Taiwan's A-Team: Integrated Supplier Networks and Innovation in Taiwan Bicycle Industry

Ren-Jye Liu

Professor
Department of Industrial Engineering and Enterprise Information
Tunghai University
Box 985 Tunghai University, Taichung, 407 Taiwan
Tel: (886) 4-23594319-130 Fax: (886) 4-23591756
liurj@ie.thu.edu.tw

Jonathan Brookfield

Associate Professor
Strategic Management and International Business
Tulfs University
The Fletcher School
Tufts University
160 Packard Ave, Medford, MA 02155
jon.brookfield@tufts.edu

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ABSTRACT

China has become a workshop to the world, and manufacturing there is increasingly moving beyond labor intensive, low value-added products. As a result, companies in many industries around the world are facing increasingly severe competitive challenges. For such companies, Taiwan's bicycle industry may provide at least a small reason for hope. Despite significant external pressures, by working hard to create innovative, high value-added products and transform the organization of production in Taiwan, Taiwan's bicycle industry has persevered. Key to its continued strength has been a reorganization of the industry's supplier network structure from a traditional modular, symbiotic structure to an integrated, co-innovative one, and a study of Taiwan's bicycle industry A-Team provides a number of insights into how that has been done.

Key words: integrated supplier networks, co-innovation, business architecture, Taiwan, bicycle industry, A-Team

I. INTRODUCTION

Many industries in the Republic of China (Taiwan) are now facing both internal and external pressures. Externally, having joined the World Trade Organization (WTO), the People's Republic of China (China) has shown a huge magnetic effect due to its large market potential and low-cost land and labor. Moreover, outsourcing to China is increasingly moving beyond labor intensive and low value-added industries. Internally, Taiwan's traditional strengths in terms of labor quality and discipline are no longer sufficient. To maintain economic growth, Taiwan must aggressively focus on cultivating the technical and innovative capabilities of its engineers and knowledge based workers.

When we look at the history of industrial development in Taiwan, we can see manufacturing success in a number of different areas, including sewing machines, machine tools, bicycles, PCs, and semiconductors. Broadly speaking, Taiwan's economic success has been built on the competitiveness of its small and medium sized enterprises, and competition among such companies has tended to be high. This kind of economic structure has not always been held in high esteem (Amsden, 1977), and without the openness and task specialization brought about by globalization and an extensive use of modularity, little would have been possible.

Small and medium sized enterprises (SMEs), however, do have some strengths. In particular, as markets change, such companies are often able to recombine and form new networks. As Liu and Brookfield (2000) have pointed out, important characteristics of such networks include a specialized division of labor in production, modularity, and supplier network flexibility. When effective, such networks simultaneously solve a typical problem of large companies – inflexibility – while at the same time overcoming a common problem of small companies – lack of resources. Because costs are often a key issue between assembly plants and suppliers, however, the result is often a rather fluid supplier network structure that allows for some interaction, but only within a rather loose overall structure.

With the separation of production processes in many industries into smaller functional modules, Taiwan has seen the emergence of many specialized, yet flexible, supplier networks – networks which have helped support the competitiveness of Taiwanese industry (Liu, 1999). Because such networks allow members to work independently, members can co-evolve and develop ties with several different industries. In this paper, we call such networks 'modular, symbiotic supplier networks', and during the 1980s and early 1990s, such supplier networks created a kind of competitive advantage for the island by virtue of their ability to support rapid product development.

Toward the end of the 1990s, however, many of the capabilities that had been associated with Taiwanese manufacturing excellence could now also be seen in the Yangtze River and Pearl River Delta areas of mainland China. With each region forming an ever larger industrial cluster, such areas are gradually taking over the position that Taiwan has traditionally held in the international division of manufacturing activities. As a result, Taiwan's modular, symbiotic supplier networks have begun to face a harsh challenge, and the island's industrial development has come under significant pressure (Liu, et. al. 2004).

Despite the difficult competitive environment, Taiwan's bicycle industry may provide at least a small reason for hope. The 1990s were a golden era for the industry with annual exports totaling around 10 million units. Since then, annual exports have steadily declined in the face of stiff competition from China. In fact, by 2003, bicycle exports from Taiwan were down to 3,880,000 units per year. If one focuses on the dollar value of bicycle exports, however, rather than on unit volumes, one sees a different story. In particular, the unit price of bicycle exports from Taiwan has increased from $124 dollars (USD) in 2002 to an average of $199.9 dollars (USD) in 2005, a change in no small part due to successful research and development into new materials as well as an increase in bike functionality.

Key to coping with unit volume declines in the industry has been Taiwan's A-Team, a collaborative association of Taiwanese bicycle assemblers and suppliers established in 2002 to revitalize Taiwan's prospects in the industry. According to the latest statistics, A-Team members have seen a growth rate of 14% in the export the whole bicycles (2005, June-August), average unit prices are now $346 dollars (USD), and sales volumes are up 36% – all of which far exceeds the average for Taiwan's bicycle industry. In fact, by driving the entire industry forward, Taiwan's A-Team is not only rewriting the industry's history on the island, it has also become a significant indicator of the upgrading and industrial transformation that is possible in Taiwan.

[Insert Graph 1. Export volumes and average unit prices for Taiwanese bicycles]

The goal of this paper is to clarify three things: (1) the way in which value is being created in the industry, (2) the structural characteristics of the new supplier network that seems to be emerging – a network which is not easy to understand or mimic, and (3) the practical implications of this kind of network for the continued development of manufacturing in Taiwan.

To that end, the rest of this paper is divided into four sections. The first provides a theoretical context for the research. It is followed by a case study of Taiwan's bicycle A-Team, which in turn is followed by a section discussing the implications of the case along with a fourth and final section summarizing the basic issues and findings of the study. In the process, this paper puts forward the notion of an 'integrated, co-innovative supplier network', reflects on the significance of the paper's findings for theory and practice, and considers some ideas for improving Taiwan's bicycle industry.

Supplier networks in Taiwan are currently facing a tough challenge which could potentially become a serious obstacle to industrial upgrading and reform. We believe Taiwan's bicycle industry A-Team is a promising example of an integrated, co-innovative supplier network, and by looking closely at the background, development, product strategy, interaction style, and network architecture of Taiwan's A-Team, we hope this paper may provide some interesting insights for both theory and practice.

II. THEORY

While the success of Taiwan's bicycle industry in the face of competition from China is interesting in and of itself, an appreciation of how manufacturing strategies and supplier management have changed with Taiwan's A-Team is critical to understanding that success, and those changes may perhaps best be understood through the application of a notion of a business architecture to questions related to supplier networks.

A. Some Basic Concepts of Architecture and Product Architecture

At its most general, the notion of an architecture is a systems design concept that describes the nature and functions of a system's basic elements, their interconnections, and the system's overall shape. As such, an architecture not only describes the distribution of functions and activities across elements of a system, but also their interdependencies and the strength of those interdependencies.

One early application of architectural concepts to the field of management came through an extension of the concept of a product architecture to the study of business systems (c.f. Liu (2005) for a more comprehensive discussion). Generally speaking, a product's architecture consists of three key elements: (1) a list of functions occurring within the system, (2) a matching of functional capabilities to components, and (3) a description of the interfaces that exist between components (Ulrich, 1995). Given this basic approach, three different kinds of product architecture can be distinguished. In particular, product architectures can be “Modular” or “Integral”, and if “Modular”, they can be “Open” or “Closed” (Ulrich, 1995; Fine, 1998; Fujimoto, 1998; Baldwin and Clark, 2000).

[Insert Graph 2. Summary of Product Architecture Types]

Within such a taxonomy, modular product architectures represent products that can be divided into components and regulated by standard interfaces. For instance, products such as personal computer (PC) and machine tools both fall into this category. In contrast, integral product architectures represent products that can not be easily decomposed due to the existence of complicated relationships between different parts of the overall system, and examples of such products include automobiles and certain small appliances. For modular products, the degree to which a system’s interfaces are regulated and standardized is higher; for integral products, interactions between functional components are more complicated (Fujimoto, Takeishi, and Aoshima, 2001). One special feature of an integral product is that, because it is not so easy to decompose into simpler elements, if it is to be copied, replication must be done at the system level, which can be hard.

For machine tools, most early product architectures were of the “integral” type. In 1930s Germany, however, Dr. G. Schlesinger applied a modular concept to machine tools by simplifying the correspondence between functional elements and architectural elements. He also standardized and simplified relationships between different components. Since the interface standards were not public or widely known, this led machine tools to a “modular closed” type of product architecture (O’Grady, 1999). Going beyond machine tools to the development of PCs and bicycles, one can see products that are not just modular, but also have open interfaces (i.e.

products with "modular open" types of product architectures). For modular products, the key distinguishing feature between "open" and "closed" product architectures is whether a product's interface standards are public or not (i.e. modular products are open if they have public interface standards and closed if those standards are proprietary).

B. From Product Architecture to Business Architecture

Business systems can also be seen in terms of their architecture and modularity. Liu (2005), for example, sees at least three different types of modularity at work in business systems (modularity in product design, modularity in the production process, and modularity in the extended value chain of an industry – which includes upstream suppliers, industry participants, as well as downstream buyers).

As Garud and Kumaraswamy (1995) have noted, technical knowledge can be divided into modular technical knowledge and system level technical knowledge, and outsourcing can often lead to a separation of technical knowledge. That said, outsourcing also creates a kind of modularity in the architecture of an industrial system, thereby enabling specialized producers to cooperate, while at the same time opening up the possibility of real competition among different producers as a result of the emergence of industry standards.

If products and industrial systems can both be seen in terms of their modularity, it is reasonable to wonder if there might be some connection between the two. In this regard, Langlois and Robertson's (1992) description of centralized and decentralized networks may be helpful. For them, a centralized network may be said to exist when all of the members of the network are connected to a leading manufacture. In contrast, decentralized networks lack the control and standard interfaces that often emerge from the presence of a single leading manufacturer. Different levels of modularization may therefore be found in different types of supplier networks. To the degree that such modularization is related to the modularity of the underlying product, it would appear that product modularity may well have an important influence on the modularity of an industrial system.

By incorporating notions of modularity at the product, process, and industry level, a business architecture may be considered a strategic system that exerts a profound influence on the nature of a firm's products, its organizational structure, and its business activities. It is therefore also likely to be tightly linked to the competitiveness of companies and industrial development (Fujimoto, Takeishi, and Aoshima, 2001).

In this context, "open" business architectures refer to business systems with a significant sharing of information among the upstream and downstream manufactures, complementary goods manufactures, and users. Companies which adopt an "open" architecture can upgrade the functionality of their product by gathering information from outside their organization, thereby gaining knowledge from different places. In contrast, companies with "closed" business architectures are less connected and have less contact with the outside. In this respect, Toyota is more closed than Ford. Though closed systems increase interaction costs, such systems have an advantage in their ability to create and maintain differentiation. While in practice no system is absolutely open or closed, key distinctions lie in the construction, maintenance, and development of the system as well as in the amount of public and widely shared information (Fujimoto, Takeishi, and Aoshima, 2001).

C. Integrated, Co-innovative Supplier Networks

In this section, we discuss supplier networks from a business architecture standpoint and put forward the notion of an 'integrated, co-innovative supplier network'. From a manufacturing process standpoint, assembly plants have relationships with suppliers out of operational necessity, and it is out of such relationships that a supplier network is formed. From a product innovation perspective, supplier networks possess potential capabilities that can aid in product development. Regardless of whether the issue at hand is production or product development, the goal is still to provide products and services needed by the customer.

Given such a perspective, this paper sees an integrated supplier network as one that stresses daily, direct, face-to-face, intensive and continuous communication, and an "integrated, co-innovative supplier network" as a network of two or more organizations that, through direct and intensive communication and interaction, enables cooperation in the development of a system or subsystem that could not otherwise be developed simply through the use of common sense and public knowledge.

Broadly speaking, we see integrated, co-innovative supplier networks as having two basic features that differentiate them from traditional modular, symbiotic supplier networks. First, whereas traditional supplier systems have tended to emphasize cost control, integrated, co-innovative supplier networks appear to be more focused on value creation through co-innovation. Second, by adopting a more integrated network structure, such supplier networks appear to have a greater ability to resist imitation.

Integrated, co-innovative supplier networks also appear to have several other distinctive characteristics, including a stable membership, a tendency towards a centralized network structure, and a strong internal foundation that includes substantial communication, intensive cooperation, and the development of an increasing amount of trust over time. While responsibilities and tasks are not always easy to divide up among members of an integrated, co-innovative supplier network, such networks do appear to hold out the potential for effective co-innovation across the supplier network. In the case study that follows, most of the data and observations related to Taiwan's bicycle industry A-Team have been oriented around an illumination of these basic characteristics.

III. A CASE STUDY OF TAIWAN'S BICYCLE INDUSTRY A-TEAM

A. Overview

At the center of Taiwan's A-Team are two bicycle assemblers, Giant and Merida. Currently, Taiwan's A-Team also includes 19 suppliers – eleven original members and an additional eight suppliers that joined a year after the organization was founded. The eleven original suppliers are Tien Hsin Industries, Tektro Technology, VP Components, KMC Chain Industrial, Velo Enterprise, Wellgo Pedal's Corporation, Formula Engineering, Alex Machine, Dah Ken Industrial, SRAM (Taiwan), and SR Suntour Incorporated. Table 1 presents some basic information for each of the suppliers in the A-Team. In order to clearly illustrate the development of the A-Team as a whole, this study has focused on the A-Team's two bicycle assemblers. Fieldwork for the study includes a number of on-site interviews and has been supplemented by telephone interviews and the collection of additional documentation. The goal of our fieldwork has been to better understand each assembler's strategy for managing its supplier network. In what follows, we first attempt to describe the overall development of Taiwan's bicycle industry A-team, then work to explain the current operating situation and product innovation efforts of the two assemblers, and finally, we attempt to link such observations to issues related to supplier networks (footnote 1).

[Insert Table 1. A-Team members]

B. Origins and Development

1. Origins

Ultimately, the critical factors behind the establishment of Taiwan's bicycle industry A-Team appear to be a strong awareness of the risks in the industry that led to a sense of crisis and luck. In order to understand why the A-Team was founded, however, one needs to start from an understanding of the industry's products and competitive characteristics.

Bicycles are over two hundred years old, and the bicycle has been widely recognized as a model modular, open product – i.e. a modular product with open standards for connections between components (Liu, 2005). In Taiwan, most local bicycle industry suppliers are small to medium sized companies. Typically, such companies have few resources for innovation or development. Furthermore, Taiwanese bicycle assemblers typically focus their efforts on rapid product changes to keep up with market needs. They don't care about strengthening the technological understanding of their suppliers, and most of the time, they purchase key components directly from more advanced foreign countries. Buying key parts from other countries, however, not only has a disadvantage in terms of price, but also in speed to market. While the early 1990s were a good time for Taiwan's bicycle industry, by the mid 1990s, with more and more production coming from Taiwanese assembly plants in China, Taiwan's bicycle industry began to suffer, and by 2000, exports of Chinese bicycles exceeded exports from Taiwan. Worse, low profits stifled innovation. Companies throughout the value chain got deeply involved in cost control. Some firms with higher prices could not stand the onslaught, and so the whole industry was soon covered by a blanket of risk and doubt.

In Taiwan, for many years, Giant and Merida have occupied leading positions. Moreover, their respective bosses (Antony Lo, President of Giant, and Michael Tseng, Merida's President) both had a strong awareness of the risks to Taiwan's bicycle industry. As a result, in 2002, the management teams of these two companies held secret talks. Based on the "power of partnership" and the "future of cycling", one direct consequence of those talks was the creation of Taiwan's A-Team (footnote 2).

When considering the A-Team's operations, however, we must recognize that, for more than ten years, Giant has been working on establishing a production system based on Toyota's manufacturing principles. In 1999, Giant's management team went to visit Kuozui Automobile (a local Toyota subsidiary) and thanks to a strong desire to learn on the part of Jin-biao Liu (Giant's CEO) and Antony Lo (Giant's president) as well as the hospitality of Kuozui Automobile's president Takehiko Harada, Giant and its suppliers have been able to make strides in importing Toyota's production system into Taiwan. In 2000, Kuozui Automobile was invited to join a project associated with Taiwan's Industrial Development Bureau (a division of Taiwan's Ministry of Economic Affairs). The project called for "the improvement of the overall competitiveness of Taiwan's automobile industry" through the IDB's Corporate Synergy Development Center. Kuozui Automobile was led by their president Takehiko Harada, who noted in a discussion with one of the authors that "Taiwanese manufacturing has a perfectly complete supplier system. Once the system is destroyed – even though Toyota will still be able to successfully produce and sell its products here – it will be a great pity." From his perspective, Taiwan's bicycle industry, even though it has no direct relationship with the automobile industry, still has significant potential and space for development. Not only did Harada provide indirect encouragement for the establishment of Taiwan's A-team, he also provided several conceptual suggestions and ideas for its operation.

In April, 2003, Antony Lo (A-Team's president) organized a press conference for Taiwanese and foreign journalists at that year's bicycle trade show in Taipei's World Trade Center. This was the first time he had talked publicly about the mission, members, and goals of the A-Team.

He hoped the establishment and operation of the A-team might break the myth that it is not possible for competitors to cooperate in Taiwan. As he noted, the A-Team's mandate was to use existing, high quality labor and technology to focus on differentiation and high value added activities so that Taiwanese production might be seen as distinct from the bicycle production of China and other countries which produce at lower cost. In total, Mr. Lo put forward three goals for the venture: (1) the implementation of lean production both within assembly plants and throughout the supply chain, (2) effective co-innovation with suppliers and (3) co-marketing. Overall, with the A-Team using methods that combine both innovation and marketing to increase the value of its products and with bicycle production for Taiwanese companies occurring both in Taiwan and in mainland China, Mr. Lo sees value creation in the industry as a kind of "laughing curve" that combines both a Stan Shi style "smile curve" (representing value added by operations in mainland China) and a sharper and more pronounced curve that represents Taiwanese value added (Chen, 2003).

2. Development

In October 2005, the bicycle industry's A-team and the team's adoption of Toyota production system practices were topics of discussion at a seminar held by the Industrial Development Bureau of the Ministry of Economic Affairs. At that seminar two basic visions and three main areas of focus (co-management, co-innovation, and co-marketing) were introduced. There was also an A-Team documentary which described the ventures development over the past three years. The video was consistent with the comments heard during our fieldwork, and overall, it would appear that the A-Team has gone through two distinct periods.

The first period began with the founding of the A-Team in 2003. It emphasized improvements in on-site management and chose to focus on lessons that could be learned by

Taiwan's bicycle industry from Toyota's production system. On-site improvements were considered according to each A-Team member's situation and potential future needs. Plans were set by the Corporate Synergy Development Center in consultation with the A-Team, and several concrete steps were initiated, including: (1) the establishment of training workshops, (2) on-site visits to some of Kuozui Motors and Toyota's best suppliers, (3) monthly instruction from a TPS team dispatched by Kuozui Motors to A-Team suppliers, and (4) the training of some outstanding technicians.

Formally, A-Team members would have meetings once every three months and results would be presented once every six months. These meetings provide opportunities for each member to exchange information, observe, and learn, and after each presentation of results, the Corporate Synergy Development Center, Giant and Merida, would join with the A-Team's operations office to evaluate the work being done. Typically, they would propose some operating changes and work to help lagging plants can keep up so that all could move forward at the same time.

In October 2005, one of this paper's authors had the opportunity to conduct interviews at several member plants. Based on the information collected, it would appear that the average inventory in each member's plant had decreased to 40% of previous levels. Productivity seemed to be increasing; space was being used more efficiently; and time-to-market was shrinking. Always at the head of the pack seemed to be the A-Team's two assembly plants, where inventories and time-to-market had both decreased over 60%. As Merida's President Michael Tseng said, "It is easy to improve from 60 to 90, but after that, it is difficult. However, we believe that there is no end to on-site improvement." Overall, it would appear that the assembly plants have driven the adoption of lean production techniques, and so laid a foundation for the rapid, small batch production of high value added bicycles.

The second period of the A-Team's development appears to have started in 2004. In an attempt to efficiently implement co-innovation, the A-Team sought to cooperate with Taiwan's Industrial Technology Research Institute (ITRI), and through such cooperation, develop a product data management (PDM) platform, which was later extended into an open PDM.

Ultimately, it is hoped that a third period of development may reach all the way to the final customer, linking Taiwan's A-Team to retailers around the globe, thereby establishing a global SBR (Special Bicycle Retailer) strategy and cementing Taiwan's position as the largest producer of high performance bicycles in the world. By working to coordinate the activities of assemblers and suppliers and also effectively implement relevant aspects of the Toyota production system for the manufacture of bicycles, Taiwan's A-team has laid a great foundation. Moreover, although product innovation efforts have just begun, it is already possible to observe differences in the product strategies of the venture's two assembly plants. The substitution of local parts for those imported from abroad has also been observed (e.g. front suspension fork), and co-marketing efforts during the Taipei International Exposition in March 2005 seem to have helped advance Taiwan's image as a producer of higher-class products. While some issues are still being worked out through trial and error, as a result of their work to date, the A-team has received considerable recognition. Membership has increased to 21 firms and the organization's visibility has increased to the point where even foreign companies like Specialize, Colnago and Scott have joined as overseas supporting members.

C. Product development, interactivity, and network architecture

As far as product innovation, member interactions, and network structure are concerned, Giant has focused on its efforts on the ReviveEB, and Merida has focused on its Julia Silver line, and so these two products will form the basis of the discussion that follows.

1. Giant: ReviveEB

The main goals of Giant are to keep its leading position, insist on the best, and differentiate. They expect themselves to become a "Global Total Cycling Solution Provider", and they have dedicated themselves to providing innovative technology, especially for competition sports bikes. In recent years, they have aggressively strengthened their design abilities.

ReviveEB is Giant's main bicycle for the casual use market, and it received Taiwan's National Golden Image Award in 2004. In line with Giant's desire to be the best, the newest "Revive EB model" has an ergonomic design, an aluminum alloy body, a sophisticated Shimano suspension system, an electrical transmission system, and a lighting device. The unit price is over $2,000 (USD). Using the best technology and targeting a higher class consumer, ReviveEB may be viewed as an architectural innovation, as it breaks with the traditional open, modular product structure for bicycles. In particular, in order to reach its goal for innovation, several Giant suppliers have needed to get involved in all stages of the product development process including (1) concept development, (2) product planning, (3) product design, and (4) implementation. Throughout this whole process, the A-Team has played a vital role.

For example, in order to have a relatively smaller volume, the frame was designed to be completely covered by the bicycle's chain, transmission, motor, battery, and cable wires – all of which are tightly connected. Moreover, the ReviveEB has been designed with a number of premium features. Not only does the ReviveEB use a lithium battery, but in considering the convenience of the charging process, Giant also designed the bike to use a special kind of motor.

In addition, the bike has been designed so that it can use three different types of seating pads, and so thereby satisfy the needs of clients from Japan, America, and Europe. Giant's supplier network has participated in every part of the design process, resulting in a more intensive interaction with such suppliers and a design process in which innovation, technology, cost, quality, and function are all evaluated together. Although the concept of co-innovation began in Taiwan's bicycle industry with the A-team, Giant has reached the conclusion that problems need to be solved as early as possible and so has worked to involve all its suppliers in its product development efforts in Taiwan.

For the ReviveEB project, Giant has signed long-term agreements with its main suppliers to encourage them to help solve problems with regard to orders, delivery, payment, and quality. That said, there is still no guarantee of the size of the orders those suppliers will get, since there is some uncertainty regarding the number of high-value bicycles that will be sold. Moreover, it is hard to estimate innovation expenses and the proper way to allocate the costs of mold and tools. As a result, the overall approach is really about a notion of sharing risks, and if successful, the profits of the venture.

In order to achieve its value added goals related to the product, Giant and its suppliers proactively communicate to solve problems. In addition to regular monthly meetings to set product development schedules, communication has also occurred through small group gatherings, emergency meetings, and other channels. In some cases, innovation and design activities occur simultaneously and independently of one another. For instance, Velo Enterprise is responsible for seats and seat cushions, and Tektro Technology provides the breaking system. In other cases, some items have been designed by Giant with supplier plants in charge of production. For example, chains are provided by KMC Chain Industrial. In yet other cases, parts have been designed and produced by supplier plants – such as the tires its gets from Kenda Rubber Industrial Company – with Giant setting the size and standards. That said, because of a need for intensive and continuous communication, some special parts for the ReviveEB, like the bike frame and suspension, are still produced internally by Giant.

As Taiwan's leading bicycle manufacturer, Giant has devoted significant amounts of time and money to innovation. Going forward, however, success will require the cooperation of others. Through Taiwan's A-team, Giant has collaborated with Merida in an effort to lower risks and share in the prosperity of a healthy domestic bicycle industry. Giant also believes there is additional room for collaborating with its supplier network as co-innovation within the A-Team becomes more natural.

2. Julia Silver

Merida's basic goal for its product innovation activities has been to meet market needs. In this, the company has worked to provide the best performance possible given existing capabilities. To that end, its recent efforts have focused on light weight, attractive-looking bikes.

In 2005, Merida-sponsored bike teams won both the men's and woman's world championships. Merida was also named as one of Taiwan's ten biggest new international brand names. Overall, improvements in the company's brand image and product strategy have been consistent, and in line with such improvements, the company's profits recently reached an all time historical high.

In thinking about the business, director Bo-lin Li, who is in charge of marketing and production, said that there are two situations in which a customer is likely to buy a bike. The first is where the buyer is a professional and pays close attention to things like a bike's functionality, design, and coating. The second is where a buyer likes the bike and finds its price acceptable. Taken as a whole, Merida focuses on the latter kind of customer, but aims to produce a bike with a quality and functionality that is no worse than what could be accepted by the former. From Merida's perspective, there is a clear distinction between the Taiwanese and Chinese bike industry, and Merida believes that at an acceptable price range for clients, there is great room for the A-Team to grow.

Taking the Julia Silver as an example, Merida has focused on the women's market. Although the market is still not fully developed, the company has received a lot of positive feedback from both Europe and Japan in 2005. Compared to other similar types of bikes, only a few parts – such as the seating pad, handlebar, and appearance – have been modified for the Julia Silver. It, for example, has a lower front bar and uses gentle colors. Merida also developed the bike into three different sizes, cooperating with the A-Team for final product innovation. Taking the lightest 10 kilogram bike for example, it uses 300 gram tires from Cheng Shin Rubber, and a 200 gram breaking system from Tektro Technology, the average weight of such parts being 30% less that of common parts. Such innovation focuses on differentiation, both in terms of appearance and weight, and as long as sales surpass 50,000 units, the costs of mold and tool innovation or development are bearable. Overall, the goal is to make a product that satisfies the consumer as well as makes a satisfying profit, and to that end, Merida has focused on a specific consumer population and used existing interface standards to creatively extend the existing supply base and service system.

Overall, as far as lean production and quality improvement are concerned, from Merida's perspective, there have been some positive results, but the company is still working on co-innovation with its suppliers. To date, by improving member willingness to learn and be competitive, the A-team has provided indirect support for Merida's innovation efforts. In most cases, Merida has not held multiple member meetings on innovation, but rather discussed issues individually with its suppliers, and while such interactions are more intensive than in the past, the level of communication has hardly changed. In short, from where Merida stands, formation of the A-Team has increased members' desire to learn and their competitive sense, which has indirectly helped the company's R&D.

While the number of bicycles sold is about the same as that for automobiles, the tools used to produce bicycles are much cheaper than those used for automobiles, and the approximate life expectancy of most tools used in the bicycle industry is about 10,0000-200,000 units. By keeping abreast of the market and updating products in a timely way, Merida has widened the distance between itself and its competitors. Knowing what consumers want, Merida can change screws, appearance, materials or paint, all using the same interface, and with support from A-Team members, the expenses spent on modifications and changes have been much less than the additional value they have created. Though producing about 1,000,000 bikes annually, Merida is still limited in terms of human and technical resources. Consequently, it believes its strategy is the most appropriate one for its position in the bicycle industry. In particular, by understanding the market and having a strong command of production details in terms of both function and materials used, Merida believes it has made it hard for Chinese companies to imitate.

3. Supplier Network Characteristics

From the standpoint of managing the supply base, Taiwan's A-Team has two functions: inculcating an innovative attitude and strengthening the stabilization of its members, both of which influence the learning and innovation of its members. While only about 15% of the overall sales of participating supplier plants go to the two assembly plants, the significance of A-team participation goes farther than just sales. If one were to classify A-team suppliers according to their long-term relationship with assembly plants, one could divide such companies into three groups: (1) a group that is more oriented toward Giant, (2) a group that is more oriented toward Merida, and (3) a middle group which is more difficult to classify. While changes in the operations of A-Team members are not always easy to discern, interactions between assembly plants and suppliers have demonstrated clear differences in terms of degree. For example, influenced by its product development strategy, Giant has had a higher level of interaction with its supplier network. At the product level, Revive EB (Giant) has manifested a higher level of interaction than Giant's line designed for road competition, and at the parts level, the frame and suspension system have required a higher level of interaction than chains.

Based on our study of Taiwan's bicycle industry A-Team, we believe its network structure can be visualized as follows (see Graph 3.d), and looking at that structure, one of its most distinctive features would certainly seem to be its having two independent centers (footnote 3).

[Insert Graph 3. Supplier network types]

IV. DISCUSSION

A. Taiwan's A-Team

Although Giant and Merida have different product strategies and manifest different levels of co-innovation, taken as a whole, Taiwan's A-Team may still be considered an "integrated co-innovative supplier network" on the basis of the direct and intensive communication and integration between assembly plants and supplier networks as well as the innovative product architecture solutions that have been jointly developed to meet the client needs. Overall, the network structure of Taiwan's A-Team is built around two independent centers and appears to be focused on innovation, technological development, and lean production. The network seems to support learning and has characteristics of both lean production and co-innovation, with the depth of interaction between assemblers and suppliers lying in a range between existing supplier networks in Japan and those in China.

Compared with traditional modular, symbiotic supplier networks in Taiwanese manufacturing, Taiwan's bicycle A-Team displays a greater degree of lean production and co-innovation, and based on our study, the special characteristics of integrated, co-innovative supplier networks relative to traditional modular, symbiotic ones are summarized in Table 2.

[Insert Table 2. A comparison of integrated, co-innovative supplier networks and modular, symbiotic supplier networks]

Overall, our investigation into Taiwan's A-Team reveals four findings, all of which we hope may help in the development of theories related to integrated, co-innovative supplier networks.

(1) The degree of market complementary between bicycle assemblers is currently greater than the degree of their competition, which should help some activities, such as co-marketing, to proceed.

(2) Value added activities have evolved from lean production to co-innovation and may perhaps ultimately extend into co-marketing. Such changes have only been possible, however, thanks to a basic foundation of trust that has developed among members of the production network.

(3) One important reason behind the establishment of Taiwan's A-Team was a strong awareness of the challenges and risks facing the industry, and it was the strong commitment and shared vision of the two assembly plants laid the foundation of the A-Team's successful development in terms of operating mechanisms and learning mechanisms.

(4) Based on our investigation, it is also very clear that competitive advantages are very difficult to maintain. A devotion to product differentiation and learning appear to be two important keys to effective integrated, co-innovative supplier networks.

B. From modular, symbiotic supplier networks to integrated, co-innovative ones

In recent years, modularity has become increasingly important to discussions of product development, innovation, and management. Combining a capacity for flexible adjustment along with a specialized division of labor, traditional Taiwanese supplier networks have provided a strong base for Taiwanese manufacturing by combining the advantages of modularity with the strengths of a dense industrial community (Liu and Brookfield, 2000). In this paper, we have called such networks "modular, symbiotic supplier networks".

While we think that such networks have done an important job in supporting the competitiveness of Taiwanese industry in the 1980s and early 1990s by facilitating concurrent production, resource complementary, and the ability to deliver products in a short period of time (Liu, 1999), it may also be a very cruel reality for manufacturing in Taiwan that supplier networks in China have also begun to adopt many of the same characteristics (Brookfield and Liu, 2005). As a result, modular, symbiotic supplier networks may well end up providing a basic foundation for the rapid growth of bicycle, PC, motorcycle and standardized machine tool production in mainland China.

If Taiwanese manufacturing is to avoid decline, Taiwan's traditional model of supplier relations will have to change. In this respect, some research related to competitiveness in the international automobile industry is encouraging. According to Fujimoto (1998), Toyota's great success is a perfect example how a company can successfully use the best features of its home culture to progress and evolve within a challenging and competitive operating environment, and he argues that the key to Toyota's success has been the development of a daily management style that, as yet, has proven difficult to easily copy or mimic. In particular, he notes Toyota's has worked hard to develop cross-departmental relationships within the company as well as communicate with its suppliers. Therefore, relative to the "modular, symbiotic supplier networks" which have been a key part to the success of Taiwanese manufacturing in the past, a new kind of "integrated, co-innovative supplier network" may be needed to support the development of manufacturing in Taiwan going forward. Taiwan's bicycle A-Team may represent an early example of such a network in Taiwan.

C. Co-innovation

While integrated, co-innovative supplier networks may be new, especially in Taiwan, in practice, co-innovation is not unknown. In fact, co-innovation can be roughly separated into two categories based on the scope of the network. In the first, one sees co-innovation spanning several industries, all of which are co-located in a particular region. In the second, one sees co-innovation emerging out of the cooperative efforts of particular manufacturers in a specific industry and their suppliers. Generally speaking, the former appears to be seen more often in new industries, where government and university research may play an important role, and Telematics Valley in Sweden would seem to be a good example of such a phenomenon. In contrast, Honda automobile's BP program for supplier networks in North America may be a good example of the latter kind of co-innovation within a supplier network (MacDuffie and Helper, 1999).

Sweden's Telematics Valley

Telematics Valley is a science based industrial park located in Gothenburg, Sweden's second largest city. The valley seeks to promote cooperation by business, government, and academia, and in 2004, one of the authors of this study had a chance to visit the site (footnote 4).

Before 1970, Gothenburg used to be one of the world's largest ship building harbors. However, with the growth of ship building in Asia, Gothenburg's ship building industry was decimated, and the regional economy suffered. Beginning in 1990, Volvo and Ericsson both began a new project in Gothenburg that has gotten an increasing amount of press from around the world. Uniting 60 companies and research teams from several universities, they began to construct a new industrial cluster area atop the remnants of the region's ship building industry. In particular, Telematics Valley hopes to see a renaissance through the development of a new generation automotive wireless technology initiated by a group of companies across a variety of different industries.

To that end, discussion and research meetings are held every month, and every quarter, group meetings are held, where promising cases are discussed and efforts to solicit capital and government support are made. Telematics Valley has also worked to strengthen its relationship with foreign companies, the success of such efforts being seen in the active involvement of German and Japanese automotive parts companies. Currently, according to some related officials, the park is making significant progress in developing a new generation of traffic systems – innovations lying at the intersection of the automobile and electrical industries. Overall, by adding value, encouraging direct and intensive interaction among members, and steadily increasing the number of companies participating in the park, Telematics Valley shows signs of both integration and co-innovation.

Honda's BP Project

While Toyota and its suppliers usually move and set up operations as a group (for example, 13 out of 18 suppliers to Toyota in Texas (TMMTX) are members of Kyohokai (Toyota's suppliers association) in Japan (Nikkei Business, 2005: 32-35), Honda – which only started producing automobiles in the 1960s – has worked to establish a supplier network system that includes both motorcycle parts companies and existing auto parts companies.

The BP project is an interactive project that Honda and its local suppliers in North America have pursued together to encourage the development and dissemination of best practices and best processes. Based on information provided by American Honda, there are 53 companies participating in the BP project. Average productivity has increased 50% across the participating firms, and seven of them have seen an increase of 66% in terms of quality (Celeste and Sabety, 1994: 34).

In a related research project, MacDuffie and Helper (1999) have looked at Honda's interactions with six North American suppliers involved in the BP project. The results are inspiring. The goal of the BP project has been to assist in improving the technical ability of Honda suppliers by allowing such suppliers to learn from Honda. Members of the BP project include both purchasing and cross-departmental officials at Honda of America as well as workers from companies that supply Honda. Sessions take place at supplier plants several times a week, and Honda has pushed its suppliers to actively help in development so that Honda can effectively adjust its production processes and improve product quality.

Interestingly, when Honda first selected the suppliers it wanted to work with, the company based its choices less on the demonstrated technical capabilities of potential suppliers and more on the attitude and entrepreneurial style of the company's managers. Honda's rationale was that, in order to lay the groundwork for a promising long-term future relationship, it was essential for Honda to partner with organizations that had the willingness and ability to learn and invest in developing new technologies.

Taken as a whole, the goals of the BP project include: encouraging innovation in manufacturing processes, getting a better handle on potential problems through on-site inspection, improving the problem solving ability of suppliers through the introduction of the 5W1H technique, and eliminating waste from the production process. Overall, the BP project has demonstrated a number of things, not the least of which is that dependency ultimately interferes with learning and assembly plants and their suppliers need to devote time and energy into both maintaining mutual trust and sustaining independent capabilities.

Looking more closely at the BP project, Honda and its suppliers seem to illustrate three lessons related to integration and co-innovation (MacDuffie and Helper, 1999: 186-196). First, value creation and the long-term pursuit of economic efficiency are essential for supplier networks to function effectively. Second, supplier relationships must be constructed and maintained on the basis of learning and trust. Third, one important key to improving capabilities in a supplier network is a stabilized membership that tends more toward the closed type.

V. SUMMARY AND CONCLUSIONS

Taiwan has maintained a consistent export led development strategy since the 1960s. In the 1960s and 1970s, export processing zones were central elements to such a strategy, and in the 1980s and 1990s, Taiwan was an important base for international OEM. Taiwan's industrial supplier networks have been an important part of the island's attractiveness as a manufacturing base, and those networks have evolved over time. During the 1980s and 1990s, Taiwan's modular, symbiotic supplier networks demonstrated a number of real strengths, including: (1) a specialized division of labor, (2) flexibility, (3) low transaction costs, and (4) short lead times for production. With the rise of several new industrial clusters in mainland China, such networks are now facing a big challenge, and traditional supplier network structures may have even become something of an obstacle for industrial upgrading and reform.

In this paper, we have examined the development of Taiwan's bicycle industry A-team, and based on that analysis, along with a review of recent literature related to modularity, supplier networks, and business architecture, we suggest that integrated, co-innovative supplier networks may be an emerging model for supplier networks in Taiwan.

From our perspective, integrated, co-innovative supplier networks have at least four key characteristics, including: (1) stable membership, (2) an orientation toward value creation, (3) a dynamic approach to co-innovation, and (4) a strong internal foundation, often bolstered by a centralized network structure, and Taiwan's bicycle industry A-Team appears to be an early, emerging example of such a form. Compared with Japanese supplier networks or Honda of America's BP project, the most distinctive feature of such a network appears to be its independent, two center network structure, and by providing a relatively detailed description of what appears to be an emerging network form, we believe this paper represents a significant contribution to applied network theory.

Integrated, co-innovative supplier networks provide integration among a relatively stable set of members, use a product differentiation strategy to support a multi-centered industrial network, and typically result in a higher priced, high value added integrated solutions for consumers. A key requirement for the continued existence of such integrated, co-innovative supplier networks is that the value derived from coordinated co-innovation must outweigh the costs of interaction. Based on a trust among network members that typically deepens over time, one see different types of cooperation and co-innovation (like lean production, lean product design, and potentially even co-marketing) emerging over time. Based on what we have seen in Taiwan's bicycle industry, there seem to be six basic conditions for establishing a successful integrated, co-innovative supplier network. In particular, there must be: (1) a strong awareness of industry risks and/or prospects, (2) trust among network members, (3) long-term interactive cooperative relationships, (4) a desire to learn, and (5) extensive communication, including (6) face-to-face communication.

Compared with traditional supplier networks, one of the most distinct features of an integrated, co-innovative supplier network appears to be its emphasis on learning and innovation. Integrated, co-innovative supplier networks don't pursue short-term, static efficiency, but rather long-term, dynamic efficiencies. By focusing on proactive communication within complex relationships, interactions between assemblers and their suppliers can achieve integrated solutions. Of course, such networks also have a special requirement – the need to figure out market needs quickly enough to ensure competition from substitute products does not become a problem. Moreover, in trying to maintain or even increase distance between a firm and its competitors, several challenges may present themselves. In particular, it can be difficult to separate out the strategies of different assembly plants. It can also be difficult to maintain an environment of continuous learning.

Practical Implications for Industrial Development in Taiwan

Taiwan's bicycle industry A-team is an emblem of positive change and upgrading for Taiwanese industry and an example of at least one strategy for coping with globalization and liberalization in a knowledge based economy. As a new model for Taiwanese manufacturing, it may also offer hope for catching up or possibly even surpassing competition in advanced economies.

In any event, maintaining the status quo is not an option. If Taiwanese companies are unable to improve their technological skill and production operations, not only will they never catch up to competitors in advanced economies, they themselves will be caught by lower cost competitors from developing countries. Taiwanese companies must work to strengthen their ability to identify market trends and move towards both ends of Stan Shih's "smiling curve" of industry profitability. In other words, Taiwanese firms must work to combine production, product development, and marketing in order to enhance their value of their products.

Overall, integrated, co-innovative supplier networks are significant for at least four reasons:

(1) Integrated, co-innovative supplier networks tend to display a multi-centered network structure. Members of such supplier networks also tend to display a strong desire to learn. Such networks typically require a stable set of members and may represent the most promising development path for Taiwan's small and medium sized enterprise (SME) industrial networks.

(2) As typified by Taiwan's bicycle industry A-team, such networks lay to rest the traditional myth that Taiwanese companies in the same industry can not cooperate or co-innovate. While the case discussed in this paper applies only to a single industry, it seems likely that other industries may also be able to benefit from such network structures.

(3) Though integrated co-innovation, Taiwanese companies can work to establish comprehensive product solutions by way of interactive communication and coordination among network members. While integrated solutions can be difficult to achieve, they may well present a new path for cooperation between industry and academia – a path very different from classical cooperative ventures between industry-academia that tend to focus only on expensive, high tech joint research projects.

(4) The process of co-innovation reflects the importance of pursuing long-term dynamic learning efficiencies in organizations. Based on the evidence that has emerged out of this research project, it seems clear that long term relationships do not guarantee supplier profits and dependency ultimately interferes with learning. Moreover, because product value is ultimately a subjective judgment of individual consumers, some "closed" types of organizational structures will necessarily face some obstacles. High trust and independent ability are essential. That said,

in Taiwan's case at least, it would appear that the A-Team structure is one that has been able to support learning.

Going forward – for supplier networks in Taiwan at the very least – integration may be as important, possibly more important, than modularity. While modularity, interface standards, and openness are a plus for outsourcing, they also tend to lead to a production system that can be imitated with relative ease. In contrast, integrated supplier networks are less easily copied and so hold out the prospect of a more differentiated and therefore more sustainable competitive advantage. It would also seem that a concept of co-innovation may be a helpful one for practitioners interested in the upgrading and reform of supplier networks in Taiwan. By providing a vision for the adaptation of existing supplier networks in Taiwan, co-innovation may, in fact, be an indispensable concept for the future of manufacturing in Taiwan.

Footnotes:

(1) This paper is part of a five year research project related to Taiwan's bicycle industry. As part of the paper's fieldwork, interviews were conducted with the former president of Kuozui Automobile, Takehiko Harada, vice president Pai-rong Wang, manager Zhao-hua Li, Giant's president Antony Lo (President of the A-team), Conductor Qinq-xin Yan (who is also secretary for the A-team), company public relations spokesman Li-zhong Xu, technical center engineer Ming-en Zeng; Merida's president Michael Tseng (vice president of the A-team), vice president Qi-bin Yuan, director in charge of exporting and product, Bo-lin Li, and production manager Ru-ding Lai. Some of the case information for the A-team was collected and summarized in a 2005 A-team presentation, and some other parts of the case study were assembled through the efforts of Kai-jia Zheng and Li-ding Zhou, graduate students in industrial engineering and enterprise information at Tunghai University in Taiwan.

(2) Giant and Merida are two leading bicycle companies in Taiwan. Both are publicly listed, have brand names that are known around the world, and have been devoted to sustaining Taiwan's competitiveness in the bicycle industry. In 2005, their annual production accounted for about 50% of all Taiwanese bicycle production. For many years, the two firms have viewed each other as respectful rivals, recognizing that it is impossible for a single plant to maintain Taiwan's competitiveness in the industry. For example, while the poaching of outstanding executives from a competitor is a frequent occurrence in Taiwan, in the bicycle industry such activities do not seem common, and for Giant and Merida, there do not appear to be any examples of job hopping between the two firms.

(3) Toyota and Daihatsu in Japan; Hyundai and Kia in Korea. These pairings get a lot of attention because of their shared ownership and joint use of particular suppliers, and from a network architecture perspective, both represent multi-centered supplier networks. What makes Taiwan's A-team so different, however, is the complete lack of cross-shareholding and ownership relations between Giant and Merida. Such autonomy and independence between the two focal assemblers makes the Taiwanese case very unusual and quite distinct.

(4) Some of the information related to Sweden's Telematrics Valley was obtained in 2004, when one member of this project went to Gothenburg for a field visit.

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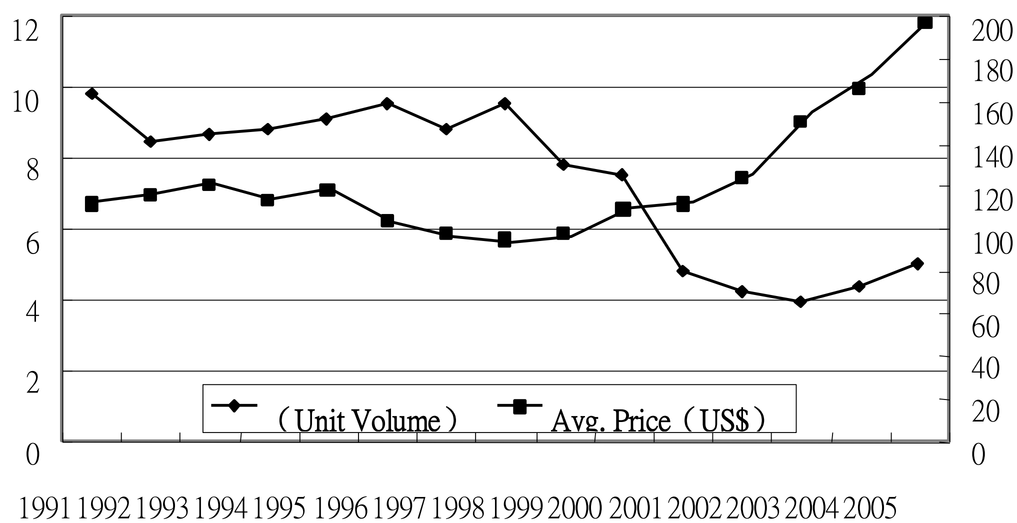
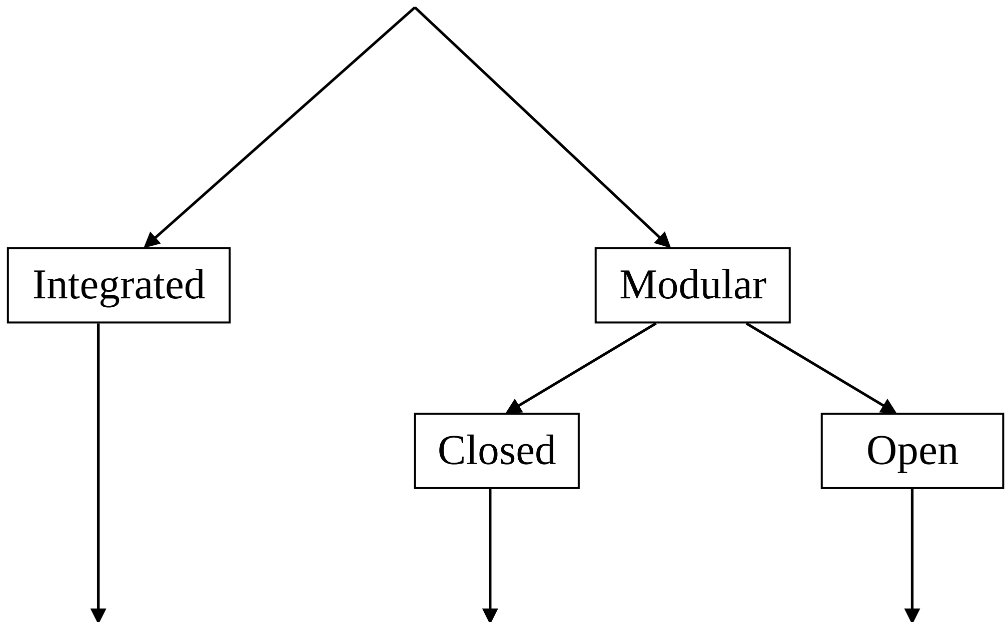
Tables and Graphs

Graph 1: Export volumes and average unit prices for Taiwanese bicycles

On the left –amount in million units (ex: top is 12 million)
On the right – U.S. dollars (average unit price)



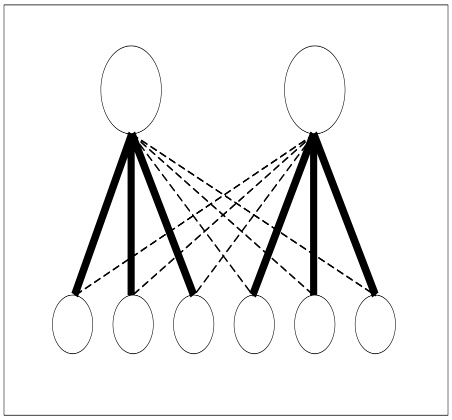
Graph 2: Summary of product architecture types



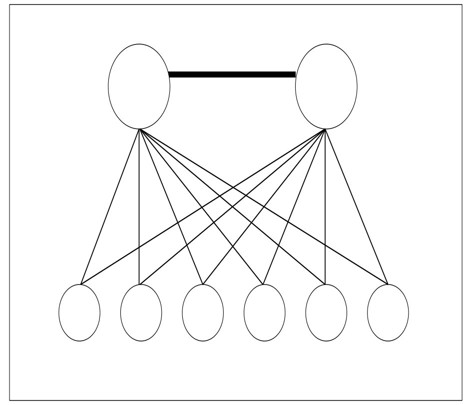
Integrated Products:	Closed Modular Products:	Open Modular Products:
The process of transforming functional elements into architectural elements is relatively complicated.	The process of transforming functional elements into architectural elements is relatively simple.	The process of transforming functional elements into architectural elements is relatively simple.
Interfaces between architectural elements are complex.	Interfaces between architectural elements are simple and standardized.	Interfaces between architectural elements are simple and standardized.
Interfaces are not public.	Interfaces are not public.	Interfaces are public.
Typical products: automobiles, motorcycles	Typical products: machine tools	Typical products: PCs, bicycles

Graph 3: Supplier network types

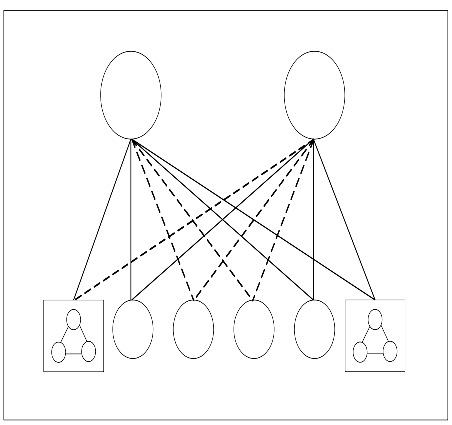
a. single center supplier networks



b. dual center supplier network



c. multi-centered, flexible supplier network



d. integrated, co-innovative supplier network

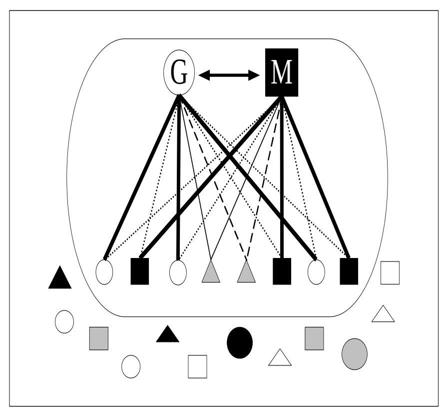


TABLE 1
A-Team members

Company Name	Giant	Merida	TIEN HSIN INDUSTRTIES CO., LTD	TEKTRO TECHNOLOGY CORP	FORMULA ENGINEERING INC	SR SUNTOUR INC	Velo Enterprise
Year of Establishment	1972/10/27	1972/9/29	1970/3/12	1986/6/17	1994/4/21	1987/2/27	1979/2/12
Employees	1135	888	150	136	121	270	200
Main Product	Bicycles, Motors and produce parts, marketing	Bicycles, and produce some parts, some mineral alloy, marketing	Front set, seating pad, wheel set, and	Breaks, grips, and parts	Hubs and wheel set	Suspension fork parts, transmission	Seating pad, grips
Location	Taichung	Changhua	Taichung	Changhua	Taichung	Changhua	Taichung

Company Name	ALEX Machine	DAH KEN IND. CO., LTD	VP Components CO.Ltd	WELLGO PEDAL`S CORP	KMC CHAIN INDUSTRIAL CO., LTD.	SRAM (Taiwan)	Kenda Rubber Industrial Company
Year of Establishment	1991/06	1971/10/1	1980	1980/5/2	1977/8/20	1990/11/1	1962/3/1
Employees	130	260	250	110	140/4600	280	1370
Main Product	Al alloy frame, wheel set	Suspension fork , rear fork, parts for motorcycle, Grips	front parts	Toe clips, straps	chains	Transmission system, motor	Inner tube and outer tire
Location	Tainan	Taipei	Taichung	Taichung	Tainan	Taichung	Changhua

Company Name	Topeak	Post Moderne	Transart Graphics	Leechi	CHIA CHERNE Industry	JOY IND. CO., LTD.	Cheng Shin Rubber
Year of Establishment	1991	1971/10/1	1973	1973/5/16	1986/1/1	1971/10/14	1969/12/19
Employees	25	100	130	434	174	135	3644
Main product	Parts accessory	Grips and suspension fork	Narks, wheel cover and chain cover	Breaks, Cable Housings/lnner Wires, hubs	Breaks, Cable Housings/lnner Wires	Hubs,	Tires
Location	Taichung	Hsinchu	Taichung	Changhua	Changhua	Taichung	Changhua

n.b. : (1) The first 13 companies are original members (2003) and the last 8 joined in a second wave (2004-2005). Currently, there are 21. (2) Sponsoring members: SCOTT, TREK, SPECIALIZE, NMDA, COLNAGO…etc.

TABLE 2

A comparison of integrated, co-innovative supplier networks and modular, symbiotic supplier networks

		Integrated, co-innovative supplier networks	Modular, symbiotic supplier networks
Network architecture	members	Stable (closed)	May be not stable (open)
	type	Centralized	Decentralized
		Possibility of developing into a multi centered structure (separate product strategy, co-marketing)	---
key to establishing		Based on the trust /evolving with time	Reasonable flow of materials
		(lean production, lean development, and co-marketing)	(modularity)
Internal foundation	bottom line	Vision, Strong awareness of risk	---
	trust	Interactive foundation	Result of interaction
	relationship	Long-term intensive	According to need
	Purpose of communication	Learning/ development(semi formal)	According to the need of the transaction
	Content of communication	Diverse and comprehensive information	Quality, cost, and delivery info based on the transaction
	Type of communication	Face to face	No emphasis on face to face communication
problems		Hard to separate, Hard to develop	Similar products competing at a low price