continue protecting them in exchange for unquestioning loyalty. The word 'collectivism' in this sense has no political meaning: it refers to the group, not to the state. Again, the issue addressed by this dimension is an extremely fundamental one, regarding all societies in the world.

3. **Masculinity versus its opposite, femininity**, refers to the distribution of roles between the genders which is another fundamental issue for any society to which a range of solutions are found. The IBM studies revealed that (a) women's values differ less among societies than men's values; (b) men's values from one country to another contain a dimension from very assertive and competitive and maximally different from women's values on the one side, to modest and caring and similar to women's values on the other. The assertive pole has been called 'masculine' and the modest, caring pole 'feminine'. The women in feminine countries have the same modest, caring values as the men; in the masculine countries they are somewhat assertive

and competitive, but not as much as the men, so that these countries show a gap between men's values and women's values.

4. **Uncertainty avoidance** deals with a society's tolerance for uncertainty and ambiguity; it ultimately refers to man's search for Truth. It indicates to what extent a culture programs its members to feel either uncomfortable or comfortable in unstructured situations. Unstructured situations are novel, unknown, surprising, different from usual. Uncertainty-avoiding cultures try to minimize the possibility of such situations by strict laws and rules, safety and security measures, and on the philosophical and religious level by a belief in absolute Truth; 'there can only be one Truth and we have it'. People in uncertainty-avoiding countries are also more emotional, and motivated by inner nervous energy. The opposite type, uncertainty-accepting cultures, are more tolerant of opinions different from what they are used to; they try to have as few rules as possible, and on the philosophical and religious level they are relativist and allow many currents to flow side by side. People within these cultures are more phlegmatic and contemplative, and not expected by their environment to express emotions.

5. **Long-term versus short-term orientation:** Values associated with Long Term Orientation are thrift and perseverance; values associated with Short Term Orientation are respect for tradition, fulfilling social obligations, and protecting one's 'face'. Both the positively and the negatively rated values of this dimension are found in the teachings of Confucius, the most influential Chinese philosopher who lived around 500 B.C.; however, the dimension also applies to countries without a Confucian heritage." (Hofstede)

Through the various studies performed by Hofstede over the years, many countries have been assigned relative scores on each dimension which allow for a direct comparison of these aspects of national culture. These dimensions, of course, need to be interpreted in the context of business and organizations to be useful in the task of supply chain architecting. Table 5 contains a summary of some of the business and organizational implications of cultural attributes taken from Schneider and Barsoux's book "Managing Across Cultures." (Schneider and Barsoux)

Home market characteristics and culture

The characteristics of a particular market also influence the culture of organizations based there. Here, important factors include the structure of an economy (free market vs. centrally-controlled), economic and market growth rates, labor demographics (age and other characteristics of the workforce), level of competition in the local market and local consumer tastes.

To the extent that any of these factors differ between a supplier's and customer's home markets, the firms should consider how these differences might indicate cultural differences that will have to be overcome. For example, location in a centrally-controlled economy might be reflected in an organization's culture in the form of a weaker profit-orientation in decision making and slowness to innovate compared to firms located in free markets. In a market where consumers are highly price-conscious, firms will be more strongly focused on cost control in manufacturing, whereas in a market where consumers are highly quality-conscious, firms may be more focused on quality control.

It is important, too, to realize that there is a time dimension to market characteristics that may affect firms of different nationalities differently. For example, because of their strong long-term

orientation, Chinese firms' cultures might be more strongly affected by long-term rather than short-term market outlooks.

Table 5: Example Business and Organizational Implications of Cultural Attributes

National Culture Attribute	Business/Organization implications
Power Distance = High	• More levels of hierarchy • Higher proportion of supervisory personnel • More centralized decision making
Uncertainty Avoidance = High	• Greater amount of written rules and procedures • Greater specialization in technical competence • Managers avoid taking risks • Managers motivated by stability and security
Collectivist Orientation = High	• Preference for group decision making • Consensus and cooperation valued more highly than individual initiative and effort • Motivation derived from a sense of belonging • Leaders must facilitate team effort and integration
Masculinity = High	• More concerned with task accomplishment than nurturing social relationships • Leaders more focused on ensuring bottom-line profits
Long Term Orientation = High	• Building up strong market position is more important than immediate results (profits) • Acceptance of hierarchical roles • Persistence in work

Firm experiences and culture

Beyond ethnicity and market characteristics, a firm's unique experiences also affect its culture. In the case of a customer preparing to work with a foreign supplier in an emerging market, it is especially important to consider what other experience the supplier has had with foreign customers and how that will affect its culture in ways that might make it easier or more difficult to partner with. Firms that feel they have been "burned" or taken advantage of by foreign customers might be more cautious when partnering with foreign customers in the future.

CHAPTER 3: BEST PRACTICE CASE EXAMPLES

In order to illustrate what successful supplier relationship management looks like, two case examples are presented below. Toyota is widely considered to be best-in-class in the automotive industry in the area of supplier development and management. Cisco has a fully outsourced supply chain (for most product lines) and has done extensive work in integrating with suppliers in the area of IT. Both cases will be used to illustrate proximity along all four dimensions of supply chain proximity, but with different emphases. The Toyota example highlights the geographic dimension more strongly, and the Cisco example highlights the electronic dimension more strongly.

TOYOTA

Toyota's products, automobiles, probably fall somewhere in the middle of the spectrum of modular versus integral product architecture. Some automobile components and systems do serve multiple-purposes, but the interfaces between components and systems are governed by at least some level of standardization. However, most components are not off-the-shelf items, but rather custom-designed for a specific vehicle. Additionally, overall vehicle performance (fuel economy, handling, etc.) is a function of many or all components. Integrated product architecture indicates a need for an integrated supply chain architecture, and Toyota has just that with much of its supply base. In fact, it could be argued that the integrality of Toyota's supply chain exceeds that which might be necessary to deliver its products. However, Toyota's *process architecture*, defined largely by Lean and Just-In-Time manufacturing (JIT), is highly integral in nature. In a manufacturing system with low levels of raw material and WIP inventory, each successive step in the manufacturing process is highly dependent on preceding steps (i.e., can become starved quickly if there are problems upstream), including those performed by external suppliers. This integral process architecture demands a high level of integrality of the supply chain, to enable more rapid communication of information and problem solving that are necessary to support Lean and JIT.

It is interesting to note that from the literature reviewed, it is unclear whether Toyota's supply chain architecture decisions, and therefore its supplier relationships, are motivated by improving Toyota's performance or by more egalitarian goals. In fact, Toyota has a purchasing philosophy dating back to 1939 that specifically states, "once nominated as Toyota suppliers, they should be treated a part of Toyota (as branch plants); Toyota shall carry out business with these suppliers without switching to others, and shall make every effort to raise the performance of these suppliers." (Sako 286) Whatever the case, Toyota has chosen to build a supply chain that is more integral than that of many other auto makers. Liker and Meier describe it thusly:

> Supplier examples "tell a story of interlocking structures with supplier partners. It is more like a marriage than casual dating. Technical systems, social systems, and cultural systems are all tightly intertwined. It goes beyond manufacturing to product development systems. It is not

enough to be a good supplier. The supplier must act as a seamless extension of the refined lean systems of Toyota." (Liker and Meier, The Toyota Way Fieldbook 279)

The Supply Chain Proximity framework is a useful tool for demonstrating the integrality of the supply chain between Toyota and its suppliers. Along the Geographic dimension of supply chain proximity, Toyota tends to have close proximity with its suppliers. In Japan, most of Toyota's suppliers' factories are located in very close proximity to Toyota's base of production in Nagoya. So many Toyota and Toyota supplier factories are located there that it is known as "Toyota City." Even outside of Japan, Toyota seeks to develop local sources for components in the markets where it assembles automobiles, although geographic proximity may not be as close as with its operations in Japan. This close geographic proximity helps support Toyota's reliance on a JIT manufacturing model by minimizing transportation time of inventory from suppliers' factories to Toyota assembly plants.

But close geographic proximity of factories serves an equally important function of making it easier for Toyota personnel to visit, observe and work with suppliers' personnel, and vice-versa. This two-way, face-to-face interaction and cooperation between Toyota and supplier personnel is, in fact, the other significant feature of Toyota's supply chain integrality along the geographic dimension. It reflects Toyota's "core philosophy of going and seeing directly, to deeply understand the situation" (Liker and Meier 275) and is codified in the term *genchi genbutsu* (actual part, actual place).

Toyota's Operations Management Consulting Division (OMCD) is tasked not only with implementing the Toyota Production System (TPS) in Toyota's own factories, but also at suppliers' factories. They deploy teams to supplier's facilities, staffed with the exact same engineers responsible for TPS implementation within Toyota, rather than with engineers focused only on external suppliers. Toyota also extends this teaching interaction to supplier-supplier interactions in the form of *jishuken*, or study groups. In *jishuken*, several Toyota suppliers meet together to engage in knowledge-sharing and joint problem-solving, and even conduct kaizen activities together in each other's factories. (Sako 287-288)

Toyota's interaction with suppliers does not end with sending Toyota personnel to work at suppliers' facilities. It also includes bringing suppliers' engineers to Toyota to work. When Toyota started working with the Mexican supplier Metalsa, "Toyota asked that a large team of engineers be dedicated to the project and that they spend significant time in Japan. They asked for a full-time engineer to be stationed in Michigan near the Toyota Technical Center (TTC), and for one and later two more engineers to be stationed full-time in Japan to work alongside Toyota engineers." (Liker and Meier 275-277)

Along the Organizational dimension of supply chain proximity, Toyota also displays characteristics of close proximity with its suppliers in some cases. Japanese industry is famous for its *kieretsu*, or conglomerates, that consist of companies with extensive equity cross-holdings. In Japan, Toyota holds equity in many of its suppliers, creating a high degree of organizational proximity. (C. H. Fine, Clockspeed 38) Even in foreign markets, Toyota will sometimes form joint ventures with suppliers. In Kentucky, for example, Toyota arranged for Johnson Controls to form a JV with a Japanese supplier, Araco, in which Toyota was the majority shareholder, to be the second-source for seats to supply to

Toyota's Georgetown, KY assembly plant. Interestingly enough, Johnson Control's own wholly-owned operation was already the first source for these seats. (Liker and Meier, The Toyota Way Fieldbook 278-279)

Toyota's OMCD organization, however, also represents a form of organizational proximity. OMCD works both with Toyota internally and with external suppliers, and uses the same personnel for both types of projects. (Sako 287-288) Its supplier *jishuken* help foster the same sort of organizational proximity between the various members of its supply base.

Along the Cultural dimension, specific information regarding national cultural adaptation or localization of management talent was not found. However, TPS is certainly a strong component of Toyota culture, and Toyota's intense work to develop and improve suppliers is, in fact, work to diffuse Toyota's TPS culture into its supply base, thereby creating close cultural proximity. Jeffrey Liker, a notable scholar of Toyota, often uses values-laden terms to describe how Toyota works with it suppliers. In "The Toyota Way Fieldbook," regarding this, he states, "The key word is 'parent.' It implies leadership and long-term relationship. It connotes trust, caring, and mutual well-being, yet also signifies discipline, being challenged, and improvement." Such descriptions lend credence to the notion that Toyota's efforts at supplier development are beyond short-term transactional in nature and are aimed at deeper, cultural development.

Finally, along the electronic dimension, Toyota also exhibits some characteristics of close supply chain proximity. It has close integration with suppliers' MRP systems, allowing it to monitor production performance real-time. This ensures that Toyota learns of supplier problems and can engage the supplier in problem-solving quickly, a critical capability for its JIT manufacturing system. (Liker and Meier, The Toyota Way Fieldbook 280)

Liker and Thomas Choi present what they term "The Supplier-Partnering Hierarchy," a six-step framework which summarizes both Toyota's and Honda's supplier partnering models (Figure 6). Both companies engage in each of the six steps, but the hierarchical nature of the framework indicates which steps are dependent on previous steps. In the list below, subsequent steps are dependent on the previous steps:

1. **Understand how your suppliers work**
    a. Learn about supplier's businesses
    b. Go see how suppliers work
    c. Respect suppliers' capabilities
    d. Commit to co-prosperity

2. **Turn supplier rivalry into opportunity**
    a. Source each component from two or three vendors
    b. Create compatible production philosophies and systems
    c. Set up joint ventures with existing suppliers to transfer knowledge and maintain control

3. **Supervise your suppliers**
    a. Send monthly report cards to core suppliers
    b. Provide immediate and constant feedback
    c. Get senior managers involved in solving problems
4. **Develop suppliers' technical capabilities**
    a. Build suppliers' problem-solving skills
    b. Develop a common lexicon
    c. Hone core suppliers' innovation capabilities

5. **Share information intensively but selectively**
    a. Set specific times, places and agendas for meetings
    b. Use rigid formats for sharing information
    c. Insist on accurate data collection
    d. Share information in a structured fashion

6. **Conduct joint improvement activities**
    a. Exchange best practices with suppliers
    b. Initiate *kaizen* projects at suppliers' facilities
    c. Set up supplier study groups

Figure 6: Toyota's & Honda's Supplier-Partnering Hierarchy

Mapping these practices to the Supply Chain Proximity framework confirms that Toyota works to develop close proximity along all four dimensions of supply chain proximity, as illustrated in Table 6.

Table 6: Mapping of Toyota Supplier-partnering practices to Supply Chain Proximity framework

Toyota Supplier-Partnering Practices	Relevant Supply Chain Proximity Dimension(s)
Conduct joint improvement activities	• Geographic • Cultural • Organizational
Share information intensively but selectively	• Electronic (potentially)
Develop suppliers' technical capabilities	• Geographic
Supervise your suppliers	• Geographic • Electronic
Turn supplier rivalry into opportunity	• Organizational
Understand how your suppliers work	• Geographic • Cultural

CISCO

Cisco is well known today for its completely outsourced supply chain model for manufacturing. But early in the company's life, Cisco did significant manufacturing in-house. It was over the course of 15 years or so that the company transformed its manufacturing from an in-house model to a fully-outsourced model. Even today, Cisco continues to refine and evolve its supply chain management practices. Along the way, several dimensions of supply chain proximity have seen significant changes. Cisco is a good example of dynamic management of supplier relationships in the face of changing operations strategy and evolving technology.

Until two or three years ago, Cisco maintained extremely close proximity with suppliers along the electronic and organizational dimensions of supply chain architecture. In most cases, it purchased and owned the component inventory that was held at and used by its contract manufacturers (CMs). Cisco also placed terminals for its own Oracle MRP system on the factory floor of its Tier 1 CMs. Among other things, Cisco's MRP system generated forecasts which dictated CMs' production schedules and volumes and also housed all bill of materials (BOM) information. Under this scheme, Tier 1 CMs served primarily as manufacturing capacity only. Supply chain management and assets (inventory, MRP system) were owned by Cisco, hence close organizational proximity. Exchange of data electronically was all performed on Cisco's own MRP system, hence close electronic proximity.

In 2006, however, Cisco began undertaking a lean initiative which has resulted in significant transformation in how it interacts with its Tier 1 CMs. (Cisco) Although Cisco still dictates sources and prices of components to its Tier 1s, the Tier 1s do the actual component purchasing and own the

inventory. Because they own the inventory, Cisco now allows them to manage it using their own internal MRP systems rather than Cisco's. There is still significant electronic data exchange and transparency between the firms, however, through a B2B exchange system. First, Cisco provides monthly and weekly forecasts to the CMs to guide their ordering of components. Second, Cisco provides a demand, or build, signal directing actual production schedules and volumes and including the BOM. Third, Cisco pushes BOM updates to the CMs on regular basis. Finally, CMs provide visibility to Cisco of their inventory and production through daily transmission of a "Supply Chain Data Transfer," also accomplished through a B2B exchange.

Person-to-person electronic communication is another aspect of supplier relationships that is evolving significantly at Cisco. Through extranet connections with its Tier 1s, Cisco has long used IP telephony to conduct tele- and videoconferences. But within the last year or so, they have begun developing "collaboration communities," utilizing more advanced communication technologies. Through their recent purchase of Webex and introduction of the Telepresence product, Cisco actually owns some of the technology it has begun utilizing. Webex allows for more multi-media interaction than typical teleconferences by supporting file sharing, instant messaging, video conferencing and synchronized sharing of presentations on each participant's computer. Telepresence takes videoconferencing to an extremely high level of quality, to the extent that participants feel as if they are in the same room with their remotely-located counterparts. In addition to Webex and Telepresence, Cisco is also exploiting wikis as a way of sharing information across organizational boundaries.

In terms of supply chain proximity, these recent moves represent a distancing along the organizational dimension, since Cisco "owns" less of the assets and activities of its supply chain. This has also resulted in a distancing of proximity along the electronic dimension with respect to data exchange. However, there has been an offsetting increase in proximity with regards to electronic people-to-people communication and collaboration. Whether or not this has been a conscious decision, it may be that the two opposite moves along the electronic dimension will result in a net zero change in electronic proximity. It is also interesting to consider the blurring of the boundary between electronic and geographic proximity that is occurring with the arrival of the latest communication technologies like Telepresence. As videoconferencing and other collaborative tools become able to convey more subtle and non-verbal aspects of people-to-people interaction as well as enabling more kinds of people-to-people interaction to occur remotely (e.g., factory tours via streaming video, training via video, etc.), the concept of "geographic proximity" may have to be redefined.

While specific cost and savings numbers were not available, Cisco's efforts to improve in the area of supply chain management are reflected in its position in AMR Research's "Supply Chain Top 25" rankings. From being unranked in 2004, Cisco has climbed in the rankings consistently year-over-year and was ranked as having the eighth best supply chain in the world in 2008. Company interviews confirmed that Cisco has increased inventory turns and managed costs more effectively as a result of these efforts.

CHAPTER 4: ANALYSIS OF SIKORSKY'S RELATIONSHIP WITH CHANGHE FOR PRODUCTION OF THE S-76 AIRFRAME

INTRODUCTION

Analysis of Sikorsky's relationship with Changhe vis-à-vis the S-76 airframe program is presented here as a demonstration of how the frameworks and case studies presented in the preceding chapters can be applied in ways to help a company strategically architect the relationship aspect of its supply chain architecture. Although Sikorsky and Changhe's cooperation on the S-76 is still in its infancy, enough collaboration has occurred that useful insights can be made and improvement opportunities identified. In fact, this type of analysis should ideally be done even before collaboration between two firms begins, and re-visited over time as strategic or operational circumstances change.

This analysis will consist of three parts. First, based on the characteristics of the product and firms involved, an "ideal" relationship's characteristics will be established. After that, the actual current state of relationship will be detailed. Finally, opportunities to improve the current state to the more ideal state will be identified. The notion of "proximity" laid out in the Supply Chain Proximity framework will serve as the primary means of describing relationship characteristics.

SIKORSKY'S RELATIONSHIP WITH CHANGHE: IDEAL STATE

The Supply Chain Proximity framework suggests that there is a range of "proximity" that customers can have with their suppliers and that the appropriate proximity, and therefore, appropriate relationship, depends on the relevant product's architecture. Ferdow's Strategic Role of Foreign Factories framework suggests that appropriate relationship is also based on the strategic role a factory plays within a company's factory network. And Moeller et al.'s SRM framework that it is based both on strategic importance and relationship contribution. All three frameworks will be utilized below to examine what type of relationship Sikorsky should ideally have with Changhe.

Product architecture & supply chain architecture

The first step in analyzing the appropriateness of a given supply chain architecture is to analyze the relevant product's architecture. Recalling the Supply Chain Proximity framework, products having modular architecture tend to be best-supported by modular supply chains and products having integral architecture tend to be best-supported by integrated supply chains. The product in the case of Sikorsky's relationship with Changhe is the S-76 helicopter airframe.

The product architecture of the S-76 airframe was already analyzed in Chapter 2 as an example, and found to be highly-integral in nature. Table 7 contains a summary of characteristics regarding the integrality of the S-76 airframe's product architecture. Given that the S-76 airframe's product

architecture is integral in nature, it would be best supported by an integral supply chain. Integrality of supply chain architecture is achieved through close proximity and therefore close relationship.

Table 7: S-76 Airframe integral product architecture

Characteristics indicating integral product architecture	Examples
Components with multiple functions	• Fuel Cell stores fuel and provides aerodynamic surface • Upper Cabin Assembly houses other systems, provides structural strength and serves aerodynamic surface
Non-standard interfaces	• Frame components' interfaces custom-designed • Avionics system custom-designed • Frame components often manually "custom fit" together, requiring craftsman-like skills from technicians
High level design parameters dependent on multiple components	• Overall airframe weight is critical and depends on all components' individual weights
Non-individually upgradeable components	• Custom nature of avionics and other electronics prevents upgrading of many other components
Highly-customizable	• BOM varies by aircraft according to customer requirements and latest engineering changes • Parts shortages sometimes delay completion only of specific aircraft

Factory strategic role

Looking at Changhe as an extension of Sikorsky's own factory network is another way to analyze what type of relationship Sikorsky should seek to develop with it. According to Ferdows, factories can play one of six roles, with varying levels of strategic performance and varying implications for investment and relationship. The way to determine the factory's role is to, "start by answering two basic questions...What is the primary strategic reason for the factory's location? What is the scope of its current activities?" (Ferdows 76-77)

Primary strategic reason for Changhe's location

While China is a low cost country (LCC), Sikorsky's primary motivation for manufacturing the S-76 airframe there is not access to low cost labor to serve export markets. The S-76 airframe is already being produced in the Czech Republic, another LCC. Changhe is merely serving as the second source for the airframe. Developing a second source for the airframe was itself a short-term strategic move aimed at mitigating single-sourcing risks (hold-up, supply chain disruptions, etc.). But the second source didn't have to be in China. China was chosen as a location primarily for market access. China promises to be a

significant market for commercial helicopters in the future as civil aviation there becomes deregulated, and Sikorsky hopes to position itself to better serve that market by producing helicopters there. Local production assists market access in two ways. First, in the aerospace industry, it is common for developing countries to favor aircraft manufacturers who make at least a portion of their aircraft locally. Second, producing locally will help Sikorsky compete on price better with local competitors by accessing local-cost design and manufacturing labor and mitigating tariff and exchange rate pricing risks.

A secondary aspect of market access that has been important for Sikorsky is that of regulatory acceptance. Sikorsky initially attempted to set up manufacturing operations in China for another commercial aircraft airframe in a joint venture with a local private investor. They quickly realized, however, that without a state-owned partner, they would find it difficult or impossible to gain regulatory approval of the aircraft they manufactured by CAAC, China's equivalent of the U.S.'s FAA. But by reforming the joint venture to include Changhe, a state-owned enterprise under the umbrella of AVIC, China's parent aerospace company, they gained the connections, or *guanxi*, to ensure regulatory approval for aircraft they manufactured in China. So, once China was chosen as a location for the purpose of market access, partnering with Changhe in particular was also a strategic move designed to gain market access.

Scope of current activities at Changhe

Sikorsky first began partnering with Changhe in the mid 1990's on the tail pylon of the S-92 commercial helicopter. Changhe signed on as a risk-sharing partner providing design, prototyping and manufacturing services in exchange for a share of the aircraft's profits. The collaboration has been successful, and Changhe still manufactures the S-92 tail pylon, manages the supply chain for its raw materials and supports Sikorsky with engineering and design services related to it.

Collaboration on the S-76 airframe represented a significant step-change in complexity of collaboration for the two companies. While Changhe has to-date not provided design or engineering services for the airframe, manufacture and testing of the airframe is much more complex than that of the S-92 tail pylon. Preparation for the program began in 2007, and actual manufacturing began in 2008. During the initial phase of the program, Changhe will merely assemble airframes from kits of parts delivered from Sikorsky's global supply chain. Management of the supply chain is actually being jointly managed by Changhe and Shanghai Sikorsky, under the direction of a Sikorsky Global Supply Chain Manager sitting in Shanghai.

Aero is also playing a fairly unique role in the program at Changhe. Despite being Changhe's competitor (as the original single-source supplier for the airframe), they are supplying kits of almost all sheet metal components to Changhe for the first phase of the program. They are also serving as a purchaser and consolidator of most other components for the airframe during this phase. Shanghai Sikorsky originally planned to assist Changhe in purchasing many of the non-sheet-metal components directly, but found that many suppliers were wary of dealing with a Chinese customer, or were taking advantage of the situation to try and boost the prices paid for their components.

Expectations now are that in the second phase of the program, Changhe will locally source most of the sheet metal components, directly purchase other components and will also begin to play a more independent role in managing the supply chain for the airframe. Further into the future, design and engineering collaboration is expected, with the goal of some day jointly designing and producing and "all-China" helicopter for the local market.

Placing Changhe in the strategic role framework

To summarize the above, Changhe's location, China, is currently strategically important for the purpose of market access. Its current activities are primarily assembly-only, with some limited design and engineering activities (for the S-92 tail pylon) and some limited responsibility for the supply chain (S-92 fully and S-76 in a limited way). These match characteristics of Server and Contributor factories most closely (Table 3 in Chapter 2 or Table 8 below). The current position is weighted more heavily towards a Server factory, but given the future plans to increase product development and supply chain management roles of Changhe, their strategic role will shift to more of that of a Contributor factory.

Table 8: Strategic roles of foreign factories

Factory Type	Factory's Strategic Role	Required Investments
Server factory	• Access to local markets • Limited product modification	• Low level of product engineering skills & resources
Contributor factory	• Access to local markets • Product and process development • Supply chain management	• Skilled engineering and management talent & resources • Supply chain management skills

Now that Changhe's strategic role has been identified, the next step is to consider the implications this has for how Sikorsky should manage its relationship with them. For the manufacturing-only aspects of the collaboration, relatively lower levels of investment are required in terms of skill development or transfer. Enough collaboration to effectively teach Changhe how to properly assemble the airframe is all that is needed. Perhaps intense, but short-duration, on-site training from Sikorsky manufacturing personnel would suffice. But for the Contributor roles, larger amounts of investment are required. Joint product development will require sustained, intense cross-organizational interaction. Supply chain management skills will also have to be transferred, and given that Changhe is expected to take more responsibility for the supply chain management role in the near future, it makes sense that investment in developing this capability should begin presently. Overall, the amount of inter-organizational collaboration necessary to prepare Changhe for and sustain it in its strategic roles indicates that Sikorsky needs to foster a relationship with Changhe that results in close supply chain proximity.

Developing Changhe to be a Contributor factory, though, also entails risks. Changhe is already a finished-product helicopter manufacturer and therefore a potential Sikorsky competitor. Realistically, it will be a long time before Changhe is competitive on a global scale, but it could very quickly develop strong enough capabilities to compete against Sikorsky in China and other developing-world markets. When looking at Changhe's current capabilities, design, global supply chain management and sales and marketing are functions that stand out as weaknesses. Developing Changhe's capabilities to serve as a Contributor would involve boosting their capabilities in two of these three functions. Therefore Sikorsky's actions to develop Changhe as a supplier will also serve to develop a stronger potential competitor. This risk of collaboration may be justified by the benefit of China market access. In other words, it may be better to share the market with Changhe as a condition of access rather than being only able to offer expensive non-China manufactured products to the Chinese market. Also, Sikorsky can potentially mitigate the risk of competition by continuing to develop a closer relationship with Changhe to the extent that they are able to serve the Chinese market primarily as partners rather than as adversaries.

Another risk that comes with deeper collaboration involving product development is inappropriate usage of intellectual property (IP). Collaborating on product development will undoubtedly involve sharing of proprietary technology and designs with Changhe by Sikorsky. Sikorsky should definitely have systems in place governing access to, and usage of, its IP. But even with preventative measures in place, risk will remain. China has a poor history of IP protection, and with Changhe's status as a state-owned enterprise, it is hard to imagine it ever being held liable by Chinese courts for infringement of Sikorsky's intellectual property rights. Mitigating the risk of IP misuse will require Sikorsky carefully thinking through which types of components or systems are "safe" to collaborate on and which are not, and limiting collaboration in product development to "safe" components. Interviews with Sikorsky management indicated that this risk is being considered and planned for accordingly.

Supplier relationship management framework

Another take on determining the level of relationship suitable in developing a particular supplier is Moeller et al.'s Supplier Relationship Management framework's strategic importance vs. relationship contribution matrix (Figure 2, pg 16). Along the dimension of strategic importance, Changhe would rank mid-to-high importance, since they are considered to be key to accessing the China market in the future, but aren't playing that role yet (since the market isn't yet developed). Along the dimension of relationship contribution, Changhe ranks fairly low. They currently provide minimal design and engineering support and minimal supply chain management. They primarily provide manufacturing capacity only. This would indicate that Changhe should be categorized as a "Potential Value Enhancer" placed in the upper-left quadrant of the matrix. According to SRM, Changhe can be managed by either Development Management or Contract Management, or some combination of the two. However, if Changhe's relationship contribution grows over time, as Sikorsky expects it to, it will become a Real Value Enhancer (top right quadrant), suitable for a greater degree of Development Management.

To the extent that Sikorsky believes it should pursue a Development Management type relationship with Changhe, it should be prepared to make specific investments to the relationship that will allow Changhe's performance as a supplier to improve over time. These specific investments would likely consist of training and teaching resources in the form of one or two-way people exchanges.

Because Sikorsky's relationship with Changhe is still relatively young, at least with respect to the S-76 program, it would still be worth considering Set-up Management aspects of SRM as well. During the Set-up Management phase of the supplier relationship, both the customer and supplier need to make "valuable and necessary" investments in the supplier according to the supplier's potential strategic value. One primary benefit of these investments is to signal relationship commitment and build trust. Given that Sikorsky's plan is for Changhe to be a fairly strategic, long-term supplier and partner in China, it makes sense for there to be this type of investment made early in the relationship.

Supply chain proximity conclusion

All three frameworks suggest that Sikorsky should seek relatively close supply chain proximity to Changhe. The S-76 airframe's architecture is highly integral and can be best produced by an integral supply chain. Changhe's strategic role as a factory is significant and will grow over time, as will its relationship contribution. Specific investments made as part of the Set-up Management and Development Management phases of SRM would be appropriate.

SIKORSKY'S RELATIONSHIP WITH CHANGHE: CURRENT STATE & IMPROVEMENT OPPORTUNITIES

The next step in the analysis is to determine what the current state of relationship with Changhe is by examining each of the four dimensions of supply chain proximity (geographic, organizational, cultural, electronic) and then determining what is being done well and what opportunities for improvement there are.

Comparison with Toyota partnering model

Comparison with Liker's Toyota supplier partnering model provides a quick, high-level view of how well Sikorsky is doing in managing its relationship with Changhe versus best practices. Overall, Sikorsky appears headed in the right direction, with activity in five of the six levels of the Toyota supplier partnering hierarchy (Table 9). The very top level, joint improvement activities, is not something Sikorsky is engaging with Changhe on in any sustained, formal way currently. However, production is in its very beginning stages and so it is not possible to conduct such activities across the full-breadth of operations there yet. Even at this early stage however, there are opportunities to work with Changhe on visual management and 5S implementation on its factory floor. A one-off materials management audit of Changhe was conducted recently by Shanghai Sikorsky procurement team staff and the improvement opportunities discovered were well received by Changhe. This might indicate they will be welcoming of future joint improvement activities.

However, depth of activity or investment in the other five levels does not yet compare favorably with the Toyota model. Systems and norms for collaboration are in place, but the amount of and level of people involvement by Sikorsky is not yet comparable with Toyota. Currently there is no engagement from Sikorsky upper management in relationship building and problem solving. Sikorsky has what amounts to a skeleton crew of staff located at Changhe, which is capable of facilitating and managing the collaboration, but not capable of ramping-up at the pace desired by Sikorsky. Additionally, there is no Changhe staff co-located at Sikorsky or Aero facilities.

Comparison with Toyota partnering model: Improvement opportunities

UTC has developed its own version of TPS called ACE (Achieving Competitive Excellence) and is quite far down the path in its implementation in many of its businesses. UTC has corporate staff that assists facilities with ACE implementation and has even begun pushing ACE into the supply base. There are multiple UTC facilities in China that have achieved "ACE Gold," UTC's highest rating for ACE implementation and compliance. Given these resources, Sikorsky might consider moving towards conducting "Level Six" partnering with Changhe by:

- Giving Changhe production staff and management tours of a UTC facility in China that has achieved ACE Gold and explaining the key components of the system.
- Deploying a UTC or Sikorsky team to Changhe to conduct joint kaizen events. This could be done now, with a focus on factory floor visual management and 5S, or in the future, with a focus on actual production flow.

In terms of people investment, Sikorsky has several opportunities for improvement:

- Get high-level (VP or higher) Sikorsky management more engaged in the collaboration on both relationship building and problem-solving.
- Improve development of Changhe's capabilities by co-locating some of their staff at Sikorsky or Aero
- Increase the amount of Sikorsky people resources co-located at Changhe

Table 9: Sikorsky vs. Toyota's supplier partnering hierarchy

Toyota Supplier-Partnering Practices	Sikorsky Activities at Changhe
Conduct joint improvement activities	• N/A
Share information intensively but selectively	• Exchange drawing, work instruction and engineering change orders
Develop suppliers' technical capabilities	• Minimal staff co-located at Changhe • No Changhe staff co-located at Sikorsky • Competing supplier sends production workers to train Changhe's workers • Shanghai Sikorsky assisting in supply chain management
Supervise your suppliers	• Minimal staff co-located at Changhe • Regular program review meetings • Visibility into Changhe's inventory and production • No engagement by Sikorsky upper management
Turn supplier rivalry into opportunity	• Dual-sourcing at Changhe • Utilizing competing supplier to train Changhe
Understand how your suppliers work	• Minimal staff co-located at Changhe • No co-location of Changhe staff at Sikorsky • Local Chinese employees on Sikorsky procurement team • Changhe representative on Shanghai Sikorsky management team

Sikorsky in the Supply Chain Proximity framework

When viewed at a very high level, the supply chain proximity between Sikorsky and Changhe is fairly distant along all four dimensions (Figure 7). Sikorsky is headquartered in Stratford, Connecticut, as are the bulk of its engineering, manufacturing and supply chain staff. Changhe is headquartered 7,500 miles away in Jingdezhen, China, where its entire staff is located. Organizationally, the companies share ownership in the JV Shanghai Sikorsky, which is primarily tasked with supporting supply chain management for the S-76 program at Changhe. The JV structure of Shanghai Sikorsky, however, has little impact on its day to day operation. Sikorsky is a publicly-traded American company. Changhe is a state-owned Chinese company. Both are independently operating subsidiaries of larger parent companies. Finally, Sikorsky and Changhe have separate and non-integrated ERP systems. There is, however, an electronic system utilized for ordering product and exchanging technical information (drawings, change orders, etc.) called the Supplier Data System (SDS). Electronic communication consists of email, telephone calls and teleconferences.

Analyzing supply chain proximity at a more granular level, however, is a more useful exercise. It reveals a variance of proximity within each dimension, either by function (e.g., procurement vs. manufacturing) or by sub-element (e.g., MRP systems vs. CAD systems in the Electronic dimension). It

also allows for very specific practices and situations to be identified and evaluated. What follows is a more granular analysis of the four dimensions of supply chain proximity between Sikorsky and Changhe.

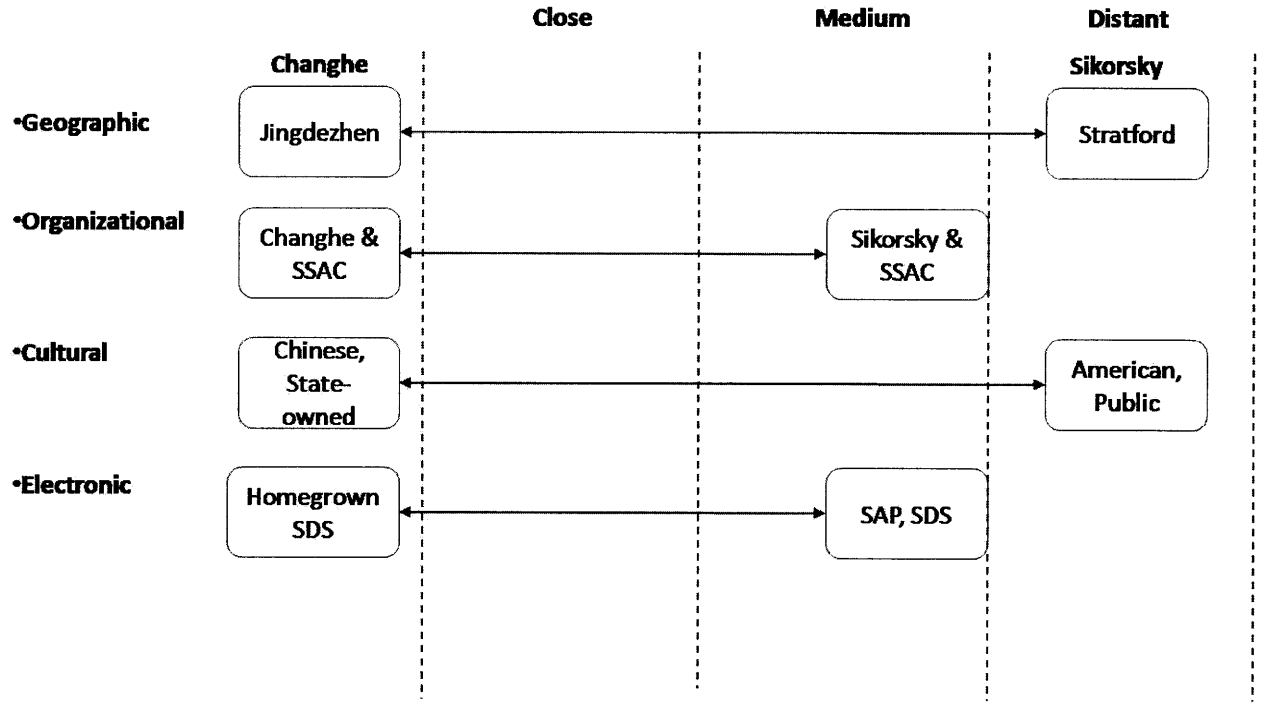

Figure 7: High-level supply chain proximity between Sikorsky and Changhe

Geographic dimension

Along the geographic dimension, there is a variance in geographic proximity of the various organizational functions with their Changhe counterparts. While all Changhe personnel are located in Jingdezhen, China, Sikorsky has people from various functions located closer to, and in higher numbers than others to Jingdezhen. (Figure 8)

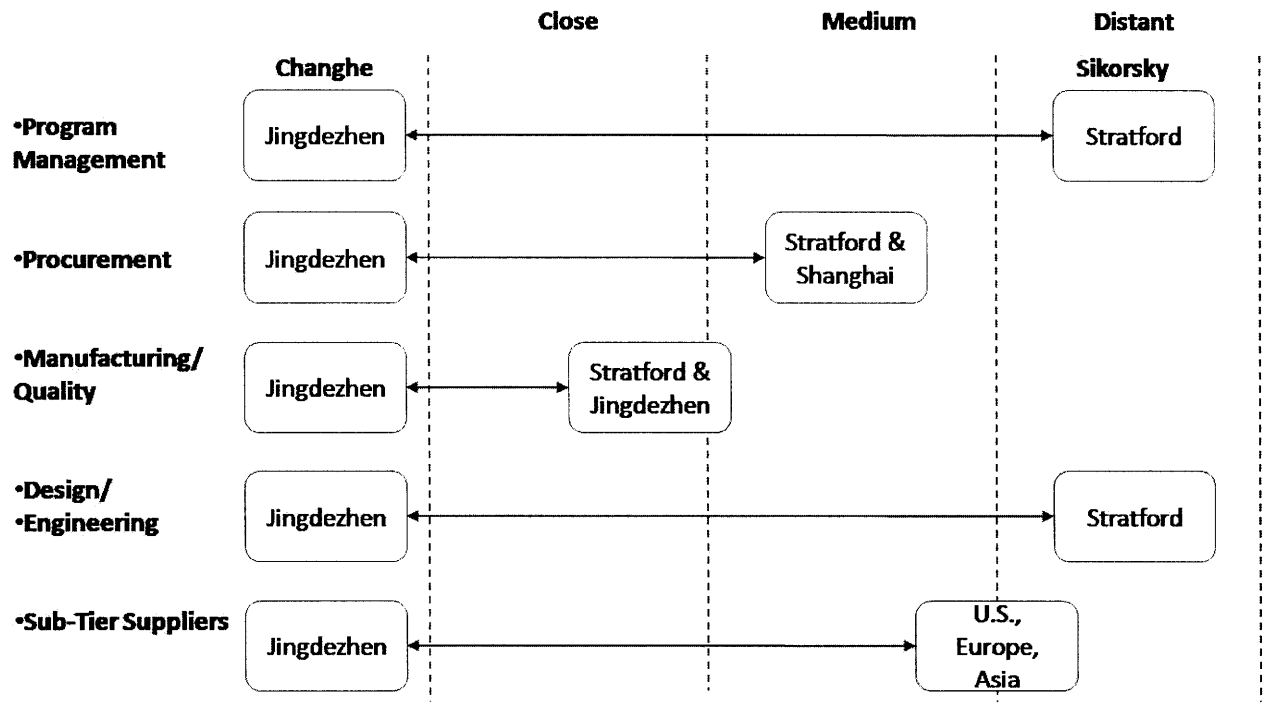

Figure 8: Functional-level geographic supply chain proximity between Sikorsky and Changhe

- Program management for the S-76 is based in Stratford, with trips to Jingdezhen for program reviews approximately quarterly.
- Procurement has a team of seven people located at Shanghai Sikorsky in Shanghai, China
- Manufacturing and quality have between seven and 10 people co-located at Changhe's factory supporting ramp-up of the S-76 program and ongoing production of S-92 tail pylons.
- Design and engineering are located in Stratford, with little or no presence in Jingdezhen currently, except for support of the S-92 tail pylon.
- Sub-tier suppliers are all located outside of China, with localization of certain content planned for the future.

Geographic dimension: Procurement

Shanghai, the location of Sikorsky's procurement team in China, is approximately 375 miles from Jingdezhen. This distance is certainly geographically much closer to Jingdezhen than is Stratford (7,500 miles). Travel time from Stratford to Jingdezhen requires a minimum of two days travel time each way, in addition to having to deal with visas, jet-lag and other international travel inconveniences. Travel time to Jingdezhen from Shanghai is only one hour and doesn't require dealing with international travel inconveniences. However, despite the fact that a Sikorsky procurement team is located in the same country as Changhe, face-to-face interaction with Changhe counterparts does still require a plane flight from Shanghai to Jingdezhen, or vice versa.

As a result of this remaining separation, most interaction with the Changhe procurement department still occurs via email and telephone, albeit from within the same time zone. Additionally, the quality of teleconferencing equipment and internet access at the Shanghai Sikorsky office are poor and make even this remote communication less effective than it could be. Purchasing agents from each organization rarely have face-time with each other. According to Allen, the frequency with which they communicate with each other also suffers as a result of this physical separation. Recall that Figure 5 indicates that almost all of the benefits of physical proximity with regards to communication frequency are realized within a physical separation of 50 meters or less. So while 375 miles of separation is better than 7,500 miles, it may not be good enough to achieve truly close geographic proximity.

By being in Shanghai, Sikorsky is capturing some of the benefits of being in the China. In addition to closer geographic proximity to Changhe, China has lower cost labor than the U.S. and also a larger pool of bi-lingual professionals. But, one might ask, why didn't Sikorsky choose to co-locate its procurement team in Jingdezhen at the Changhe factory where it does have other personnel co-located rather than in Shanghai? Part of the reason is that Shanghai Sikorsky's Shanghai office was already in existence and had underutilized procurement staff, which allowed faster ramp-up of the procurement function for the S-76 program in China. In addition to this, Jingdezhen is a small, interior city, making it more difficult to locally hire high quality bi-lingual professionals and is an unattractive relocation option for both expatriate and Chinese managers.

One interesting paradox of geographic proximity is that moving closer to one supplier might move the customer farther away from its other suppliers. Currently, Changhe is the only S-76 airframe supplier in China. Most components are produced in the U.S. or Europe. But since the China S-76 airframe procurement team is now located in Shanghai and made up of Chinese procurement agents, there is no one in the U.S. responsible for managing U.S. suppliers, and no Americans to do the communicating with them from China. So, geographic proximity with suppliers in the U.S. and Europe has become more distant as a result of Sikorsky's decision to base the procurement function in Shanghai. This has led to time lags in communicating with suppliers. This geographic move has also led to a distancing culturally between Sikorsky and its suppliers. Language barriers cause difficulties at times. Additionally, some of the local Chinese staff in Shanghai have little experience in working with western suppliers and using the more direct, and sometimes even aggressive, communication tactics necessary when working with them.

Geographic dimension: Procurement improvement opportunities

Given that the procurement team has already been established in Shanghai (for some very legitimate reasons), achieving closer geographic proximity with Changhe will require overcoming the remaining 375 mile gap between the two companies' locations. This can be accomplished in several ways:

- Increase the frequency of trips to Jingdezhen by Shanghai Sikorsky staff. Travel between the two locations is inexpensive and relatively convenient, and will result in significantly more face-time with Changhe counterparts.

- Co-locate part of the procurement team at Changhe. Since co-locating the entire team is not currently feasible, co-locating a few members represents a partial solution. They can serve as the "face" of the Shanghai-based procurement team to Changhe. The manager of the Shanghai Sikorsky procurement team, in fact, already has plans to co-locate a team member at Changhe.
- Improve the quality of telecommunications equipment and internet access. Ensuring that teleconferences are clear will improve the effectiveness of remote communication, especially since Chinese staff often must communicate in their second language (English) with Sikorsky managers. Use of videoconferencing would help even more.
- Consider a "split" procurement team that still has members located in the U.S. who are in the same time zone as American suppliers, are able to communicate more fluently in English with these suppliers and are experienced in the tactics and communication styles effective in dealing with them.

Cultural dimension: U.S. & China national culture differences

Hofstede's five dimensions of national cultural difference provide one good framework for more closely analyzing the nationality aspects of cultural proximity between Sikorsky and Changhe.

According to the values for each dimension listed in Figure 9, Masculinity and Uncertainty Avoidance represent aspects of national culture where Sikorsky and Changhe have close proximity, while the other three dimensions represent aspects of national culture where they do not have close proximity.

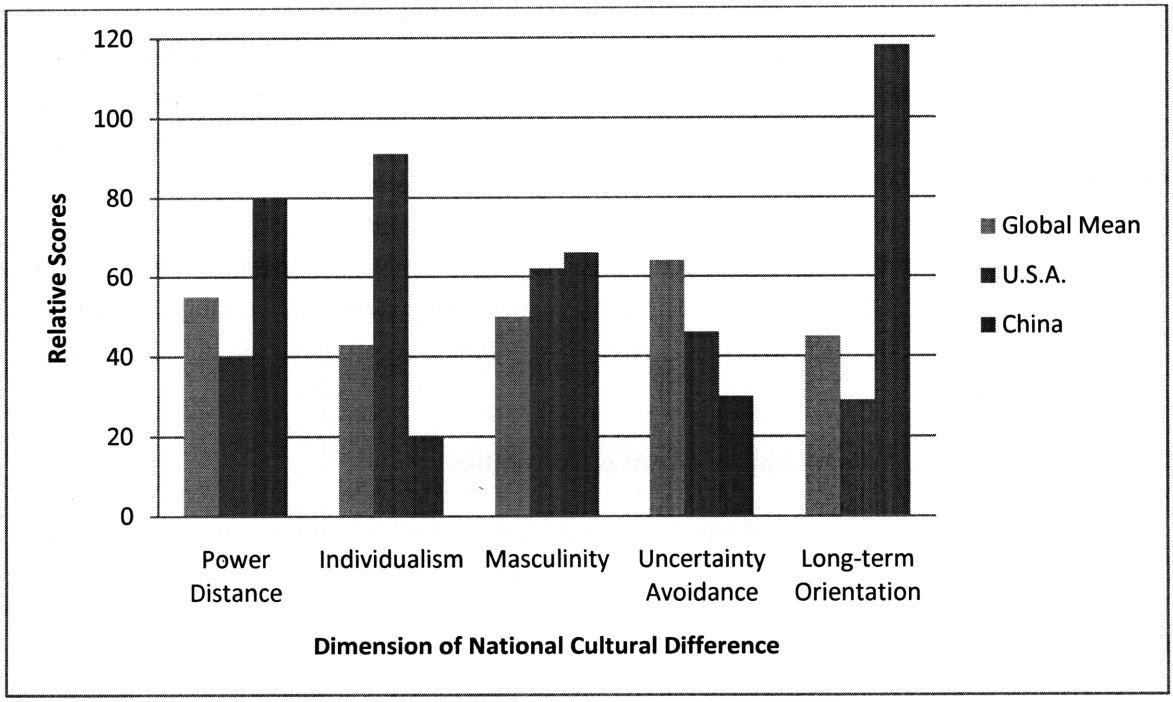

Figure 9: Hofstede dimensions of national cultural difference for the U.S. and China

China's relatively higher power distance score means that Changhe is likely to have a more hierarchical organizational structure where decision making is more centralized than at Sikorsky. This type of mismatch does exist in the procurement functions within each organization. Sikorsky's expatriate manager who leads the procurement team in Shanghai has much greater decision making authority from Sikorsky than his counterpart at Changhe has from Changhe's management. In fact, he has decision making authority on the order of Changhe's VP of Procurement. But because of the hierarchical nature of Changhe's organization, it is difficult for Sikorsky's supply chain manager to gain access to Changhe's VP of Procurement. Changhe's likely point of view is that their VP of Procurement should deal directly with Sikorsky's VP of Supply Management. But currently, Sikorsky's VP of Supply Management is not involved in-depth with the S-76 program at Changhe and has no relationship with his counterpart there. All of this has led to inefficiencies in helping Changhe negotiate contracts with sub-tier suppliers and frustrating delays.

Similarly, the mismatch along the Individuality dimension has caused frustrations for Sikorsky. China's low individuality score indicates that Changhe employees might have a preference for group decision making and place high value on consensus. Rather than being able to reach immediate conclusions during conversations or negotiations, the response of Changhe's representatives is often that they must confirm decisions with others in the organization. This is certainly partially due to the Power Distance issues discussed above, but also derives from a desire to make final decisions in a collective way.

This Individuality mismatch may have even hurt procurement efforts from the very beginning. Purchase contracts with certain sub-tier suppliers were negotiated by Sikorsky on Changhe's behalf before engagement with Changhe's procurement department began. Sikorsky likely thought that as a company that was experienced in dealing with these sub-tier suppliers and had existing relationships with them, they were doing Changhe a favor by negotiating ahead of time for them on their behalf. It is easy to see how this, "We are the experts, so let us do this for you," mentality, while helpful in intent, may only fit well in a culture with high individualistic orientation. But rather than accept these contracts negotiated on their behalf by Sikorsky, Changhe has chosen to renegotiate some of the more significant ones, leading to delays in purchasing component inventory. Given China's high collectivist orientation, if Sikorsky had used a "We're the expert, so let's do this together" approach to negotiating purchasing contracts, Changhe might have found the same exact outcomes of negotiations to be more acceptable because all relevant parties would have been involved in the decision making.

China's much stronger relative Long-term Orientation indicates that Changhe will in general be more long-term future-oriented in its strategy for its relationship with Sikorsky. Sikorsky is likely to be more focused on the speed with which the relationship can begin to generate profits, while Changhe may be more focused on positioning itself to be a major contender in the aerospace industry in the future. This is reflected in a perceived lack of urgency on their part by Sikorsky and an emphasis by Changhe on learning and technology transfer from Sikorsky.

Cultural dimension: U.S., China & Czech Republic national culture differences

Another important aspect of national culture for Sikorsky to consider is the differences in culture between the Czech Republic, where it first outsourced production of the S-76 airframe, and China, the location of its current outsourcing effort. Figure 10 again shows Hofstede scores for the U.S. and China, but this time also with scores for the Czech Republic added for comparison. All three countries have similar scores on the Masculinity dimension. Along the Power Distance and Individuality dimensions, the Czech Republic falls in between the U.S. and China scores, indicating it is more similar to China and the U.S. along these dimensions than the U.S. and China are to each other. Along the final two dimensions, Uncertainty Avoidance and Long-term Orientation, the Czech Republic is even more dissimilar with China than is the U.S.

There are three important implications of these relative scores amongst the three nations. First, the nature of cultural differences they need to deal with at Changhe are different than at Aero, both in type and degree, and so the tactics necessary to deal with them may be different. For example, both the Czech Republic and China score higher than the U.S. in Power Distance. Whatever tactics Sikorsky found useful in overcoming this cultural difference at Aero may be useful at Changhe as well, but may have to be used to a greater degree, given China's even higher Power Distance score. But in the case of Long-term Orientation, Sikorsky can leverage little or nothing from its dealings with Aero to inform it as to how to deal with China – the two countries are polar opposites along this dimension. Certainly, Sikorsky should leverage past learnings from working with Aero at Changhe when appropriate, but this must be done on a case-by-case basis after careful comparison of Chinese and Czech culture.

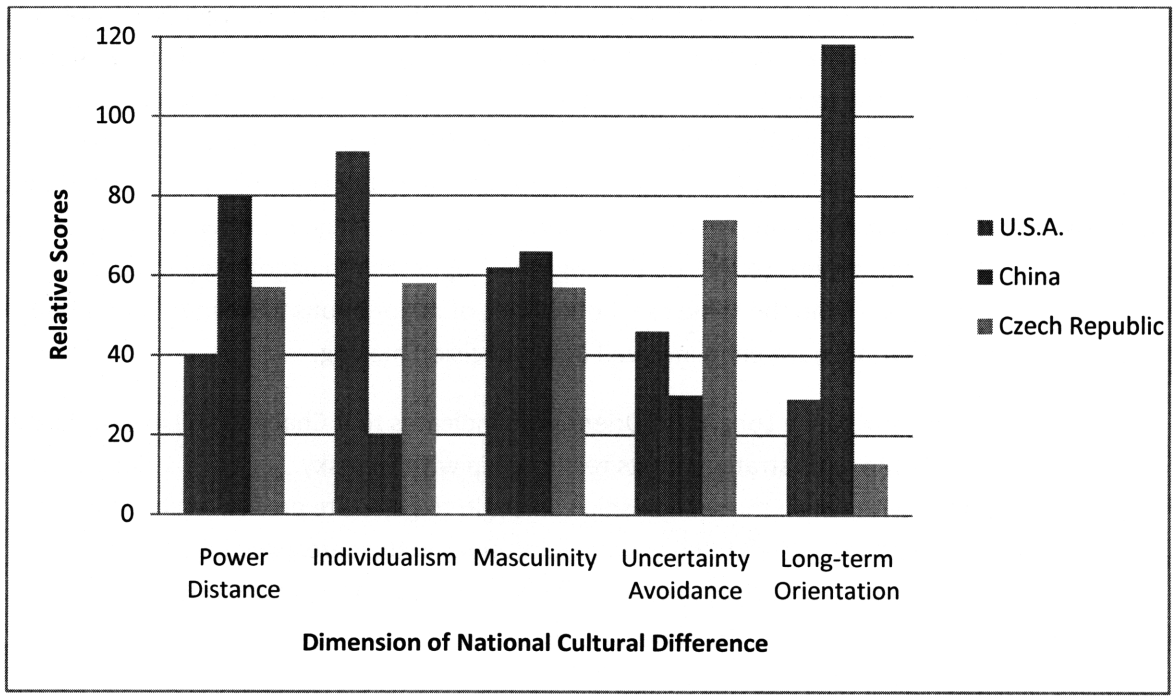

Figure 10: Hofstede dimensions of national cultural difference for the U.S., China and Czech Republic

The second implication of these scores is that Changhe and Aero will have their own set of challenges in working together due to their own differences in national culture. During the first phase of the S-76 program at Changhe, Aero will be the single largest supplier and is also being tapped by Sikorsky to train Changhe how to build the airframe (since Sikorsky no longer has full internal capability in this area). This means that Changhe and Aero have been working together quite closely on the program's ramp-up in China.

One interesting example of conflict in this area has been training of Changhe production staff by Aero's production staff. Aero has sent teams of production workers and engineers to Changhe on a rotating basis to teach them about their tooling and assembly techniques. Aero's technicians, though, felt that rather than willingly accept the techniques they were teaching, Changhe's staff often expressed that their own existing techniques were superior to the ones Aero was teaching them. Several months into the cooperation, one Aero engineering manager remarked that the teams they sent ended up frustrated at what they felt was the Changhe staff's "arrogance" and lack of teachability. He doubted whether there was significant value in continuing to send his people to train Changhe. There are likely multiple factors that led to this particular dysfunction, and national cultural differences are probably amongst them. The Czech Republic and China have a significant mismatch in Long-term Orientation according to Hofstede's analyses. One feature of Short-term Orientation, that held by the Czechs, is a strong respect for tradition. On the manufacturing floor, this very likely manifests itself as pride in technique and a belief that "the way we've always done things" is probably the right way to continue doing them. If Aero's trainers believed this, it may have led them to react strongly against Changhe's seemingly arrogant willingness to discard proven, time-tested techniques for their own techniques. Whatever the reason for Changhe's seeming unwillingness to accept Changhe's technical training, if they had understood their counterparts' Short-term Orientation, expressed as strong respect for tradition, they might have taken a different approach in their response to the training. Perhaps they could have expressed greater appreciation for and admiration of the techniques being taught by Aero while the trainers were present, and then after completion of training, internally make decisions about whether or not to adopt specific techniques.

The third implication is that the customer may need to serve as a kind of cultural coach for its various suppliers that have to work together. Knowing how both Aero and Change operate, Sikorsky can play a valuable role in helping the two suppliers better understand each other in light of national cultural differences. Transfer of cultural learnings from the customer to its suppliers could be a valuable source of joint continuous improvement efforts – continuous relationship improvement.

Cultural dimension: National culture differences & language

Language is, of course, another important component of national cultural difference. Changhe's employees are all native Chinese speakers and most of Sikorsky's employees are native English speakers. Language then, represents a significant barrier to close cultural proximity between the two organizations. Both, however, have bi-lingual Chinese employees who are able to bridge the language

barrier that exists. However, the English skill level of all but a few of the bi-lingual staff is at a fairly basic level. This results in a reluctance to communicate by telephone in situations requiring interaction in English, such as calling U.S. suppliers to discuss problems. It also occasionally results in unclear written communication. Both of these situations lead to a slower accomplishment of tasks. Despite having bi-lingual employees, language is still an element of culture where there is not close proximity between the two organizations or between the two organizations' Chinese staff and the international supply base.

UTC, Sikorsky's parent company, is aware of its need to overcome cultural barriers as it does more business in and with China and is hiring native mainland Chinese who have spent significant time in the U.S. for graduate school and work to return to China and manage its businesses there. Sikorsky is making headway in bringing on bi-cultural, bi-lingual managers as well. Shanghai Sikorsky's current GM is a Chinese man who went to work for UTC in the U.S. after graduate school and recently returned to China to take the GM position. Sikorsky has also placed a Chinese quality engineer who previously worked for Sikorsky in the U.S. on its team co-located in Jingdezhen.

Cultural dimension: Home market characteristics

While the differences in nationality between Sikorsky's and Changhe's employees are significant, they do not represent the only cultural differences between the two organizations. Past and present home market conditions in the two countries are also quite different. China's economy today has a much greater degree of freedom and greater contribution from the private sector than ever before. By almost any measure, it has a free market economy. But there are still vestiges of a state-controlled economy lingering in certain protected industries. Changhe is, in fact, a state-owned enterprise which primarily produces helicopters for the Chinese military. Even as the Chinese economy liberalized, state-owned enterprises were deemed worthy of protection and subsidization by the government in order to keep unemployment levels low and protect certain industries from foreign competition. This is especially the case for ones whose primary customer is the government. The "corporate welfare" that state-owned enterprises often receive has led to a weaker profit-orientation than private-sector firms like Sikorsky.

This is often beneficial to foreign customers who find that these companies will produce and sell goods for unmatchable low prices compared with firms that must be profitable to survive. Because of state-support, these firms are also often amongst the few in a given industry in China with the financial means to invest in the most expensive capital equipment, like the very expensive machine tools required to manufacture many aerospace components. Their weaker profit-orientation, however, also has its downsides. There is typically also a corresponding lack of urgency in doing business that can prove frustrating to profit-oriented firms seeking to bring new products to the market as fast as possible. In the ramp-up of the S-76 project, Sikorsky has often experienced this frustration, as Changhe doesn't seem to prepare ahead of time, allocate additional resources or order component inventory as quickly as Sikorsky believes they should. There are no incentives for on-time or early delivery of products or penalties for late delivery in Sikorsky's contract with Changhe.

In place of strong profit-orientation, many Chinese state-owned firms, or any other Chinese firms, for that matter, have a very strong learning-orientation. They desire to improve their technological capabilities by learning from the world and become world-class manufacturers. This means that often they are more interested in the knowledge they can gain from collaboration with a foreign customer than they are with the short term profit potential of the collaboration. This is one of the reasons, beyond its own strategic interests, that Sikorsky has agreed to collaborate with Changhe in product development at some point in the future. But this learning-orientation also means that Sikorsky must be vigilant about IP protection, especially given China's history of weak legal protection of IP rights.

Cultural dimension: Individual firm experiences

The experiences of a firm, either individually or collectively over time, work to affect the firm's culture. Many Chinese firms still have relatively little experience doing business with foreign customers. And due to various reasons, cultural misunderstandings among them, they have sometimes had negative experiences with the foreign customers they have worked with. This is the case with Changhe. Prior to cooperating with Sikorsky on the S-76 airframe, Changhe began working with Augusta to produce airframes for one of Augusta's helicopters. This program has now been underway for approximately four years, but Changhe has yet to ship their first completed airframe to them. Numerous manufacturing and quality issues have been encountered and Changhe now has a hangar full of completed airframes that it cannot ship to its customer. Instead, it is forced to continue carrying huge amounts of inventory on its books until quality problems are resolved and it is able to ship the completed airframes. Even its past experiences with Sikorsky on the S-92 tail pylon include an instance of Changhe feeling that an agreed-upon material price escalation clause in its contract with Sikorsky was not properly administered, causing Changhe to incur a significant financial loss in the early stages of production of the tail pylon. It should be expected that, collectively, these experiences would lead Changhe to be more risk averse when it comes to purchasing component inventory for new programs than it otherwise would be.

With the current S-76 airframe program, Changhe is solely responsible for much of the up-front investment required. They purchased and own the tooling, are responsible for purchasing test equipment and also purchase and own all inventory. Since the original purchase contract between Changhe and Sikorsky was negotiated, Changhe has insisted on re-negotiating an inventory carrying-cost subsidy, but as of the end of 2008, was still purchasing component inventory at a pace much slower than what Sikorsky wanted.

Cultural dimension: Improvement opportunities

Sikorsky will never become a Chinese company, nor will Changhe ever become an American company. Dominant ethnicities in each organization will ensure that their respective national cultures persist. Similarly, neither company can shed the aspects of their culture determined by their home market or specific experiences. But based on the above analysis, though, there are several opportunities for Sikorsky to improve its closeness with Changhe on the cultural dimension of supply chain proximity.

- Greater engagement of Sikorsky functional leaders, such as the VP of Supply Chain, might result in better access to the real decision makers at Changhe. When someone such as the VP of Supply Chain does visit Changhe, he should be sure to include the on-the-ground Sikorsky managers in meetings he has with Changhe upper management as a means of elevating their status in the eyes of Changhe. Over time, this may result in their being more able to directly engage higher level managers in Changhe on issues they need support on.
- Be more understanding of Chinese counterparts' desire for consensus and collective decision making, as well as the need to adhere to their company's hierarchy by allowing time for multiple rounds of negotiations or conversations before a final decision is demanded.
- Restructuring or amending the contract with Changhe in such a way that Sikorsky engages in more risk sharing up front or makes some type of commitment to Changhe's profitability (a la Toyota) might result in Changhe having a greater comfort level with purchasing inventory and test equipment at the pace Sikorsky wants. This risk sharing could take the form of joint investment in tooling or test equipment. It could also take the form of Sikorsky initially purchasing component inventory and transferring ownership of it to Changhe once it reaches Changhe's factory. This would save Changhe from having to worry over the details of every purchasing agreement with the many component suppliers and purchase only from Sikorsky, with whom they are in partnership.
- Providing English language tutoring to both Shanghai Sikorsky and Changhe staff would lower some of the communication barriers that currently exist.
- Creating rotational positions that allow U.S. employees to spend time in China or vice versa will help Sikorsky's employees become more sensitive to the complexities of working cross-culturally. This idea has already been proposed by Shanghai Sikorsky's procurement team manager and is currently in the planning stage.
- Continuing or even strengthening its practice of hiring mainland Chinese people who have spent significant time working in the U.S. to return to China and manage its businesses there will improve the organization's ability to culturally adapt and educate itself about cultural aspects of doing business in China.

Organizational dimension

One way to analyze the organizational dimension of supply chain proximity is to think of it in terms of specific investments that each firm makes in the relationship, per Moellar et al.'s SRM framework and Ferdow's strategic role of factories: the greater the amount of investment, the closer the organizational proximity between the two companies.

In the case of Sikorsky and Changhe, Sikorsky has made some significant specific investments in people resources. Between seven and 10 Sikorsky staff work with Changhe in China on a full-time basis supporting ramp-up of the S-76 program. Other program management and technical staff also visit Changhe regularly to provide support. Sikorsky's ability to provide people resources however, is somewhat limited. They no longer produce the S-76 airframe in-house and so some of the shop-floor level technical know-how no longer resides in a coherent way internally at Sikorsky. Their single-source

supplier in the Czech Republic, Aero, is now the expert when it comes to building the airframe. Additionally, Sikorsky's business is currently booming, and underutilized people resources are hard to come by. They have however, hired an engineer who formerly worked for Aero and have a program in which Aero sends some of its production workers to Changhe on a rotating basis to teach them how to assemble the airframe. Despite the fact that Aero is a crucial player in the first phase of the program, though, there is no direct linkage between the top management of Change and Aero.

One specific way Sikorsky is investing in the program with people resources is through the formation of Shanghai Sikorsky, a JV with Changhe. One of the primary near-term functions of Shanghai Sikorsky is to provide supply chain management expertise during the early phases of the program, since Changhe has little experience purchasing internationally.

In terms of capital investment, Changhe has carried the large part of the up-front investment burden of tooling, test equipment and inventory. Tooling and test equipment costs are estimated at $1.5M-$2.5M, all of which has been or will be purchased by Changhe. Component inventory costs approximately $2M per airframe, and again, Changhe is responsible for the cost of purchasing and holding inventory. Because the program is in the ramp-up phase and production therefore is moving slowly, it is expected that it will take more than a year to complete the first aircraft after commencement of production. Due to this long production lead time and uncertainties regarding production and inventory lead time, inventory turns are expected to be very low, and inventory carrying costs to be on the order of $160,000 per airframe initially. Sikorsky will reimburse Changhe for a portion of its tooling and equipment costs, but reimbursement will be amortized over several years' worth of production. Sikorsky has also agreed to compensate Changhe for a portion of inventory carrying costs, on the order of $30K per airframe, and has also made some supplementary payments for excessive test equipment costs that were not predicted accurately during initial contract negotiations.

Contrast this with the ramp-up for manufacture of the S-76 airframe at Aero in 2002. At that time, Sikorsky manufactured the airframe in-house, but the aerospace market as a whole was in a down period. 9/11 had led to economic slowdown and the military spending boom from the Afghanistan and Iraq wars had not yet started. So when Sikorsky made the decision to transfer manufacture of the S-76 airframe to Aero, they had good availability of people resources and those people were the experts at making S-76 airframes. Sikorsky had a team of between 15 and 30 people at any one time on the ground at Aero assisting with ramp-up. Additionally, since Sikorsky was shutting-down their own production of the airframe, they just shipped all of their own already-qualified tooling to Aero for its use. And since sales were slow, Sikorsky had enough inventory to allow them to send some completed sub-assemblies to Aero, which allowed Aero to not only have physical samples to examine, but also to begin manufacturing in a more step-wise fashion, rather than having to build from scratch from the very first airframe.

The goal of this comparison is not to show that a certain level of investment is "right" or "wrong," but to highlight what differing levels of organizational proximity might look like. Sikorsky has certainly made some significant specific investments in its relationship with Changhe, especially in the area of people resources. However, this investment pales in comparison to the investment made in its

relationship with Aero in 2002. In the language of the Supply Chain Proximity framework, Sikorsky took greater effort to develop closer organizational proximity with Aero during ramp-up than it has so far with Changhe, and was already "closer" in terms of cultural proximity to Aero than Changhe to begin with.

What is important, though, is the expected effect of the greater organizational distance with Changhe. It would be logical to conclude that one effect of this disparity in investment would be slower ramp-up time at Changhe than at Aero. Fewer support resources will mean that Changhe has to learn more on its own, which will take time. Another effect may be a lower level of perceived buy-in or commitment by Sikorsky from Changhe's perspective. This in turn, might reinforce Changhe's reluctance to deploy its own capital at the rate Sikorsky wants.

Organizational dimension: Improvement opportunities

Along the organizational dimension, selecting the "right" amount of proximity in this case depends on Sikorsky's goals for the program in terms of ramp-up speed. Simply put, higher levels of specific investments as part of the "Set-up Management" effort by Sikorsky will result in faster ramp-up of the program at Changhe. To the extent that Sikorsky is interested in faster ramp-up, it might consider:

- Bearing a greater share of the capital/risk burden for the program by owning inventory for some portion of the production process or jointly investing in tooling and test equipment up-front.
- Making a capital investment in the form of sending sub-assemblies to Changhe as samples to speed their move down the production learning curve. This is difficult to do in the current market environment where Sikorsky has a significant order backlog for the S-76 already, but may be worth it in the long run.
- Sending a team of Changhe manufacturing staff to Aero's factory to learn from them since Sikorsky itself can't provide the level of production expertise to Changhe that it was able to provide Aero.

Electronic dimension

The two main aspects of the electronic dimension of supply chain proximity currently relevant to Sikorsky's relationship with Changhe are electronic information exchange and electronic communication.

Sikorsky and Changhe each have their own MRP system, with no direct integration between them. But there are "syncing" activities that occur to ensure that the BOM Changhe uses is the latest version from Sikorsky and to ensure that when Changhe makes changes to the BOM, Sikorsky is notified. Engineering change orders are also handled through an electronic system. And through its web-based SDS, Sikorsky exchanges ordering and shipment information with Changhe. The procurement team at Shanghai Sikorsky is not currently connected with either Sikorsky's or Changhe's MRP systems, despite the fact that it is tasked with helping manage procurement of all components from over 200 suppliers. The team currently uses Excel spreadsheets to transfer purchasing and inventory information between suppliers, Changhe and itself.

As mentioned in the geographic dimension section, all electronic communication occurs via email and telephone. Teleconferences often have participants in three or more locations globally. At the Shanghai Sikorsky office, internet connection speed and poor teleconferencing equipment negatively affect the quality of electronic voice communication. Videoconferencing is not currently used.

Electronic dimension: Improvement opportunities

Improving the quality of electronic voice communications would be easy to do and is especially critical given that most participants in conference calls are communicating in their second language.

- Replace teleconference phones at Shanghai Sikorsky.
- Invest in faster data lines at Shanghai Sikorsky.
- Experiment with free videoconferencing options like Skype.
- Experiment with more sophisticated video/teleconference options, like WebEx, which allow for sharing of visual media (Power Point slides), written communication (chatting) and video, in addition to voice.

Improving Shanghai Sikorsky's ability to track and share ordering and inventory data is also critical as the program ramps-up and more suppliers have to be dealt with.

- Investigate feasibility of integrating with either Sikorsky's or Changhe's MRP system. This has been suggested by Shanghai Sikorsky and is currently in the process of being investigated.
- If MRP integration proves to be unfeasible, invest in a simplified off-the-shelf MRP system that for more efficient collection and exchange of information than is possible with the spreadsheets currently being used.

SELECTION AND PRIORITIZATION OF SUPPLIER RELATIONSHIP INVESTMENT OPTIONS

All of the improvement opportunities for Sikorsky listed in above sections would require spending a certain amount of money or people resources to accomplish, and theoretically, should result in an improved supplier relationship with Changhe. Drawing again from terminology introduced in the discussion of the Supplier Relationship Management framework, these improvement opportunities can be thought of as potential investments to be made in Sikorsky's relationship with Changhe. Before taking any of these actions however, Sikorsky must determine if the effect of a given action, its return on investment, justifies the investment. And for any company, the ultimate effect of actions should be measured by their impact on the company's profits. That is, does taking a certain action lower costs, increase revenues, or perhaps even both? If so, what is the magnitude of the effect and how quickly will it be realized?

In the case of Sikorsky's cooperation with Changhe on the S-76 airframe, actions which have the effect of shortening production lead time during the ramp-up phase of the program should be strongly considered. As of the end of 2008, Sikorsky had an order backlog for the S-76 of almost two years, or approximately 100 aircraft, representing approximately $1B in sales. This means that every airframe

Changhe is able to produce has already been sold to a customer, and any acceleration in the ramp-up of production capacity will result in an acceleration of revenue recognition and/or net cash inflows.[1] Just how valuable ramp-up acceleration would be to Sikorsky can be calculated quite easily using a simplified net present value (NPV) analysis if the current ramp-up production schedule is known.

In order to illustrate the potential value of ramp-up acceleration, an NPV analysis was done using the actual predicted production ramp-up schedule and the following arbitrary numbers:

- Margin per helicopter of $500,000
- Annual discount rate of 7%
- Time period of three years with June 2008 as the start date
- Maximum final production capacity of one airframe per month (approximately one-fourth of Aero's current production capacity).

The results of this analysis, shown in Table 10, show the value of one, three and six month accelerations of production ramp-up. The benefit in terms of increased margin NPV ranges from $450K for a one month acceleration to $2.73M for a six month acceleration, due solely to cash flow acceleration.

If these numbers were actual real-world numbers rather than an illustrative scenario, the values could be used to help determine which improvement opportunities are worth pursuing, by comparing their cost to their benefit. For example, consider if Sikorsky had believed that co-locating 10 additional technicians at Changhe for six months would accelerate production ramp-up by three months. Would that have been an investment worth making? Assuming the cost to Sikorsky of relocating a technician is equal to 100% of his current fully-loaded cost, and that technicians have a fully-loaded cost of $75K, it would cost $375K to co-locate 10 technicians at Changhe for six months. Achieving a three month ramp-up acceleration would yield $1.35M in increased margin NPV, for a net increase in margin NPV of $975K (assuming the cost of the co-locations is fully recognized up-front). The fact that the margin NPV increases on net indicates this is an investment Sikorsky should have considered making if it believed it would have resulted in a three month acceleration in ramp-up of production.

Table 10: Illustrative production ramp-up acceleration analysis results

Production Ramp-up Scenario	NPV of Margin ($M)	Benefit of Ramp-up Acceleration ($M)
Current actual scenario	7.25	--
1 month acceleration over actual	7.70	0.45
3 month acceleration over actual	8.60	1.35
6 month acceleration over actual	9.98	2.73

[1] Whether increased production capacity would result in acceleration of financial revenue recognition or not depends on when revenue is recognized by Sikorsky. If revenue is fully recognized upon contract signing, increasing production capacity would not result in acceleration of revenue recognition. But in either case, net cash inflows would be accelerated. One direct profit impact of this would be a reduced cost of capital.

Accelerating production ramp-up would not only accelerate cash flows to Sikorsky, but would also reduce Changhe's inventory carrying costs for the first several airframes. An analysis conducted assuming a 5% cost of capital demonstrates that Changhe's inventory carrying costs per airframe would decrease by $12,000 per month of ramp-up acceleration (Table 11). Given Changhe's actual inventory purchasing schedule, ramp-up acceleration would likely have affected carrying costs of the first five airframes they will produce. So in total, each month of acceleration of production ramp-up would have resulted in a $60,000 increase in Changhe margin. Given the relatively low margin that Changhe will make per airframe, savings on this order are actually somewhat significant.

Table 11: Illustrative production ramp-up acceleration analysis results - inventory carrying cost impact

Production ramp-up scenario	Inventory carrying cost per airframe ($)	Per-airframe benefit of ramp-up acceleration ($)
Current actual scenario	161,000	--
1 month acceleration over actual	149,000	12,000
3 month acceleration over actual	124,000	37,000
6 month acceleration over actual	87,000	74,000

Even though Changhe has primary responsibility for bearing inventory carrying costs, Sikorsky could also benefit from Changhe's savings. As mentioned previously, Sikorsky has agreed to compensate Changhe approximately $30K per airframe for inventory carrying costs. If Changhe's inventory carrying costs were lowered, Sikorsky could argue that these payments are no longer necessary. The other potential benefit to Sikorsky would be accelerated inventory purchasing by Changhe. In an effort to minimize its inventory carrying costs, Changhe has sometimes delayed component purchases so much that parts needed for current production have been missing, resulting in production stoppages. Increased investment of people resources by Sikorsky and the corresponding accelerated production ramp-up might signal greater buy-in by Sikorsky to Changhe, resulting in higher levels of trust in Sikorsky's commitment and the program's likelihood of success, which in turn might lead Changhe to accelerate its purchases of inventory.

After the profit impact of various improvement opportunities has been estimated as in the illustrative analyses above, it is important to utilize a prioritization framework to help determine in which order opportunities should be pursued. One way to prioritize is by feasibility. A feasibility prioritization can be made by ranking each opportunity according to required investment and speed of implementation in a two-by-two matrix as shown in Figure 11 for some of the opportunities discussed (Table 12). Opportunities falling in the lower right-hand quadrant of this matrix are the most feasible

opportunities. A second-order prioritization matrix mapping feasibility versus financial impact could then also be constructed to further guide prioritization decisions.

Table 12: Sample Improvement Opportunities for Sikorsky

Improvement opportunity	Estimated cost	Estimated time to implement
Better speaker phones	$500	1 week
More frequent factory trips	$300/person/trip from Shanghai to Changhe factory	1 day
More senior-level management engagement	$7500/person/trip to China	1-3 months
Rotational programs	$40k/person/6 months	1-3 months
Greater risk sharing	$250k-$1M	1-3 months
Change in hiring demographics	Minimal	3-5 years until significant effect
Co-location of staff	$25k/Changhe staff/year $75k/Sikorsky staff/year	0.5-1 year
Supply base relocation	Minimum of $500K/factory setup	3-5 years

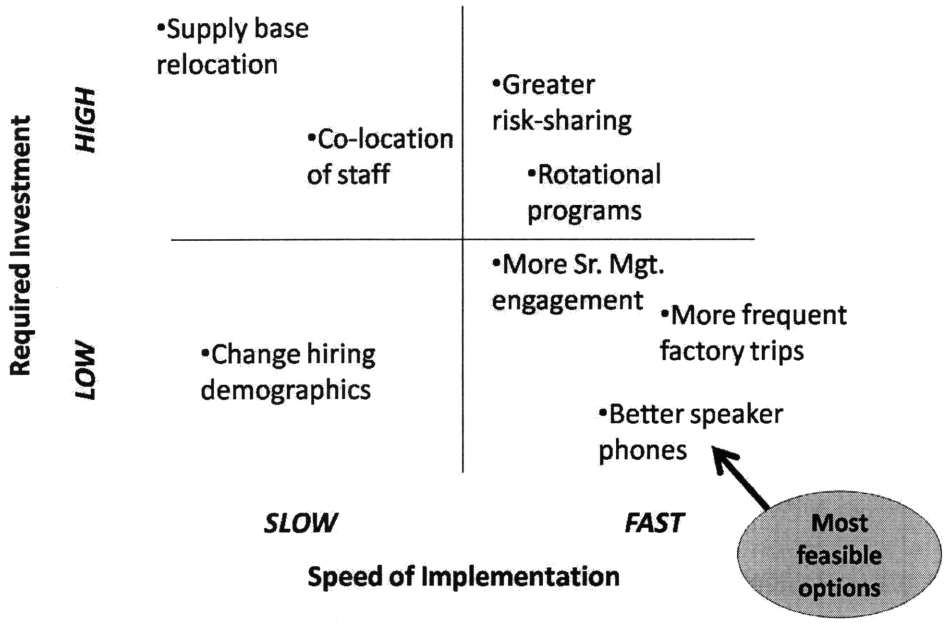

Figure 11: Feasibility-based prioritization matrix for Sikorsky-Changhe improvement opportunities

CHAPTER 5: GENERALIZED APPLICATION AND CONCLUSION

GENERALIZED SUPPLIER RELATIONSHIP MANAGEMENT PROCESS

While the Sikorsky analysis focused on a specific case of a publicly-traded American helicopter manufacturer's relationship with its state-owned Chinese supplier, much of the learning from Sikorsky and the other case studies presented, as well as the literature reviewed, is widely applicable across industries, geographies and specific products. Based on the frameworks and case studies presented above, a generalized six-step process for managing supplier relationships is presented below and summarized in Table 13.

1. Determine the appropriate type of supplier relationship

Determining the appropriate type of relationship to develop with a supplier requires two analyses, one of which reveals the relevant product's architecture and one of which reveals the importance of the supplier's location.

First, utilizing the concepts of product architecture, a firm should determine the degree to which its product has an integral architecture. Products having more integral architectures are better supported by integral supply chains, which require closer supplier relationships. Products with more modular product architecture can be supported by more modular supply chains, which require less close supplier relationships.

Next, the strategic importance of a supplier's location should be determined, especially in the case of foreign suppliers. On the low strategic importance end of the range, a supplier's location may only be important for providing access to low factor costs (i.e., an "Offshore factory"). On the greater strategic importance end of the range, a supplier's location may be important for product development and gathering of market intelligence (i.e., a "Lead factory"). The higher the strategic importance, the more important close supplier relationships become.

The Supplier Relationship Management framework provides another way of determining appropriate relationship to develop with suppliers by looking at both the strategic importance of the supplier and the supplier's potential for contribution to the relationship. Suppliers are mapped in a two-by-two matrix with these two dimensions to determine what level of supplier relationship management is optimal (Figure 2, p16).

2. Determine current type of relationship

Once the appropriate type of supplier relationship has been determined, it is important to understand the current type of relationship that exists between the firm and its supplier. The Supply Chain Proximity framework can be used to demonstrate how "close" a relationship is along the four dimensions of supply chain proximity (cultural, geographic, organizational, IT).

The cultural dimension of supply chain proximity is especially important to analyze in the case of foreign suppliers. When analyzing cultural proximity though, it is important to remember that nationality is only one aspect of culture. Organizations can vary in culture due to home market

characteristics and individual experiences as well. Hofstede's five dimensions of national cultural difference is a good framework for analyzing cultural differences due to nationality and their implications on the business relationship.

To determine cultural differences arising from home market characteristics, firms should start by determining the level of openness and competition in, maturity of and customer demographics of the supplier's home market and comparing it to the firm's own home market. Where differences exist, thought should be given to how they might indicate resulting difference of business behaviors. For example, suppliers located in markets with high levels of government protection or subsidy may tend to conduct business with less of a sense of urgency than their customer located in a more open and competitive market.

Determining cultural differences arising from individual firm experiences requires a firm to gather information on the supplier's past experiences with similar customers, products or markets and determine if those might affect how the supplier will approach its relationship with the firm. For example, negative experiences with previous foreign customers might cause a supplier to be more cautious in dealing with subsequent foreign customers.

3. Determine current stage of relationship & appropriate type of investments

Insight gained from the previous two steps will be used to develop actions or measures to be taken. But what types of actions are appropriate is partially dependent on what stage of supplier relationship management the firm is currently in. The Supplier Relationship Management framework is useful for this determination. It defines three main stages of supplier relationship management: Out-supplier management (the process of selecting future suppliers), In-supplier management (the process of managing on-going supplier relationships) and In-supplier dissolution management (the process of ending a supplier relationship). Within In-supplier management, there are four types of relationship management that occur, depending on stage of relationship and strategic importance of the supplier.

The framework considers actions and measures to be "investments" in the relationship, and describes appropriate types of investments depending on stage of relationship management. For example, investments by both the customer and supplier which have the effect of indicating commitment to the project and relationship are more important during Set-up management, the first stage of In-supplier management, than in other stages of relationship management.

The Supply Chain Proximity is also useful in this step. Its output of relationship "closeness" provides another way of viewing the current stage of relationship with the supplier and can be used to paint a picture of an ideal future state of relationship as well, which can also guide thinking about investment options.

4. Develop a menu of investment options

Once the current stage of supplier relationship management is known, and therefore the most important type of relationship investments has been determined, the results of the appropriate relationship type and supply chain proximity analyses can be used to generate a list of potential investment options. In other words, investment options should be ones that would either help a supplier achieve its strategic role for the customer or help overcome lack of proximity in a way that is

relevant to the current stage of relationship management. For example, in the case of a supplier that has lost significant money on a previous collaboration with a similar foreign customer, a new customer might determine that greater up-front financial risk-sharing on its part during the Set-Up Management phase is a relationship investment option that might result in faster production ramp-up by the supplier.

Here again, using the Supply Chain Proximity framework can be a useful tool for ensuring that all aspects of the supplier relationship are considered when developing investment options.

5. Determine attractiveness of various investment options by analyzing their potential financial impact and feasibility

Once a menu of relationship investment options is determined, they should be analyzed for expected or potential financial impact. This entails calculating the cost of the each investment and each investment's expected return. In addition to determining the potential profit increase due to the investments, estimating the timing of this impact can also be important. Timing of profit improvement can be incorporated into a financial impact analysis by using some form of NPV calculation.

In addition to affecting calculations of financial impact, understanding the time and costs required to make and receive a return on investments also helps in determining which options are most feasible, where feasibility is defined as "ease of implementation."

It is important to differentiate between potential financial impact and feasibility. For example, recall two of the investment options analyzed in the Sikorsky case study. Co-locating ten Sikorsky technicians at Changhe for six months would cost approximately $375K and might take six months to arrange and another six months before the return on investment would be fully realized. In the illustrative analysis, it was calculated that the financial impact would be on the order of $1.35M dollars. Installing better conference telephones at Shanghai Sikorsky, on the other hand, would require only a few hundred dollars investment and could be completed in a week's time. Financial impact of the new phones is difficult to estimate, and an uncertainty-adjusted estimate of impact would most likely be lower than $1.35M. So, considering these two options, it would be safe to say that co-location of technicians would have a greater positive financial impact for Sikorsky, but installation of better phones would a more feasible option because of the low cost and short lead time necessary for implementation.

6. Select, prioritize and make investments

Once their financial impact and feasibility have been estimated, the firm must determine which investments options will actually be made, and what the priority of investment is. Use of 2X2 matrices can be useful for informing both selection and prioritization. A first matrix that ranks on dimensions of time and cost of implementation, as in Figure 11, can display which options are most feasible. A second matrix that ranks on dimensions financial impact and feasibility would result in a prioritization based on attractiveness. Investment options falling in the quadrant of the matrix representing high impact, highly feasible options should receive highest priority for implementation.

After selection and prioritization of investment options, the firm should begin to make the investments at the appropriate time.

Table 13: Generalized Process for Supplier Relationship Management

Step Sequence	Steps for Managing Supplier Relationships	Relevant Analyses/Frameworks	Thesis reference location (page #)
1	Determine the appropriate type of supplier relationship	• Product architecture • Strategic role of factories • Supplier relationship management	• 18 • 16 • 16
2	Determine current type of relationship	• Supply chain proximity • Hofstede's five dimensions of national cultural difference • Home market comparison • Firm experiences analysis	• 21 • 26 • 28 • 29
3	Determine current stage of relationship & appropriate type of investments	• Supplier relationship management • Supply chain proximity	• 13 • 21
4	Develop a menu of investment options	• Supply chain proximity • Results of above analyses	• 21 • N/A
5	Determine the attractiveness of various investment options	• Cost & time for implementation • NPV of financial impact	• 59 • 57
6	Select, prioritize and make investments	• Feasibility matrix • Attractiveness matrix	• 59 • 59

When to use

This six-step process for supplier relationship management is useful under a variety of circumstances and should not be seen as being useful only on a one-off basis. Additionally, the process is somewhat modular and flexible. Not all six steps will necessarily need to be followed in every instance. What follows are some circumstances under which the process is useful and guidance about which steps are most relevant.

Evaluation of potential suppliers. Performing Steps 1 thru 3 of the process will force a firm to consider which potential suppliers are capable of fulfilling a certain strategic role, what cultural differences will have to be bridged in working together and what level of investment may be required to develop a high-performing relationship with a given supplier.

Set-up Management of new suppliers. Following all six steps of the process before initiating a supplier relationship or as early as possible after the relationship has been formed is highly recommended. This is because the analysis can be very valuable in informing activities that occur at the very beginning of the supplier relationship management cycle: contract negotiations, budgeting of time and people resources, locating of offices, forming of teams, etc. Conducting these activities without analyzing cultural differences and their impact, for instance, will very likely result in non-optimal decision making in these areas.

Improvement of supplier performance. The desire to improve the performance of a supplier is often born out of some dissatisfaction with current performance. There can be any number of reasons for unsatisfactory performance, including a non-optimal relationship between the customer and supplier. Performing step two of the process, determining the current type of relationship, can reveal sources of poor performance that stem from difficulties related to relationship. If such problems are revealed, Steps 3 through 6 should be followed as a means of improving the relationship with the supplier.

Change in desired supplier strategic role. As a firm's strategy for a particular market changes, so might the strategic contribution it expects its suppliers located in that market to make. In this case, revisiting Step 1 of the process can help a firm to think about how a change in strategy affects the type of relationship it should have with its suppliers. The results of that analysis may indicate a change in the type or level of investment a firm should make in a supplier. Steps 2 through 6 of the process can help the firm make specific decisions about investments.

Ending of supplier relationships. When a firm makes a decision to shift business from one supplier to another, it should carefully consider how to reduce investments in the existing supplier relationship in a way that still enables the supplier to perform appropriately during ramp-down. Steps 3 and 4 of the process are useful for this. Step 2 of the process, particularly the cultural differences analyses, can help a firm predict what difficulties may arise as it begins to lower its level of investment in that supplier relationship.

CONCLUSION

In today's environment of outsourcing and globalization, excellence in supply chain management can be a key competitive advantage for manufacturers. Beyond choosing what to buy and where to buy it from, managing supplier relationships is also a key component of supply chain management. And managing supplier relationships is not a trivial matter. The optimal relationship for any one supplier is likely to be different from that for other suppliers a company works with. This is because the appropriate supplier relationship is dependent on market and operations strategy, product architecture, geography, culture, organizational characteristics and communication needs. Fortunately, there are tools a firm can use to effectively manage its supplier relationships by considering all these factors and informing relationship investment decisions. The supplier relationship management process detailed in this paper and developed from literature and case studies is one such tool. Application of its analyses and principles with both existing and future suppliers will help a firm better manage its supplier relationships.

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