Organizational Identity, Organizational Capabilities, and the Evolution of the Multinational Corporation: JTech's Transmission Systems Business in the US

by

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ABSTRACT

When a multinational corporation (MNC) internationalizes by establishing a new subsidiary, the subsidiary's evolution depends upon its acceptance within its host country environment, by its home country headquarters, by other subsidiaries, and by all other stakeholders, including employees, suppliers, customers, complementary innovators, product market critics and analysts. To be accepted, the subsidiary organization has to have a legitimate form with some combination of properties – such as activities, features, and boundaries – that make it recognizable and understandable as a meaningful social unit. In short, as a social object, the subsidiary has to have an identity that conforms to a recognized and accepted type, so that it is evaluated positively as belonging to a legitimate category of organizations.

Yet, if value creation simultaneously depends upon a subsidiary developing organizational capabilities, how does its identity shape the development of those capabilities? How do the capabilities in turn alter the subsidiary's identity? How does the identity-capability relationship influence the subsidiary's strategy, and how do the organizational structures put in place to cope with these changes affect the organization's identity and legitimacy?

I explore these issues by analyzing the case of the evolution of a US subsidiary of a Japanese high technology MNC, which had responsibility for activities related to the development and sale of transmission equipment into the US, over a fifteen year period ending in 2000. I find that organizational members constructed an identity for their organization through which they enacted their environment, organizational capabilities, strategy, and structure. These, in turn, recursively interacted with the organizational identity in complex ways, either reinforcing the salient organizational identity or stressing it, resulting in identity work through which organizational members sought to reconstruct a new and legitimate organizational identity.

Understanding the identity of a subsidiary is necessary in efforts to improve the effectiveness of managing across borders. As a corollary, management practices designed to improve collaboration, such as facilitating the transfer of more complex information, or that aim to deepen understanding among collaborating units of an MNC, such as increasing personnel transfers, may actually undermine cross-border knowledge development through their negative effect on organizational identity.

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1 Introduction

I came to Sloan School of Management, MIT, after several years of work experience as a manager in the UK subsidiaries of multinational corporations (MNCs) with home countries in the US and in Japan. I had also visited and had short stays at the respective headquarters of these MNCs. What I had learned from this combined experience was that success in foreign environments depended upon the management system in place, both within the home country, as well as in, with, and among host country subsidiaries. In simply layman's terms, if you had the "right management system" you could hire the people you wanted, design and implement particular strategies, develop desired products, and success would follow. Intuitively, it seemed almost to be reversal of the strongly held strategic management perspective that an organization's design, or structure, follows its strategy (Chandler, 1962). I arrived at MIT, therefore, with a strong interest in understanding and analyzing the MNC as an organizational form.

During the spring of 1992, I carried out a number of semi-structured interviews with managers of US-based subsidiary organizations of Japanese MNCs to gather data for my Masters thesis at MIT. The general theme of the interviews was focused upon eliciting managers' experiences of the issues that they confronted as their subsidiaries evolved, especially in establishing and growing research and development (R&D) as a designated function. The selection of R&D as the context for this work was for the reason that the institutional pressures on organizational structures and processes to emulate those of a host country environment would be stronger in organizational subunits in which it was relatively difficult to draw clear causal linkages between the subunit's activities and performance (Meyer, Scott, & Deal, 1983; Westney, 1993b). These pressures would present special challenges for organizational forms spanning countries with significant differences in their institutional and cultural environments, such as between Japan and the US (Westney & Sakakibara, 1985).

During one such interview, I asked the Japanese chief development engineer in the US subsidiary of a Japanese MNC that I call JTech[1], whose Raleigh (North Carolina, USA) subsidiary was mandated to contribute to a collaborative effort to develop and supply central office switches to large US telecom operators, about the difficulty of securing customers in the US. I had anticipated that in supplying central office switching

[1] A pseudonym

equipment, software technology and understanding customers' needs would probably be the two most significant capabilities necessary to win new business. Instead, he gave this response:

> "We need to show an American presence to customers. We need a balance. Right now, Tokyo's R&D is much bigger than here so we need to rely on them a great deal, but we must show to customers how we can manage our internal organization, and show our local presence. We need to make some good balance. We must become more Americanized, so we need to take over some R&D parts from Tokyo. This is not achieved overnight."

Some years later, as I reread this and other interview transcripts, I was struck, first, by how my interviewee (and others) had focused upon the image that their customers had of their organizations. Such issues of organizational identity have long been salient for Japanese firms trying to establish themselves in the US, with it being especially difficult for overseas subsidiaries to shake off their home country identity, with some even claiming that the MNC cannot exist (Hu, 1992). For example, Brannen (1995) found that among the cultural barriers to technological changes to the US operations of an American firm that had been taken over by a new Japanese parent was the attribution to the North American organization of simply being "Japanese." She found that "the Japanese" were regarded as "the Enemy," with the organization adopting an identity ascribed by media images of Japanese-owned factories as "hell camps" (Brannen, 1995), a perspective supported by popular books on working conditions within Japanese companies in the US (e.g., Fucini & Fucini, 1990).

Second, my data suggested that, whatever my interviewees' perspectives on their organizations' technologies or other more tangible resource advantages, what seemed even more important to them was how their organizations were seen. The most consistently mentioned dimension of managing was identified as being able to successfully integrate activities from the subsidiary to headquarters in Japan, so as to be capable of securing the resources to develop and supply products and services that customers would buy. This emphasis on integration has been identified by scholars within the strategic management and international management fields as an organizational capability that is especially critical to sustainable competitive advantage (Grant, 1996; Kogut & Zander, 1992, 1993, 1996; Woiceshyn & Daellenbach, 2005), as well as within the international management field (Kogut & Zander, 1992, 1993, 1996; Whitley, 2001).

Third, I realized from the transcript excerpt above, and others, that not only were the images that customers had of the subsidiary organizations and the capabilities of managing important, but these two concepts – image and capability – were in some way related. In the case above, my respondent clearly perceived that improved internal management, including locating research and development (R&D) in the subsidiary, would improve customers' images of the organization, holding R&D tangible (scientific/technical) outputs constant. In this case, becoming "more Americanized" meant embracing a more "American" identity, in contrast to earlier framings of local responsiveness in terms of activities and outputs (Bartlett & Ghoshal, 1989; Prahalad & Doz, 1987).

It was these themes that I took with me when, seven years' later, as part of the data gathering stage of the work of this dissertation, I interviewed an American senior manager from the Texas subsidiary of a different business unit of JTech, which developed and supplied telecommunication transmission system equipment. He responded to a question about the challenges of building the subsidiary's business with the following observations:

> "JTech here had a terrible reputation. In fact, part of it was its own fault, and part of it was NEC. Japanese companies have a certain way of doing business. NEC was probably the stereotypical company there. And, the transmission business in terms of people isn't very big. And, maybe every business is like that. There is a core of people that just moves around from one place to another. And you always run into each other, you always have friends everywhere, so a lot of the people who we knew at Siemens knew a bunch of people at NEC. And, NEC was just a... probably the stereotypical Japanese company with a glass ceiling where the glass was this thick. And, everything was being directed from Japan. So, it was an awful place to work for. And, I think that the success that they have had in the US pretty much mirrors how they work.
>
> So, even though we were sitting in the middle of Telecom Corridor, we had a really tough time attracting people here because nobody wanted to work for JTech here, locally. And, not all of that was NEC's fault, although everywhere in every company people know people who worked at NEC. So, it really turned them off. But, also the fact that the organization here had been pretty weak. People know that too, you know. So, really in the beginning we couldn't get anybody out of the [Texas] area to come work for us. And, that has now totally gone away.
>
> So, anyway, we all knew that this company was a little bit different, without really knowing exactly how different. But, it wasn't NEC."

This interview transcript excerpt echoes themes from the earlier one. These include the importance of the image of the subsidiary held by its key outside audience of potential employees, and of the management of the internal organization. He was working for an employer that was, apparently, at one time a "Japanese company," but was no longer. Perhaps because my interviewee on this occasion was the American chief development engineer, the property of internal organization that he mentioned was that of local control. However, instead of telling of the need to embrace and project more of an American organizational image to customers, he instead emphasized the importance of distancing his organization from the NEC image to a different outside audience, not to customers but to potential employees. Being "Japanese" was by then associated with high quality and reliability in manufactured goods by customers (e.g., Womack, Roos, & Jones, 1990), but the negative image of the work organization identified by Brannen (1995) remained.

Further, my interviewee having categorized NEC as a Japanese company, in describing his own subsidiary organization's identity, he disassociated it from the category "Japanese." I interpreted the difference in audience, not customers but employees, as reflecting the relative needs of each of the respective subsidiary organizations at the times of my interviews. I also realized that an organization's image could be created and/or managed by two possible processes, by embracing or by distancing.

By any formal classification based upon criteria such as ownership, the subsidiary was Japanese. However, to its employees it was not Japanese. JTech was "...a little bit different." This was the property of its identity that was salient in the minds both of the subsidiary's members and of its outside audience.

At a later stage of my work underpinning this dissertation, I came to understand the difference – between distancing and embracing in these two interviewees – based upon the structure and nature of competition. In the transmission business, there were no particular other organizations that JTech's US subsidiary members would have been attracted to, since the industry was changing and incumbents were largely discredited and had unattractive images. In the switching business in 1992, however, JTech's US subsidiary members seemed to be expressing a wish to become more similar to other legitimate industry incumbent suppliers.

Though I did not have the opportunity to talk directly to JTech's US transmission equipment customers, I assumed that my JTech interviewees would have had a good understanding of what its significant stakeholders, particularly its customers, were expecting in and of JTech. While in other interviews there was occasional mention of competitors in terms of product market characteristics, interviewees consistently returned to descriptions of their organization using language such as "the new kid on the block" or "not NEC."

When I searched for some concepts and theories that I could draw on to help me organize my interview and other data, I was initially drawn to contemporary institutional theory, in which stability and meaning to social behavior are provided by cognitive, normative, and regulative structures and activities (Scott, 2001). Such institutions provide an objective reality that both defines the features that an organization must project to relevant audiences in the social environment if it is be considered legitimate and so attract the resources needed for survival and the actions necessary to comply with regulations and expectations of its form and in how it operates (DiMaggio & Powell, 1983; Meyer & Rowan, 1977). In practice, this means that if an organization is to survive, it must be recognizable as belonging to a legitimate category of organizations. If the organization does not belong to a legitimate category of other organizations or does not follow the prescribed patterns of behavior laid down for organizations of its type, it will be sanctioned and risk adverse consequences such as failure. Further, if the organization is legitimate, this legitimacy can only be based upon it having a recognizable identity, such as "not NEC".

While organizational identity has become an increasingly accepted concept by the community of scholars within the field of organizational theory (Hatch & Schultz, 2004; Hsu & Hannan, 2005; Whetten & Godfrey, 1998), it has not been a concept widely used within the literature focused upon the management of the MNC as an organizational form. Prior work on the latter has generally emphasized less tacit and elusive properties by which to distinguish organizations, such as by product market characteristics (e.g., high quality Japanese), function (e.g., sales, development, manufacturing) or legal form (e.g., joint venture, acquisition).

Part of the reason for this has been that the management of MNCs has been conceptualized at the level of the MNC as a whole, with researchers from a managerial perspective highlighting the challenges of managing competing pressures across the MNC network of subsidiaries (Bartlett & Ghoshal, 1989; Prahalad & Doz, 1987). This work generated insights about how MNC managers have to make trade-offs, such as between being more similar in human resource management practices to either its home or host country. An alternative approach, focused upon organizational identity, avoids constructing such a zero-sum problem and thinking according to which a subsidiary's gain or loss (e.g., of a charter, a management practice) balanced by the losses or gains of other MNC subsidiaries or headquarters.

In addition to having a legitimate organizational identity, a subsidiary also has to be capable of performing coordinated sets of tasks utilizing organizational resources, in order to attain a particular end result. It is organizational capabilities that enable a subsidiary to put together and deploy resources in order to produce significant outputs. I consider that the essence of an organizational capability is the capability to integrate knowledge from internal and external sources (Grant, 1996; Woiceshyn & Daellenbach, 2005), requiring "deep competence" in "distributed organizing" (Orlikowski, 2002). For example, such an organizational integrative capability may include knowledge of customers' needs or of how software will interface with hardware modules in technology-based products.

Yet, if the evolution of an MNC subsidiary is to be theorized as simultaneously related to its having a legitimate identity and developing organizational capabilities, how does its identity shape the development of those capabilities? How do the capabilities in turn alter the subsidiary's identity? How does the identity-capability relationship influence the subsidiary's strategy, and how do the organizational structures put in place to cope with these changes affect the organization's identity and legitimacy?

1.1 Main Themes and Findings

While in Chapter 2 I write about my focal concepts and my own journey into identifying and progressing my case study, it is essential to provide some background to my case in order to summarize my themes and findings.

In my dissertation, I explore and unpack the relationship between the concepts of organizational identity and organizational capabilities through an analysis of the case of the entry and evolution of the business unit of a Japanese high-technology corporation, JTech, into North America over the period from 1985 through 2000. The business unit that I selected had as its principal business the development and supply of telecommunication transmission systems equipment, not only in Japan, but in all principal markets around the world. My primary level of analysis is the MNC business unit subsidiary organization's identity in its host country environment, the US.

JTech as a whole underwent many reorganizations during this period of the internationalization of its transmission systems equipment business into the US, so that it is not possible to present a single organizational chart. JTech periodically sought to realign its organizational structure to the ever evolving market opportunities and to reflect changes made by its competitors. JTech was constantly monitoring its principal domestic and international competitors, to observe how they were organized, as well as companies in less-overlapping fields that were considered leading in Japan in terms of organization and management (e.g. Sony Corporation). Reporting lines were also complex and depended upon purpose, such as financial reporting, product planning, strategy, or brand management.

JTech in fact did not make general use of organizational charts. On several occasions soon after I arrived at JTech I asked to see an organizational chart, as I struggled to understand the mixture of technologies and businesses in which JTech was engaged, but none was available. Instead, the organization was presented as mapped out on technology maps, or space, almost resembling the inside of a rigid disk drive, with some parts shaded green (profitable) and other parts red (unprofitable).

Nevertheless, between 1985 and 2000, I could identify three high-level changes in JTech's overall organizational structure. Initially, JTech was organized into three main divisions, namely computers, communications, and semiconductors/devices, with the last of the three a principal component supplier to the first two product-focused divisions. During the 1990s there was a shift to a business unit model of organization, in which the three divisions were broken up into some 50 different business units, each separately accountable to the President. From around 2000, there was a further attempt to realign the businesses of JTech, which were then classified and grouped into solutions businesses, product platforms, or infrastructure.

Figure 1.1 shows an indicative organization chart of JTech's principal activities, positioned vertically from parts (components) to platforms and to solutions (services).

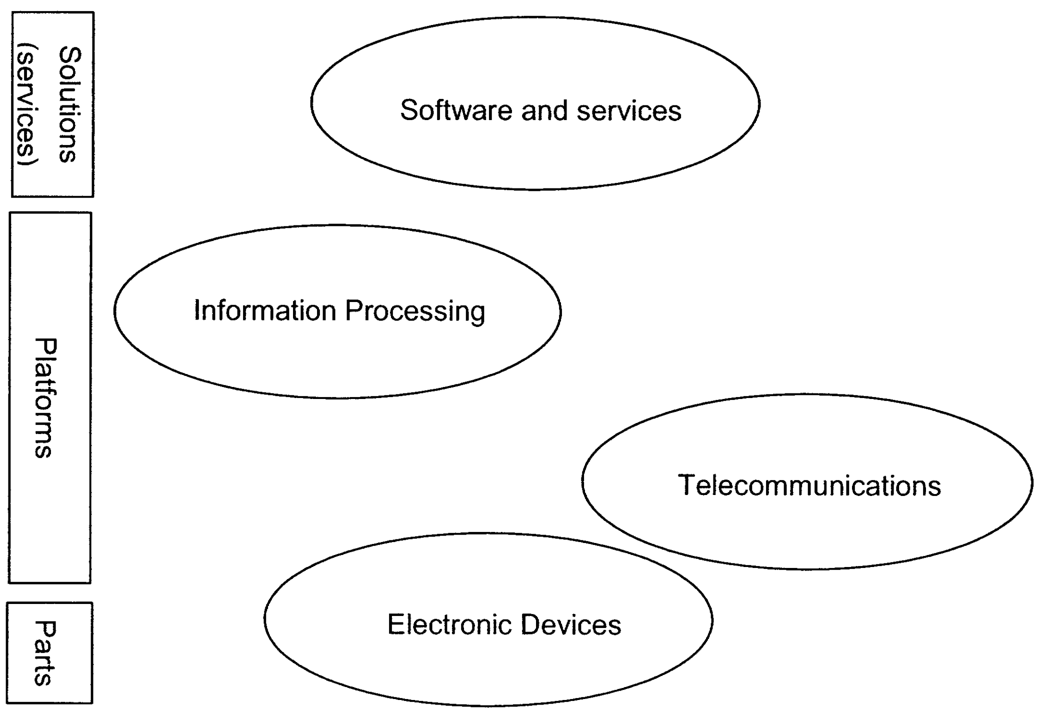

Figure 1.1: JTech Indicative Organizational Chart

Over the period of my study JTech's corporate strategy changed from a focus upon devices and products to a new focus upon customer solutions and service through software development. Software and service businesses within JTech became higher status, with transmission systems businesses at the platform level. Most of the electronic devices used by the transmission systems businesses were developed within JTS, such as within the divisions of the Semiconductor Group. In some instances, however, in which the quantity required of a particular device was relatively small or the device was complex, the Transmission Systems Group would design and develop its own electronic device within its own cluster of hardware subsidiaries, distributed across Japan. The Transmission Systems Group would also develop its own software for use by its customers, such as software used to manage the transmission network. In this sense, the Transmission Systems Group was directly responsible for parts, platforms, and for customer solutions.

Software and service businesses were generally higher in status within JTech. For example, in addition to transmission systems equipment, telecom service providers also needed much more software-intensive switching equipment. I frequently read stories alluding to the inferior status of JTech's transmission equipment business compared to its switching equipment business, both within the telecommunications area. This status difference was not without consequence, for it was far more difficult for lower-status divisions in JTech to select the best employees from the JTech graduate intake each year.

Internationally, many businesses were managed under country subsidiary umbrellas, but for relatively large international operations or for cases in which a different organizational identity was sought, the respective division within Japan would directly manage its own overseas subsidiary. Within the US, the history of JTech's country-level subsidiary goes back to 1968, when a subsidiary was established that became a corporate "umbrella" to manage a diverse range of businesses in computers and telecommunications. By 1984, as some divisions had taken direct control of their own US operations, this had become one of four JTech subsidiaries in the US, among which 94% of the employed staff of 1,700 were American. The majority of the senior executives of these subsidiaries were also American, including the presidents and chief executive officers of two of them. JTech's declared policy was to have each of its subsidiaries operate as an independent division "completely run by American staff as a local American company." Concerning decisions over what to retain within the firm or to outsource, its US strategy varied by business and product, with a preference for OEM for makers of large system components and using existing American distribution channels.

The main US umbrella country subsidiary was renamed JTech America, Inc. (JAI) in 1980 and headquartered in California, JAI had a policy of giving each of its divisions a strong local identity by dispersing its divisional businesses to different parts of the US. For example, JAI established the headquarters of JTech Business Communications, its PABX sales subsidiary that had developed out of its former JVI joint venture (see Chapter 3, section 3.5.1) in a different city in California.

As an example of divisions setting up their own divisional country subsidiaries within the telecommunications sector, in 1988 the switching equipment business was taken away from JAI's control and separately incorporated into JTech Network Switching of America, Inc. (JNSA), an overseas subsidiary of the switching business division in Japan, with its own headquarters in North Carolina. While part of JAI, the switching business in the US had been a division of JAI, but following separate incorporation it was directly controlled by the switching division within Japan and a relocation to North Carolina allowed it to more easily recruit development engineers.

This was indicative of a pattern, which can be identified by the close relation between the setting up or the significant expansion of development engineering activities in the US and the separate incorporation of these activities (and related manufacturing, sales, and other functions) into a new US subsidiary directly controlled by the division in Japan. The addition of development engineering to, typically, manufacturing and sales activities, necessitated closer working relationships with the divisions in Japan than could be handled through the country subsidiary umbrella as intermediary. So, on the one hand we can see the division establishing its own directly-owned and managed subsidiary in the US as a strategic response to the additional cross-border knowledge management demands and complexity associated with the expansion of development engineering.

However, my data suggest that political and cultural explanations are at least plausible alternatives. First, motivation for separate incorporation into a US subsidiary directly owned by a business division in Japan seems to have been an attempt by the division to distance its respective US operations from the organizational identity of being a "Japanese subsidiary," so as to more easily recruit the skilled development engineers necessary to expand the US business. This was the case, both with the Telecommunication Troup's Switching Division's directly-owned US subsidiary organization in North Carolina, and with the Transmission System Division's establishment of its own US subsidiary in 1991 (see below). Second, the method by which JAI surrendered control of its activities from under its umbrella to the divisional subsidiaries seems to have been through struggle.

Take the case of the formal organization of JTech's transmission systems equipment business. The North American activities of JTech's Transmission Business Division in Japan were established as the Communication Division of JAI in 1980. This was part located on the East Coast near to the headquarters of its customer MCI (see

Chapter 3, section 3.5.2) and part located in California. They continued to be part of, and formally managed by, JAI until 1991. This provided the division in Japan with country-specific knowledge, but at a loss of direct control. Across businesses, JAI was relatively strong in sales and in manufacturing, but weaker in development engineering. For example, although JTech's US activities were managed through JAI until 1991, in practice JTech's Transmission Division in Japan had for many years had their own direct relationships in the US. JAI was headquartered in California, but the Japan division had informally had groups of development engineers in small offices around the US, located close to customers.

From 1991, JTech Transmission Division took full direct control of its US activities and set up a directly managed US country subsidiary from the business unit in Japan, away from JAI. The sales operation for transmission equipment had moved from California to Texas in 1984, together with the development engineers from California and from the East Coast. They now co-located with manufacturing centered in a new divisional directly-owned subsidiary in Texas, near to a cluster of other transmission equipment suppliers and customers. Relocated in a larger site in Texas, the new divisional subsidiary, JTech Network Transmission Systems (JNTS) changed its name in 1996 to JTech Network Communications (JNC), when it expanded the scope of its products to include switching equipment.

As discussed in Chapter 4, there was a two-stage struggle by which the Transmission Division in Japan wrestled control of its US operations away from JAI. In the first stage, in 1984, the Division in Japan effectively deposed the JAI appointed head of their US activities by refusing to recognize him. In his place, a Japanese development engineer who had been working on the US East Coast on JTech's MCI business moved to take over and head up then JAI's Communication Division headquarters as President. From 1984, JAI's control over JTech's transmission equipment business in the US was significantly weakened until, eventually, in 1991 then JTech's Transmission Division folded its US transmission equipment activities into its newly established directly-owned subsidiary, JTech Network Transmission Systems, Inc. (JNTS).

In this thesis, I analyze the evolution of JTech's North American transmission systems equipment business over the period from 1985 through 2000, including some of the relevant background to this. During this period, the US-based subsidiary collaborated with its business unit headquarters and organization in Japan, as well as with other organizations, in developing five families of products for sale into the US marketplace. Over this period, there were changes in the roles played by the US subsidiary and its Japanese business unit headquarters in relation to the distribution of development-related activities between Japan and the US. Most notably, the US subsidiary took on increased responsibility for development engineering in new product development over the period of my study, as shown in Figure 1.2.

Product Family	Products	Product Type	Core Technology	Development Period 1	Main Product Sales Period 2	Principal Customers	Distribution of Principal Development Activities	Notes
JTech Digital Loop Carrier ("JDLC")	JTech Digital Loop Carrier ('JDLC')	Local access	Fiber optics	1985-1989	1989-1997	RBOCs/ CLECs	US: Market research, Product Planning Japan: Development Engineering	3
Terminal Products	TP 50/150, TP 600	"SONET Phase I" line terminal multiplexers	Fiber optics	1986-1989	1989-1997	RBOCs/ CLECs	US: Market research, Product Planning Japan: Development Engineering	
ADM Products	ADM 150, ADM 600, ADM 2400	"SONET Phase II" ADM	Fiber optics	1989-1993	1992-	RBOCs/ CLECs	US: Market research, Product Planning Japan: Development Engineering	
ADX Products (Development Engineering Job Sharing)	ADX 150, ADX 600 SPARK 192 10 G (OC-192)	SONET ADM with ATM and IP	Fiber optics	1995-1999	1999-	RBOCs/ CLECs/ IXCs	US: Market research, Product Planning, Development Engineering Japan: Development Engineering	4
	SPARKWAVE 320G (WDM)	DWDM	Photonic	1997-1999	1999-	IXCs	US: Market research, Product Planning Japan: Development Engineering	5
Photonic and Optical Network Products (Technology Co-location)	SPARKWAVE POADM, SPARKWAVE DOADM	Optical ADMs/DWDM (data)	Photonic	1997-1999	2000-	RBOCs/ CLECs/ IXCs	US: Market research, Product Planning Japan: Development Engineering	6
	SPARK 2400 ADX	Enhanced SONET ADMs (voice)	Fiber optics	1999-	2000-			

Acronyms

RBOCs: Regional Bell Operating Companies
CLECs: Competitive Local Exchange Carriers
IXCs: Interexchange carriers (long distance carriers e.g., Level 3, Worldcom)
ADM: Add-drop multiplexer
ADX: Add-drop cross-connect
SONET: Synchronous Optical Network
ATM: Asynchronous Transmission Mode
IP: Internet Protocol
DWDM: Dense wavelength-division multiplexer

Notes

1 The main development period for the project i.e., excludes technology and the development period for features transferred from other products.

2 Generally excludes periods for minor add-ins of replacement cards, minor upgrades, repairs, etc.

3 JDLC was superceded by a local access product called JACTR (JTech access/transport system)

4 Development engineering work in the ADX 150 was designed to be reciprocally interdependent between primarily two locations in the US.
Development engineering work in the ADX 600 was designed to be sequentially interdependent between Japan and the US (Japan: hardware development, US: software development).
Development engineering in the SPARK 192 10G was reciprocally interdependent between Japan and the US (both hardware and software development shared between Japan and the US).

5 This is not an ADX product, but it was developed during a period of significant development engineering job sharing between Japan and the US. In this case, Japan had primary responsibility for hardware development, while the US had responsibility for Product Planning, Software Development, and Systems Engineering.

6 POADM and DOADM development engineering in Japan, co-located with technology from JTech Laboratories Ltd. However, in 2000 some members of JTech Laboratories responsible for photonic technology relocated from Japan to the US headquarters of the American subsidiary. In the future, the US was to be responsible for the development of products based upon photonic technology, while Japan was to assume responsibility for products based upon optical network technologies. ADX 2400 development engineering was the responsibility of Japan.

Figure 1.2: Summary Chronology of the Development of Five Transmission Product Families for the US MarkeTPlace by JTech

Figure 1.2 shows what I have identified as five product families, some of the products that defined each family, the type of product, underlying core technology, development and sales periods, and the distribution of development activities between Japan and the US over the period, from 1985 to 2000.

In defining and dividing this fifteen year period by development of a product family, I have given analytical privilege to new product development as the most significant activity related both to organizational capabilities and to the organizational identity of the US subsidiary. I have taken this approach for three reasons. First, my interviewees overwhelmingly considered the development of a product family to be the most significant defining feature of the US subsidiary organization in terms of its implications for organizing and for its identity. While the subsidiary was engaged in other activities during the period, including sales, marketing, manufacturing, and research, these were mentioned less often during my interviews. Recent work within the technology and new product development literature has increasingly focused upon strategies of developing and manufacturing families of product variants derived from common platforms and/or modular architecture (Gawer & Cusumano, 2002; Sanderson & Uzumeri, 1995), such as by reuse of components, processes, and design solutions. However, such strategies have implications at the organizational level that may overwhelm advantages such as from learning curves or economies of scale, including the influence of a product's modularity on the organization and the scope of the firm (Brusoni & Prencipe, 2006; Brusoni, Prencipe, & Pavitt, 2001; Sanchez & Mahoney, 1996).

Second, by implication, the development of a product family affords a useful window through which to observe changes in organizational capabilities and identity, since it was the way that my interviewees described the evolution of the US-based organization. Third, while early stages models of internationalization portrayed the evolution of MNC activities as incremental or sequential (Johanson & Vahlne, 1977) – for example from export to sales offices to manufacturing to full value chain subsidiary – more recent work has stressed the significant difficulty in internationalizing research and development (Asakawa, 2001; Westney, 1993a). Research and development, such as is associated with the development of a new product family, is closest to knowledge work, which is widely considered especially difficult to manage across international borders because of different principles of organizing and knowledge management in different countries (Hedlund & Nonaka, 1993; Kogut, 1991).

In the case of JTech's transmission equipment business, typically many of the core technologies for a particular product platform would have been under development for many years prior to commencement of product development. Organizationally, there was a transfer from JTech Laboratories to the transmission system business unit in Japan. New releases of products within each product family would continue to be developed for many years after the principal development period that I define. I focused my work on the product development phase as a unit, and looked backward and forwards through time, as necessary.

Each product development family was marked by some significant change in activities, such as in the targeted customer segment, the underlying technologies, or the distribution of development-related activities between the US and Japan. This focus upon development-related activities overshadows the fact that the US subsidiary organization was additionally involved in other activities during the fifteen year period of my study. Such activities included, most notably, local manufacturing and sales operations in the US. While these were important in terms of numbers of employees and in underpinning the US business, to the senior executives to whom I spoke – including the heads of sales and manufacturing – the core activities that they identified as defining their organization were those related to new product development. These in turn had direct implications for my concepts of particular interest, namely organizational identity and organizational capabilities.

As I analyzed my data oriented around these two concepts, what became evident to me was that, as the US organization progressed through the development of the five product families, the organizational capability to integrate the required knowledge and activities was being shaped (both constrained and enabled) by its salient organizational identity. More conceptually, at any given time the organizational capabilities formed the basis of claims about the subsidiary's identity that were projected toward the organization's audience. Feedback from the organization's audience based on its image of the US organization provided a mirror on its claimed identity that, in turn, shaped the evolution of the subsidiary's organizational capabilities. In making organizational identity claims, organizational members would make sense of their organization through stories that were shared among members, with me, and with validating audiences.

At a deeper level, I noticed that subsidiary managers would seek to make their stories of their organization's identity more credible based upon what I have called justificatory logics. These espoused justificatory logics were organization members' beliefs or values that underpinned the particular salient organizational identity at any given time. Such beliefs were either moral or practical, such as a belief that proprietary transmission systems were in nobody's interest except vendors, or that never sacrificing on quality was the right metric to assess all decisions in cross-border collaborative new product development.

Analytically, I found it helpful to think of organizational capabilities as constructed out of assemblages of the underlying routines, which Nelson and Winter (1982) have held should be the center of the analysis of organizational and economic change. The concept of a routine, while variously defined (Becker, 2004), implies some patterning to actions, activities, behaviors, or interactions, through which everyday activities are carried out. Routines may be more or less inert. Many of these routines, such as patterns of working in software development, were culturally and socially defined, based upon differences in working practices at multiple levels, especially at the country, industry, and company levels (Perlow, Gittell, & Katz, 2004). The sources of, and explanations for, these differences, about which there are several literatures, are beyond the scope of this study.

Figure 1.3 is a heuristic showing the relationship among these constructs. In my dissertation, I concentrate only upon the subset of relationships, between organizational identity and organizational capabilities.

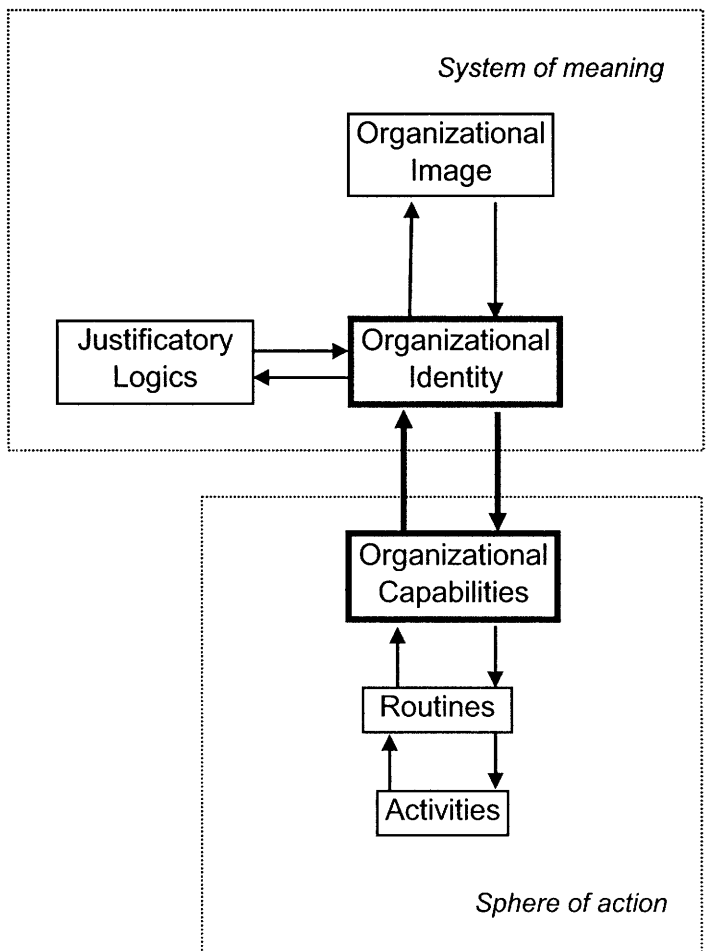

Figure 1.3: Relationship between Organizational Identity and Organizational Capabilities

As I discuss in Chapter 2, the widely held view of organizational capabilities from a number of perspectives, including within international management, is that they are inertial and path dependent. These properties underpin theories of evolution of the MNC as sequential or incremental. What the concept of organizational identity contributes is to introduce a system of meaning into the model of international expansion, so that organizational capabilities depend upon the organization's identity being recognizable as belonging to a legitimated organizational form.

The organization's identity was impacted both by members' enactment of the changing environment and by the capabilities within the organization, and became the foundation for the organization's strategies, especially its business and functional strategies. I found that the subsidiary's strategies were molded, not out of some inertial, path-dependent set of capabilities, but by the way that the subsidiary made sense of its capabilities through its salient identity as organizational members enacted the changing environment. In other words, the way that organizational members perceived the organization's identity affected the definition and the development of its capabilities, thereby impacting its strategies and evolution as a subsidiary. As the subsidiary and its business unit headquarters made changes to its strategies, it often redesigned its organization in ways to support that strategy. For example, a strategy of relocating development activities across borders had implications for the way that the subsidiary managed linkages among its divisions and functional groups. This relationship is shown in Figure 1.4 below, which is both a summary and extension of Figure 1.3 above.

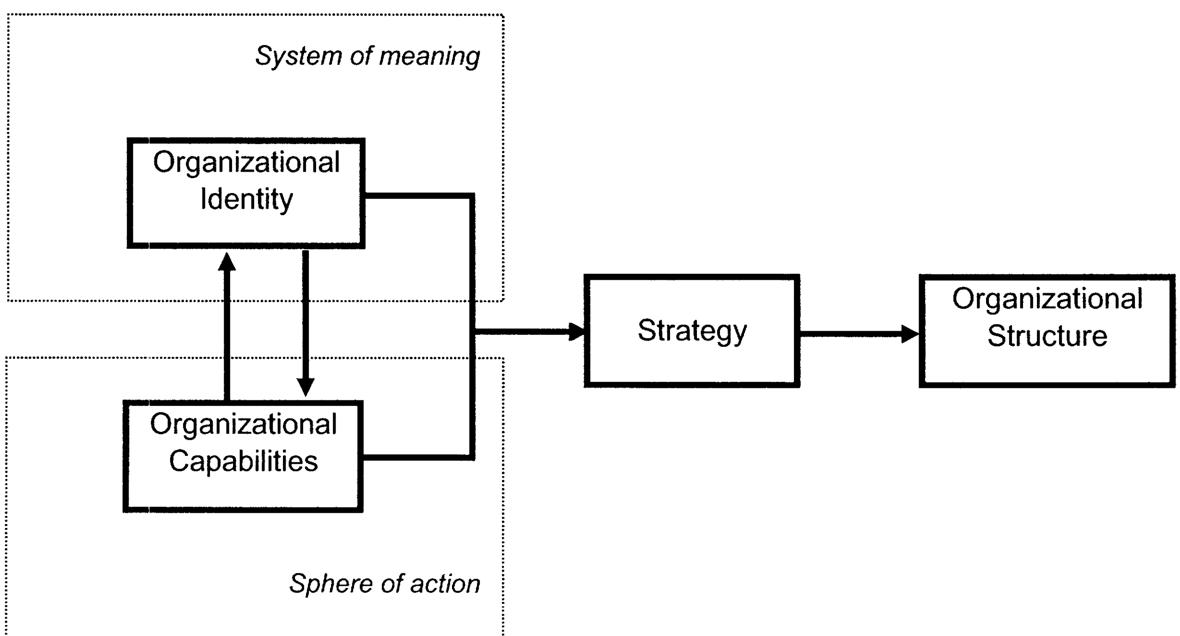

Figure 1.4: Relationships among Organizational Identity, Organizational Capabilities, Strategy and Organizational Structure

Yet, whether or not such organizational redesign initiatives achieved their objectives depended upon the effect that they had on the organization's prevailing salient organizational identity. Changes in the design of cross-border collaboration mechanisms could either reinforce or undermine the subsidiary organization's identity and the subsidiary's organizational capabilities. For example, putting in place management practices to improve collaboration across borders, such as to facilitate the transfer of more complex information or to deepen understanding among collaborating units of an MNC – practices such as increasing personnel transfers – could unintentionally undermine cross-border collaborative capability development if the new practices were not consistent with the organization's identity.

I came across several examples of the effect of organizational redesign initiatives on JTech's US transmission systems' identity. In one example, immediately before the start of the period that I study, in 1984, the Transmission Division wrestled greater control over the US country subsidiary JAI's Communication Division in the US from the country subsidiary. It did so by relocating the transmission equipment development engineers and sales staff from California and from the East Coast to the recently established site of a transmission equipment factory in Texas. It was in part the increase in distance between Texas and California, with the President of JAI having remained in California, which created the conditions for JTech's Transmission Division in Japan to win this struggle.

In Texas, however, the staffs were kept physically separate from the factory, and were joined by experienced product planning staff. The relocation and co-location of these transmission activities in Texas lead to a new and clearer organizational identity, that of a new venture, in place of having the "Japanese subsidiary" organizational identity of the country-level subsidiary. The new venture identity was strengthened in 1990 when JAI's Communication Division was incorporated as a separate North American company owned direct by JTech's Transmission Division within Japan.

Moreover, having left behind in California a number of low-value communications' businesses (e.g., the manufacture of Mickey Mouse telephone handsets and modems) to focus upon a limited number or higher value added transmission systems equipment products, the subsidiary enacted a stronger and more powerful organizational identity as a new venture. This new venture organizational identity shaped the subsidiary's organizational capabilities, through having occasioning the development of a closer and more integrated relationship between US product planning and the Japan-based development engineering activities. The co-location into a single Texas divisional US headquarters from an early dispersed pattern across California and the East Coast further enhanced the new venture identity.

In a second example, at the end of the period that I study, JTech Laboratories, headquartered in Japan across which its network of laboratories was distributed, established a small satellite group within the division' subsidiary location in Texas in 2000. The declared purpose of this was to improve technology monitoring within the US and to work with customers, although my evidence suggests that this change in organization occurred at least in part for the purpose of the US subsidiary exerting more control over the technology direction of JTech Laboratories. While this was planned to be a small office of just 13 staff in Texas, nevertheless the symbolic effect and meaning of this establishment of a research function in Texas was out of all proportion to the size of commitment made.

With a local research function in Texas, JTech's transmission subsidiary members now considered it to have the complete set of support activities across the entire value chain (Porter, 1985) in North America. This contributed to their making a renewed claim to an organizational identity as a new venture, but this new claim was for a different model of a new venture since the available model of a "new venture" in the environment had changed. This resulted in organizational members formulating and seeking to implement plans for greater independence from JTech in Japan through an equity carve out through an initial public offering (IPO). This new claim of a new venture organizational identity was out of all proportion to the scale and scope of the research activities undertaken for the first time in Texas, which was focused upon customer relationships and technology monitoring, not research underpinning new technology development.

In general, changes to the organizational structure and design of working practices would have one of three possible outcomes. Newly implemented organizational practices could be rejected either outright or in substance (in the latter case the practices may remain nominally), leaving the current organizational identity unchanged. Alternatively, the implementation of the new working practices triggered a period of sensemaking, as organizational members reevaluated their organization's identity claim. Such identity work by organizational members as they sought to make new sense of their organization's changed identity could also be occasioned by change in the environment, such as by the delegitimation of a particular organizational form previously held to be legitimate, or by the emergence of new organizational forms.

Below, in Figure 1.5, I summarize these findings by presenting an indicative conceptual model of MNC subsidiary evolution, which shows how feedback from changes in the organization design impacts the organizational identity and capabilities through organizational redesign initiatives, what I have called organizational structure.

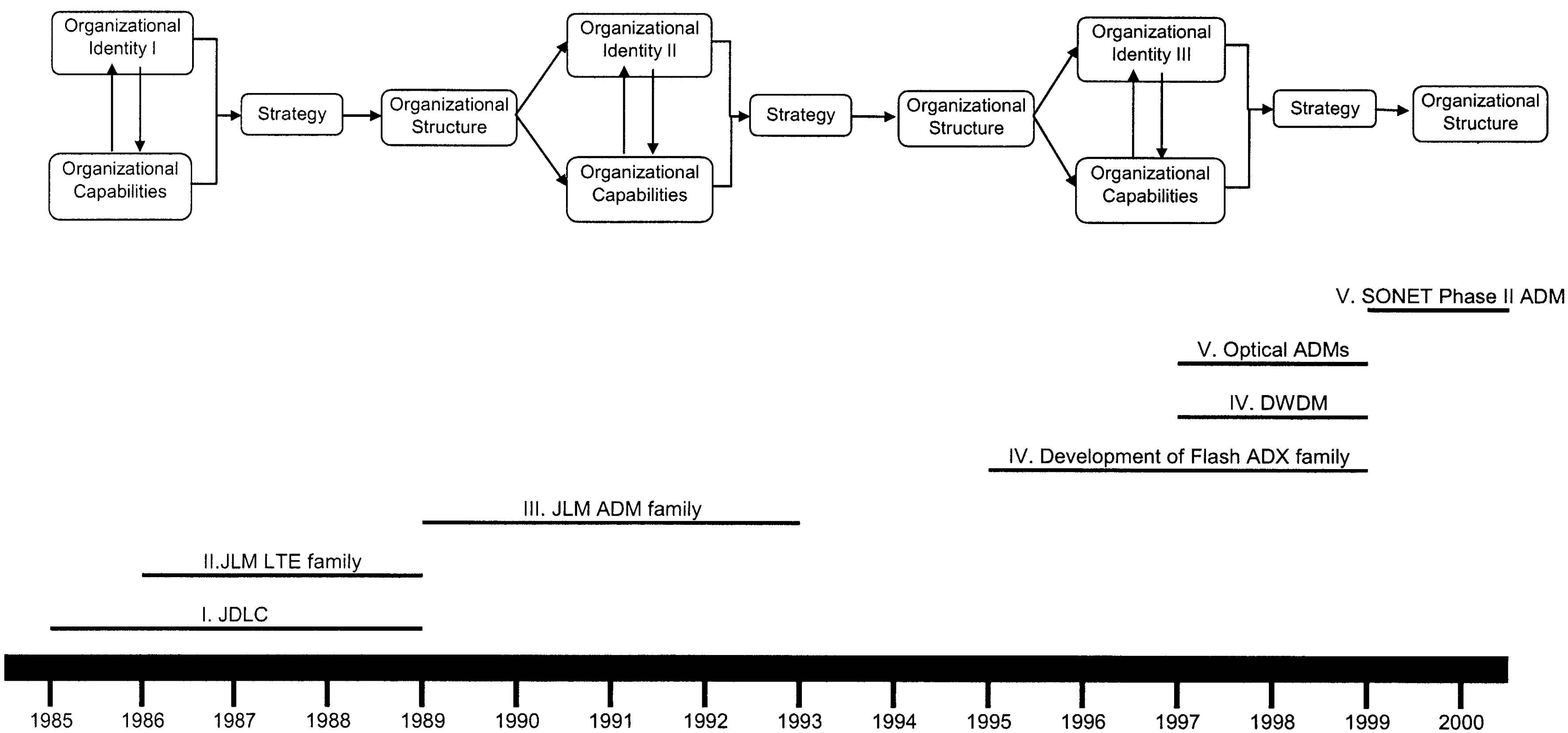

Figure 1.5: Model of Subsidiary Evolution

During the fifteen year period of collaborative new product development activities between Japan and the US across five product families, I found that organization members' perceptions of JTech's transmission business division's US subsidiary's identity changed through two rounds of sensemaking across three distinct organizational identities as organizational members worked to claim membership of a recognizable and legitimate organizational form. These identity changes were not defined exactly by the timing of changes in the commencement and ending of the development of product families, since the trigger for the organizational identity change was either internal, such as changes to the cross-border collaborative management system or in the size of the organization, or external, in the environment.

The first organizational identity claimed by JTech's US transmission business organization was that of a "new venture," which endured over the period from around 1985 until approximately 1992. Up to 1985, its organizational identity was opaque, with the transmission business division's US activities buried within the MNC country-level subsidiary organizational form JTech America Inc. (JAI), which had the mandate to manage its US activities. At this time, JTech's transmission business in Japan was a relatively low status supplier to its principal domestic customer, the then Nippon Telegraph and Telephone (NTT), having fourth place in terms of market share of NTT business.

The construction of this new venture identity was occasioned by a rupture in the relationship between the business division in Japan and the senior executives responsible for the country subsidiary system of international management, JAI.

This rupture led to a chain of events in the US, which culminated in the relocation to a new US transmission business headquarters in Texas. The transmission division already had some manufacturing in the US located at Texas, but the added new activities transformed the identity of the Texas operations, which became a direct overseas subsidiary company of the Transmission Systems Division in Japan. The construction of the new venture identity involved distancing from the earlier opaque identity of JTech's US transmission business organization in the US, from its Japan home country organization, and from other illegitimate organizational forms in its environment. There was also a positive dimension to this identity work, which included a number of complementary activities, namely relocation and reorganization, by selective association with individuals, groups, organizations and institutions consistent with the new venture identity, and especially by verbally constructing the identity through storytelling.

One effect of this new venture identity was that it enabled JTech organization members to be more innovative than would have been the case had they claimed membership of another category of legitimate organizations of a particular form.

Nevertheless, the claim and maintenance of a new venture identity also necessitated conformity to audience expectations from a new venture. An important organizational capability that was molded by and in turn shaped the construction of this identity was the receptiveness to changes in work routines, such as those occasioned by having imported (through hiring) from outside organizations routines for capturing and specifying product features based upon customers' requirements, a practice known as product planning.

The business and functional strategies at the time reflected the new venture identity, with new products being developed for new categories of customers. The host country organization was led by individuals who were entrepreneurial and not afraid to challenge the traditional management system and authority. The plausibility of the new venture identity also contributed to the effectiveness of the collaborative working relationship with Japan, whose development engineers were a key audience for receipt of product plans for execution in development. Contrary to predictions from rational organizational theories, had the identity of the US organization been understood as closer to an overseas subsidiary form, which would probably have led to a greater degree of functional overlapping of activities, then this would have undermined the US organization's claimed identity as a new venture and shifted it towards the then illegitimate organizational form of a (Japanese) MNC subsidiary.

The strategies of JTech's US "new venture" were shaped both by its identity and by the capabilities given meaning by its identity. The US organization focused its business and product strategy on targeting a new segment of the transmission equipment market with innovative new products, with the organization itself being built around a core network of individuals all known to each other from earlier working relationships. A new venture identity in the US was recognized and legitimate as an organizational form, to both the key audiences of customers and the home country development engineers in Japan to which the US-based product planners would send aggressively targeted specifications for development. The design of work activities included a clear separation between product planning in the US and development engineering in Japan.

Over time, as demands on available development engineering resources increased, these stressed the development engineering departments and divisions in Japan. This triggered a number of organizational changes from around 1992. One of these was to build a stronger US organizational representation in Japan, including establishing a separate North American development team and a product planning department in Japan that was staffed by development engineers strongly identified with the US. Second, development engineering, until then a relatively minor part of US activities, was expanded in the US and became more interdependent with the development engineering effort in Japan. The US organization overall had also grown significantly in absolute and relative headcount and business revenues compared to the organization in Japan, while the Japan organization was gaining in status with its key domestic customer, NTT, relative to its three principal competitors. Third, in 1993 the Japanese head of development engineering was dispatched to the US to become the new President of the US organization, in part as a first step in what became a build up of the US development engineering capability to cope with an increased workload.

These stresses undermined the new venture identity of the US organization. In the absence of a plausible alternative, there was a risk that it would take on the default identity of being a "Japanese overseas subsidiary." While this would have brought to the organization's members some legitimacy, such as from the reputation of Japanese large firms for high quality manufacturing, this was not an identity widely embraced by organizational members in the US. They worked to distance the identity of the US organization from this unfavorable identity, and the identity of the subsidiary now became more ambiguous. On the one hand, the bricks and mortar of the new facility were new and reinforced the earlier new venture identity. On the other hand, the new emphasis on development engineering and the build up of these relatively high-status activities in the US was consistent with an identity of a "development engineering organization" that owned and led new product development projects.

To a noticeable degree, the struggle among these two identities appeared to continue from 1992 until 1998. During this period, the development engineering and new venture identities were claimed and projected by organizational members over the alternative identity, that of a "Japanese subsidiary."

Several important capabilities were shaped during this period of noticeable identity tension. Probably the most significant of these was the capability of increasing development engineering resources, which had been learned in Japan and was recontextualized (Brannen, Liker, & Fruin, 1999) to North America. During this period, JTech's US transmission systems organization sought to enact its identity as development engineering organization by expanding its development engineering activities across the US. It established a network of dispersed development engineering centers in locations resource-rich in labor pools of engineers skilled in newly emerging standards and technologies, such as Asynchronous Transfer Mode (ATM) and Internet Protocol (IP).

JTech had a capability, developed and learned in its home country environment, of expansion through the establishment of new satellite development engineering organizations that were dispersed geographically across Japan. This pattern of development had initially been a response to the constraints imposed upon JTech in the domestic labor market. JTech had been founded in the 1930s and had greater difficulty in hiring good engineers in Japan, relative to its older-established, higher-status competitors. By hiring locally near to regional universities with strong engineering departments dispersed across Japan, JTech had to some extent been able to mitigate its "liability of newness" (Stinchcombe, 1965). The opportunity to join a large, albeit lower status, firm near to young engineers' home towns must have been attractive to many graduates, especially given the cultural norms within Japan of the eldest child returning home to look after their aging parents.

However, dispersal of development engineering resources among a network of organizations across Japan seems also to have solved a second problem that JTech confronted as it adapted from working with NTT to developing new transmission systems for the US marketplace. Within Japan, systems' development had largely been carried out by NTT, with product and component development allocated to its domestic suppliers, including JTech. In the US, on the other hand, system development engineering had been the responsibility of transmission system equipment suppliers, such as Western Electric. JTech needed to take on this role, which had been undertaken by NTT in the Japanese context.

By dispersing the development of hardware and software components and modules across its network of development engineering centers in Japan, JTech may have avoided the rapidly diminishing returns to scale and complexity from having its entire engineering effort co-located. This is also consistent with the argument of Itami (1994), that relative to US firms, Japanese firms in general face greater pressures to de-integrate to respond to limitations of their domestic coordination systems, which rely heavily on face-to-face contact. While wages and salaries were the same among the network of subsidiaries to those within the main JTech organization, other costs – especially those of real estate – were undoubtedly lower. Similar wages and parallel hierarchies (Yoshino & Lifson, 1986) of job title and career track meant that personnel transfers across organizations in the domestic development engineering organizational network – known as *shukko* in Japan – were unencumbered by status differences among the organizations.

The capability to relatively rapidly build up new engineering resources in new technologies in turn enabled JTech in the US to adopt a product strategy of incorporating emerging protocols and technologies into its existing products. This strategic thrust, made concrete in the commencement of development of the ADX family of products from 1995, was achieved by establishing new development centers in New York (ATM), and in California for ATM and IP technologies/protocols, respectively. This new organizational structure in turn reinforced the organizational identity of development engineering organization claimed by US organizational members.

At the same time, as JTech's US transmission organization took on more key development work and began to be responsible for the development of entire products, its enacted environment changed. First, its US-based customers began expanding abroad from the US, such as into South America. Second, within Japan, JTech's lead customer for transmission equipment, NTT, began to introduce products into its transmission network using technologies adapted from those developed for the US market. Third, the US continued to be the environment in which new technologies for next generation products would emerge, such as using Internet Protocol and dense wave-division multiplexing (DWDM). There was what can only be described as a frenzy of transmission industry activity focused upon optical technologies – communications systems that run on all glass – with developers of optical networking technologies offering a new model of what it meant to be a "new venture."

Accordingly, the US-based organization welcomed the establishment of a research facility in the US as being entirely consistent with its enhanced status as global leader, as well as being a response of to the strategy of JTech Laboratories to internationalize. It sought to emulate the newly available models of a "new venture" in the US environment and, through this, to legitimize its establishment of its own designated subsidiaries overseas. This new venture identity was further enacted through a number of other events. Most prominent among these was the failed attempt of the US organization to divest itself from JTech through an equity carve-out involving the sale of subsidiary stock to the public via an IPO. This plan was rejected by JTech's business division headquarters and by JTech Japan corporate headquarters.

In each of these three phases of the evolution of JTech's transmission equipment business organization in the US, I found that the JTech enacted its environment in claiming a particular organizational identity. This key variable depens our understanding of the evolution of organizational capabilities, which in turn may reinforce or undermine a salient organizational identity. Such a structuration relationship influences the strategies pursued by the organization and the organizational structures put in place to implement these strategies. These organizational structures, designed to cope with the changing strategies, may then inadvertently undermine the salient organizational identity, causing a new round of identity work as organization members' work to enact a new definition of their organization.

1.2 Outline of the Dissertation

I have organized this dissertation in nine chapters. In Chapter 2, I review the relevant literatures on a number of themes and constructs, in order to construct a scholarly context into which I aim for my dissertation to be placed. Most directly, my dissertation comprises my telling a story of the evolution of the business unit of an overseas parent, and I locate my story within the general body of international management research concerned with the evolution of the MNC. However, while earlier work has conceptualized this primarily as a process involving changing organizational structures, value-adding activities, or managerial mindsets, I alternatively portray this as a process of changing organizational identities and capabilities, which in turn influence the subsidiary's strategy and the organizational structures put in place to cope with the changes.

In Chapter 2, therefore, I focus upon my core concepts of organizational identity and organizational capabilities, since central to my theoretical claim is that of a structuration of the relationship between these two concepts. I also discuss strategy and organizational structure, both of which are broader in conceptual scope for my purposes. As a category, Japanese firms were relative latecomers to internationally dispersed technology and product development organizations, and the differences in their employment and production systems pertaining to new product development are also discussed. In the second part of this Chapter, I introduce my research setting, identify my data sources, and describe how I carried out my analyses.

I provide some historical background to JTech in Chapter 3, covering the period up to 1985 when my analysis evolution of JTech's transmission business subsidiary organization in the US begins. Having read a number of histories of JTech and been told stories into which various dates and events have been emplotted, I have chosen to tell this general historical background in the form of seven short stories. These stories tell of JTech's history, examples of other experiences in internationalizing, JTech's transmission business with NTT in Japan, and of the internationalization of JTech's transmission business. The aim of this Chapter is to provide an overview of the history which provides a foundation for a number of themes in the ensuing chapters.

The next five chapters are dedicated to each of the five product development families that were the basis for my data analysis. Both for consistency and in anticipation my model of MNC subsidiary evolution, I have set out each chapter in six parts, beginning with a general introduction that summarizes the key elements and insights from that follow as a guide to my analysis. My analysis is contained within the next five sections, namely the enacted environment, organizational identity, organizational capabilities, strategy, and organizational structure. The last four headings follow the labels that I have used in Figure 1.5 above.

In Chapters 4 and 5, I begin my story of the evolution of JTech's transmission business organization in the US by telling of the development of the JDLC (1985-1989) and Terminal (1986-1989) product families, respectively. During both these overlapping periods, the US organization had an identity of a new venture. In Chapter 6, I discuss the development of the ADM family of products (1989-1993), and it is during this development period that I identified a shift in the organizational identity of the US organization away from a new venture to a more ambiguous identity, including that of a development engineering organization. Chapter 7 tells the story of the development of the ADX family of products (1995-1999) and the DWDM products (1997-1999). It was during the development of these products and that of optical ADMs and Enhanced SONET ADMs (1997-1999; 1999-2000 respectively), discussed in Chapter 8, in the context of major changes in the market environment, that the North American organizations identity shifted to a newly available model of a new venture.

Finally, in Chapter 9, I summarize my findings about the importance of organizational identity to subsidiary evolution to conclude that the establishment of a subsidiary has identity implications that are not as explored as much as they could be. Organizational identity seems to play a central – perhaps the key – role in how a subsidiary enacts its environment, and organizational identity interacts with organizational capabilities, organizational structure, and strategy in interesting ways. Rather than international evolution being driven by an underlying premise of search and adaptive learning as a response to the reduction of uncertainty or risk, my findings are at least consistent with an alternative perspective that the construction of a plausible identity shapes the knowledge (organizational capabilities, strategies, and organizational structure) which guides the way that the firm internationalizes. While some dimensions of a subsidiary's internationalization may be seen as incremental, organizational identity appears to evolve through periods of relative stability, with punctuated changes as organizational members make sense of changes in the environment and of internal organizational changes to create new meanings of "who we are" as an organization.

2 Literature Review and Research Methodology

In this Chapter, I review the literatures on which I have drawn. My work is principally anchored in several different subfields of organization theory and international management, although my own theoretical contribution is aimed at the international management subfield of the evolution of the MNC subsidiary. In the second main section of this Chapter, I outline my research methodology, including my research setting, my data sources, and analysis.

2.1 Literature Review

2.1.1 Introduction

My core argument in this thesis is that the way that a subsidiary's members enact their organization's identity shapes organizational capabilities and that these capabilities, in turn, reciprocally reproduce or alter (reinforce or undermine) the subsidiary's salient organizational identity. This relationship influences the subsidiary's evolving strategy and the organizational structures that get put in place to implement the new strategy. I therefore orient my literature review to the touchstones of the relevant subfields of international management and organization theory.

In my work I am using structuration theory (Giddens, 1979, 1984) as a metaphor to link two important areas of theory. I begin my literature review with a discussion of my central concept, that of organizational identity. Organizational identity has attracted burgeoning interest from the disciplines of both sociology and social psychology and I emphasize how it is constructed through processes of sensemaking and storytelling.

Second, I discuss the literature on organizational capabilities and routines, which have been important concepts for the fields of strategic management and international management, but for different reasons. Strategic management researchers have conceptualized organizational capabilities in one of two ways. First, capabilities have been cast as inert in the evolutionary tradition of the growth or failure of firms. Second, a more strategic perspective has sought to differentiate organizational capabilities from relatively inert routines, with capabilities being infused with intentionality, such as the capability to integrate routines or deploy resources. International management scholars, on the other hand, have emphasized that organizational capabilities are embedded in different institutional and country contexts and manifest most obviously in differences in work practices across borders, a form of inertia based at a higher level of analysis. What is important for my discussion is that, across these different perspectives, there is a consensus that knowledge integration is the essence of organizational capability.

Japanese firms were relative latecomers to establishing internationally dispersed technology and product development organizations, and have distinct patterns in their employment and work practices pertaining to new product development. Third, I therefore include a separate review of the literature on "Japanese" new product development capabilities. Japanese firms' new product development capabilities have often been observed in work at the new product development project level of analysis, but are principally embedded in organizational practices of work and of managing human resources.

In the final part of this literature review, I port the concepts of organizational identity and organizational capabilities to the international management literature and ask how these concepts have been taken up into prior work. In much of the literature on the MNC as an organizational form, the subsidiary is not the primary focus. Only relatively recently has the subsidiary been taken as a level of analysis in and of itself. Nevertheless, studies at a higher level of analysis, of the MNC as an organizational form, do imply patterns of subsidiary evolution that can be identified using concepts of organizational identity and organizational capabilities. While the MNC should be a rich setting for organization theorists to develop and test new theories, the two fields have not enjoyed a particularly close relationship (Ghoshal & Westney, 1993). An important exception follows from key insights of Westney (1993b), who reframed the tensions for global integration and local responsiveness in work such as Prahalad and Doz (1987) using institutional theory. I too draw upon concepts from organization theory to develop an understanding of MNC subsidiary evolution, and seek to build upon the insights from this important earlier work that builds bridges across the two academic fields.

2.1.2 Organizational Identity

At the heart of the neoinstitutional theory of organizations (DiMaggio & Powell, 1983; Meyer & Rowan, 1977) is the idea that social actors face pressures to demonstrate that they conform to recognized types. It is through this categorical imperative (Zuckerman, 1999) that existing structures and organizational fields are reproduced. Actors evaluate others' forms and actions by comparing them to accepted categories of forms and role performances, with a positive evaluation – and survival for the organization – conditional upon membership of a legitimate category. This core idea has been taken up both within the subfields of economic sociology and within organizational sociology.

Recent work in economic sociology has reinforced the importance of these social pressures for conformity and has defined the need for and sources of organizational legitimacy in terms of the role structure (White, 1981a, 1981b) or status structure of product markets (Podolny, 1993; Podolny & Phillips, 1996a). Sharing a product markets' focus with economists, the role-based approach sees the market as comprising an identity order of interlocking producer roles, with market sustainability dependent upon players conforming to recognized roles (Phillips & Zuckerman, 2001; Zuckerman, 1999). A different constitution of market identity order is suggested by the status-based approach, which finds that conformity to a particular status confers consistently greater returns independent of product quality (Podolny & Phillips, 1996b). Violation of a legitimate organizational form, such as through varying organizational features, behaviors, or product offerings, is likely to be penalized by an organization's respective audience.

Much of this work on the social basis underpinning competition and markets within economic sociology defines organizational forms and identities by industrial and product market distinctions. However, in organizations whose outputs depend heavily upon human capital and knowledge, such as R&D, the basis of organizational identity may also emanate from the nature of the employment relations and personnel practices that bind members to the organization (Baron, 2004).

Irrespective of the pressures for conformity based upon product market distinctions, there are therefore pressures on organizations to achieve legitimacy by conforming to default expectations of an organizational form held by an organization's audience. This is perhaps most clearly illustrated in the case of new ventures, whose role or status in product or resource markets is often unclear, but whose organizational members work to achieve legitimacy as a new venture organizational form through identity work such as storytelling, such as about relationships with high-status elites (Lounsbury & Glynn, 2001). Successful entrepreneurs are skilled users of cultural tool kits (Rao, 1994) who use encompassing symbolic language and behaviors to gain cognitive legitimacy more quickly than others (Aldrich & Fiol, 1994).

These insights had already been made by organizational sociologists studying the MNC as an organizational form. Especially, Westney (1988) identified the evolutionary pressures upon organizations such as MNC subsidiaries as consisting of strong isomorphic pressures to adapt to other organizations within their field, conceptualized in terms of differences between organizations measured by features at the country level of analysis e.g., between host country patterns, home country patterns, and patterns in other MNC subunits. Subsequent empirical work operationalized this by exploring the extent of isomorphism in organizational patterns and practices of human resource management (Robinson, 1994; Rosenzweig & Nohria, 1994) and work (Zaheer, 1992).

The concept of organizational identity has been alluded to in prior work in international business. For example, Hu (1992) strongly implies that an overseas MNC subsidiary organization's identity is indelibly marked by the home country-industry identity, such as the "German chemical industry," or the "Japanese computer industry." The overseas organization is, in this meaning, "subsidiary," a marking that may not easily be erased, if at all.

For Whitley (2001), the growing managerial coordination across borders within MNCs generates novel forms of organization and capabilities distinct from nationally-focused organizations, and he implies that the patterning of cross-national coordination itself may be determining of an MNC's identity. Thus, mature MNCs with long experience of transnational activity may engage in activities that are incongruent with their home country activities. Whitley's (2001) argument is more sociological than perspectives that see MNC structure as contingent upon the requirements of globalization (Bartlett & Ghoshal, 1989; Egelhoff, 1982; Nohria & Ghoshal, 1997; Prahalad & Doz, 1987), in that he envisages different capacities for action in MNCs depending upon their embeddedness in their home country environment (Lane, 2001). He writes:

> "It is the coordination of major activities across significantly different institutional contexts through organizational routines that potentially makes MNCs distinctive kinds of organizations... they become more complex organizations than more domestically focused firms and may develop distinctive routines and capabilities as a result" (Whitley, 2001).

Distinctiveness, and organizational identity, in this meaning come from integrating major operations located in very different and strongly isomorphic business systems through organizational integration routines.

International management scholars using institutional analysis have responded to this by shifting the level of analysis down from organizational structures and design, through managerial processes (Kostova, Athanassiou, & Berdrow, 2004), to focus upon specific routines and practices (Westney & Zaheer, 2001). Continuing a conceptual focus from earlier work on the control of subsidiaries, in the first of three examples of this genre of study, Robinson (1994) compared parent and subsidiary firm personnel manufacturers in Japan, focusing on the routines or practices involved in recruiting, training, and performance appraisal and their relationship to parental control. This work implied that a subsidiary's identity would depend upon the degree of control exerted by the parent over subsidiaries exposed to local pressures to comply with the institutional requirements of host country environments.

This focus upon control within subsidiaries was further taken up by Zaheer (1995) and Zaheer and Mosakowski (1997), who analyzed patterns of control in foreign-currency trading rooms to show that "importing" successful home country practices led to improved financial performance through helping the subsidiary to mitigate the costs it faces from its liability of foreignness in an overseas market. This work was an important statement that organizational capabilities, rather than product differentiation or product-market fit considerations, provide an important source of competitive advantage (Zaheer, 1995). While organizational identity is not explicitly considered in this work, it is implicitly included within Stephen Hymer's insight that foreignness may be a liability (Hymer, 1976).

The assumption implicit within the work of both Robinson (1994) and Zaheer (1995) is that practices of control define the identity of the subsidiary as organization, continuing a long strand of international management scholarship. An important shift in approach was marked by the third example I cite of international management scholarly work that has moved down a level of analysis to examine routines and practices. Kostova (1999) reminds us of the simple, but sociologically important property of such practices, which is that they are meaning and value based, as well as knowledge based. In her words, strategic organizational practices are "value-impregnated" (Kostova, 1999). Practices have symbolic as well as substantive meaning (Kostova, 1999), with certain strategic practices serving as a basis for organizational identification or as a source of personal satisfaction for employees (Selznick, 1957). She cites an example from 3M:

> "For example, a well-known organizational practice at 3M allows company engineers and researchers to spend 15% of their time in activities not directly related to their immediate tasks... This practice has a symbolic meaning for the employees at 3M that goes beyond the formal rules associated with it. It is a source of identity for the employees, for it is part of what makes working for 3M different from working for other companies. It is also a source of satisfaction, since employees understand the value of this practice for the company. Finally, maintaining this practice helps the company preserve its identity and integrity as a highly innovative organization, which is arguably its most inimitable source of competitive advantage" (Kostova, 1999).

Practices transferred abroad to subsidiaries may be adopted, but they are only valuable – and the transfer successful – if they are institutionalized at the recipient organizational unit. A practice is implemented if the formal rules implied by that practice are followed, but a practice becomes infused with value (Selznick, 1957) and internalized when employees at the recipient unit attach meaning to it. This is largely consistent with the emphasis of Whitley (2001) that practices are embedded in different business systems and institutional environments.

Kostova and Zaheer (1999) further developed institutional theory approaches to the MNC by assessing how positive and negative legitimacy spillovers across MNC subsidiaries and across firms might occur, disaggregating the concept of legitimacy at the parent and subunit levels of analysis. Subsidiaries of MNCs may comply by adopting organizational practices symbolically or ceremonially if it is inappropriate or inefficient for the particular host country (Kostova & Roth, 2002; Kostova & Zaheer, 1999), and legitimacy spillovers may occur across MNC subsidiaries and across firms (Kostova & Zaheer, 1999).

For organizational sociologists, organizational identity consists of social codes, or sets of rules, specifying the features that an organization is expected to possess. These codes comprise default expectations held by audiences about organizational properties and constraints over properties (Hsu & Hannan, 2005). A legitimate organizational form is not necessarily one that is efficient, but it conforms to expectations formed from socially constructed belief and rule systems (Scott, 2003).

Organizational identity sits comfortably within recent cognitive approaches to institutional theory. One way to think of this is to locate organizational identity as an intermediate construct between the institutional environment and the features of the organization, a conceptual location supported by recent work on cultural-frame institutionalism showing how identity movements create institutional gaps at the immediate and proximate level of identities, rather than the more distant level of institutional logics (Rao, Monin, & Durand, 2003).

It is instructive to contrast this definition of organizational identity with that common to perspectives from social psychology and organizational behavior. From this more micro perspective, organizational identity is that which is held by organizational members to be core, distinctive, and enduring about the character of an organization (Albert & Whetten, 1985). This definition privileges the role of organizational members in sensemaking (Weick, 1995). Who organizational members think they are shapes what they enact and how they interpret, which affects what outsiders think of them (the organization's image) and how they are treated, which either stabilizes or destabilizes the organization's identity (Weick, Sutcliffe, & Obstfeld, 2005). Organizational identity changes through the efforts of organization members to change the images that outsiders send back to the organization. If organization members use those images to make sense of their actions, then the changes in organizational image catalyze reflection and redrafting of how the organization defines itself (Gioia, Schultz, & Corley, 2000; Gioia & Thomas, 1996).

I consider that both of these perspectives offer different, but largely complementary, conceptualizations of organizational identity. While sociological approaches tend to emphasize the cognitive processes of identity construction, the perspective from organizational behavior locates the focus of identity construction on sensemaking, such as by sharing plausible organizational stories about "who" we are as an organization. It is through such identity work (Snow & Anderson, 1987) that organizations resolve the tensions between the identity that they ascribe to themselves and the image others hold of them (Dutton & Dukerich, 1991; Zuckerman, 2000). Organization members may engage in impression management tactics to manage threats such as those that call into question their perceptions of highly valued, core identity organizational attributes, by emphasizing their organization's membership in other organizational categories that highlight favorable identity dimensions and bring about other interorganizational comparisons (Elsbach & Kramer, 1996).

Organizational sociology's more macro perspective looks to the institutional environment, and reminds us that organization members' beliefs as to their organization's identity might be highly circumscribed by agents external to the organization, such as regulators, potential investors, and other intermediaries (Zuckerman & Kim, 2003). There are heavy constraints on efforts to shape organizational identity, especially when the relevant audience comprises external, rather than internal, constituents (Ginzel, Kramer, & Sutton, 1992; Zuckerman, 2000). This is the key insight of neoinstitutional theory (DiMaggio & Powell, 1983; Meyer & Rowan, 1977).

A central methodological challenge for work on organizational identity is that organizational identity is not a stable list of organizational features or behaviors that can be observed and measured, since the legitimacy of an organization's identity depends upon shifting perceptions, beliefs, and actions of contemporaneous audiences (Hsu & Hannan, 2005). When the default codes of a legitimate organizational identity are known by organizational members, they may work to achieve legitimacy for their organization by shaping its features and their behaviors through identity work such as storytelling, embracing, or distancing (Snow & Anderson, 1987). There may also be pressures to conform to different or multiple organizational identities held by different audiences, and organizational members themselves may differ in their understandings of what constitutes a legitimate default identity for their organization. Organizational sociology reminds us that there is no stability to the organizational features or behaviors that are valued over time.

2.1.3 Organizational Capabilities

Probably more than any other concept, that of organizational capabilities defines international management as a field. International management scholars are almost by definition of the scholarly field concerned with how the MNC as an organizational form evolves in response to internal or external selection pressures (Westney & Zaheer, 2001). Other scholarly fields have only relatively recently shifted to a focus upon organizational capabilities. For example, a major theme for international business scholars from around the 1970s has been that firms internationalize based upon superior internal capabilities that they can extend abroad. Over time, many of the most critical capabilities have been identified as organizational, and there has emerged a consensus in the literature that the essence of organizational capability is knowledge integration (Grant, 1996). The lead of international management scholars was only later picked up within the fields of strategic management and international business, within which there was a shift in focus from industry and market structure to seeking to understand the internal organization of firms.

While there are differences among the various definitions of an organizational capability, a widely accepted definition is that of Grant (1996), who defines it as a firm's ability to perform repeatedly a productive task which relates either directly or indirectly to a firm's capacity for creating value through effecting the transformation of inputs into outputs. The words capability and ability imply purposive action.

Within organizational behavior and evolutionary economics, capabilities have been conceptualized as high-level routines that, together with implementing input flows, confer on management a set of decision options to produce outputs (Winter, 2000). Whereas their constituent routines are often invisible, the control levers of capabilities and their intended effects are known. Taken into the field of strategic management, organizational capabilities have been linked to integration, concerned with the carrying out of a coordinated task, utilizing organizational resources, for the purpose of achieving a particular result (Helfat, 2003).

If to be capable of something is to have a generally reliable capacity to bring that thing about through intended action (Dosi, Nelson, & Winter, 2000), then it is continuity that is key to this capacity (Gavetti, 2005). Capabilities have been shown to be highly specific to the context in which they develop and to accumulate gradually (Narduzzo, Rocco, & Warglien, 2000). These inertial and path-dependent properties make their transfer across organizations and into different country contexts challenging (Kogut, 1991). Within the organizational behavior perspective, the origin of organizational capabilities and their constituent routines can be traced to bounded rationality (Simon, 1955), with rules (March, Schultz, & Zhou, 2000) or routines (Nelson & Winter, 1982) replacing calculative rationality and conscious action. Routines have been held to be the basic components of organizational behavior and repository of organizational capabilities (Becker, Lazaric, Nelson, & Winter, 2005).

Within sociology, although organizational capabilities are not theorized, quite a different perspective on routines is provided. Routines are depicted in the form of the reality of institutional constraints on individual actors pursuing their own ends (Giddens, 1984). Like the routines of organizational behavior, these institutional realities pre-exist and outlast individuals who embody them. However, in place of the perspective from organization behavior that routines are followed by individuals mindlessly without drawing on substantial cognitive resources from the realms of consciousness (Gersick & Hackman, 1990; Kilduff, 1992; Nelson, 1995), sociology emphasizes that routines are *meaningful accomplishments* (Giddens, 1984). Individuals may cooperate to stage routines in an attempt to enact a particular situation with routine interactions having a dramaturgical aspect (Goffman, 1959). Everyday performances of routines are held to high standards of "aptness, fitness, propriety, and decorum" by audience members (Goffman, 1959; Kilduff, 1993). Routines are resources used by conscious and purposeful individuals in pursuit of particular ends.

Within the organizational behavior perspective on routines, recent work has recognized that, though relatively inert, routines can and do change (Feldman, 2000; Feldman & Pentland, 2003). Several reasons for the change can be identified, varying in their degree of intentionality. For Nelson and Winter (1982), knowledge of routines is partly tacit, so replication of routines in new contexts becomes problematic as there may be unintentional slippages. If routines are a truce between potentially conflicting interpretations of a situation, then a change in organizational context may bring about a renegotiation of the situation and a change to the routine. Change has also been found to result from differences in different orientations of individual agents (Howard-Grenville, 2005), but the dominant image within organizational behavior and evolutionary economics perspectives on organizational routines is one of relative inertia.

The possibility for meaningful and intentional change in routines is stronger within sociological perspectives, with enacted routines being the intended result of individual actions. Just as language is likely to vary across different contexts of meaning, enacted routines will vary across contexts in accordance with variations of meaning (Kilduff, 1993). Apparent similarities in routine performances across contexts may mask heterogeneous meanings, goals, assumptions and values, which will vary with context. As routines are enacted in different contexts, such as among the different cultural contexts across international borders, they are not just transferred or translated, but transformed (Carlile, 2004) or recontextualized (Brannen et al., 1999) as the meaning of routines practices changes from one cultural context to another. This is likely to occur to a greater extent the more highly embedded practices are in the institutional and cultural environment and when they involve a large tacit knowledge base (Brannen et al., 1999). The focus upon the changed meaning of enacted routines subsumes many other concepts that researchers have applied to try to understand the difficulties in transferring practices across different contexts, including absorptive capacity and motivation as predictors of knowledge "stickiness" (Szulanski, 2003).

Differences in meanings among cultural and institutional contexts imply instability of what is sociologically real and raise questions about the definition and significance of the value of stable organizational features such as organizational capabilities. Whether an organizational routine is valued as an organizational capability will depend upon its significance to an organization's identity and upon how that routine affects the organization's membership of a legitimate category of other organizations based upon its resemblance to its collective organizational form.

Focusing on the mechanisms of transfer has allowed labor process theorists to add a more political perspective to the largely social constructionist views above, through having shown that the recomposition of a routine in a new context is in every case an outcome of local negotiations and conflicts among managers and between managers and labor (Elger & Smith, 2006). One good example of this was Elger and Smith's (2005) study of five different multinational Japanese electronics subsidiaries in the Telford region of Great Britain, in which they were able to show how their observed variety of practice outcomes resulted from the working out of local negotiations and conflicts.

2.1.4 New Product Development Capabilities in Japanese Companies

In the last section, I discussed recent work across a number of disciplines, that has claimed or shown that the essence of organizational capability is the integration of specialized knowledge (Grant, 1996). This is especially difficult to achieve when the knowledge required is embedded in different cultural and institutional contexts and when the underlying knowledge is relatively tacit, such as knowledge in R&D. Numerous subfields within organization theory, technology management, and strategic management have studied how firms have (or have not) achieved effective integration across various boundaries at the technology, project, function, or firm levels. Moreover, patterns of human resource management and work practices in new product development vary markedly across national borders, such as between Japan and the US. If integration is at the heart of organizational capability, then the way that integration is achieved will also vary across borders. This has significant implications for collaborative new product development across borders at the project level, and for the evolution of the MNC as an organizational form as it crosses borders.

Take Japan and "the West." Generally, Japanese and US manufacturers have different approaches to new product development. One compelling explanation for these differences attributes them to Japan's late-developer status (Dore, 1973), following in the tradition of Gerschenkron and Veblen. The kernel of Dore's argument is that Japan, by virtue of the timing of its industrialization (relatively late so it could take advantage of then prevailing social technologies and ideologies then current), adopted certain *organizational forms* which were to crystallize into what he called the welfare corporatism that characterized Japanese industrial relations' practices in large Japanese firms. The key items of the welfare corporatism organizational form included a highly developed internal labor market with in-company training and career progressions for even manual workers, high loyalty and commitment to company goals, enterprise unions, and large-scale welfare benefits involving the company in employee lives even after working hours (Dore, 1973). He contrasted this to more market-oriented approaches to industrial relations in England, characterized by high interfirm mobility, wage systems oriented to the external labor market, weak loyalty to the company, minimal fringe benefits, and precariously present unions.

This is suggested as an alternative to cultural explanations that direct attention to Japan's feudal tradition (Abegglen, 1958), or to other institutional explanations. Still others trace the differences between the Japanese and Western organizational form to more recent developments, minimizing the importance of earlier historical developments. For example, Gao (1997) sees the new thinking and policies associated with the wartime economy between 1940 and 1945 as the crucial moment in the creation of the Japanese economic system, including the relatively distinctive features of its organizational form.

What are the implications of these differences for new product development? In an oft-cited and early set of case studies of new product development in five large Japanese firms, Imai, Nonaka, and Takeuchi (1985) identified six organizational factors that they considered contributed to speedy and flexible new product development in Japanese firms. Their seventh piece of their "seven-piece jigsaw puzzle" was the relationship between the main firm and outside suppliers. These are that top management acts as a catalyst, project teams are self-organizing, development phases overlap, there is multilearning and subtle control, and organizational transfer of learning. While the distinctive features of the Japanese new product development process were apparently identified without comparative cases from the US, this article was undoubtedly seminal in highlighting key differences across organizational forms between Japan and the US. While apparent at the project level, many of these differences are embedded at the higher, organizational level of analysis. These practices include the practices identified by Dore (1973).

More recent work has grouped within-country practices and contrasted them, such as between a "Japanese 'human-oriented' approach" and Western "'systemic-rationality-oriented' practices" (Baba & Nobeoka, 1998). The Japanese product development system of large organizations relied heavily on human resource management and work practices that supported high information redundancy, with relatively high sharing of information and the greater importance of the project team for idea generation than individuals (Nonaka, 1990). The Japanese system has also been characterized as more flexible (Nonaka, 1990). In contrast, in the Western systemic-rationality oriented model, the development process is more integrated through the use of information technologies. In this model, possible options are analyzed using well-defined objectives, with decision-making a rational process that follows comparison and review of options (Baba & Nobeoka, 1998). The Western model is more suited to the burgeoning use of information technologies in new product development, such as 3-D CAD systems, with Japanese firms lagging US firms in the adoption of such systems.

These almost stereotypical and generic differences in the work and human resource management practices that support new product development in large US and Japanese firms were evident in JTech, as I describe later on in this thesis. Moreover, the differences are not just between Japan and the US at the country level, but there are also differences among large firms in Japan based upon factors such as the time of founding of a company. The differences affected the evolution of the US transmission subsidiary organization of JTech as its activities evolved from sales and marketing and product planning to new product development. I will describe how the US organization drew from organizational practices of its parent in Japan in a way that enabled the organization to demonstrate conformity with a legitimate organizational identity, while maintaining its distinctiveness. New product development capabilities are capabilities if they support a desired or ascribed organizational identity, but become *in*-capabilities if they do not.

2.1.5 MNC Subsidiary Evolution

The concept of MNC subsidiary evolution has been implicit in almost all theories of the evolution of the MNC as an organizational form, but only comparatively recently have scholars begun to focus explicitly at the subsidiary level of analysis. Probably the most significant factor that has allowed researchers to extract the subsidiary as an object of study in its own right has been the widespread recognition that firms internationalize, not only to exploit ownership-specific advantages developed in their home countries, but also to tap into or to create new advantages abroad that may not be brought into the firm as efficiently by methods other than through a directly-owned subsidiary located in a foreign country. Hence, in more recent work, subsidiaries have been characterized as important centers for learning and for building capabilities, perhaps no more so than in the concept of the subsidiary as a "center of excellence" (Frost, Birkinshaw, & Ensign, 2002). Nevertheless, despite the heightened recognition of the importance of organizational capabilities to subsidiary evolution, the identity of the subsidiary as an organizational form is almost without exception described based upon its role in the MNC as a whole.

It is also worth noting that, as the importance of the subsidiary to the survival of the MNC has increased, so use of the word "subsidiary" has seemed all the more inappropriate, with its implication of subordination (to headquarters), of being of secondary importance, or of serving to assist others. Language itself has probably played no minor role in perpetuating the assumptions and stereotypes of much of the early work on the role of the subsidiary within the MNC. To talk of *head*quarters has always been to speak about the *identity* of the *sub*sidiary, an ever present comparison.

Early work on the evolution of the MNC as an organizational form only implicitly considered the evolution of the subsidiary and derived their models from studies of MNCs with a US home base. For Fouraker and Stopford (1968) and Stopford and Wells (1972), as the MNC itself evolved and grew, so the internal stresses on the international management system would lead to an evolution in the way that the subsidiary was managed, from management of international activities through an international division in the MNC, to management through an area division or worldwide product division, or some combination of the two. Introduction of gendered assumptions about the relationship between headquarters and the subsidiary was made by Franko (1976) in his characterization of the portrayal of this relationship as mother-daughter in the first stage of internationalization of many European multinationals. Again, the level of analysis remains the MNC, but the subsidiary at this early stage of internationalization is characterized as having relative autonomy, with informal relationships to the head of the MNC being the main management method, along with personnel rotation (Hedlund, 1984).

Asking the different question of why firms would internationalize, building upon earlier work from scholars including Stephen Hymer and Raymond Vernon, international business researchers considered firms more likely to internationalize if they were in industrial sectors in which their home country had a comparative advantage (Cantwell, 1989; Pavitt, 1987). This triggered several streams of work on the evolution of the MNC, in which the evolution of the subsidiary was implicit, explicit, or not considered.

The product life cycle model of Vernon (1966) suggested that, at a stage of later product maturity, product cost becomes a more important competitive basis for firms, which results in a shift of production abroad to lower-cost locations. In later adaptations to his evolutionary model, the role of the subsidiary gradually changes to take on greater responsibilities for higher value-added activities, from offshore manufacturing for the local market and to re-import back into the home country, to adapting products to the local market, and eventually to contributing to product development (Vernon, 1979).

This almost mechanistic depiction of subsidiary evolution focuses upon its role, which has become an important basis of characterizing subsidiary evolution across much subsequent literature. The subsidiary is defined by its relationship to headquarters through its role, which is always subservient; there is no space given for the subsidiary to author change. Nor is the possibility of subsidiary decline considered (Birkinshaw & Hood, 1998). In this model, the MNC is fully rational and its development is determined by economic forces according to the changing product life cycle. Subsequent work that built upon this approach has continued to focus upon subsidiary roles.

The assumption of complete rationality is relaxed in the MNC internationalization process literature, which is most directly identified with the important internationalization process model of Johanson and Vahlne (1977). Because managers are cognitively limited in their ability to process information, they incrementally commit to foreign markets as they learn (acquire, integrate, and use knowledge) about foreign markets and operations. Subsidiary development is, in this theory, the outcome of a cyclical interaction between investment and learning. In an interesting contrast to the focus upon subsidiary roles, this work is perhaps the earliest recognition of the importance of organizational capabilities' to subsidiary evolution (Madhok, 1997). As with the subsidiary in the product life cycle model, the subsidiary is subordinate to its home country headquarters, but unlike the earlier model, the subsidiary role is not simply to reduce costs, but to learn about the host country market, to gain local experience, and to transfer it back to headquarters.

The metaphors of learning and of capabilities' building are central to the internationalization process literature, which has modeled international expansion as an incremental process unfolding over time, whether of MNC activities (from export to sales office to full value-chain subsidiary), mode of operations (from contract to joint ventures and alliances to wholly-owned operations), or location (from more culturally proximate to more culturally distant locations) (Westney & Zaheer, 2001). Kogut (1983) extended this early work by emphasizing the sequential nature of foreign direct investment, which explains why firms formed organizational platforms overseas and gradually deepened their activities in overseas subsidiaries. He showed empirically how investment behavior by Japanese electronics companies in the US was highly heterogeneous across firms, reflecting their individual technological capabilities and their history of previous investments (Kogut & Chang, 1996). While the timing of investments was triggered by exchange rate movements, the more important finding for the purposes of this dissertation is that of a deepening of capabilities within the subsidiary as learning occurs. Again, the possibility of decline is not considered in this work.

An important stream of work that sought to build on the internationalization process model followed Sumantra Ghoshal's 1986 Harvard University dissertation in which he sought to move the level of analysis down from the MNC to understand the different roles played by subsidiaries within the MNC (Ghoshal, 1986). This work began to recognize that subsidiaries should be conceptualized as a level of analysis in themselves. Again, the identity of the subsidiary was defined by its role within the MNC.

Subsequent network models of the MNC have allowed for the role identity of the subsidiary to increase in strength relative to headquarters and the rest of the MNC, even to assume strategic leadership as one of four generic roles (Bartlett & Ghoshal, 1986, 1989), depending upon the strategic importance of the local environment and the level of local resources and capabilities. Subsidiaries' roles depend upon not only the importance of the local environment to the MNC's global strategy, but also to the subsidiary's competence in functions such as technology, production, or marketing. While this defines a given subsidiary's role identity within the MNC according to the dimensions Bartlett and Ghoshal (1986) set out, it does not take into account the fact that the subsidiary as a social form will have an organizational identity held by its audience, an identity that may or may not be legitimate. We also need some understanding of how subsidiaries transition between such MNC-defined roles.

The possibility of subsidiary decline was, however, considered by Bartlett and Ghoshal (1989), such as in their analysis of the gradual erosion of the competitive position of the Canadian paper-making machinery manufacturer Dominion Engineering Works, a subsidiary of the US-headquartered MNC General Electric. This presaged later work focused upon developing a more dynamic theory of subsidiary evolution by Birkinshaw and Hood (1998), who conceptualize subsidiary decline through loss of charter or depletion of capabilities. Birkinshaw and Hood (1998) define subsidiary evolution as the enhancement or atrophy of capabilities over time, where capabilities are, in their framework, the capacity to deploy resources in combination to achieve a desired end. This definition of capabilities is closer to that of dynamic capabilities than organizational capabilities.

Organizational capabilities, it will be recalled, are the ability to integrate knowledge from internal and external sources. The focus is very much upon the accomplishment of coordinated tasks, whereas dynamic capabilities are more concerned with the ability of an organization to respond rapidly to changes in the environment, such as by reconfiguring resources. They are tied to alterations in the resource base of the firm rather than to the integration of knowledge in a coordinated way. Dynamic capabilities are the "organizational and strategic routines by which firms achieve new resource configurations as markets emerge" (Eisenhardt & Martin, 2000). They are about how firms upgrade their resource base to respond to new environmental contingencies.

This approach enables Birkinshaw and Hood (1998) to introduce the glue analogy of "stickiness" to capabilities, used in Von Hippel (1994) for information or knowledge that is costly or difficult to move across locations. They define subsidiary evolution in terms of (1) the enhancement/atrophy of capabilities in the subsidiary and (2) the establishment or loss of the commensurate subsidiary charter, defined to be the subsidiary's role in the MNC (Birkinshaw & Hood, 1998). Examples of a charter include markets served, products manufactured, functional areas held, or technologies owned. The relationship between charter and capabilities is not necessarily one of reflection and is not straightforward. What this extension of the earlier frameworks on subsidiary roles achieves is to allow for the fact that subsidiaries may themselves act outside their role and initiate a change in role, such as by enhancing or depleting capabilities.

Yet, central to the argument developed in Birkinshaw and Hood (1998) is that in order for subsidiary evolution to occur, the subsidiary's capabilities have to be *valued* by corporate management. While extending the earlier work of Bartlett and Ghoshal (1986, 1989), what is not considered is whether and how the organizational capabilities reinforce or undermine the subsidiary's salient organizational identity in the eyes and minds of key audiences, including the subsidiary's employees.

For example, it is possible to imagine a subsidiary adding to its capabilities but at the cost of delegitimizing its organizational identity. Take, for example, the case of a subsidiary in a host country that has a charter to develop new technologies, perhaps a subsidiary of a Japanese MNC located in Silicon Valley involved in developing high-end products. The subsidiary may have established itself as a member of a legitimated organizational form (Hsu & Hannan, 2005; Zuckerman, 1999) based upon the scope of its engineering effort and a variety of practices, including building appropriate external networks. If the subsidiary were to add, say, a research capability in low-end products, to engage in manufacturing, or to shift to dealing with new customer categories, it may lose its legitimacy as an organizational form based upon its previous identity.

In the example of JTech in this thesis, at an early stage of JTech's US subsidiary evolution, the transmission division separated itself organizationally and in location from development work on low-end and lower-status modem products. Yet, this depletion of a capability and loss of a charter did *not* lead to subsidiary decline, as would be predicted by Birkinshaw and Hood (1998), but led to subsidiary development, because any subtraction of capability and charter in a mechanical sense nevertheless conferred on the subsidiary an identity as a legitimate member in the sociologically real category of a new venture developing high-end products.

Other, more recent work at the level of the MNC has advocated practices that may lead to almost limitless integration, such as proposals in popular management writings to establish "magnet teams" to move distributed knowledge to where it is needed (Doz, Santos, & Williamson, 2001). Yet, organizational structures put in place to cope with changing strategies and evolving capabilities risk destabilizing the identity developed by the subsidiary in the previous product era. For example, management practices designed to improve communication across borders, such as through adopting new information technologies to facilitate the transfer of more complex information, or that aim to deepen understanding among collaborating units of an MNC, such as increasing personnel transfers, may undermine cross-border knowledge development through their inadvertently delegitimizing the organizational identity of an MNC subsidiary.

2.2 Research Methodology

I collected the data for this dissertation part time, over the period from August 1998 through April 2002, during which time I simultaneously held an appointment as a salaried Manager in the then Corporate Planning and Business Development Department of JTech's corporate headquarters in Tokyo (Japan). As well as collecting data for my dissertation, my role included reviewing corporate governance, brand management, business unit strategy formulation, and overseeing new product development and supply-chain management assessments. I also established and ran a year long training program for senior managers covering topics relevant to their business needs from the fields of strategy, organizational analysis, and international management. Throughout my dissertation, I have changed names and some insignificant details in order to ensure the anonymity of JTech and my informants.

2.2.1 Research Setting

From my position in JTech's corporate headquarters, I came to know many mid-career managers from the business divisions – from across electronic devices, server, PC and other products, and IT software services – who were on secondment to headquarters for typically a couple of years or thereabouts. Let me briefly set out some key events and facts about JTech to further clarify the context of my research.

JTech is well known by its real name throughout the world as a global leader in the fields of computers and communications, with its corporate headquarters in Tokyo, Japan. JTech had been founded in the 1930s as a spin out from a larger company, and so was relatively young compared to its major domestic competitors (see next Chapter). At the time of my study, JTech principally developed, manufactured and sold device technologies and computer and communications products, was a global top-five provider of computer servers and PCs, and a top-three provider of IT services to a global client base that includes over half the Fortune Global 500 as its customers. Its various constituent businesses were headquartered in various dispersed locations around Japan, and its activities were globally distributed in the major world regions and markets. In March 1996, it employed more than 150,000 employees worldwide and had sales of approaching 5,000 billion Yen.

I had had a longstanding interest in internationalization of firms and especially of R&D as a designated function within firms (e.g.,Voisey, 1992) principally motivated by my prior work experience in the London subsidiary organizations of both US-headquartered and Japan-headquartered MNCs, in which I was collaborating with other subsidiaries and business units within the respective home countries in knowledge-intensive work. Prior to any exposure to the now substantial literatures on knowledge management and on international management, I had direct experience that international collaboration seemed to involve a step change in increased difficulty when work shifted from less to more knowledge intensity.

At JTech, I searched for cases of internationalization involving new product development that I might put together into a comparative case study, but I could not find suitable cases that would fit into a research design meeting established research methods criteria. This was despite the fact that JTech was pushing its internationalization of new product development in several different businesses. The principal difficulty of constructing an across case analysis was that the initial conditions were different so that differences in the evolution of cross-border collaboration due to process could not be identified from those due to initial conditions. In three of the cross-border cases for which I did preliminary work, one case was a project joint venture, another was a project between two JTech organizations with quite different histories (the overseas subsidiary had been acquired by and assimilated into JTech), and another was a collaborative relationship between a JTech divisional headquarters and its Greenfield subsidiary.

Eventually, I decided to focus on a somewhat unusual case, the case of one of JTech's business units that had successfully internationalized from Japan into the US. JTech's transmission business had started from a position of having had a relatively weak home base to successfully developing a collaborative relationship with its subsidiary in North America, the most challenging marketplace in the world. As a further and intriguing twist on this story, at a later stage the business unit in Japan went on to achieve success in its Japan home country marketplace based upon what it had learned from its earlier overseas activities.

Obtaining research access was a somewhat serendipitous and constrained journey, but I decided to progress with a study of the case of the internationalization of JTech's transmission business into the US country market, social, and institutional environment for a number of reasons.

First, differences between Japan and the US production systems at the factory, enterprise, and inter-organizational levels have long been of interest to scholars with backgrounds in comparative sociology, industrial relations, economics, and political science. Early work, notably Abegglen (1958), had examined differences between respective employment systems at the factory level. This was followed by cross-country comparative work at the same factory level by industrial relations' scholars (Whitehill &

Takezawa, 1968) and by studies conducted by comparative sociologists focused more upon the production system (Cole, 1979).

Subsequent work moved up to the enterprise level (Abegglen & Stalk, 1985), with scholars documenting and seeking to explain the very different patterns of social organization and corporate governance between Japan and the US, especially between the respective patterns of corporate diversification and vertical integration (Fruin, 1992; Hamilton & Biggart, 1988). This work has generally concluded that Japanese firms were more likely to organize manufacturing, sales and marketing, and non-core businesses through subsidiary or affiliated group companies, known as *keiretsu*. The case of JTech's transmission business provides a counter example to this general finding, since it was the higher value added hardware and software development engineering activities that were de-integrated into two vertical groups of subsidiary companies, as JTech responded to internal coordination and external institutional constraints on its growth and overseas expansion (see Chapter 4). Finally, at the inter-organizational level, horizontal linkages among enterprises form a different kind of *keiretsu*, with six such groupings of firms across different industries (Gerlach, 1992).

The differences between the social organization at each of these three levels of analysis between Japan and the US supported my view that the case of the internationalization of JTech's transmission business from Japan to the US would be both a unique and revelatory case for study (Yin, 1994). It is the precisely the coordination of major activities across such significantly different institutional contexts through organizing routines that defines the MNC as a distinctive organizational form (Ghoshal & Westney, 1993; Whitley, 2001).

My second reason for having selected the case of the internationalization of JTech's transmission business into the US environment was that, at the level of the enterprise, JTech was dispersed across Japan with a management system that was relatively decentralized compared to its older-established competitors. This potentially afforded me the opportunity to identify the features of any relationship between patterns of collaboration across distance within Japan with patterns of collaboration across distance and borders to the US. Such a home country pattern of dispersed organization was very different to the co-location of activities in Toshiba's Yanagicho Works described by Fruin (1997). Fruin (1997) argues that competitive advantage for Japanese firms is based on their ability to combine knowledge assets at the level of the single-site factory, but that this presents difficulties for transplanting such an organization abroad.

Third, JTech's transmission division, which over the period of its internationalization was also designated a business unit ("BU"), succeeded in rapidly building a successful business in a large, dynamic, foreign market of global "lead user" customers without an existing leading-edge technology developed for the Japanese market that it could adopt or adapt for non-domestic markets. Indeed, the BU was largely excluded from supplying its target Government-owned primary customer in Japan. Instead, the BU relied heavily on US-sourced knowledge to develop new products for the US market. This case was undoubtedly an outlier and the aim of my research was not to discover some invariant model of best performance, but to try to develop some new insights (Lewin, 1988).

2.2.2 Data Sources

I have drawn my data from six main sources. First, the data comprises 22 interviews with Japanese-speaking respondents from the Group's headquarters and main development center in Japan, and with Japanese- and English-speaking interviewees in the US development center. When interviews were held with respondents for whom Japanese was the mother tongue, I conducted interviews in Japanese. I transcribed all interviews and translated all Japanese language interviews into English. Selection of interviewees was based upon their historical involvement in the development of the US business and to try to achieve a balance of perspectives across location and activity. Access to interviewees was generally open in Japan, but the content of my interviews in the US were more focused upon the cross-border collaborative development of earlier products, up to 1993. For data on more recent collaborative new product development projects, I relied to a greater extent on non-US data sources but also on data supplied by American respondents when they raised this in conversation – to comply with my conditions of restricted access set out by the President of the US subsidiary.

Second, as part of the interview process, I made numerous site visits within Japan and a week-long visit to the US subsidiary, JTech Network Communications, Inc. ("JNC"). The site visits provided additional insights not available from interviews. For example, at JNC I noticed how the design of the physical layout of building space seemed to echo the organizational structure of JNC – each of JNC's organizationally strongly distinct functional areas (called 'organizations') was separately located in different parts of the JNC main building, with its own entrance. Either these spatial relationships had become embedded in the organization or they had come to reflect the organization design and culture, but they mirrored each other.

Third, I examined a number of artifacts, including internal historic mid-term strategic plans, product planning and product development documentation, and product information. As I explained in the last section, I was also provided with a set of documents comprising narratives of part of the history of the development of transmission technology within JTech, which contained some information on management and organizational issues.

Fourth, I obtained data from external industry trade journals, primarily Chilton's Electronic News, Communications International, Data Communications, Datamation, Fiber Optic News, Network World, Telephone Engineer & Management, and Telephony.

Fifth, an important source of data resulted from my daily interactions with JTech employees with in-depth working knowledge of its transmission business. Such interactions typically followed one of three routines. In the first, I would ask my colleague focused (not typically open-ended) questions. In the second routine, I would invite my colleagues to react to tentative and working hypotheses. Third, my request for assistance on explanation of Japanese language that I did not understand often generated expanded insights.

Sixth, during the process of preparing interview transcripts, translations, and reviewing other archival material, I developed a set of eleven "conceptual memoranda" in which I recorded my emerging ideas and themes of interest. I used my conceptual memos to record my ideas and thoughts as I iterated between my efforts at trying to make sense of the data. In relation to transcripts, the search for themes of interest included reading each transcript and reliving the interview experience as a whole, and then comparing across transcripts by theme. I then noted and referenced such themes of interest on a conceptual memo. In the early memos, I was seeking to find tight linkages between my data and existing concepts and theories. However, whichever theoretical perspective I sought to impose, I felt that I was losing data and had some missing data. As I progressed and reflected on my progress, I noted a trend to move back to the data, to let the concepts emerge from the data. In a sense, my early approach was underwritten by the question, "What theories do my data support or not?" and by the time I finished, I was asking, "What are my data telling me?"

2.2.3 Analyses

My data analysis has been a process of ongoing reflection and dialogue, both internally and in interaction with my colleagues within JTech. I rejected quantitative techniques, such as computerized content analyses of transcripts for several reasons. Not only would this waste data, but I could not see any way that such techniques could avoid biasing my analysis in an international management setting in which all sorts of contextual factors were important (see below). Third, my research relied on a variety of data sources rather than a single source, such as analysis of results from having administered and coded a questionnaire instrument.

I was especially concerned by the effects of context on my data as I proceeded with my analysis. I was also familiar with findings from the learning and knowledge management literatures that have stressed how knowledge is inevitably embedded in context. So, too, I could not simply cleanse my data from context. For example, my interviews were always set up in a particular ways, took place at different times and in unique circumstances. These diverse settings for my data gathering were of no small importance. Context determined in a very significant way what I learned from an interview. Let me illustrate this through some examples.

The content of interview question responses varied according to the local setting – the interview context. For example, American respondents in the US were most direct and provided more detailed answers to questions if interviews were held in private rooms. However, the same dimension of variation was not observed for Japanese respondents in Japan, for whom responses to questions seemed independent of spatial privacy.

Japanese-speaking interviewees were reluctant to speak if interviews were held with more than one person simultaneously. However, this was not the case for interviews in Japan with Japanese-speaking interviewees who had spent several years working in the US, even when the interviews were in Japanese. I speculated that these respondents were used to responding in a more direct way to non-Japanese nationals and were able to culturally adjust in style, holding constant their (Japanese) language.

English-speaking American interviewees would provide more active responses to questions, invariably stressing the importance of a named subject (person) in instigating a particular action. In contrast, Japanese interviewees would make extensive use of the passive tense, omitting the subject, and would use more varied language, from fragments of casual Japanese to polite (*keigo*) language. Thus, the active subject in English-speaking American interviews was in contrast to, at times, an absolute absence of perspective in responses by Japanese interviewees. Almost as an aside, I conjecture that this was a country-level effect, as I noticed a relative absence of perspective in other areas of Japanese society, such as in ukiyo-e Japanese art.

Japanese-speaking interviewees would be very indirect in describing events, while English-speaking American interviewees would 'tell it like it was.' But, actually, the American interviewees did not tell it like it was, because all accounts were retrospectively rationalized and I am sure that they were dramatized, just as the events surrounding my own first day working in New York had been retold and dramatized over time. Quite often, for example, it was hard to understand what actions or events had actually taken place from listening to the tape or reading the transcribed interviews. For interpretation, I relied upon placing the interview in context and on the opinions of colleagues either present at the interviews or familiar with the Transmission Division of the Transport Systems Group.

Transcriptions of interviews often failed to convey the most important information. The significance of actions and events was often expressed by means of emotions, pauses, and by what was unsaid. To overcome this, wherever possible I added explanatory notes to my interview transcripts, and notwithstanding the transcriptions, I listened to tapes many times to deepen my understanding of the issues, recalling interview experiences. In my Japanese-English translation of narratives and stories of the history of JTech's transmission technology, I was also aware that the Japanese would deliberately avoid mentioning some of the most obvious points – not just to present a desired and consistent image, but perhaps also so as not to insult the reader by assuming her lack of knowledge. I spent several hours each week going over documents with engineers trying to identify and fill in the missing gaps.

Japanese words often had multiple interpretations and the language of Japanese-speaking interviewees did not relate directly to concepts in American organization theory. Rather than selecting one particular English translation, wherever possible I continued to refer to the Japanese language during the process of conceptual development.

When I did rely on my own translations into English, I was conscious that I was reflecting my theories and mental models into the data, since language is not neutral. Every time I chose an English word to describe the Japanese, I felt that I was imposing an analysis and intruding into what the original author was trying to convey. His or her words, of course, were often conceptually-laden reflections using words from management theories or the popular press. It was clear to me that there are, for these reasons, no theory-free data.

3 JTech and JTech Transmission: Historical Context

3.1 Introduction

In the previous Chapter I described how I came to focus upon internationalization as a process of identity construction. I found that identity acted as a framework for action, provided a system of meaning for subsidiary managers and other stakeholders, and connected them with the subsidiary and to the world with which the subsidiary interacts. I came to reframe my interest in the internationalization process as asking how an internationalizing firm can influence the construction of a meaningful and legitimate organizational identity in a foreign country.

While I start my analysis from 1985, the earlier history of JTech significantly influenced the organizational design, the culture, and the distribution of power throughout JTech. The seminal insight that organizations are "imprinted" with indelible characteristics of the founding period, and that these characteristics depend upon the social technology available at the time, was the seminal insight of Arthur Stinchcombe (Stinchcombe, 1965). One of the ways that this history continued to influence JTech was through storytelling, which was highly institutionalized as a practice of socialization throughout JTech.

I was told and read numerous tales of JTech's earlier history in historical documents containing memories of and facts about JTech, at office parties, and at breaks in the working day. Some of the more recent stories only made sense against the backdrop of more general stories and understandings of JTech's earlier history. For example, the meaning of a story of competitive rivalry was only a tale worth telling if you knew the bigger story to which it appended and merged.

My sources and data for these stories are multifarious. I read books written by past Presidents of JTech, and had many internally produced and circulated Japanese language documents and company history books that were confidential, that I was allowed to take away with me, but that cannot be cited for reasons of confidentiality. In other cases, I listened to stories, asked for elaboration of stories told, and was told tales in response to questions intended to flush out simple facts and dates. In some cases I have changed names in my efforts to maintain confidentiality.

My story is that the tales I tell have been pieced together from various sources, and these sources have not been specifically identified to maintain confidentiality. For example, citing a book written by a past President would risk revealing JTech's identity. I also realize that, in the words of John van Maanen (Van Maanen, 1988), I did not arrive at JTech as a simple student. Rather, I had been thoroughly socialized into the theories of organizations that dominated American management schools in the 1990s as well as from my earlier career history of having worked in subsidiaries of MNCs. I was always an interpreter and translator of indigenous texts about the social world of JTech that were available to me in the field (Geertz, 1973), *given* my embodied habitus and my cultivated disposition (Bourdieu, 1977).

This Chapter provides some historical background to JTech, covering the period up to 1985 when my analysis evolution of JTech's transmission business subsidiary organization in the US begins. Having read a number of histories of JTech and been told stories into which various dates and events were emplotted, I have chosen to tell this general historical background in the form of seven short stories. These tales of JTech's history include examples of other experiences in internationalizing, JTech's transmission business with NTT in Japan, and of the internationalization of JTech's transmission business. The aim of this Chapter is to provide an overview of the history to which a number of themes in the ensuing chapters are related.

3.2 Stories of JTech

3.2.1 The endless struggle of the JTech fighters

JTech was founded in the 1930s as a spin out from a larger parent, and was established to specialize in the production of "knockdowns" from the telephone switching technology and equipment that had been developed by a major German company. It was a late entrant into this marketplace, which was already occupied by well-established companies with earlier founding dates, namely NEC (1899), Oki Electric (1881), and Hitachi (1910).

Much of the telephone equipment in Japan had been destroyed in the Great Kanto Earthquake of 1923, and the rebuilding coincided with a technological change through the shift to automated switching. As a start-up, JTech was unable to recruit engineers from the leading universities, but attracted graduate engineers who were unable to get into the more prestigious companies to its factory in Kanagawa, near Tokyo. Much of the engineers' early work involved translating documentation and technical diagrams into Japanese as JTech sought to adopt or adapt technology introduced from Europe.

JTech's subsequent entrance into computers can be traced to its contribution to technology in a time of War. In 1944, a military research institute was established within

JTech's Kanagawa plant, and the engineers turned their attention to experimentation to build a radar as part of a defense system. Much of that work involved computation and the transmitting of data to anti-aircraft guns. The processes involved in anti-aircraft ballistics were observation, calculation, laying or sighting, and firing – which were essentially input, computation, and output. After the war, the Japanese Ministry of Communications reduced its new telephone installations by more than half. JTech responded in by laying off more than a third of its workforce in the late 1940s, as well as by seeking out new business directions.

From 1950, the Japanese Ministry of International Trade and Industry ("MITI") was making grants available to Japanese firms to promote industrial development. JTech submitted a report on audio standards for telephones and related equipment to MITI, and with its resulting grant award it purchased the complete set of 30 volumes of Articles on Military Technology that had been collected by Massachusetts Institute of Technology ("MIT"). From analyzing these 30 volumes in the MIT collection, JTech explored entry into computers, microwave multiplex transmission, and television technologies.

However, JTech was unable to find a willing overseas technology transfer partner in computers, and was forced to revive its old ties with its German ally to assist in developing microwave radio technologies. The German company, however, had a home base in a country that had also been on the losing side of the War, and was lagging other companies in technology. In particular, it had been slow to move from analog to digital technology and to develop transistors. At every corner, JTech had hit a wall. It had no computer technology and weak communications technology. Generally, at that time, Japanese companies had fallen behind their counterparts in the US and Europe and were competing to introduce new technologies from abroad.

It was these difficult circumstances of layoffs, of no overseas partners, of weak technology, that became, in the words a past President of JTech, "the source of the "fight" in [JTech] man." He described how,

> "...in the area of computers we were not able to obtain technology agreements with anyone. Consequently, we had to do all of the development ourselves. Looking back, I would have to say we were surprisingly lucky in this endeavor which promised to be one uphill struggle after another with tremendous obstacles along the way."

Coda: The endless struggle of the JTech fighters

This story of the early history of JTech is told in the form of a tragedy. The textualized summary in the past President's words uses metonymy to compare JTech's early history to the struggle of rolling a boulder uphill and overcoming one obstacle after another. JTech was involved in a futile and hopeless labor of ceaselessly rolling a rock to the top of a mountain, only for it to fall back again. This was Homer's Myth of Sisyphus in Odyssey, the wise man who despite endless toil reaps no rewards, but whose heart is full with the struggle itself and through which he achieves happiness.

There are three points to note from these events that would be emplotted into any history of JTech (Czarniawska, 2004; White, 1987), that are relevant to my study. First, JTech is a relatively recently founded company compared to its older-established domestic competitors and this has had two important organizational consequences. With regard to concentration/dispersal of its activities, JTech's distribution of activities across Japan tends to be more dispersed – it does not have the scale equivalent of "Hitachi City" in its industry. Part of the reason for this dispersal seems to have been that it led to more effective recruitment. JTech's difficulty of recruitment compared to older and higher status competitors led it to establish organizations in the provinces, often near provincial universities, so as to more easily recruit. Second, power is more decentralized in JTech than in its competitors' organizations, so that at any level an employee or group might expect to have greater authority relative to competitors.

Second, JTech was founded as a spin-off and from its inception was involved in the introduction and adaptation of foreign technology (initially from its German partner) into products for the Japanese marketplace. Third, its relatively recent founding has had the continuing consequence that it has enjoyed a less privileged relationship with many key governmental and large corporate domestic customers, in a society in which age and status are more closely correlated than in most western societies. These last two factors have continued to encourage JTech into a more extensive search overseas for new technologies which it could introduce into Japan to leapfrog over its domestic competitors, and also into developing its own technologies and products. Although the data are difficult to present in a convincing way, there can be little doubt that the difficulties that JTech has confronted competing domestically against its longer-established competitors has led to JTech being more aggressive in seeking new markets and customers overseas.

3.2.2 Reliability and Creativity

JTech, a manufacturer of communications equipment, was saved by its strategic move into developing computer technologies in the early 1950s. In 1952, a highly regarded professor from Japan's most prestigious university, Tokyo University, sounded JTech out about building a stock transfer and accounting system for the Tokyo Stock Exchange. With Board level support, a special team of engineers was created which developed a Stock Transaction Computation System that was instead put into operation at Daiwa Securities. Leading computers at the time, produced by IBM and Univac, used a punch card system of data input. Instead, JTech used a slower paper tape system, which was less reliable as a means of inputting data. Given JTech's inferior data inputting system, it decided to adjust its research and development effort to focus upon computers for applications that required extended processing with limited amounts of data.

Through the genius and efforts of a small number of executives, but especially through the efforts of a brilliant engineer, JTech completed its first computer, the Jaco C in 1954. He would often break the rules by working from home. Other rules were broken by individuals taking big decisions. For example, JTech's then President staked the entire company on computers. Decision making within the organization was so slow relative to the speed at which the engineers were working on projects, that if only three of ten directors were in agreement, it was "go ahead" on a new project, "By the time half agreed, it was already too late in the game to be successful," as a past President reminisced. JTech received orders for follow-on models from major Japanese corporations, including from Toyota and the Government.

In the computer field, to which JTech was now firmly committed, by 1961 its competitors had all tied up technology sourcing agreements with the leading US and European companies. The only foreign candidate left for JTech was IBM, which flatly refused to consider technology transfers unless it was able to purchase JTech. JTech had no available option other than independent technology development.

JTech was disadvantaged in all its businesses from being a newer company and later to market than its competitors. In telephone switching equipment, a friend of a past JTech President who worked at the public monopoly Nippon Telegraph and Telephone told him,

> "If you want to obtain a lion's share of the orders from us, you have to become the undisputed leader so well known in markets outside NTT's sphere of influence, that everyone will be asking why we are not buying JTech equipment."

The same was true in computers in which, while JTech was the first company in Japan to develop an experimental model, Hitachi made the first sale and thereafter gained substantial market power in Japan. During the early 1960s, JTech was trailing in third place in computers. JTech's response included implementing a dual policy of decentralizing operations to foster creativity and of delegating authority to speed decision making. This was in contrast to the strong top-down organizational hierarchies of JTech's older-established competitors, and this enabled JTech to become the top domestic computer company in Japan by 1968.

Another factor contributing to JTech's catch-up with its domestic rivals was that senior executives were willing to bet the company on its technology and products. When JTech sold its new products to major customers, it offered these customers unlimited liability guarantees. Given the huge scale of these risks to JTech from potential losses from customers such as the Japan Central Horse Racing Association, JTech moved rapidly into high reliability manufacturing. In 1966, it started a company-wide "High Reliability Campaign," and JTech caught up with its competitors through its "fighting spirit." Its computers "never broke down." Not being able to source technology from abroad, its "twin pillars" became "reliability and creativity." A number of innovative and high-performance home-grown technologies were developed, including a revolutionary new field effect transistor in 1980. A past President of JTech described this era of "Challenge" as follows:

> "[My boss] used to say: "Copy? Our technology will never grow that way. If it's something from abroad, unless you really make it your own, you won't be able to do anything with it." In this company we call JTech, time and again we see instances of employees badgering their bosses with, "Give it to me to do. Let me do it this way." And I think it no exaggeration to say that this has been the driving force behind JTech's growth."

Coda: Reliability and Creativity

This second story is presented in the form of a triumphant tragedy, rather like the crucifix is a symbol of suffering for Catholics, the tragedy of One Who was never so successful as when He looked like a failure, never so victorious as when He seemed nearest defeat. JTech begins in a clearly deficient situation, in which it suffered at every turn, unable to obtain technologies from abroad, unable to break into large customer markets in Japan in virtue of its relative youth compared with its competitors, and with an ineffective organizational structure. The story portrays JTech as having been in an almost ridiculous situation; fantastic but real. Yet, the final state is a happy ending with JTech having broken through into its main customer markets, and of having overtaken its domestic competitors. This transition does not happen without friction, as JTech becomes more decentralized, people break the rules, and its challenge culture, made tangible through focused efforts at reliability and creativity, reaps happy rewards.

3.3 Stories of JTech's Internationalization

3.3.1 Compatibility and Internationalization

JTech's home grown computers were incompatible with software used overseas, especially with IBM software. It had failed to sell its Jaco D computer through a marketing agreement with a US company, and so established a "boot camp" in California in the late 1960s under the umbrella of a new subsidiary, JTech California, with the objectives of accumulating technological expertise, testing its technologies in the US, and acquiring skills to operate internationally.

Later, in 1970, following a disagreement with his employer, the chief engineer resigned from IBM and established a new computer development and manufacturing company, Genie Corporation[2]. Genie's strategy was to try to compete head on with IBM. JTech entered into a patent licensing and joint development agreement with Genie, and made an initial investment of $5 million in Genie. A then JTech Executive Vice President explained their policy for managing overseas as:

> "Since JTech has little experience doing business abroad, in America or elsewhere, we absolutely must not interfere in the day-to-day management. Our relationship should be on the technical and financial level only."

Genie continued to need additional financing and eventually approached JTech for further support. However, JTech was worried about Genie's reliability, since in contrast to JTech, Genie planned to outsource all its components and focus solely on assembly. Moreover, when Genie's computer development plans were effectively trumped by a new computer release from IBM, Genie did not adjust its development strategy. JTech by now had massive financial exposure to Genie and reversed its principle of "non intervention in management;" it assumed "direct involvement in managerial decisions" at Genie. Dr. Genie[3] himself was "kicked upstairs to Chairman" and, having brought in a new American President and let go one-third of its workforce, Genie recovered. But, in the "vanguard of the battle" to develop a compatible computer, JTech's lead computer engineer in Japan died at the age of only 51.

Several texts give extended space to his death and to visits to the dying engineer in hospital. Genie subsequently announced the launch of a high-end mainframe computer, the Genie P, a product of Japanese-American cooperation, that was built at JTech's Kanagawa factory and then moved for assembly and testing by Genie in the US. Its first sale was to the American National Aeronautics and Space Agency ("NASA"), and its sister computer in Japan, the Jaco C, was the machine that beat IBM in Australia (see the next story).

Coda: Compatibility and Internationalization

This third story combines elements of a romantic engagement with personal tragedy – the death of the engineer at a young age and the difficult tasks of managing the takeover from Dr. Genie when JTech concluded it had to interfere in the operations

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[2] A pseudonym

[3] A pseudonym

of Genie as a US company. The romantic aspect is told through the trope of metaphor (Czarniawska, 2004), in which JTech portrays Genie and its own engineers as heroes standing against the enemy of IBM representing the force of evil. Despite the differences over strategy, in this chivalrous tale JTech and Genie engage in adventures and overcome various trials to find success and glory.

3.3.2 The "Computer-Gate Incident" and "Our First Triumph over IBM"

In the second half of the 1970s, JTech, through its country subsidiary JTech Australia, was bidding in competition with three large American MNCs to supply a major mainframe computer and network to the Australian government. The computer was to be used by the Australian Bureau of Statistics and the Trade and Resources Department. At the time, while Japan was already renowned for its strength in such core industries as steel, automobiles, and television sets, there were doubts as to whether or not Japan had yet caught up with the US in computers. Nevertheless, the shortlist of bidders was reduced to just JTech and IBM.

A Japanese newspaper journalist had got hold of information that JTech had the winning bid and published this, which was followed by the Australian Government abandoning its decision-making process. There were rumors that this had occurred because JTech had employed an ex-government official, which indeed it had done in order to better understand local conditions and requirements. Given the technical merits of JTech's computer over that of IBM, the Australian press and members of Parliament began to speculate that their Prime Minister, who had exerted political influence in the competitive bidding process, was in the pay of IBM. Second tenders were called for, in which JTech was invited to tender against IBM which now submitted an untested computer. Eventually, after a two-year delay, JTech was notified that it had won.

JTech's strategy in Australia had been based on "thoroughgoing localization: the JTech Australia president was an Australian and there were only seven Japanese employees (4%)." "Triumph over IBM" in this bid was followed by several other large government orders in Australia. In comparing JTech's computer with that of IBM, JTech had demonstrated that its machine was reliable, whereas that of IBM had been untested. JTech had stood back out of the public fray, and maintained its belief that it would win the bid. This bidding battle cemented JTech's company motto, "Reliability and Creativity."

Coda: The "Computer-Gate Incident" and "Our First Triumph over IBM"

This story is almost satirical in its emphasis on the absurdity of the decision-making process by which JTech was eventually awarded its first overseas computer contract. It is paradoxical that JTech had the best computer, but was not initially given order for this computer, a computer that it had developed as a result of its collaboration with Genie in the US. While there is a great respect for the international marketplace and the customer, the Prime Minister of Australia and the political process are caricatured as almost buffoon-like and this depiction is strengthened by setting it in opposition to a depiction of JTech and its customers as rational and moral actors, focused upon the relative merits of the technologies and acting with integrity.

3.4 Story of JTech's Transmission Business

3.4.1 Entering the NTT Market

The story of entering the NTT (then Nippon Telegraph and Telephone Public Corporation) market as a supplier of transmission equipment is the story of how JTech started from a position of technological inferiority compared with NTT's dominant supplier, NEC, of how it was unable to forge any meaningful technological agreements with overseas technology companies, and of how it turned to "our own domestic" technology to catch up with NEC.

Various accounts generally recognize three turning points in this process. The second and third of these were, respectively the "AT&T Bid Incident" (see section 3.5.1 below) and JTech's entry into the market as a supplier to the RBOCs in the US (discussed in subsequent chapters).

The first turning point was catching up with, and surpassing, NEC in the domestic market in some technologies that enabled JTech to enter the NTT market, first as a supplier of repeaters, and then in supplying the technologically more complex terminal equipment. A repeater serves the function of refreshing a signal during transmission.

NTT had announced, in 1953, a five-year plan to expand its telegraph and telephone infrastructure network, of which the largest and most valuable market was to supply terminal equipment. JTech initially relied upon analog technology developed by its German partner, which was superior to competitors' equipment that was based on technology developed by the then Standard Telephone & Cables Ltd. – a British company that later became STC Telecommunications Ltd., ITT's UK telecommunications operation, before being taken over by Northern Telecom in 1990.

JTech's first home-grown technological success had been in developing an analog repeater system. In its design of the line amplifier for this repeater, JTech exceeded the performance of NEC's repeater in terms of equalization and distortion of the signal. The degree of equalization from having regenerated the signal in a repeater is a comparison of the refreshed (output) signal with the distorted (input) signal. Symbolically of great importance, NTT was instrumental in securing for JTech a patent license for this famous "flattening filter" from NEC. The flattening filter was named after the principal engineer involved in its design and it was used in the amplifier that formed part of the repeater.

When the transmission network changed from analog to digital transmission in the early 1960s, JTech was a late entrant into the market. It lagged its principal rival, NEC, by a year. It could no longer rely on its German ally for technology transfer, for its German partner itself was a late entrant into developing digital technology, especially transistors. JTech's strategy was to follow NEC, but to develop and offer a superior product. This it did, principally due to the development efforts of its chief engineer, with JTech's new digital repeater consuming 50% of the electric power required by NEC's repeater.

One of the reasons for this success was that transistors had recently been introduced into computers, and JTech was able to use these devices in its analog-digital conversion equipment. This internal technology transfer was based on wide-ranging organizational cooperation between JTech's then Transmission, Semiconductor, and Information (Computer) Divisions. JTech was paying a great deal of attention to developments and trends announced at international conferences and there was a relatively good level of cooperation among the various JTech divisions and JTech Laboratories. For example, in developing JTech's digital signal processors in the late 1970s, historical accounts describe how many of the design engineers from the Transmission Division having desks in the Semiconductor Division, with the employees having developed strong personal and working ties.

If the first generation of technology JTech developed was analog and the second generation was digital, based upon the transistor, the third generation of equipment was an extension of digital technology through large-scale integration (LSI) technology. It was based in part upon the organizational changes that enabled it to develop LSI that JTech was able to enter the US market as a supplier to the RBOCs in the late 1980s and 1990s – see Chapter 4 and the establishment of the Transmission Division's cluster-type enterprise group of development organizations, JTech Digital Technology Group. JTech also made advances in optical transmission equipment, described below. JTech's lead in LSI technology was in part attributed to its collaboration with NTT in the early development of complementary metal oxide semiconductors (CMOS) in collaboration with JTech Laboratories and JTech's Electronic Devices Division. JTech was also first to market with CMOS gate array LSIs and in using computer-aided design (CAD) in LSI design.

JTech's early lead with CMOS in Japan was based on a technology agreement with a small US company, Silico Inc. established by a Professor of Electrical Engineering at Stanford University. It was JTech's adaptation of this technology that contributed significantly to JTech's catching up NEC in digital transmission equipment for NTT. JTech Transmission Division's first LSI equipment was supplied to NTT as *kenshi* (trial version) equipment to NTT Laboratories in 1980.

Around the middle of the 1980s, just as JTech was about to start development of its digital loop carrier products for the US market (see next Chapter), JTech's Transmission Division was unable to obtain the commitment of resources from the Semiconductor Division to develop products using the necessary LSI technology. Requests for LSI would be met with the response that "the work was too hard" and the Transmission Division's projects were often cancelled as the Semiconductor Division prioritized work for projects that would lead to products with a larger volume output. The Semiconductor Division did not have sufficient human resources to commit to the Transmission Division's projects.

In response, the Transmission Division and the Semiconductor Division established and institutionalized bi-annual meetings, called "LSI Promotion Meetings." This meeting was attended by JTech board members as well as relevant business directors and division directors. The meeting was subsequently renamed "Top Meeting," but the substance of the meeting, to adjust policies toward LSI between the Divisions, remained the same. It was the enormity of the resources needed in LSI design that led to the establishment by JTech's Transmission Division of its domestic cluster of hardware technology development companies, JTech Development Group, described in this thesis.

JTech had also used external international networks to keep abreast of developments in other technological fields relating to transmission equipment, including passive device parts that, unlike active device parts such as LSI, do not require electrical power to function. These active parts include relays, connectors, coils, condensers, and filters. For example, in the earlier analog world, JTech learned a great deal from a special session on channel bank filtering at the International Symposium for Circuits and Systems organized by the IEEE in April 1974. They learned from this Symposium how its German partner had introduced a "48 kHz pre-emphasis system mechanical filter" into the transmission network of Deutsche Bundespost, and how Bell Laboratories had developed a six-channel eight mHz tiered mechanical filter. JTech had introduced a prototype. In developing digital passive components, JTech began as early as 1950 from having transferred technology in the form of specification documents from its German partner on resonators, before further developing its own advances based upon its partner's technological foundation. In later passive device development, JTech collaborated closely with engineers at domestic universities, including Tokyo University, Tokyo Institute of Technology, and Yokohama National University.

A third important hardware technology, in addition to active and passive electronic devices, was and continues to be optical devices, which assumed increasing importance as transmission technology increasingly moved from electrical to optical transmission. JTech also lagged behind NEC in optical technologies. Bell Laboratories had established an early lead in optical device technologies and had an overwhelming lead over JTech during the 1960s and 1970s. However, JTech Laboratories established a Basic Research Department in 1969 to research into optical transmission. The first decade, up to 1979, was a period of research and intensive collaboration into optical transmission technologies with NTT's Yokosuka Electric Telecommunications Laboratory. NTT was pushing NEC and JTech hard to develop optical telecommunications systems – for example the number of researchers working on this doubled in 1973. JTech Laboratories led the effort in this project for NTT and coordinated its activities with four development departments within the Transmission Division.

The second decade, from 1979 until 1989, was one of commercialization and further major technological advances in optical devices, leading to JTech's "victory" in winning the AT&T bid in 1981 (see section 3.5.1 below). By 1980 JTech had also caught up with Bell Laboratories in a number of technological areas. Following collaborative development with NTT, JTech conducted the first on-site testing of its optical devices in 1978, and introduced the components into the domestic transmission network and in Hong Kong in 1981. Following optical technology development in JTech Laboratories, some of the researchers transferred into five optical device development teams in the Development Division and into the Manufacturing Technology Division.

JTech's Transmission Division had to establish its own manufacturing facilities, since its requirements were for small batches of products with frequent product changes. This was "small quantity, multi-product" manufacturing, with many product changes due to innovation, and large changes in the quantities of goods. It established a Manufacturing Technology team to interface between its Design Division and its Manufacturing Division. In 1985 it completed a new production facility, called "North First Building" at its Tochigi factory, which won the Okochi Memorial Prize in 1988 (see section 3.5.2 below). This factory was overwhelmed with requests to visit it. It had five years' earlier established a small optical system factory in Texas in 1983, which it later replaced with a new factory built on 100 acres of land that it had purchased nearby in Texas.

Coda: Entering the NTT Market

The historical accounts of the development of JTech's early transmission equipment point to a number of reasons for its early successes in entering the NTT market and catching up in some areas with NEC. Distilling the accounts yields four main explanations.

First, the success is attributed to the foresight of the senior management at the time, especially in JTech's early lead in LSI technologies. Second, almost paradoxically, JTech is portrayed as naturally responding to the environment constraints that it faced as a laggard behind NEC and unable to simply import leading technologies from abroad through technology licensing agreements with overseas companies. In this story, JTech was forced to innovate if it was ever to catch up NEC. The third story is one of collaboration among JTech Laboratories and the various manufacturing and other divisions, especially in developing electronic semiconductor devices. The fourth story portrays JTech's Transmission Division as being pulled up the technological ladder by NTT in Japan.

In fact, as my interviewees recalled, the Semiconductor Division was very reluctant to cooperate with the Transmission Division in developing LSI devices, for two reasons. First, it did not believe that the Transmission Division would succeed in its contribution to the LSI development effort. Second, the Semiconductor Division did not believe that LSI had a big role in future system development, which turned out to be plain wrong. It was NTT that was pushing the Transmission Division into development based upon the more advanced technologies. The Transmission Division responded by going abroad, to Silico Inc., and by itself developing the first LSI to be used in transmission equipment.

While the technologies were developed in collaboration with overseas companies, with NTT, and among JTech's divisions, it is interesting to note how particular technologies and products became named after the chief engineers who led their development. In addition to the "Takeuchi flattening filter" named after Takeuchi Koichi, recollections of the history brings up names such as "Mr. Ogawa's mechanical filter," "Mr. Aoshima's crystal oscillator, and "Mr. Takeishi's and Mr. Matsura's CAD" for designing analog circuits[4].

JTech kept abreast of technological developments in all technological fields relating to transmission equipment. It licensed technologies where it could. It collaborated in development among its divisions and with JTech Laboratories. Above all, it knew from its inferior position relative to NEC with its principal domestic customer NTT that it could only win NTT's business if it offered something that was technologically head of NEC. This pressure to develop next-generation technologies rather than to try to equal or just catch up with NEC seems to have been at least cognitively related to a crucial later decision to develop synchronous optical network ("SONET") protocol equipment for the US marketplace in preference to developing technologies and products for existing market segments (see Chapter 5).

[4] Pseudonyms

3.5 Stories of the Internationalization of JTech's Transmission Business

3.5.1 The AT&T Bid Incident

I recount this story, since several narratives concur that it was the "AT&T bid incident" which was pivotal in JTech's successful entry into the US transmission business.

JTech's earliest transmission business in the US had been to supply an American electrical goods manufacturer in the 1960s. In 1976, JTech established an 82%-owned joint venture company, JVI, with a US telecommunications manufacturer, US Telecom Corporation[5] ("USTC") in California, to market electronic private automatic branch exchange ("PABX") equipment. PABX equipment consists of small electronic switchboards for transferring telephone calls within a building. In 1975, JTech investigated how to enter the US wireless transmission business and, (yet again) unable to find a suitable joint venture partner, it folded this business into its JVI. In 1978, JTech Japan and the US joint venture received an order from a US regional phone operator for a 45 megabyte/second transmission system, which was delivered in 1979.

Following this order, JTech and its joint venture partner fell out over issues such as profit sharing, the need for ongoing customer support, and the division of responsibilities between the two partners. JTech's US partner, USTC, was then sold by its owner to Principal Dynamics[6], which wanted to increase its ownership of the venture from 18% to 51%. As a result of a top management meeting in July 1979, including the President of JTech and a number of other senior executives, JTech acquired USTC's 18% stake in JVI to acquire PABX skills and knowledge. Subsequently, in April 1985, JTech changed the name of JVI to JTech Business Communications, a company that would concentrate on PABX equipment, while JTech's transmission business remained under the JTech America, Inc. ("JAI") US corporate country subsidiary umbrella until 1991, when the Japanese division, the Transport Systems Group, wrestled control of it.

JTech established its US transmission business as the Wireless and Transmission Division of its corporate US country subsidiary JAI. This Division of the corporate country subsidiary received an early order from MCI for digital access terminals ("DA terminals").

JTech's use of personal networks was important to securing this early order. JTech had decided to work with one of its USTC joint venture US executives as a consultant in trying to develop its US transmission business. This consultant introduced JTech to a Vice President at MCI, having previously worked for him at Rockwell. The MCI Vice President had begun his career as a Radio Technician First Class in the US

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[5] Pseudonyms

[6] A pseudonym

Navy where he gained expertise in emerging wireless communications technology. He then moved to Motorola and subsequently on to Collins Radio Company. At Collins, he directed product development and was responsible for all telecommunications products. In 1973, Rockwell acquired Collins Radio Co. and changed its name from North American Rockwell to Rockwell International. Alcatel bought Rockwell's Rockwell Collins facility two decades later. He eventually consulted for JAI after his retirement as Senior Vice President for MCI Telecommunications Corp. in 1986. Collins Radio was located in an area that would become known as Telecom Corridor, in Texas. JTech would later establish its US transmission headquarters nearby.

In May 1980, JTech invited MCI to inspect its operations in Japan, and was rewarded with an order for wireless equipment. At that time, MCI was a new entrant into the US long distance telephone service market, and was open to equipment suppliers such as JTech, whereas the hitherto monopoly telephone service provider, AT&T, was equipped by its captive supplier, Western Electric. Part of this first MCI transaction involved JTech providing a substantial revolving credit facility to MCI. Other suppliers had been unwilling to provide a similar financing package to MCI, and JTech's financial commitment was seen by both sides as cementing strong personal relationships between JTech and MCI.

From the mid-1970s, AT&T had been under threat from anti-monopoly legislation and a lawsuit from the US supplier Harris challenging it to purchase equipment from suppliers other than Western Electric. As a result, in 1974 AT&T established an internal division with responsibility for acquisitions from third-party suppliers, the Bell System Purchased Product Division ("BSPPD"). While BSPPD sought information from suppliers, it made few actual purchases.

Its first large-scale open invitation to tender, in 1981, was for a supplier to lay a large-scale fiber-optic communications network to link up the "Northeast Corridor," including Boston, New York, Philadelphia, and Washington DC. The project was known as The Northeast Corridor Lightwave Project. It was a crucial project in the US, as it was the first important use of fiber optics technology in the US long distance telephone market (Meadows, 1982). The US Federal Communications Commission ("FCC") had insisted that the bidding be international. Out of eight bidders, JTech submitted the lowest bid at $56.8 million. However, the contract was awarded to the AT&T subsidiary Western Electric for $75 million.

How had JTech been able to supply the lowest bid? It submitted the lowest bid because it had developed technology that enabled it to do so.

The underlying technology for optical communications came from two US sources. First, in 1971 Bell Laboratories achieved continuous oscillation using semiconductor lasers. Second, Corning had developed a high reliability (low loss) optical fiber (with a loss of 20 dB/km). As early as 1970, JTech had established a joint venture on research into optical transmission with Corning and with Furukawa Electric. Having established an internal relationship between the transmission business division and JTech Laboratories, JTech was able to supply 32 Mb/s optical transmission prototype equipment to Nippon Telegraph and Telephone Public Corporation by 1974. In order to develop the transmission equipment, JTech needed optical fiber, and Furukawa Electric transferred the early optical fiber manufacturing technology to JTech. JTech was early in starting to develop optical transmission equipment and established manufacturing facilities early on in the development process.

JTech had made use of two key technical advances. First, its Semiconductor Division in Japan had developed low fiber transmission loss through its long wavelength germanium diode (a photo detecting device that converts optical power to electrical power) and its laser diode (a lighting device that converts electrical power to optical power). Second, JTech had developed higher transmission speed optical multiplexing technology. At the time of the bid, while Western Electric could conduct optical multiplexing at a speed of 45 Mb/second, JTech was able to do this three times faster, at 135 Mb/second. JTech had developed some of this technology through collaborative research and development with NTT (then Nippon Telegraph and Telephone Public Corporation) at NTT's Yokosuka Electric Telecommunications Laboratory. JTech had tied up with Siecor, the then Siemens-Corning joint venture leading optical fiber supplier in submitting its AT&T bid.

The cost advantage of JTech's technology should be briefly explained. With faster transmission speed, not only was the optical transmission equipment cheaper, but AT&T would only require one-third of the optical fiber. Moreover, in transmission, a signal has to be restored by repeaters at specified intervals in transmission. If you can transmit at three times the speed, then you need one-third the number of repeaters. This transmission technology was developed as a result of collaboration among JTech Japan's Semiconductor Division, Research Division, and Transmission Division. At the time of the bid, seven or eight transmission and semiconductor researchers from Bell Laboratories and from BSPPD visited Japan to verify JTech's capability through inspection.

In October 1981, JTech's lead in the AT&T bid was leaked, at which time by all JTech accounts "all sorts of political pressures and slanders were flying about almost like in a storm." Documents "slandering" offshore vendor JTech were sent to the White House, US Congress, and US trade committees. The slandering was traced, through an article in the 22nd March 1982 edition of Fortune magazine, to Vice President J. Arnold of Harris Corporation, one of seven unsuccessful bidders. Harris's strategy had been to try to persuade the FCC to disqualify overseas bidders, leaving it to share the order with

Western Electric. Harris Corporation described the bid as a "planned attack" typical of "the Japanese" in trying to enter the US market using so-called low-balling. As J. Arnold said:

> "That's typical of the Japanese. They've bought themselves into markets all over the world. Often when four of them bid, three will hold their prices at a normal level and one bids low.... They do this through a planned attack... It's common knowledge." (Meadows, 1982)

Arnold lobbied Senator Strom Thurmond, chairman of the Senate Judiciary Committee, who delivered a memo to a presidential aide at a White House dinner. Continued lobbying by Arnold led to the bid being classified as a national security matter and AT&T rejected JTech's bid blaming "concerns raised in government circles." In an environment of growing trade friction between Japan and the US, AT&T had made a "political decision" to purchase the system from Western Electric. The President of JTech made a trip to protest to AT&T and to lodge a petition with the FCC. JTech showed resolve in stressing the merits of its bid, even as the FCC approved the construction of AT&T's system by Western Electric.

In Japan, however, the accusation of low-balling threatened JTech's domestic (home country) reputation and through its own lobbying in Washington it obtained an apology for the charge. Arnold won the battle, but lost the war – Harris Corporation received no interest in the joint venture supply agreement from Western Electric.

In March 1982, JTech senior executives and AT&T held a reconciliation dinner at the New York Waldorf Astoria Hotel. Through these events and the publicity that they attracted, including a cover feature story in Fortune magazine, JTech's optical technology attracted a great deal of attention in the North American communication business world.

In a more personal account, one of the JTech engineers involved in testing the technology in the US and in preparing the bid tells of the breakthrough technology. A critical technology underlying JTech's bid had been its high-reliability laser. The technology underlying this laser actually originated in Bell Laboratories in the US. Bell Laboratories had succeeded in room temperature continuous oscillation, which triggered many equipment vendors and telecom supplier laboratories, including the eight bidders for the Northeast Corridor Lightwave Project, to move the technology into product development.

In 1975, JTech was conducting field trials with Nippon Telegraph and Telephone Public Corporation. "Field trials" was the Japanese (NTT) way of developing transmission systems. It involved repeated field trials – of trial and error. While it was more difficult to develop devices this way from a technical perspective, this development method had organizational advantages of being able to establish clearer milestones. Having such clearer milestones was an important motivator for the Japanese development engineers.

A major challenge in developing the semiconductor laser diode was how to increase its lifespan. Through a trial and error process of examining failed chips in relation to the laser stripe and the defect of the crystal on the failed laser diode, JTech learned that the primary factors causing short lifespan were dark lines and dark spots. Eventually, through collaboration with NTT, JTech was able to ensure a lifespan of more than 100,000 hours at a commercial temperature of 50 ° C. It was because of this collaboration that JTech was able to start development of its laser diode earlier than other companies. Other features of the diode, such as its Vestigial Side Band architecture, were similarly developed through this applied method of field trials, rather than the more theoretical Western approach to new product development. The Northeast Corridor Lightwave Project was the first time that JTech had relied on this new laser diode.

The story has it that when JTech's engineers were carrying out field trials of its new laser diode, its equipment was lined up alongside that of a competitive bidder, without JTech's prior knowledge. Subsequently, during the field trials, the needle on JTech's monitor measuring bias did not move, and AT&T informed JTech that its equipment was defective. When everybody realized that this lack of movement had in fact been due to the stable operation of JTech's equipment, the faces of the competitor engineers turned deadly pale.

Coda: The AT&T Bid Incident

The various renditions or stories associated with the AT&T Bid Incident contain elements of tragedy, comedy, and satire. The irony of the story is that, although JTech tragically lost out unfairly in the Northeast Corridor Lightwave Project bid, it actually resulted in JTech receiving legitimacy in the US as a technological leader in transmission and as the "real winner." Good things come from bad. The story was also tragic, and its meaning to the identity of JTech is given added power through many light stories told by the development engineers, such as the comedy of the lack of movement on the monitor testing the bias of JTech's equipment.

3.5.2 Entering MCI and Mutual Prosperity with MCI

While AT&T did not buy JTech's leading-edge technology, its emerging rival MCI did. MCI installed JTech's equipment as the first 135 Mb/s system in New York Manhattan, known as the New York City Lightwave System. It opened for traffic in the summer of 1982 after the optical cable supplied by Siecor had been laid.

Subsequently, MCI placed a second large order for JTech's 405 Mb/s optical transmission system, which ran along the Amtrak railroad linking New York and Washington, which officially opened in May 1984. This was a very difficult project to have realized. With MCI as a facilitator, JTech worked with the optical fiber supplier Corning to match the characteristics of its laser diode to the optical fiber supplied by Corning, through which the technically most efficient wavelength was 1.31 μm [micrometer]. Organizationally, JAI's Communications Division established a Washington branch office in the suburbs of Washington in August 1984 to manage its relationship with MCI and also to try to develop its relationship with the newly established RBOC Bell Atlantic.

JTech then moved into a period of "mutual prosperity with MCI." MCI was digitalizing its transmission network, so while sales of JTech's DA terminals and other digital to analog and analog to digital equipment decreased, JTech increased sales of its digital multiplexers as MCI's optical network spread. In 1986, JAI's Wireless and Transmission Division had achieved more than $100 million of sales of its 405 Mb/s optical system, principally to MCI.

As its MCI business grew, as a response to new US-Japan trade rules specifying minimum local content, JTech leased and established a transmission equipment assembly factory in Texas in March 1983. However, it seems that the move to establish a factory would have occurred even in the absence of specific local content requirements, as JTech was anxious to internalize production so as to maintain direct quality control over production of its own products. The leased Texas factory remained the principal US manufacturing centre in the US until its relocation in October 1990 to a new 100-acre headquarters in nearby in Texas on land that JTech purchased outright.

This sudden increase in business for the North American market posed challenges for the then existing factory at Tochigi in Japan, which could not cope with orders. There was an extraordinary increase in production in 1984, and an urgent need to reinforce manufacturing to overcome delivery delays and quality problems. To respond to this, the senior executives of the Transmission and Wireless Business Division in Japan formed an inter-divisional and departmental team among Manufacturing, Design, Manufacturing Testing, and Manufacturing Technology to design and build a new building at the Tochigi factory for manufacturing optical transmission equipment.

The automated new manufacturing facility was contained in a new building, North First Building, at Tochigi factory. This building was designed and built based upon strong cross-divisional cooperation. The senior executives joked about the management style, calling it "*fundoshi* management." A *fundoshi* is a loincloth worn by a Japanese sumo wrestler. The words had been appropriated and recontextualized to describe the development method of posting up written papers in a large cross-divisional meeting room to show daily progress.

In the case of conflicts between development and manufacturing, the senior executives would take the development engineers to the factory and instruct them to, "Please listen to what the factory members say." In the US, such an automated factory was known as computer integrated manufacturing, shortened to CIM, but in Japan there was no such catchphrase for what was a "first" in Japan. The Japanese came up with their own word for their home-grown factory, *tougou jidouka* (literally translated as "integrated automatically"). The new facility at Tochigi factory was awarded the Okochi Memorial Prize, the highest award given in Japan for achievement in the field of production technology.

The collaborative relationship between design and manufacturing was sealed symbolically in other ways. For example, in producing the 405 Mb/s optical systems for MCI, there were considerable problems in manufacturing. Yet, a single symbolic act did as much to overcome these problems than anything else.

In a highly institutionalized practice throughout Japan, on the first working day after the New Year holiday in Japan it is customary for staff to go into their offices and to greet their colleagues in a formal way, almost certainly beginning with the words, *akemashite omedetou gozaimasu* ("Happy New Year"). Sections will then tour other sections and greet them at the level of the group.

In the midst of the development of North First Building, however, the head of development in Kanagawa did not initially visit his colleagues, but instead he traveled direct to Tochigi Factory to greet the manufacturing divisions and departments, carrying two bottles of *sake*. Many personal accounts and reminiscences of the development of North First Factory talk of how both manufacturing in Tochigi and designers in Kanagawa were deeply moved by this symbolic act.

MCI, JTech's principal US customer at the time, was under pressure to increase local content and procurement for transmission equipment sold into the US. MCI requested that JTech build a factory in the US, which led to the construction of its first factory for transmission equipment on leased land in Texas, in 1983. In a pattern that continues to this day, the factory in Japan generally produced higher-end components and manufactured a wider set of components and products for the global market, while the US factory was mainly involved in lower-end manufacturing, such as component assembly onto printed circuit boards.

JTech continued to supply MCI with ever faster high-speed optical transmission systems, which enabled MCI to compete effectively with AT&T and so to rapidly develop. For example, JTech developed an 800 Mb/s system, supplied to MCI in 1986, and a 1.8 Gb/s system, supplied in 1988. MCI led its business expansion against AT&T with slogans that pointed to its being the first to introduce new technologies to the US transmission network. MCI's external announcements of its introduction of high-speed optical systems were of JTech's successes in technology development. The negotiations with MCI in relation to the development of these leading-edge optical systems were mostly led by the 2nd Transmission Business Division, by the head of JAI's local sales team. This individual went on to contribute to the rapid growth of JTech Network Transmission Systems ("JNTS") and to JTech Network Communications ("JNC") – the renamed US directly established country subsidiary of the Japanese transmission division – in its Sales Department where he was responsible for sales to long-distance telecom carriers.

In spite of such remarkable success in photonic systems with MCI, JAI's Communication Division's transmission sales were sluggish, at $67 million in 1987, $70 million in 1988, and $90 million (MCI: $65 million; RBOCs: $25 million) in 1989, which led to restructuring and independence for the transmission division's US subsidiary. One contributing factor was that JTech's competitor Northern Telecom had entered the MCI customer market with its own 2.4 Gb/s system before JTech.

At this juncture, narratives of events vary. Several accounts see the problems JTech encountered with MCI as having been technical. This story ending has it that, following JTech's introduction of its 1.8 Gb/s system, JTech was unable to resolve certain technical problems (so-called dribble errors) in its successor 2.4 Gb/s system, and so the introduction of this system was delayed until late 1991/1992.

A second storyline recasts the technical difficulties in terms of resource availability and allocation. In this account, JTech had been spreading its development engineering resources to focus upon technologies needed to meet the newly emerging so-called synchronous optical network ("SONET") standards for transmission systems being promoted by the RBOCs, at a time of a general lack of resources due to the early 1990s economic downturn in the US and Japan.

Yet a third explanation recasts JTech's loss of its MCI market at the level of interpersonal relationships. In this account, the problem facing JTech was that the Senior Vice President at MCI in charge of technology, who really "understood JTech", retired from office and was replaced by a new MCI Senior Vice President, who came from IBM. JTech could not fight against "this headwind."

In a fourth tale, one that is more recent in origin, the decision to exit the MCI business had in fact been strategic and rational. In this version of events, JTech had made a strategic decision to focus on SONET standards, following the then recent divestiture of the RBOCs, the emergence of new standards for local telecom networks (especially SONET), and the willingness of the RBOCs to purchase equipment from third-party vendors built to an open (rather than proprietary) architecture.

During this period, the global head of JTech's transmission business in Japan worked tirelessly to build the basis of JTech's approach to its US business, to build mutual trust with customers ("heartware" as well as hardware and software), to be "number one" in efficiency and quality, and to deal with problems swiftly and in good faith.

It was only with JTech's approval as an authorized model supplier for its 10 Gbit/s optical system by the renamed MCI WorldCom, in 1999, that JTech resumed its business with MCI WorldCom.

Coda: Entering MCI and Mutual Prosperity with MCI

The simultaneous existence of more than one story about JTech's 1991 loss of its MCI's business does more than challenge the plausibility of a single account. It also shows how history dramatized into stories is recast, or rewritten. Two of these retrospective rationalizations of JTech's loss of its MCI business – the resource allocation story and the strategic shift story – serve the purpose of constructing the identity of JTech as a strategic, rational actor and of enhancing the esteem of its managers. The technical difficulty story served to distance the teller from the source of the problem and to enhance his or her feelings of being competent. The story of interpersonal difficulties similarly shifts the problem down a level from roles (the organizing level) to personal relationships, while also laying the blame outside JTech in the environment – JTech's *bête noire* of IBM!

What I am suggesting is that the existence of these multiple retrospective rationalizations serves to enhance the identity of JTech in one form or another. The fact that the same person would say more than one story, not just in different contexts, but in the situation or interview, shows how the history of JTech's internationalization is reconstructed day in day out to serve current needs. Identity theorists write of a need for consistency with the self-concept (Stets & Burke, 2003), but these stories are not immediately consistent, yet were offered as consistent explanations for JTech's loss of its MCI business. While not described in this Chapter, I was aware of another occasion in which such a plurality of stories was narrated to describe an event that was not dissimilar in some respects, the reasons for the delayed entry of JTech into the market for dense wave-division multiplexing technology products in the 1990s. In these cases, JTech employees seem to write their history in a way that suits current and changing needs.

We can also see how each story follows a literary convention. At times, the relationship between JTech and MCI is depicted as similar to romance, with a deep understanding of each other leading to mutual prosperity. The added emphasis on individuals and personal relationships contributes to this feeling of affection between JTech and MCI. JTech replaces a claim to superior technology with the construction of a story of its being the only equipment supplier willing to provide the additional financial backing (credit facility) to MCI. It is this affection, this close affinity between the customer and JTech that additionally contributes to JTech's identity.

4 JDLC Product Development (1985-1989)

4.1 Introduction

This Chapter tells how JTech's US transmission business began to construct a new organizational identity, that of a corporate new venture, that it could project to key audiences in the US market and institutional environment. The sensemaking that led to the construction of this new venture identity was occasioned by major changes in the institutional environment, most notably related to the 1984 divestiture by the monopoly telephone service provider AT&T in the US of its seven Regional Bell Operating Companies (RBOCs) that provided local exchange service across North America. It was also appealing because of the availability in the North American institutional environment in the 1980s of the model of an internal corporate venture. The internal corporate ventures of the 1980s were invariably established to bring internally-generated new technologies to market through new internal entrepreneurial subunits, in which levels of compensation were not different from other non-venture divisions of large corporations. These internal corporate ventures were unique in the strong autonomy granted to their managers relative to other divisions within the firm.

The identity work (Snow & Anderson, 1987) that JTech organizational members undertook to construct their new venture organizational identity had four elements. These included breaking away from the control previously exercised over its activities by the country-level US subsidiary, JAI, distancing from NEC, co-location of transmission systems activities at a new center in Texas away from JAI, JTech's US country subsidiary, and granting complete autonomy and control to the US organization of key parts of the product development process, especially product planning.

The earlier history of JTech, set out in Chapter 3, pointed to a number of features of JTech's organizational design, culture, and work practices that were significant in their uniqueness to JTech in Japan. It was the enactment and recontextualization (Brannen, 1992) of these distinct features in working with its US subsidiary organization that underpinned the development of an organizational capability in the US organization. Even in Japan, relative to older and more established Japanese competitors, in some ways JTech resembled a large new venture, even half a century after its founding. This proved an advantage in overcoming what would otherwise have been possibly insurmountable barriers to working with US customers based upon the practices and routines by which JTech worked with and for NTT in Japan.

For example, since NTT was responsible for transmission equipment system integration, Japanese suppliers and product developers were weak at this element of new transmission system development. In contrast, system integration had always been the responsibility of transmission system equipment suppliers in the US marketplace and institutional environment. Nevertheless, JTech's Transmission Division in Japan was more capable of adapting to undertake large system integration work in new product development than its older-established competitors. It achieved this through decentralization, reorganization, and dispersal of its development engineering work into newly established networks of transmission development subsidiary organizations spread across Japan. It was through this reorganization of its development engineering effort within Japan that JTech was able to overcome this country-level *in*capability in system development and integration, and this became an organizational capability for developing new products to the newly deregulated US marketplace.

Furthermore, JTech's history of having collaborated with relatively autonomous internal organizations in Japan became an organizational capability that transferred across borders when it extended to working with its US subsidiary organization. JTech's longstanding focus upon high quality and reliability (see Chapter 3.2.2) in product development provided a practical and moral membrane that connected the parts in a way that contributed to an effective collaborative working relationship between the JTech organizations in Japan and in the US.

JTech's strategic response in the new environment of the break-up of AT&T was to shift from serving MCI (see Chapter 3, s. 3.5.2 "Entering MCI and Mutual Prosperity with MCI"), AT&T's principal long-distance telephone service competitor, to serving the newly established Regional Bell Operating Companies (RBOCs). Its choice of product to enter the RBOC market as a transmission equipment supplier was a digital loop carrier (DLC), for which JTech did not have any particular technological advantage relative to competitors. Indeed, JTech was late to market with its US product, the JDLC. While the key new technologies in the new generation DLCs being developed at the time were based upon new developments in computer-related technologies – notably very large-scale integration (VLSI) technologies – and possessed by many competitors, developing products that the RBOCs would buy required substantial involvement in host country standards-setting networks within the US and the management of ambiguity and uncertainty over the definition of product features and standards. The technology was necessary, but very insufficient, to enter the RBOC market with a DLC product.

Through its new venture identity, JTech was able to recruit a cadre of top transmission professionals to its new transmission systems' facility. When judgments had to be made concerning which features to include in the first JDLC product release, these calls were correctly made by the product planning team that JTech had hired in the US. Had the identity of the US organization assumed the default "Japanese subsidiary" among key audiences, it could not have recruited the very high quality American staff to work with and gain the confidence of the RBOCs in defining the JDLC product. For JTech in Japan, being open to new ideas had been part of its history since inception, as the stories in Chapter 3 described, stories which were documented and retold and so carried into, and embedded within, JTech's future culture and identity.

The final stages of the development of the JDLC significantly overlapped with the product development of the Terminal Products family, discussed in the next Chapter. I analyze the JDLC product development separately for two reasons. First, it was with the JDLC that JTech broke into the market to supply the RBOCs with transmission equipment. Since JTech's JDLC did not have a significant advantage over its competitor products in technologies, this shows most directly the impact that the new venture identity had on JTech's effectiveness in the US marketplace. Second, the design of the Terminal Products was based upon radical innovation (Henderson & Clark, 1990) that involved both new product architectures and knowledge, as well as new underlying technologies, whereas the JDLC was incremental innovation in the meaning of Henderson & Clark (1990).

Yet, the Transmission Division learned how to compete in a marketplace for transmission products in the US in the mid-1980s with its JDLC product. It went on to use the knowledge about competing in successive US product introductions and, by the late 1990s, it would subsequently want to transfer this knowledge into Japan to compete in a newly deregulated competitive home country marketplace.

The discussion in this, and the ensuing, Chapters differ in that this Chapter focuses more upon the early stage of establishing a new venture identity in the US marketplace and on the establishment of new development subsidiaries across Japan. The next Chapter turns to look at the internal system of collaborative working between Japan and the US, and among different divisions and departments within Japan.

4.2 The Enacted Environment

The period from 1985 to 1989, the period of the development of the first release of JTech's digital loop carrier product, the JDLC, was an era of ferment (Anderson & Tushman, 1990; Utterback & Abernathy, 1975) in the US telephone industry. Precipitating this was the reorganization of the US telephone communication system and network in 1984. Telephone service providers rely upon two core categories of equipment to operate their networks, namely switching and transmission equipment. It is JTech's transmission equipment business and organization in the US that is the focus on this thesis, and so the changing institutional environment in the US was of great consequence for it. This era of ferment resulted in opportunities for new equipment suppliers to enter the US marketplace, as hitherto tied-in supply relationships broke down and there was the beginning of a general push toward open, rather than proprietary, equipment architecture and for standardization of product components.

In the late 1970s and early 1980s, the US Government was implementing the deregulation of its telephone industry and privatizing its monopoly provider, AT&T. A major industry restructuring was brought about under the terms of AT&T's 1982 antitrust litigation settlement with the US Government. As a result, in 1984 AT&T divested itself of its 22 regional telephone systems. These were reorganized into seven Regional Bell Operating Companies (RBOCs) that were given designated regional and local area charters to provide telephone service.

Following the divestiture by AT&T of its regional telephone systems, there were two principal market segments within the US transmission equipment marketplace from 1984, both by customer and by type of transmission equipment. One segment comprised the long distance interexchange carriers, principally AT&T and newer entrants such as MCI (see Chapter 3, section 3.5.2, "Entering MCI and Mutual Prosperity with MCI"), as long-distance telephone service providers had earlier fought for the right to compete with AT&T, which continued its mandate as a long-distance telephone service provider. The second segment was to supply the local telephone companies, the RBOCs and CLECs.

The local telephone network remained regulated, but was also opened up to new entrants, which became known in the industry as competitive local exchange carriers ("CLECs"). The Government intended that the CLECs would provide competition to the RBOCs, though in practice after many years they largely remained very weak competitors, since there remained significant barriers to entry into the RBOCs local markets. In this new post-divestiture institutional environment, the RBOCs were under pressure to upgrade their networks for two principal reasons.

First, their customers were demanding enhanced transmission services, especially consumers and businesses using telephones and faxes. Not only were the RBOCs seeking higher functionality from their equipment, but their primary requirements were for reliability, interoperability, and upgradeability in purchasing telecommunications equipment.

Between the 1950s and 1980s, there had been little increase in average usage of voice telephone service in the US – an increase from 20 minutes per day to 24 minutes per day over the 30-year period. Local access lines to central office switches were copper wire pairs and signals were analog. Expectations of increasing demand for data transmission and the availability of lower cost optical fiber, however, marked a gradual shift in technology to digital transmission and DLCs and, eventually, to fiber optics and optical loop carriers. Fiber optic cable offered several advantages over copper wiring, including lower signal attenuation, and avoidance of errors from over-voltages and other electrical problems. Fiber optic networks, instead, use light as the medium for data signaling.

The second pressure on the RBOCs to upgrade their networks came from the threat of entry into their regional and local marketplaces from the CLECs.

Turning to the long-distance segment of the market, AT&T had been a captive customer of its own transmission equipment supplier, 1872-founded Western Electric, in what effectively had been an almost closed transmission equipment marketplace to intending new entrants in the US up to 1984. At divestiture, AT&T retained ownership of Western Electric, as well as its technology research arm, Bell Laboratories. It was only much later, in April 1996, that AT&T combined Bell Laboratories and Western Electric into a single entity, named Lucent Technologies, and spun off 17% of Lucent Technologies' equity. Lucent Technologies became completely independent from AT&T in September 1996, when AT&T distributed its remaining shares in Lucent Technologies to its shareholders as dividends. Organizationally, Bell Laboratories then became a division of Lucent Technologies. Other Lucent Technologies' operations included its Service Provider Networks unit, which develops switching and transmission systems for voice and data, data networking routing switches and servers, wireless network infrastructure, optical networking systems, communication software, and support services. Both in research and in product development, Lucent Technologies remained a strong competitor to JTech in supplying transmission equipment to the global marketplace up to the time of its merger with the largely French-owned telecommunications' equipment supplier, Alcatel, on December 1, 2006, with the newly merged company renamed Alcatel-Lucent.

An advantage to customers from having a single monopoly supplier, such as AT&T had with Western Electric and with Bell Laboratories, is relatively good equipment interoperability. Within the newly deregulated US telecommunications environment, it remained important for telephone equipment to be interoperable and to meet minimum quality standards. Efficient and effective interoperability among transmission equipment was advantageous to customers, for both technical and economic reasons. From a technical perspective, interoperability was a functional requirement – absent interoperability the equipment simply would not work. From an economic perspective, it offered telephone companies the prospect of a competitive equipment supply industry, rather than their being tied into particular suppliers for parts of their networks and facing monopoly supply prices. Achieving interoperability among multiple suppliers' equipment required standardizing equipment interfaces.

As a JTech spokesperson noted at the time of deregulation, a standardized interface "would be in the best interest of the end user, not the [transmission equipment] vendors." In its public face, market leader AT&T apparently shared what was an industry-wide consensus, when a spokesman noted that RBOCs would like standardization so they "can mix and match products. But that, of course, leaves manufacturers with a funny taste in their mouths."

To promote standardization, there were many formal standards-setting organizations in the transmission equipment industry. The evolution of standards was both international and within countries. International standards were being pushed for by the then-named International Telegraph and Telephone Consultative Committee (CCITT), which was subsequently replaced by International Telecommunication Union-Telecommunication Standardization Bureau (ITU-T), the Telecommunications Standardization Sector of the International Telecommunication Union (ITU). ITU-T combined the standards-setting activities of the predecessor CCITT and the International Radio Consultative Committee ("CCIR").

Within the US, there were a number of national standards-setting committees and bodies especially focused upon the specific needs of the RBOCs in the newly deregulated environment. Before the divestiture of the Bell operating companies, AT&T's Bell Laboratories and Western Electric established guidelines for physical configuration and compatibility of telecommunications' equipment used within the Bell System. After divestiture, in 1984, the RBOCs formed a separate research organization, called Bell Communications Research (Bellcore) to coordinate and promote interoperability and standards. Bellcore was headquartered in New Jersey, but had teams dispersed across the US near to equipment suppliers' premises for activities such as quality assurance. Subsequently, the RBOCs sold Bellcore to Science Applications International Corporation (SAIC), in 1995, and in 1999 SAIC restructured Bellcore and renamed and rebranded it as Telcordia Technologies, Inc.

Bellcore was responsible for developing generic requirements for switching, transmission, distribution, and operations' support systems to meet the typical needs of its RBOC owners in finding the optimal equipment to implement their network plans. In addition to developing these proposed generic requirements, Bellcore analyzed both suppliers' products against applicable criteria and suppliers' quality programs, processes and results. Bellcore was the primary technical support for the RBOCs on network equipment issues. It consisted of a full-time professional staff and its responsibilities were divided and allocated among various committees which would work with the Bell operating companies and suppliers in developing standards for equipment for various parts of the telephone network.

Formally, Bellcore had five means of communicating with, and supporting, its RBOC owners and transmission equipment suppliers:

1. It published preliminary requirements in the form of "Technical Advisories" ("TAs"). These were guidelines to equipment vendors.
2. It issued formal standards in the form of "Technical References" ("TRs").
3. Periodically, on a specific subject, Bellcore would conduct a Technology Requirements Industry Forum ("TRIF"), at which suppliers had an opportunity to engage in public dialogue with Bellcore staff.
4. It would respond to RBOC requests and investigate whether or not particular telecommunications products performed as claimed by vendors and met the RBOCs' needs. It analyzed equipment against relevant, objective technical criteria and tested it against manufacturers' specifications. Often, the criteria were contained in the TRs.
5. To ensure product durability over time, Bellcore had a quality assurance program covering equipment suppliers' new products and manufacturing processes.

Despite the overt technical and rational image presented by the formal view on Bellcore's activities, there was a high level of ambiguity over definitions and great uncertainty over the evolving standards, which were the result of intense jockeying and gamesmanship among equipment suppliers and the RBOCs, both as to the content and timing of standards' releases. For example, while Bellcore could only specify standards for technologies and products based upon what was feasible from leading-edge technologies, with each equipment supplier ahead or lagging in particular technologies, the standards formally issued were as much a political outcome as a rational solution or a socially constructed understanding among industry participants of transmission equipment definitions. Manufacturers would try to build products, and RBOCs to install products, in advance of the formal release of the TRs and in so doing hoped to influence the content of the resultant TR. Consistent with the perspective of Tushman and Rosenkopf (1992), trends in transmission technology and products in this period were a negotiated agreement among principal industry participants rather than determined by a technological imperative.

If JTech was to successfully enter the new market for supplying transmission equipment to an entirely new customer segment, the RBOCs, its first step had to be to develop a very close relationship with Bellcore and to deeply understand not simply the standards explicitly issued by Bellcore, but to understand what was not written down, how standards were emerging, to anticipate the standards, to participate in the standards-setting process, and to know what the RBOCs expected in terms of performance that was not explicit in the issued standards. This was essential if it was to be competitive, let alone stay ahead of competitors.

To take a specific example, during the 1980s, RBOCs required DLC products to be based upon so-called TR-008 specifications. However, during this time the RBOCs and manufacturers were jointly preparing replacement TR-303 specifications, which contained provisions for additional product features (see below). It was because of the uncertainties and ambiguities that pervaded the environment that industry participants had to enact the environment through what Karl Weick has aptly called sensemaking, or the need to construct sensible, sensable events from the environment (Weick, 1995).

While the RBOCs and their equipment suppliers had direct lines of communication, Bellcore also assumed a role of an indirect means of communication between the equipment suppliers and the RBOCs. Despite the activities of Bellcore, the openness of the market to supply transmission equipment to RBOCs was, nevertheless, something of an illusion. The RBOCs faced two constraints in upgrading their equipment, which were equivalently barriers to entry to new equipment suppliers.

First, the RBOCs remained highly dependent for equipment on AT&T, the then dominant equipment supplier. A JTech transmission interviewee described this dependence as follows:

> "Everybody was struggling to carve out a piece of the resulting RBOC market based on the modified Final Judgment, which split Western Electric and Bell Labs away from the operating companies. It allegedly created opportunities for vendors, companies like Rockwell and like JTech, to go in and sell to those end users. In reality, well… they gave us good lip service, but most of the Bell operating companies were still intensely loyal in post-1984 to AT&T. They had a great sense of security with them. AT&T understood their networks. I mean, it was just as you can imagine… so they had a real struggle putting their confidence in companies like JTech or NEC. But, specifically companies like JTech, because we didn't even have a presence here."

Gradually, something of a conflict emerged in the marketplace between leading equipment purchasing customers (especially the RBOCs), which increasingly wanted an open architecture and their historic suppliers, which were reluctant to release their grip on their customers that had adopted and were tied into their proprietary systems.

In 1991, emphasizing his Company's commitment to an open network, in 1991 the manager of network architecture planning at RBOC Ameritech said:

> "We don't want to perpetuate proprietary solutions… We can't afford to. A proprietary 303 product is clearly a dichotomy… Bellcore has to narrow down the whole array of alternatives and options available… We have to give the vendors guidelines… Our message to vendors is: We will not sacrifice the open architecture for a turnkey vendor-proprietary solution."

Second, the RBOCs were unable to easily write off large quantities of installed, depreciating assets, before the ends of their depreciated lives. Product introductions, therefore, tended to be enhancements to existing products, and favored incumbent suppliers. Such enhancements avoided write-offs and were interoperable.

RBOCs' local network "loops" provided an almost an entirely analog service. Upgrading the network to transport and interconnect digital signals required moving to an all-digital loop network. From the 1980s, RBOCs were seeking to install new (so-called "next generation") DLCs with greater functionality, primarily driven by very-large-scale integration ("VLSI") technologies being developed for computers.

During the 1980s, the principal supplier of DLCs had been AT&T (Western Electric), with its SLC 96 product. AT&T (Western Electric) dominated the DLC market with a share of around 80%, even by 1989. Its DLC equipment had set a *de facto* standard. Subsequently released products from other vendors typically adopted the basic design architecture of AT&T's SLC 96. AT&T developed a SLC 5 Series DLC product in 1988, as a successor to SLC 96. In 1992, AT&T replaced SLC 5 with its synchronous optical network ("SONET") protocol based SLC-2000, which served as a vehicle for fiber-to-the-curb deployment, supported both Bellcore TR-008 and TR-303 standardized interfaces, as well as standard feeder interfaces at DS1 (1.544 Mbit/s) and SONET OC-3 (150 Mbit/s.) transmission rates.

Other than AT&T (Western Electric), there were a few other established suppliers and new entrants. The second main supplier behind AT&T was Rockwell International, which introduced its LMS-3192 generation DLC to the market in 1987. Rockwell International was principally a defense electronics company, for which developing communications equipment was not a core activity. At that time, George Hunt[7] was Director of Product Planning for the Wescom Telephone Products Division of Rockwell International, where he was responsible for Rockwell's DLC program and one of its sales organizations. In 1990, he joined JTech's US Transmission Division as Senior Vice President of Sales and Marketing, then still part of JAI.

The Canadian telecommunications giant, Northern Telecom, was also in the US marketplace, with its DMS-1 Urban DLC product. The engineer who had developed the first DLC concentrator in 1969 through Digital Telephone Systems, had formed a new company, which became the fourth supplier in the market with a product called Litespan-2000, the first Synchronous Optical Network ("SONET")-based DLC.

In 1988, AT&T, Northern Telecom and JTech were all planning to release DLCs compliant to the updated Bellcore TR-303 standard, incorporating SONET-compatible

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[7] A pseudonym

transmission rates. By 1989, with AT&T still dominating the DLC marketplace, there was a race to develop SONET and Bellcore TR-303 generic integrated DLC interfaces. DLC manufacturers were working to bring optical fiber to the curb through incorporation of multiplexers or architectures based on SONET. As I mentioned above, standards were in flux, but all of the manufacturers believed that they would shortly be fixed, and most had set their sights on TR-303, which provided a new switch interface specification. Existing DLCs were based on the older TR-008 specifications.

TR-303 was designed to replace the interface known as TR-008 that was adopted at the time of the AT&T divestiture. TR-008 was based on the AT&T SLC 96, which had originally developed in 1977 and had become a *de facto* AT&T standard. TR-008 did not support important features such as integrated services digital network ("ISDN"), SONET or "fiber to the curb" ("FTTC"), and it lacked robust operations, administration, maintenance and provisioning ("OAMP") features. While optical fiber was already used for much of the long-distance part of the network, the installation of FTTC would mean replacing telephone lines with optical fiber lines, which is extremely expensive.

TR-303 allowed telephone companies to mix and match among a variety of vendors' transmission and switching equipment, so avoiding risks of future incompatibility. It was a standard that effectively signaled the break from having to rely on equipment supplied by the hitherto monopoly supplier, AT&T (Western Electric). Further, TR-303 allowed for forward-looking features such as efficient ISDN transmission and computerized operations support such as system alarms, performance monitoring and provisioning. The generic interface would also create a direct optical interface for SONET transmission rates (see Chapter 5). Most importantly, it would allow users to employ new-generation DLCs made by different central office switch manufacturers. TR-303 was the result of a concerted effort by the RBOCs, manufacturers and Bellcore to get something in place that would accommodate new-generation products. And a majority of manufacturers were already developing TR-303 interfaces for their products.

Synchronous optical network ("SONET") protocol interfaces were another DLC industry focus. In the near future, "all DLCs are going to have the have TR-303 and SONET interfaces… In fact, we are more interested in a TR-303 interface at this moment" according to the staff manager-network tactical planning at Southern Bell, in 1989.

Telephone service operators such as the RBOCs faced a choice between buying either several vendors' products or an integrated solution from a single vendor, such as Northern Telecom's Fiberworld or AT&T's Service Net 2000. These two product families offered a whole line of equipment, ranging from transmission to switching systems.

Despite openly advocating open systems, in practice both Northern Telecom and AT&T were stressing the advantages to the telephone companies of buying integrated systems from proprietary vendors.

As late as 1991, stressing the advantages to telephone service providers of proprietary, integrated systems, such as from more efficient operations and training, the director of marketing development for the Fiberworld product line at Northern Telecom said,

> "There will be mixing and matching for while... There's so much embedded equipment in the network now that we have designed to ensure the ability to mix and match. But wh at we're trying to show with Fiberworld is that you may have multiple vendors, but in the long run, when you look at one piece of the network, it is better to use a single vendor's products... When you have products that are designed to interwork, you get a level of integration that you can't get when you mix and match... We are designing to standards, but there is additional functionality in a family of products."

Incumbent vendors AT&T and Northern Telecom were emphasizing the advantages of single vendor systems, a system lock-in strategy (Hax & Wilde II, 2001) which they claimed offered the advantages of enhanced integration. Newer market entrants such as Rockwell International had best product strategies (Hax & Wilde II, 2001), with products developed to their particular interpretations of the evolving Bellcore standards that sought to achieve interoperability among different vendors' equipment.

Given the pressures to upgrade their networks, which vendor and product option would the RBOCs select? The RBOCs varied in their responses to the choices on offer from equipment vendors. Some, including the RBOC Ameritech, were strongly in favor of more open systems based upon industry-wide standards, but with ongoing support.

By December 1991, all of the RBOCs were disappointed that it was taking so long for AT&T and Northern Telecom to bring generic TR-303 switch interfaces to market, because it meant waiting longer for the multi-vendor environment that they desired. Adding to the RBOCs' frustration, both AT&T and Northern Telecom initially offered versions of the TR-303 interface that would work only with their own proprietary equipment.

By October 1992, "TR-303 has lost some of the limelight," noted Doug Soldier[8], Director of the Access Products group for JTech Network Transmission Systems, Inc.

[8] A pseudonym

("JNTS"), the divisional US subsidiary established in 1991 by Transport Systems Group's predecessor focused upon the transmission business. Although customers were issuing requests for proposals ("RFPs") for TR-303 products, they were concentrating RFPs on newer SONET and fiber-in-the-loop (FITL) systems, he said. For example, on August 31, 1992, Ameritech finalized an RFP for a $1-billion fiber investment plan and signed a three-year contract for DSC Communications' Litespan 2000 and its accompanying Starspan FITL system. The SONET-based DLC accommodated TR-303 and TR-008 specifications and provided sophisticated traffic control, maintenance and alarm monitoring, inventory and remote diagnostic capabilities.

4.3 Organizational Identity

The period from 1985 through the development of the FDLC, to 1989, and up to around 1992, was an era in the development of JTech's North American organization when it sought to distance itself from being a "Japanese subsidiary" and to enact an alternative, almost oppositional, identity as a new venture.

The organizational model of a new venture had long been available in the North American environment of large corporations, going back to the 1970s (Fast, 1978), but many of these earlier corporate venturing programs had been disbanded (Chesbrough, 2000). However, the period of the early 1980s through to the US Stock Market downturn of 1987 was a period of renewed interest in corporate venturing in the US but, compared with the earlier 1970s cycle of corporate venturing programs, during the 1980s internal corporate venturing grew alongside the growth of independent venture capital. Nevertheless, during the 1980s, the model of the internal corporate new venture program that prevailed within large corporations was that most companies using corporate venture programs did *not* include compensating venture managers any differently from their other managers (Block & Ornati, 1987), since large corporations were concerned to maintain internal equity across their divisions. Other research of internal corporate ventures at the time found that the principal motivation of internal corporate entrepreneurs at the time was the perceived opportunity to become general manager of a new business division (Burgelman, 1983).

Outside the large corporation, new ventures have been described as start-up companies backed by venture capital, and are especially known as prime vehicles for launching new products (Gersick, 1994). In her study, Gersick (1994) further characterizes new ventures as having to build their organizations in new markets and to mediate between perseverance – needed to overcome obstacles to innovation – and flexibility – needed to change unworkable plans – in environments of great uncertainty. Strategic management researchers have additionally found that new venture investment by large established firms is an effective way for these firms to source external knowledge and so to increase their innovative output (Dushnitsky & Lenox, 2005a, 2005b).

These new ventures often fail due to a lack of resources, legitimacy, and coordination, depicted by Stinchcombe (1965) with his phrase, the liability of newness. New ventures may increase their chances of survival by engaging in activities that increase reliability and accountability so as to enhance the legitimacy of the organization (Hannan & Freeman, 1984; Meyer & Rowan, 1977), by building social ties with external stakeholders (Stuart, Hoang, & Hybels, 1999), and by controlling and recombining resources in a way superior to that of established organizations (Delmar & Shane, 2004; Nelson & Winter, 1982).

Of particular interest to my dissertation research, scholars of new ventures generally have defined them as young, independent firms, explicitly *in opposition to* and by contrasting them with subsidiary or divisional forms of organization (Forbes, 2005). In this meaning, to construct an identity as a new venture would be to oppose, or to distance an organization from, an organizational identity as a subsidiary. This oppositional definition mirrors the distancing from other organizations that my interviewees often made mention of.

In many ways, use of the word *new* to describe a venture is unfortunate and misplaced. Although a new venture may have a new corporate name, in substance it may be little more than novel combinations of available resources, routines, and organizational blueprints. This has been a key insight of the neoinstitutional perspective on organizations (Baron, Hannan, & Burton, 2001), which has shown how designers of organizations draw on culturally appropriate and available templates and conceptions of control in crafting structures, work roles, and employment relations. For neoinstitutional theory, it is prior socialization and enculturation that preclude new organizations from constructing entirely new patterns of work organization. Alternatively, strategic management scholars have shown how a new venture entrepreneur may strategically leverage culture through stressing the normative appropriateness of a new venture, such as by telling stories that identify its symbolic congruence with similar organizational forms and ideologies so as to increase legitimacy and the chance of survival (Lounsbury & Glynn, 2001).

Five identifiable factors contributed to the construction of a new venture identity for JTech's US transmission business organization. The first of these was the seizing of direct control of its US transmission business activities and organization by JTech's transmission division in Japan. While "control from Japan" may seem inconsistent with a new venture identity, the Division in Japan managed its home country organization and activities through policies of dispersal and decentralization, and it extended these practices its management of its US organization. Second, when it relocated to Texas, the Transmission Division shed a number of businesses that were unrelated to transmission, such as the manufacture of modems, giving the new venture a greater focus. Third, the co-location of its activities into a new Texas headquarters some distance from JAI in California added to the sense of a new venture. The fourth element in the construction of a new venture identity involved both a distancing from NEC in terms of how overseas subsidiaries were managed, coupled with an embracing of new customers, products, and markets. Finally, the Transmission Division gave almost complete autonomy and control to key activities in the new product development process.

Until 1984, JTech's transmission equipment activities in the US were hidden under the umbrella of the Transmission Division of JAI, the California-based country subsidiary. Its principal North American activities were in California. JAI's Communications Division had established a Washington branch office in the suburbs of Washington in August 1984, both to manage its relationship with MCI but also to try to develop its relationship with the newly established RBOC Bell Atlantic. JTech's US transmission business was closely identified with MCI, a customer that was the first new entrant into the long-distance telecommunications service marketplace to prove to be an effective competitor to AT&T.

In 1984, JTech's Transmission Division in Japan gained control of its US transmission business activities and succeeded in relocating its transmission equipment development engineers and sales staff from California and from the East Coast to the site of a recently built transmission equipment factory in an area known as Telecom Corridor in Texas. This transition – from diluted control through a country subsidiary to direct control by the home country Division – appears to have come about through political struggle between the Division and corporate offices of JTech.

The history of Telecom Corridor can be traced back to the 1950's. In 1956, Texas Instruments located its corporate campus at the intersection of US 75 and LBJ Freeway, in the Dallas/Richardson area. In 1957, Collins Radio, a well-established electronics company from Cedar Rapids, Iowa, built its first building of a multi-building campus on a 400-acre site near US 75 and Arapaho Road. Both companies attracted a cadre of engineering talent and eventually spawned a number of new technology-based enterprises. Collins Radio was acquired by Rockwell in 1971, and that Rockwell unit was subsequently acquired by Alcatel in 1991. The pace of Telecom Corridor's expansion was accelerated even further in the 1980's with the deregulation of the telecommunications industry. Following the divestiture of AT&T, MCI no longer needed its headquarters in Washington DC, and relocated to be near to Collins Radio, in Telecom Corridor, upon whose microwave network it relied for transmission. Later, Nortel, JTech and Ericsson brought major operations to the area, effectively making Telecom Corridor the US center for the transmission equipment industry. In 1992, the local Chamber of Commerce formalized the Telecom Corridor moniker by registering it as an official trademark.

As I mentioned above (see section 3.5.2), JAI Communication Division had established a Washington branch office August 1984 to maintain a close relationship with MCI's Washington headquarters – MCI's Technology Division was also in Washington. That office also kept close relations with the RBOC Bell Atlantic. JAI Communications Division had established separate offices in San Jose, in California, to keep close relations with the RBOC Pacific Bell and with another potential customer, Sprint, and it had a separate sales office in New York. It had also had a small factory in Texas, since 1983, mainly focused upon assembling products for MCI. Six Japanese engineers had been involved in establishing these offices and were locally based in the US.

In 1985 the President of JAI, who had led the country subsidiary in dealing with AT&T and the FCC during the AT&T Bid Incident (see section 3.5.1), was replaced by a new President. The new President of JAI sought to wrestle back greater control of the US transmission business from the Division, and summoned the Japanese engineers dispersed across the US to return to JAI's California head office. He then appointed an American Senior Vice President, head of modem sales as head of transmission sales, and imposed him above the Transmission Division's US-based transmission engineers then under the JAI umbrella. As a sidebar, it is relevant to note that modems are generally relatively low technology products sold in a very competitive marketplace, compared to the highly technologically sophisticated transmission systems equipment that the Transmission Division was endeavoring to supply to the US marketplace.

When the Transmission Division in Japan designated its new Texas, headquarters, the President of JAI dispatched his head of modem sales there as President. However, he was not the JTech's Transmission Division's choice of head, and they considered him completely ineffective in working with the development engineers in Japan. In 1984, he was deposed and a development engineer from JAI's former Washington office was pronounced President of the new JAI Communication Division's headquarters by the Transmission Division, over the head of the President of JAI. From that time, while symbolically part of JAI, the country subsidiary's power over JTech's transmission activities in the US was substantially weakened.

When the transmission equipment facility was set up in Texas, activities focused upon lower-value products, including modems, were left under the control of JAI from California, so giving the US Transmission Division's business a greater focus. The manufacture and sale of these low value products was largely a business-to-consumer business involving prioritizing cost over quality, almost the reverse of the capabilities required to compete in the transmission equipment business, involving the design, development, and manufacture of technologically advanced, high-quality products for sales to a business marketplace. The problem was most acute for JTech, since its low value products consisted of "Mickey Mouse" telephone handsets and modems – hardly helpful to the transmission systems' customers and other audiences with which the Transmission Division was trying to build relationships through projecting a focused identity.

Having left behind in California these low-value communications' businesses to focus upon a limited number or higher value added transmission systems equipment products, the subsidiary enacted a stronger and more powerful organizational identity as a new venture.

Third, within the new Texas facility, non-manufacturing staffs were kept physically separate from the factory, and were joined by experienced product planning staff. The relocation and co-location of these transmission activities in Texas led to a new and clearer organizational identity, that of a new venture, in place of having the default "Japanese subsidiary" organizational identity of the country-level subsidiary. The new venture identity was strengthened in 1990 when JAI's Communication Division was incorporated as a separate North American company owned direct by JTech's Transmission Division within Japan.

Fourth, while the new facility was located in Telecom Corridor, near to other transmission equipment manufacturers and to the early customer MCI, there appears to have been some effort to distance the new facility from the management system in place for other subsidiaries of MNCs, especially NEC. Having a Japanese parent company was considered to be disadvantageous because of the dual impact of the generally poor image of Japanese firms as employers in the US (Brannen, 1995) in the US at the time, which was given support by the reputation that NEC had given Japanese firms in the transmission industry in the US. In contrast, JTech managed to project a different identity based upon strong local autonomy, which its strong local cadre of senior executives helped to create.

A US-based American interviewee gave a sense of the extent of identity work that was necessary for JTech to engage in to distance itself from the default identity of being a Japanese subsidiary, as he talked through the challenges facing JTech in growing a transmission systems' equipment business in the US. He described the period around the time of the move from California to Texas as follows:

> "JTech here had a terrible reputation. In fact, part of it was its own fault, and part of it was NEC. Japanese companies have a certain way of doing business. NEC was probably the stereotypical company there. And, the transmission business in terms of people isn't very big. And, maybe every

business is like that. There is a core of people that just moves around from one place to another. And you always run into each other, you always have friends everywhere, so a lot of the people who we knew at Siemens knew a bunch of people at NEC. And, NEC was just a... probably the stereotypical Japanese company with a glass ceiling where the glass was this thick. And, everything was being directed from Japan. So, it was an awful place to work for. And, I think that the success that they have had in the US pretty much mirrors how they work.

So, even though we were sitting in the middle of Telecom Corridor, we had a really tough time attracting people here because nobody wanted to work for JTech here, locally. And, not all of that was NEC's fault, although everywhere in every company people know people who worked at NEC. So, it really turned them off. But, also the fact that the organization here had been pretty weak. People know that too, you know. So, really in the beginning we couldn't get anybody out of the [local] area to come work for us. And, that has now totally gone away. But, we really had to first of all clean house.

It is not really the Japanese part. It is the headquarters part. I think that a lot of companies have trouble with that, right? Because I think that even at NEC it is not really a cultural issue... with Siemens it was the Germans right, and with AT&T it is the people from New Jersey. It is headquarters. Nobody really cares about the cultural part, certainly not in this country.

But here, just like it is in most successful companies, the company that is responsible for a certain part of the business actually has a fairly good amount of control over that business. So, the charter of this company was transmission in North America, and the people in this company actually got to decide what the product should be... which seems very logical, but certainly NEC was not like that.

Nortel has the same problem. From an engineering perspective and a product development perspective, their center of gravity is Ottawa, and they keep trying to do things on the outside. And, every time there is a problem in the business, it is back to Ottawa. Ottawa, by definition, always wins. They have had a lot of problems. They have closed a lot of development centers and a lot of planning organizations. Those buildings over there are probably the first ones that really broke through and I think that they are now established enough that they are independent from Ottawa. But, I have seen in transmission and switching, and a lot of other businesses where within Nortel it just hasn't worked. And even after they

[Nortel] bought Bay Networks, they are doing the same thing to Bay Networks now, so… And, culturally, Ottawa and [Texas] are not that far apart… from the perspective of Texas and Tokyo. It is all relative, right?

So, anyway, we all knew that this company was a little bit different, without really knowing exactly how different. But, it wasn't NEC."

The interviewee also alludes to the fifth means of constructing a new venture identity, which was that the Transmission Division's US facility was granted substantial autonomy and control over major portions of the value chain, specifically product planning and sales. The same interviewee described this as follows:

"But here, just like it is in most successful companies, the company that is responsible for a certain part of the business actually has a fairly good amount of control over that business. So, the charter of this company was transmission in North America, and the people in this company actually got to decide what the product should be… which seems very logical, but certainly NEC was not like that."

It is also worth reemphasizing that JTech as a whole was characterized as something of a new venture in Japan relative to its older-established rivals in the transmission equipment business, NEC, Oki, and Hitachi. As a relatively new firm serving its domestic competitor, NTT, in Japan, founded only in the 1930s (see Chapter 2), JTech had both a more distributed organizational network in Japan and a relatively decentralized system of power and decision making than its older-established principal three competitors in the transmission equipment industry. This imprinted (Stinchcombe, 1965) decentralization of power and local responsibility shaped the development of the US transmission organization at this time, as it was allocated non-overlapping responsibility for product planning, which autonomy in turn reproduced the new venture identity claimed by the US organization. In the early 1980s, JTech was a distant fourth behind these other, much older-established competitors in terms of the value of equipment sales to their common principal Japanese customer, NTT.

It is very clear that it was this new venture organizational identity that shaped the subsidiary's organizational capabilities, through having facilitated the development of a closer and more integrated relationship between US product planning and the Japan-based development engineering activities. It also shaped relationships outside JTech, as JTech was more open to new ideas from outside, not only technologies, but to new ways of organizing, such as the routines of product planning for translating and transforming (Carlile, 2004) customers' requirements into legitimate JTech documents. Such openness to foreign ideas had been a hallmark of JTech as a relatively recently established company, seeking to catch up with its rivals in computers (especially

Hitachi) and communications (especially NEC) within Japan. As an interviewee succinctly put it, we were "the new kid on the block."

4.4 Organizational Capabilities

In my earlier discussion of organizational capabilities (see Chapter 1), I described an emerging general consensus across the strategic management and organization theory literatures that the essence of organizational capability is to be effective at integrating knowledge from internal and external sources (Grant, 1996; Woiceshyn & Daellenbach, 2005), which requires what Orlikowski (2002) identifies as "deep competence" in "distributed organizing." Though real, capabilities may only be inferred, identified and observed through the effectiveness of particular activities, such as in recruitment (a means of bringing new knowledge inside the firm) and in collaboration within and outside the MNC. The fact that JTech's Transmission Division was able to hire and to collaborate effectively in its North American business in developing the JDLC is evidence of organizational capability. In this section I will explain the source and nature of this organizational capability.

JTech could only have built this integrative organizational capability in its North American transmission equipment business if its organizational design and processes had led to effective collaboration between the US and Japan, both between and within designated functions, such as development engineering and product planning, as well as at the project level. JTech did not have a significant technological advantage that it could simply throw at the US marketplace in the hope that the additional value thereby generated could offset any costs from poor and ineffective organization.

There were two important aspects to this capability to integrate knowledge across borders and boundaries from organizations distributed across Japan and outside the home country. The first of these was JTech's openness to new ideas and knowledge from abroad, which had been an important part of its early history as I described in section 3.2.1, at root born of necessity to try to catch up with its older-established competitors in Japan.

The second integrative capability needs much greater elaboration and explanation, and relates to the history of JTech having faced unique difficulties relative to its three principal and market-share leading competitors in developing transmission equipment for sale to NTT in Japan. The way that JTech in Japan organized its development activities to overcome these difficulties gave it a unique organizational capability when it came to responding to the different working relationships with its customers in the US marketplace. This advantage derived from the way that the domestic subsidiaries were managed, both with strong local identities and responsibility for activities, and through the development of internal quality and reliability standards to compensate for a dispersed pattern of activity (see below).

One of the major barriers to expanding its business overseas for the Transmission Division was a shortage of labor in the form of development engineers. It will be recalled that JTech had been founded in the 1930s, and was a relatively young company compared to its principal competitors, namely NEC (1899), Oki Electric (1881), and Hitachi (1910). This represented a "liability of newness" (Stinchcombe, 1965) for JTech in Japan in terms of its ability to hire good engineers out of Japanese universities, in an environment in which older companies were generally higher status employers and preferred by new graduates. The problem was doubly acute for the Transmission Division, which was considered low in status within JTech compared to other divisions, and compared even with the more prestigious Switching Division within the communications field.

One way that JTech's Transmission Division's attempted to manage this problem was organizational. It realized that it could recruit and employ new graduates near to regional universities with strong engineering departments dispersed across Japan. The opportunity to join a large, albeit younger firm with commensurately lower status near to graduating engineers' home towns appealed to many graduates, especially given cultural norms within Japan of the eldest child returning home to care for aging parents.

The Transmission Division managed its US business activities from its divisional headquarters in Kanagawa, which was about an hour by train from the center of Tokyo. Divisional headquarters included primarily the development design teams, planning, and management activities. Other than the transmission equipment factory in Tochigi, other principal transmission activities for the US and overseas markets were co-located at Kanagawa.

In the 1980s, however, JTech's Transmission Division strategically redesigned and reorganized its development engineering activities within Japan across a network of divisional subsidiaries, divided between two clusters, one for hardware development and the other for software development. Its higher status, but sibling Switching Division was principally responsible for establishing the software development cluster of development subsidiaries, but the Transmission Division was involved in their growth and management.

The result was that for much of the 1980s, most of the development work for transmission and switching products for the Japanese and overseas markets was dispersed across Japan in two groups of subsidiary companies that represent two home country inter-organizational networks. JTech Digital Technology Group (JDTG) was the hardware development subsidiary company, with its headquarters in Kanagawa but separate from the Transmission Division. Software development was undertaken by another cluster of development companies, collectively known as JTech Communication

Systems Group (JCSG), also headquartered in Kanagawa, but in a different part of Kanagawa to JDTG. The resources and subsidiary members of the two groups, JDTG and JCSG, were dispersed across Japan.

JDTG subsidiary companies and locations in the 1980s were JDTG Kanagawa (HQ; 231 employees by 1988), JDTG Hokkaido, JDTG Osaka, JDTG Fukuoka (132 employees), and JDTG Miyagi (119 employees). The majority of the 2,100 or so engineers in the Transmission Division involved in hardware development remained at the Transmission Division's headquarters in Kanagawa. In addition, JTech Digital Technology Ltd. had a small number of engineers located at the main transmission product manufacturing location, in Tochigi.

JCSG subsidiary companies and locations in the 1980s were JCSG Tokyo, JCSG Hiroshima, JCSG Kanagawa (HQ), JCSG Hokkaido, JCSG Ishikawa, JCSG Osaka, JSCG Fukuoka, JCSG Aichi, and JCSG Miyagi. The first development center was established in 1983.

JCSG was set up at the initiative of the Switching Group, rather than the Transmission Division, since software development was the greater challenge for switching products, compared with the greater hardware element in transmission products. Nevertheless, by agreement, most of the firmware for transmission system products was developed at JCSG Ishikawa. With the exceptions of JCSG Hokkaido, JCSG Aichi, and JCSG Miyagi., each of the other JCSG subsidiaries were to some extent involved in software development for transmission products.

For JTech in Japan, the organizational model of a network of dispersed domestic subsidiary companies involved in product development was a general corporate form of organization, not tied to particular technologies. Other than telecommunications, the other main part of JTech business is the computer side. The Computer Group had its own large network of dispersed subsidiaries, especially for software development work. For JTech in Japan, organizing product development through sets of domestic subsidiary companies was an established and legitimate way of managing home country operations.

Where hardware and software subsidiary companies are separately established in the same town, I learned that nowhere do they share the same location, or even part of the town. Each subsidiary organization has always had a distinct identity and hired locally. The subsidiaries were separately established and related vertically to their respective JDTG and JCSG headquarters within Kanagawa, an hour or so by train from the Transmission Division and Switching Division's headquarters. From their founding, the responsibilities of these dispersed subsidiaries were defined by type of development work. Only in 2000 were the activities of the JDTG and JCSG subsidiary organizations reorganized.

I discussed how establishing clusters of development subsidiaries were a solution to labor shortages confronting the Transmission Division in Japan, and also to a lesser extent facing its sibling Switching Division. In interviews and in documents studied in Japan, five related explanations were given for the establishment of separate companies and for the associated dispersion of the hardware and software development activities across Japan in the 1980s.

Other than to facilitate hiring, three additional reasons for this dispersion of the development effort within Japan were variously described in 1980s business planning documents. These were to strengthen development in modules and micro-modules, to strengthen the business, and to reduce the development time by systematizing the development effort and allowing for a greater focus by the Transmission Division's headquarters in Kanagawa on high-level integration. The documents generally had dispersion as a policy in many areas. For example, the documents also referred to a plan for distributing production across three locations – among Japan, the US, and "Newly Industrializing Countries." The factory in Texas was, at that time, manufacturing the JDLC product, at least in part to satisfy minimum 'local content' conditions set by US governmental organizations and customers.

Since the establishment of the clusters of development engineering subsidiaries across Japan was considered to be so central to the Transmission Division's ability to internationalize, and because the information in the documents was ambiguous, I explored this further in interview discussions. What came out in my interviews, albeit with my respondents making sense of what had occurred retrospectively, was that it was considered difficult to manage a large number of engineers in a single location, due to limits of complexity. They said that it was simply more efficient to disperse the development engineering effort.

While the costs of coordinating across dispersed locations arising from distance (e.g., travel costs, additional communication costs) would undoubtedly have been higher, many of these additional costs would have been incurred even with co-location, in view of the necessity of systematizing, formalizing, and documenting new product development activities for the purpose of quality control.

Other than easing the difficulties of hiring, the other really important benefit from dispersal of development activities across Japan was that it allowed Kanagawa to focus on system integration, which involves designing the overall architecture of the system, including the way that components and modules are designed so that they work together more effectively.

All four principal suppliers of transmission equipment to NTT in Japan were at a disadvantage at least in one respect in entering the North American marketplace relative to suppliers from other countries. This disadvantage arose from differences between the way that Bell Laboratories in the US worked with Western Electric (principal equipment supplier to AT&T) and the way that NTT's research arm, NTT Laboratories, worked with its four equipment suppliers in Japan.

Very different from the US marketplace led by AT&T, in Japan responsibility for system integration work on new transmission systems was retained by NTT and managed through its research arm, NTT Laboratories. Following this, development engineering of particular products or modules was allocated among its four principal and other suppliers, using a so-called *goso-sendan* (convoy) system for its equipment suppliers. The *goso-sendan* system classified the top four equipment suppliers as (preferred) makers, and smaller or newer companies as second-tier suppliers, mainly for less technologically advanced equipment. NTT allocated market shares to its suppliers to a precisely negotiated and agreed specification. In the US, in contrast, system integration work was managed within Western Electric, monopoly supplier to its captive customer, AT&T. Japanese suppliers had to learn system integration.

The Transmission Division's solution to managing the new system integration activities was an outcome of the organizational structures it put in place to overcome the different problem it faced, of being able to recruit sufficient numbers of good engineers. Dispersal of development of components and modules had the outcome of creating the organizational conditions for JTech to develop a capability in transmission systems' integration. By distributing development engineering of hardware and software modules around Japan, away from the Transmission Division's headquarters in Kanagawa, it created the conditions for JTech to focus upon developing the skills and routines of system integration at its Kanagawa headquarters.

Of the other reasons for dispersing development engineering activities across Japan, interviewees elaborated on other ways in which this strengthened the transmission business. By dispersing the development of hardware and software components and modules across its network of development engineering centers in Japan, JTech may have avoided the rapidly diminishing returns to scale and complexity from having its entire engineering effort co-located. This is consistent with the argument of Itami (1994), that relative to US firms, Japanese firms in general face greater pressures to de-integrate to respond to limitations of their domestic coordination systems, which rely heavily on face-to-face contact.

It was this capability to relatively rapidly build up new engineering resources to develop new technologies in Japan that, in turn, enabled JTech in the US to adopt a strategy of developing leading-edge products that incorporated emerging protocols and advanced technologies. This capability was shaped both by the identity of JTech (as a relatively young firm), by that of its Transmission Division (as lower in status compared to other JTech divisions), as well as by the organizational identities of the individual organizations within the Japanese clusters of subsidiaries (that were equal in status to the Transmission Division's Kanagawa headquarters). The enactment of the organizational capability in everyday activities, in turn, reproduced the respective organizational identities.

How were these domestic subsidiaries managed? My literal translation from documents indicates that these new domestic development centers were designed and managed to have "fighting power" based on a principle of "concentration and specialization." Each subsidiary was identified by its distinctive role and responsibility, which contrasted with how JTech generally worked with other external suppliers, such as with subcontractors. Each JDTG and JCSG subsidiary was a development center that was considered a "partner" in terms of status. Each subsidiary was given its own name and had a career structure in parallel (Yoshino & Lifson, 1986) to the other development centers and to BU headquarters. Salary structures were invariant across subsidiaries and with BU headquarters.

The domestic subsidiary system was set up based on ten management principles, which included a "libertarian atmosphere, with people calling each other by 'san' not by title" (aside: referring to an engineer as Ms. Kamo for example was less formal than calling her by her position title such as "General Manager Kamo"). Work was managed among subsidiaries by flexible contracts. The early history of the two clusters of development subsidiaries was a period in which a "unique way of speaking was born, with expressions such as 'information democracy' and 'undirected education.'" The subsidiaries were responsible for developing core technologies. By 1991, these domestic development subsidiaries had 1,000 employees, which rose to 1,350 by 2000. All companies acquired ISO 9001 certification for design quality by 1996, and there was extensive design and development collaboration among these subsidiaries across Japan.

While wage and salary scales among the network of subsidiaries were the same as those within the main JTech organization, other costs – especially those of real estate – were undoubtedly lower. Isomorphic wage scales and parallel hierarchies (Yoshino & Lifson, 1986) of job title and career track meant that personnel transfers – known as *shukko* in Japan – across organizations in the domestic development engineering organizational network were unencumbered by status differences among the organizations.

Underpinning a home country organizational capability at collaborating across distance were a number of shared properties of the organizational designs of JTech and its domestic transmission product development subsidiary groups, JDTG and JCSG. It was a combination of these organizational level properties and project level management practices that led to effective work at the project level. While much of the literature on new product development focuses exclusively upon project-level practices, the story of JTech's dispersed collaborative practices is a good reminder that organization level practices may be just as, if not more, central. Such practices may not be revealed through a lens with an exclusive focus on projects. For example, the isomorphism, or correspondence among characteristics of the various organizations, such as roles, has been both symbolically and practically significant in contributing to enhanced effectiveness in collaboration among dispersed locations. It has done so in a number of ways.

First, it has facilitated lateral transfers. For example, the former President of JDTG Osaka was transferred there from JTech's Transmission Division for a period of years, before returning to the Division. At lower levels of the organization, many engineers from the Transmission Division in Kanagawa made short-term transfers to work on projects at JDTG and JCSG subsidiaries for periods of months, and JDTG and JCSG engineers would transfer for shorter periods to the Transmission Division headquarters. The Transmission Division had also implemented a program whereby young recruits were selected from JDTG subsidiaries to stay at JTech's Transmission Division for periods of up to three years to learn how to develop systems; these were called "learning stays". They were not primarily tied to projects, but focused upon relationship building and on general knowledge absorption and transfer back to the subsidiary. When they returned to their subsidiary company, they were promoted and they returned to JDTG "as leaders". In addition, JDTG engineers would often make short-term visits to help the Kanagawa team on projects, for which the objective was not learning but project-related. On learning stays at the Transmission Division in Kanagawa, JDTG engineers learnt general systems architecture, design, and software. The reverse, of short-term transfers from JTech to JDTG, were rare and not institutionalized.

Second, it has facilitated collaboration through there having been no significant status differences laterally among the organizations. For example, there was no status difference between a *kachō* (Manager) in a JDTG or JCSG subsidiary company or in the Transmission Division headquarters in Kanagawa. One indicator of this was that the criterion for selection of location for collaborative meetings was the relative numbers of members attending from each organization. Routine project meetings were sometimes held in Kanagawa and sometimes in the JDTG or JCSG subsidiaries. The organization with the largest group of meeting attendees routinely acts as host.

Third, this absence of a 'Headquarters Hierarchy Syndrome' (Bartlett & Ghoshal, 1989) within Japan – a term used to refer to a superior-subordinate relationship between a headquarters and subsidiary organizations across international borders – was coupled with a distribution of work that gave each subsidiary in Japan in JDTG and JCSG its own skill set and designated responsibilities for product development. JDTG and JCSG subsidiaries have very different responsibilities and distinct organizational identities, principally based upon their role within the JTech Transmission Division and socially based upon their being employer of choice in the local communities in which they were based, spread across Japan. These distinct identities, based upon decentralized power and non-overlapping responsibility for discrete parts of a new transmission system, seem to have improved the effectiveness of collaboration with the Transmission Division beyond the level that would have occurred had the subsidiaries had been more integrated with the Division.

At the organization level, cross-domestic subsidiary relationships were managed through a set of activities including monthly management meetings, quarterly meetings on operational matters, monthly technology exchange meetings, and a twice-yearly forum for high technology exchange. There were also informal meetings, including an annual sports meeting for all transmission employees. There were very few permanent transfers of staff among subsidiaries, but occasionally engineers from the development centers would often spend several months in the Transmission Division's headquarters collaborating on development projects. The location of meetings and site visits was rotated among the different subsidiaries – it was not always the case that staff from the subsidiaries visited their own headquarters or the parent Transmission Division headquarters in Kanagawa.

While the two subsidiary groups, JDTG and JCSG, were managed separately and independently managed from different group headquarters' offices in Kanagawa, the various subsidiary companies would work directly with each other on particular projects, as well as through their respective headquarters in Kanagawa. However, since high-level product and system architectures were decided by the Division's headquarters in Kanagawa, there was relatively little direct communication among the JDTG and JCSG dispersed network.

To deepen my understanding of the emergence of these subsidiary groups, I used historical documents and follow-up interviews to map out the evolution of the development organizations for transmission within JTech focusing upon software development. Putting together various information and with the benefit of clarifying discussions with my former colleagues at JTech, Figure 4.1 summarizes the early history of software development organizations for transmission products, which breaks down into three identifiable stages.

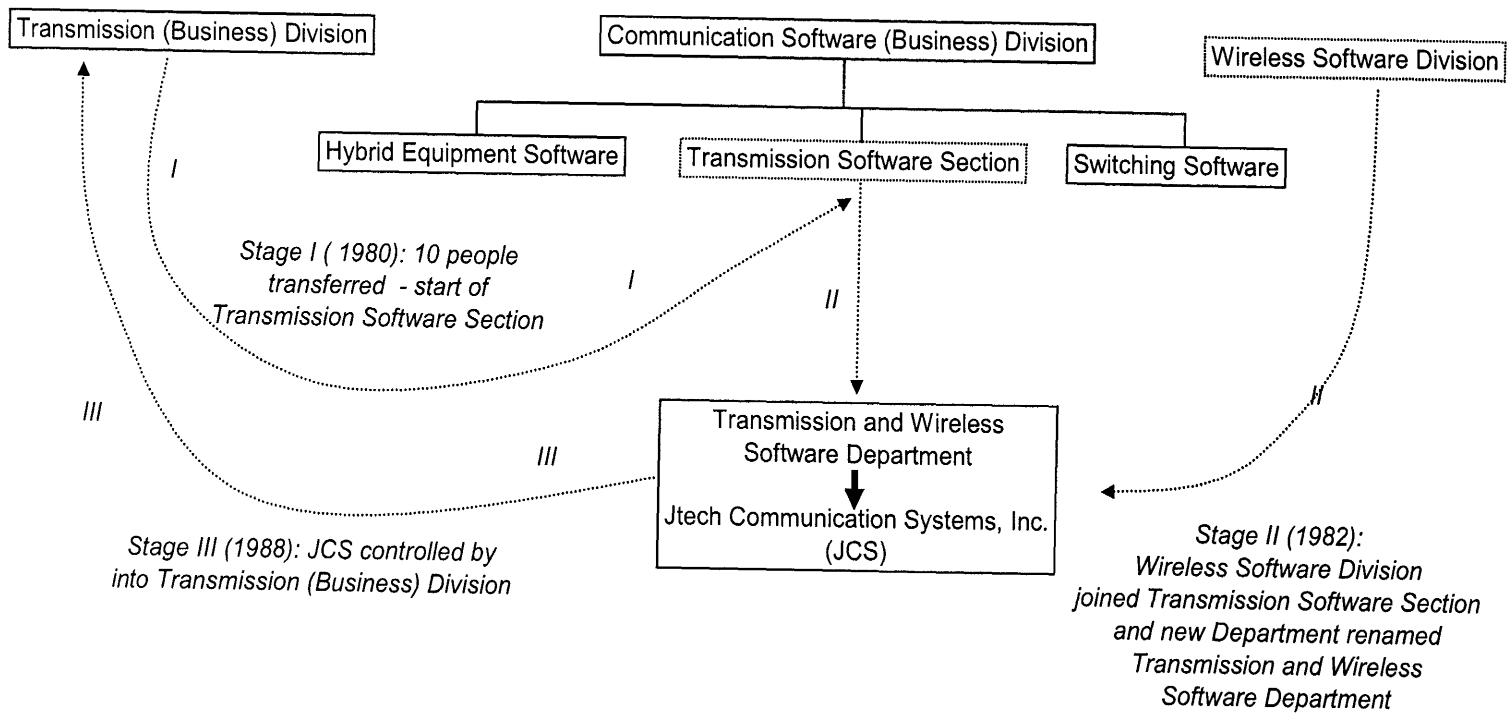


Figure 4.1 Strengthening the Internal Development Organization

In the first stage, in 1980, the Transmission (Business) Division transferred ten engineers into a new Transmission Software Section that was part of a separate and parallel Division, the Communication Software (Business) Division. This Division was dedicated to software development for a wide variety of communication products, including switching products. This organizational change had the objectives of building deeper functional expertise in software development and to achieve this by creating a separate software center and a stronger identity for this work.

In the second stage, in 1982, a new Transmission and Wireless Software Department was created from within the Communication Software (Business) Division by a merger of the Transmission Software Division with the Wireless Software Division. This organizational change appears to have been motivated by the objective of further deepening the functional expertise of transmission software development, and it indeed led to the creation of a stronger software development center. This Department was established in Kanagawa and later moved to a different town in the same prefecture.

The new Department had eight temporarily transferred employees and ten engineers dedicated to software development for transmission products. The principal problem confronting this new Department was that the ratio of new employees to experienced engineers was greater than 50%, which meant that too much time was spent on training relative to product development. Despite this, the new Department succeeded in developing some key products for NTT and for new common carrier entrants (competitors of NTT) into the Japanese market. Having relocated within Kanagawa, the Department was eventually incorporated into a subsidiary company, JTech Communication Systems (JCS), which had been established in November 1979.

In the third stage, in 1988, the Transmission (Business) Division took back control of JCS in order to achieve improved communication and more effective integration between software and hardware development. It was explained to me that this was because the size and complexity of transmission product development had significantly increased, but it was also expected to lead to more effective project-level planning.

What this chronology of events reveals is a gradual growth of a group focused upon software development for transmission systems, including wireless and wired systems, which was given a stronger shape and identity being folded into the new subsidiary JCS, for which responsibility was moved to the respective Department in the Transmission Division responsible for software development.

It was in Stage I that JTech established the internal software subsidiary group, JCSG. It had established JCS in 1979, and JCS grew to have 30 software development engineers focused on transmission products by April 1986 and 50 engineers by December 1991, when the Wireless Division was separated off.

While the tasks of integrating software and hardware increased in complexity and importance in the 1980s, so too did the quantity of software that was needed to provide the enhanced functionality required by telecom carrier customers. Other than deepening its own internal software capability, as shown in Figure 4.1, JTech further responded to these pressures with a strategy of outsourcing, which had two thrusts. Initially, the Transmission Division established and collaborated with related software development subsidiaries owned by JTech. However, as the quantity of software development work increased beyond a level that could be managed through internal subsidiaries, the Division outsourced software development to external software development companies.

Although managed by the more heavily software dependent Switching Division within the Transport Systems Group of JTech, the Transmission Division was more directly and heavily involved in establishing JTech Ishikawa in April 1990. This was the first subsidiary company to specialize almost exclusively in transmission software development. It was established by initially transferring 30 engineers from JTech's Transmission Division and from JCS, engineers who already had experience of collaborating with JTech in Kanagawa from the Kanagawa-based subsidiary. JCSG Ishikawa was to become the principal transmission software development subsidiary and hired some 30 new graduate engineers each year, so that by 1993 it had more than 120 new product development personnel.

Other subsidiaries followed, and each founding was attributed to the need to focus development engineering effort, either in a new product type or for a new customer category. For example, JCSG Fukuoka – established in November 1983 – went on to assume responsibility and control for developing software for particular products for the US market and for collaborating with a US-based software development supplier, OCS. JTech had learned that mixing software development for different categories of product – especially switching versus transmission – or for different customers – especially NTT versus other domestic carriers or US customers – led to conflicts among different software development cultures.

The process of subsidiary formation was extended in the US on a smaller scale. US country subsidiary JAI's Communication Division established a Software Development Division in, California, in 1984, with just three engineers. Its work expanded through collaboration on three projects with another JTech part-owned company in the computers' field, almost "by chance" according to Transmission Division interviewees. Its location was well-suited for collaboration with West coast companies involved in the early development of graphical user interface (GUI) technologies that replaced former character-based control systems for computers. Such technologies were used, for example, on computers as the front-end to network management system software, where the network operator would input instructions in managing the transmission network.

This new California software development centre was early in developing a new software network management system for JTech's transmission products based on GUI and displayed the first GUI-based system at the leading global transmission industry conference, SuperComm 1991. Just as JTech had built an organizational capability in dispersed and integrated new product development at the organizational level in Japan to overcome difficulties in recruiting and building development engineering resources, so it faced similar difficulties in North America. Later, in the 1990s, the Transmission Division's US subsidiary expanded its software development activities across a network of other US subsidiaries, including in Texas and in New York (discussed in the context of job sharing in section 7.4). Each software center was embedded in geographically-defined environments with labor skilled in particular technologies, and was co-located with associated hardware development.

JTech's Transmission Division also used domestic software development suppliers, both third party suppliers and companies in which it had invested a small stake. Overseas, it collaborated with a New Jersey-based company in the US and with a well-known software development company in India. It would often take minority stakes and have board-level representation in these companies as the relationships deepened.

I have mentioned that, relative to its three principal competitors, JTech in Japan was the newest entrant, always having to engage in more challenging development work to try to overtake its Japanese competitors. JTech's dispersed organizational pattern within Japan, coupled with relatively decentralized and diffuse power, gave lower-level employees power to make decisions that they would never have been able to make in NEC.

At the risk of less considered decision-making, this had two benefits to JTech. First, decision-making was faster. Second, the responsibility and power that relatively young JTech engineers inherited made the company a more attractive employer. As I suggested earlier, although founded in the 1930s, in the social structure and stratified world of transmission equipment suppliers to NTT in Japan, JTech was very much "the new kid on the block" in Japan. Its organizational capabilities were so shaped, and in turn they reproduced its organizational identity.

Without prompting, several interviewees in Japan and in the US constructed a link in their stories between what they considered to be the relationship between how JTech had learned to manage across its domestic network of organizations within

Japan, and how it subsequently managing the international organizational network. The concepts were missing, but the linkage was made. I cannot verify if the facts are well represented in these stories, but I am in any case less interested in factual accuracy than I am in the more profound reality constructed by my interviewees, since this was the meaning that they gave to past events that allowed them to claim a meaningful identity for their organization and so to maintain their sense of being competent actors.

It would be hard to argue against a conclusion that the Transmission Division's experience in setting up the two domestic networks of organizations in Japan drew attention to dispersed organizational establishment and local hiring as a feasible and legitimate solution to a labor shortage problem. The availability of this model and pattern of organizing *within Japan*, including the institutionalized practices of collaboration among organizations in the development engineering clusters of organizations, represented a model that JTech's Transmission Division was able to adapt to the inter-organizational relationships that the Division established between Japan and the US, and eventually within the US. I discuss this further in section 7.4 in the context of job sharing on development projects.

While the historical documents I examined inclined to present a perspective that JTech's Transmission Division had no alternative but to disperse its development activities across Japan, in arguments strongly reminiscent of environmental determinism, my Japan-based interviewees suggested alternatively that the reorganization into subsidiaries had occurred by design, as managers sought to rationally optimize the Division's activities to achieve their goals.

A Japan-based interviewee remarked that:

> "So, you can see that transmission is very strong in hardware, and switching is strong in software. We can hire people in the regional locations, which is why they are spread out. We need more engineers, so we increase engineers in the subsidiary companies and overseas, especially in JNC [an acronym for the name of the US Company which was later set up to hold JTech's US transmission business activities]. There are over 500 design engineers in JNC, all in transmission, 200 design engineers in JTEL in Europe, and 120 design engineers in JAL [an acronym for the Australian subsidiary company set up to hold JTech's Australian transmission business activities] in Australia. There are about 50 engineers for switching... and now switching group is not so successful in the US market, so we shrink switching there."

At the project level, hiring locally was further facilitated by a second dimension of learning, a capability at sharing work, or collaborating among subsidiary organizations (see section 7.4).

Other than a similarity of patterns of dispersal of activities into subsidiaries, perhaps the clearest evidence of a linkage is provided by practices of personnel transfers between Japan and the US. During the 1980s, the Transmission Division trained a cadre of engineers within Japan who had gained their skills while having learned to collaborate over distance within Japan. These engineers were a resource and assisted in building collaboration among development organizations elsewhere, especially with the US. An interviewee mentioned that:

> "…to strengthen the hardware engineers in JNC [the later name for the Transmission Division's US subsidiary], more than ten ASIC engineers were sent to JNC to build up the hardware group in JNC. They were sent from JDTG subsidiary company – mainly ASICs and hardware unit."

These engineers were experienced in developing hardware components for system products across distance, from dispersed locations within Japan. Their subsequent transfer to the US represented the transfer of a capability of managing relationships across distance within Japan to managing relationships across international borders. I learned that these transferee development engineers were relatively junior, in their early 20s.

From the US perspective, while welcomed as contributing to building an embryonic development engineering effort in the US to complement the sales, product planning, and manufacturing "organizations," they were regarded as useful "windows" on the Japanese organization. They were young enough not to threaten the new venture identity claimed by the US organization, as might have happened if more experienced managers were sent over. The young engineers could facilitate communication across borders. Although they were technically local (US) employees, their careers were Japan-centered.

As a corollary of the organizational capability of managing across distance within Japan, JTech's Transmission Division developed an early capability in managing quality control in design, product development, and within manufacturing, a capability that was again organizational. This aspect of JTech's collaboration system within Japan was an important property of the organizational capability that underpinned its successful entry into the US marketplace.

There is a long history of quality control within Japan that goes back to, and precedes, 1960, when Nippon Telegraph and Telephone Public Corporation (the predecessor to NTT) established an Inspections Division to inspect quality within its domestic suppliers. In 1980, Nippon Telegraph and Telephone Public Corporation switched to a system that required its suppliers to submit to it quality assurance commitment documents for each product. This was still a passive system, in that the customer decided the format of the documents to be submitted, but from the mid-1980s the newly-privatized NTT replaced the earlier "check box" system with a system that required suppliers to propose their own quality assurance commitment documents. They later replaced this system with an enterprise-level New Quality Assurance System ("NQAS") in 1995. Each time JTech made an organizational change or introduced a new technology, it was inspected by NTT.

In the US, the RBOCs managed quality control among their suppliers in the mid-1980s using a Quality and Reliability Analysis system, which covered evaluation of a supplier's quality program, product reliability program, parts, and circuit design. JTech took several months to understand these requirements, and observed audits of quality for products destined for the US started at its Tochigi factory in 1986 and in Texas in 1987. JTech engineers recalled the great difficulties that they had in understanding the quality requirements, especially given the level of detail in which they were encoded. For example, there were strict regulations embedded in the quality documents that dealt with the contact points between various types of metal in parts touching connectors and with regard to the meniscus from controlling leakage onto the wiring of the coating of the parts in the through hole, attaching electrically conductive foreign parts such as micro-diameter solder balls, and the connecting strap for the wiring of the parts. Eventually, in 1994, the US quality system shifted to a method using indirect inspections and the Customer/Supplier Quality Process ("CSQP") which required a supplier to become CSQP Registered. JTech got an early lead in this aspect of quality management and this helped to differentiate it as a supplier from its competitors.

Separate from the specific RBOC and Bellcore requirements, from 1987 JTech's Transmission Division saw translations and explanations in Japanese of an emerging set of international standards known as ISO 9000s. This was the first time that JTech had seen quality from the side of the customer, and the new international standards were a "shockingly different way of looking at things from the way that we were proceeding with quality management from our side as producer." JTech's different transmission-related business subdivisions obtained ISO 9001 Certification related to the relative importance of the standard so that, for example, its Factory Division was the first to be Certified (January 1994), followed by its Overseas Division (March 1994), NTT Division (March 1996), and Wireless System Division (February 1997).

JTech's Transmission Division had developed and used a set of internal standards for design, development, and manufacturing, to facilitate internal collaboration in advance of ISO 9000 standards, and this early initiative speeded up considerably its subsequent ISO 9000s Certification. In other words, the reorganization of development engineering into different design and development subsidiaries through differentiation and integration had given JTech an advantage through its early lead in meeting external standards.

The Division had two sets of internal standards, one (SN) was internal to the Transmission Division and used to facilitate integration among its departments, and the other (TN) was used to cover relationships with other collaborating JTech Divisions, such as the Devices Division. Despite this, there were differences between the standards, with JTech's SN and TN dealing with technical issues and criteria, while ISO 9000 and ISO 9001 were more focused on processes.

In seeking ISO 9000s for its US transmission business, the Japan development divisions had started off collaborating with the NTT development engineers, but NTT engineers gave ISO 9000s a lower priority, so the overseas transmission North American group separated and moved ahead on ISO 9000s independently, ahead of the NTT development group.

JTech's Transmission Division had established its own quality control system for parts and components purchased from other JTech divisions and from third-party suppliers. In many cases, it had to compensate for its suppliers and to invest in its own testing equipment. For example, during the second half of the 1980s, JTech had to provide a guarantee to US customers that its DLC equipment could operate within relatively wide temperature limits of from -40° C. to +85° C., since the equipment was to be installed outside at remote locations in the US (while it was located within buildings within Japan). JTech purchased a VLSI tester to test within these temperature limits.

The system of quality agreements, documents, and standards that was embedded within its working practices contributed significantly to improving collaboration among the different groups through enabling them to work to common standards. When collaborating across distance, more explicit documentation was required, and it seems most unlikely that such an elaborate system of documentation would have been required or developed had the transmission business activities in Japan had a greater degree of co-location.

This organizational capability was vital to the expansion of the Division's business into the North American marketplace. Once in place it was as though the quality documents and standards had the status of powerful actors who could enforce compliance with other actors.

As one of the American engineers commented:

> "Let me give you something that I think has gone very, very well, and continues to go well and is something that we have to continue to do. That is that we have the highest quality and highest reliability products on the market bear none. You put one of these products in and they work. And it is largely due to our design and manufacturing processes. We have our manufacturing processes and our manufacturing capability and the attention to detail that we spend and work with just produces incredibly reliable products. Across the board. And we have not lost that. And, that is probably one of the things that totally amazes me and impresses me about our Company. If you ever talk about making a trade-off on quality, boy will you get people riled up about that. Which is great. I never want to make a trade-off on quality."

If the US side was unhappy with some aspect of the work being done collaboratively with Japan, the engineers would sometimes reframe the issue in the language of quality to reach agreement. For example, in developing the ADM products discussed in Chapter 6, the then head of quality at the US subsidiary JNTS sent a memorandum to his counterpart in Japan headed, "To Poor Quality Manager" to put pressure on the Japan development side to find a solution to a particular (so-called "green wire") problem on the TP 150 product. Quality was talked about extensively in JTech. Especially, it was embedded within the company through stories, such as the story of the sale of JTech's first SONET equipment, its Terminal equipment multiplexer, to US West (see next Chapter).

It is clear from this discussion that JTech's Transmission Division had developed an organizational capability in managing distributed technology and new product development across distance within Japan. Such a capability, across distance, does not represent a capability across international borders. Yet, there were certain aspects of how the Division managed its internal domestic network of subsidiaries that led it to take quite a different approach to managing across borders than did its competitors.

Within Japan, the domestic subsidiaries of the Division had clear identities that were linked to their roles and they were managed as equal partners. Because of the embedding of collaborative practices such as system integration in Kanagawa and of the existence of documentation for quality management, they were able to offer good work to graduating development engineers from Japan's provincial universities. Within the environment of Japan, having a Japanese parent did not carry the same stigma that "working for the Japanese" (Fucini & Fucini, 1990) did in the US. Working for JTech in a medium-sized provincial city in Japan would have been very attractive to graduates, for whom NEC, Hitachi, or Oki would have been harder employer targets. Indeed, none of the older engineers that I interviewed had come from the leading Japanese technical universities, such as Tokyo University or Tokyo Institute of Technology.

There did not appear to have been so much effort by the Transmission's domestic subsidiaries to distance themselves from their divisional parent. In contrast to the identity of a new venture that was claimed by its Texas-based subsidiary during the development period of the JDLC, the identity of the Japan-based subsidiaries was more role-based, focused upon particular technologies, components or modules. JTech was embraced as a parent.

In the US, however, a Japanese parent was not generally embraced in the 1980s, least of all among the kinds of highly skilled development engineers and other key professional that JTech would have wanted to recruit. The environment was certainly unusual to the extent that many of the incumbent organizations had been illegitimated, either because transmission equipment was not their main business and focus or because they were developing products to proprietary standards. On average, this would have made entry and establishing legitimacy easier for new entrants (Kostova & Zaheer, 1999). Others like Northern Telecom (later renamed Nortel) and Siemens were perceived to be strongly controlled from their respective home countries. In this cultural, institutional, and market environment in the US, the establishment of largely non-overlapping role responsibilities in the US – notably for market research and for product planning – had the effect of allowing the Transmission Division's employees at their new Texas facility to claim, not primarily a strong role-based organizational identity, but a social identity as a member of the class of organizations known as new ventures. The Texas facility was, in every sense, "the new kid on the block." This significantly influenced the strategy that the Transmission Division adopted for entry into the US transmission equipment industry, as I explain in the next section.

4.5 Strategy

In section 4.2 I discussed the changed environment in the US transmission industry from around 1984, especially with the break up through divestiture of AT&T, and some of the strategic responses of the incumbent and new entrant transmission equipment suppliers. In this era of change, JTech's North America transmission organization had begun to construct an organizational identity as a new venture, through identity work including having broken away from the control of JTech's US country subsidiary, relocating and centering transmission business activities in Texas, charter loss by shedding low value business (e.g., Mickey Mouse modems), distancing from NEC, and by the US organization being granted increased autonomy in virtue of its direct control by the Transmission Division. A new venture identity in the US was recognized and legitimate as an organizational form, to both the key audiences of customers and the home country development engineers in Japan to which the US-based product planners would send aggressively targeted specifications for development. At the same time, the Transmission Division in Japan had developed an organizational capability in transmission system integration, and in integrating dispersed hardware and software development activities – having overcome the labor market constraints on hiring through having established clusters of development subsidiaries across Japan.

The business strategy of JTech's US "new venture" was influenced both by this organizational identity and by the capabilities given meaning by the identity. The US organization focused its business and product strategy on targeting a new segment of the transmission equipment market with innovative new products, which in turn changing its organizational design to deliver on its strategy, especially by allocating roles and responsibilities across borders and by developing a new network in the US through selective hiring into the new venture of a core network of entrepreneurial individuals who could manage and grow JTech's North American new venture.

Within its home country, Japan, during the earliest year in which I have data, in 1988, JTech's transmission product sales were heavily concentrated at home, with only 11% of its sales outside Japan in the financial year from April 1988 to March 1989. Within Japan, 58% of sales were to the domestic telephone company, NTT, and the Transmission Division was preoccupied with a strategy of "NEC catch-up" based on lowering costs for customers, improving technology, and stronger sales efforts. It had steadily increased its share of the domestic transmission equipment market to reach a 41% share, which it sought to increase to 50% within the following five years. After this period of catch-up in the 1980s, based upon its internal reorganization into networks of dispersed subsidiaries and the capability that this gave it for integrating activities in Japan, NEC and JTech had roughly equal shares of the market in Japan, with Hitachi and Oki having the balance. In contrast, JTech's share of the 1988 $2.6 billion US transmission equipment market was 3.7%, which it aimed to increase to 5.7% within five years.

Orchestrated and largely controlled directly through Japan, JTech's Transmission Division had been involved in the North American transmission marketplace in developing products for AT&T and MCI for a number of years, as discussed in sections 3.5.1 and 3.5.2. JTech had also been closely involved in the evolving standards that were meant to assist the spun-off RBOCs in the deregulated era so that they may more easily purchase transmission equipment in the more open marketplace, based upon standards for technical specifications to ensure interoperability among different vendors' equipment.

JTech's Transmission Division's revised strategy for the era immediately after the 1984 AT&T divestiture consisted of two strategic thrusts. First, JTech sought to shift transmission equipment product development resources from the long-distance market (i.e., from MCI) to the regional and local transmission equipment markets, principally served by the RBOCs. JTech's Transmission Division had not sold products to the RBOCs before, and JTech realized that it would take some time to really understand the general requirements of the RBOCs.

Second, along with other equipment vendors, JTech sought to take advantage of developments in very large-scale integration (VLSI) technologies in the computer field to introduce a digital loop carrier (DLC) product to the market.

In simplest terms, a digital loop carrier ("DLC") enables digital signals to be transmitted over the existing installed copper wire in the local network. DLC products began to be incorporated into the telephone networks from around 1979. DLC products were first introduced in 1970, when the independent supplier Digital Telephone Systems introduced its D960 product. Western Electric followed this by releasing its SLM DLC system in 1971. DLCs bundle a number of individual phone line signals into a single multiplexed digital signal for local traffic between a telephone company central office and a business complex or other outlying service area. Analog phone lines of individual users are connected to a local DLC box which then converts the analog signals into digital and combines (multiplexes) them into one signal that it sent to the phone company's central office on the single line. At the central office, the combined signal is separated back into the original signals.

It was in 1987 that the Transmission Division made an important change in strategy for its US transmission business. The core of this was a shift from focusing upon long-distance interexchange carrier ("IXC") customers, such as MCI, to the local exchange carriers, especially the incumbent RBOCs. In April 1988, the then Director of Marketing for the Transmission Division of JAI noted:

> "Our success has been in the interexchange market... but the interexchange carrier business is very unpredictable. So our concentration for over a year now has been on the loop. And this means the Bell operating companies."

The first product that the Transmission Division developed specifically for the RBOCs, the JDLC, was a 1989-introduced copper-based T-1 carrier access product that was used in the local loop part of the RBOC telephone network. It was a pre-SONET standard product (see next Chapter). Market research and product planning for this was carried out through the Division's US operations, and development work was largely done in Japan except for cabinets to house the equipment, which were designed and built in Texas toward the end of the JDLC development period, in 1989. JTech did not have any particular technological advantage in developing its JTech Digital Loop Carrier (JDLC) product, and was in fact late to market.

The earliest business plan document that I was able to review in Japan, the Transmission Division's 1988 Business Plan, describes five initiatives with the objective of building market share in the US, namely:

1. Restructure the North American business by establishing a task force team between the Sales and Development/Engineering Departments, focused on the subscriber line products (JDLC and TP).
2. Reorganize the structure of the US country subsidiary JAI, and concentrate resources on the three RBOCs Bell Atlantic, BellSouth, and US West, as well as on the long distance carrier, MCI.
3. Increase penetration of RBOCs from three to seven between 1988 and 1990.
4. Increase market share in the trunk line and enterprise markets by establishing new channels and promoting a strategic model for 1.6G, DAX, and DMIX-F.
5. Provide leading-edge technology, dealing through OEMs.

The Business Plan noted that this was a focused strategy for resource concentration, so that there would be product gaps. To fill these gaps, it proposed to form alliances with other companies to make up a full product line. It also planned to standardize its new product systems, to make them more differentiated from competitors. The Division was also clearly following developments in the evolving standards in relation to the new CCITT and SONET standard hierarchies (see section 4.2).

JTech's DLC product strategy was to avoid introducing a product that was too far advanced of those on the marketplace. Technically, the JDLC system was composed of a so-called T-1 carrier system and a management system. The T-1 carrier system consisted of a central office terminal and a remote terminal, and provided the interface between customer premises equipment and the switching system. The management system provides the operation support system center the interface for provisioning, maintenance and testing. Providing greater capacity than the then dominant AT&T-supplied SLC 96-type system, JTech's software-driven DLC supported 192 channels per channel bank.

Reflecting on its entry into the DLC marketplace, JTech described its organization and market entry at that time as being "the new kid on the block." JTech faced stiff competition in its target markets. In the DLC market, JTech's objective was to move above Rockwell International for DLC market share, into second place behind AT&T.

Even though it was a late entrant into the DLC market, JAI's Transmission Division successfully sold the JDLC to the RBOC BellSouth, and subsequently to another RBOC, Ameritech. At divestiture Ameritech had inherited many AT&T-supplied

SLC 96 systems. Yet, by 1991, as an interim replacement for its SLC 96 installed systems, all Ameritech companies were standardized on the JDLC product, which was designed to be upgradeable to the TR-303 interface (see section 4.2) when switch interfaces were offered.

The Transmission Division was also making headway with other RBOCs. For example, Southern Bell had approved AT&T's SLC Series 5, Northern Telecom's DMS-1 Urban and "market newcomer JTech's JDLC." While JTech was initially aiming for a 1991 release date for TR-303 interfaces, it was behind DSC Communications in releasing its upgraded product, in part because of a shift in resource focus to its SONET family of multiplexers. One of the constraints on DLC products was that for DLCs to reach their true potential, switches had to be equipped with TR-303.

JAI's sales of JDLC products gradually increased from $5 million in 1989 to reach a peak of $90 million in 1992, falling to $46 million in 1993 and more gradually thereafter. Despite this sales success, there were problems in the early stages of developing the JDLC within JAI, which was responsible for making the cabinets for this product. As an American interviewee noted:

> "I think that we had pretty poor performance on the JDLC product. That is when I joined the Company. We were developing OFDLC – optical fiber digital loop carrier system. And, we came out with a pretty good one. And, we sold it to BellSouth and to Ameritech. We found out that we weren't particularly good at putting them in enclosures. Our Achilles' heel became that our cabinets were poorly designed and we had a lot of problems in the field, so we lost our quality reputation around that product for a little while. Actually, we still sell JDLC product today. It is all replacement plug-ins as opposed to new growth. But, I don't know that we ever got all of our R&D back out of that product."

The successful sales of JDLC equipment to the RBOCs was, however, an important success in two less direct ways. First, it established a successful working relationship between the Transmission Division in Japan and its US organization centered in Texas, at that time still under the umbrella of JTech's US country subsidiary, JAI. Second, this was the first sale of any product that JTech had made to the RBOCs, which had very stringent and particular quality conditions to be met by suppliers, such as the requirement for JTech to guarantee that its DLC equipment could operate within relatively wide temperature limits of from -40° C. to +85° C., since the equipment was to be installed outside at remote locations in the US (see section 4.4).

JDLC was a transmission system product that was developed and sold in the 1980s, after which it faded in importance. It was a local access digital carrier, not in the same product category as the subsequently developed SONET-compatible TP family of multiplexers that would create such a significant presence for JTech in the US transmission product marketplace. Eventually, JTech replaced JDLC with a new local access product, known as JDLC II.

4.6 Organizational Structure

The new business strategy for the US market put in place by the Transmission Division in the mid-1980s, shaped by its organizational identity in Japan and by the capabilities that were given meaning by that identity, went hand in hand with four significant and complementary changes in how the Transmission Division organized its US activities. These were the re-location and refocusing of the organization into a new transmission equipment headquarters in Texas, the clear separation between designated functions between the Japan and the US organizations, the decentralization of power and allocation of decision-making and responsibility to the US organization, and the recruitment of key executives to run the Transmission Division's "new venture".

What I emphasize is how these changes were enabled by the organizational identity and capabilities. For example, it is very doubtful that JTech would have been able to hire the key American executives that drove the breakthrough into the US marketplace measured by first sales to the RBOCs unless JTech had made these other changes to its organization and been perceived, not as a "Japanese subsidiary," but as a new venture with a well-organized development engineering capability in Japan.

First, as the Transmission Division altered its business strategy for the US marketplace to target the RBOCs with the JDLC, it sought to change the design of the organization, both in Japan and in the US, in ways that it hoped would support its strategy in the US marketplace. The start on establishing the clusters of dispersed development subsidiaries across Japan described in section 4.4 slightly preceded the development of the JDLC product. As I have discussed above, this allowed the Transmission Division's Kanagawa headquarters to focus upon system integration, and secured the additional engineering resources needed to support additional new product development work for the US marketplace.

Within the US, it was the co-locating of the Transmission Division's US activities in Texas that both removed the risks of strategy cooption by JAI, such as into developing "Mickey Mouse modems," and that brought the previously dispersed elements of the US business (e.g., West coast sales, East coast sales) together under "one roof" in Texas. The problem for the Transmission Division with the "Mickey Mouse modems" business was that it represented almost an extreme example of the costs that firms can incur if they diversity outside socially defined and legitimate categories of activity (Zuckerman, 1999). It was everything that the Transmission Division did not want to be. Contrary to the predictions contained in the framework of Birkinshaw and Hood (1998), the loss of this charter led not to subsidiary decline, but quite the opposite – to subsidiary development.

JTech's Transmission Business Division in Japan had established a Transmission Development Division ("TDD") as part of JAI's Communication Division in August 1984, which had itself been established on the west coast of the US in 1982. Initially, TDD engineers began by working on the DLC product, but expanded into software development for transmission network management systems and control systems for the US market. Eventually, the hardware engineers from TDD relocated to the Transmission Business Division's Texas factory in 1989, leaving the software engineers in California.

The Texas location was a strategic choice for the new US transmission equipment organizational headquarters, with JTech having located there to be part of what is known as "Telecom Corridor," identified by its local clustering of transmission-related firms into a concentrated spatial area (see section 4.3). The locality had an identity born from a fusion of technology, standards, organizations, and space. In addition to being near to the Transmission Division's then principal US customer, MCI, the cluster of local firms in transmission in Telecom Corridor offered JAI an enhanced possibility of hiring skilled transmission workers locally.

The second crucial aspect of the organizational design was that JTech's Transmission Division established a clear separation between Marketing and Product Planning in the US and Development engineering in Japan. It was the task of Product Planning in the US organization to define product specifications for development, from first to subsequent product releases.

Third, each designated areas was given responsibility for that area, with very limited overlap. The Transmission Division in Japan did not have product planning as a designated function at all, and was completely unfamiliar with what in the US market were product planning routines, since specifications for new products for the Japanese marketplace tended instead to be decided by JTech's key Japan customer, NTT. As in Japan, across the Transmission Division's networks of subsidiaries, and in a mantra that I heard many times, the area or group with formally designated responsibility for an area of work had that responsibility in practice.

There was, however, no more important result from the construction of the new venture identity and strategy than the ability of the new US organization to recruit a network of highly capable experienced industry individuals. Without this, JTech simply could not have developed its transmission business in the new US environment of deregulation. Had the identity of the US organization assumed the default "Japanese subsidiary" among key audiences, it could not have recruited the very high quality American staff to work with and gain the confidence of the RBOCs in defining the JDLC product.

Responsibility for crucial tasks of interfacing with US customers to ascertain market demand and desired product features was the responsibility of Ron Finch[9], who was appointed Director of Product Planning at JTech in 1987. But, Ron's task wasn't as passive as the last sentence suggests. Since the RBOCs did not have clearly defined product needs and in an era of evolving new standards (see my discussion on the evolving standards in section 4.2), JTech was another voice promoting particular solutions to Bellcore and to the RBOCs. In a real sense, the job of product planning was to actively construct with the RBOCs their network needs, and then to convey that information back to development engineering in Japan. JTech's Texas new venture was set up just to do this.

JTech's two core activities in the US in relation to developing transmission products in the JDLC Age were Marketing and Product Planning. At the time, the Director of Marketing for the Transmission Division of JAI was a former Western Electric executive, who was not part of the network of executives who JTech brought in to run its new venture. He later left JAI to become Vice President of Marketing at a rival local loop products' developer. However, the important work of interfacing with customers for the purpose of defining product characteristics was the responsibility of Ron Finch, Director of Product Planning at JAI's Transmission Division.

Ron Finch's career had started with AT&T in Bell Laboratories in 1971, where he spent time in the Outside Plant Products Group developing transmission products, before progressing to General Departments and working in AT&T's Product Line Planning & Management ("PLPM") organization. He also made two separate "tours" with two different operating companies at that time, namely Northwestern Bell and Southwestern Bell. Ron Finch was working in Texas on a special project for General Departments in 1984 at the time of the divestiture of AT&T, when the General Manager of Rockwell International recruited him, initially to develop a DLC to compete with AT&T.

Ron Finch left AT&T in 1984 and went to work for Rockwell International in Chicago as a Program Manager for a DLC, a D4-type channel bank product. At Rockwell International, Ron Finch worked for George Hunt, who had been at Rockwell International since 1985, and who subsequently joined JAI's Transmission Division as Senior Vice President of Sales & Marketing in 1990. George Hunt went on to become Executive Vice President, Sales & Marketing, until he left JNC in 1999, only to return to JNC (short for JTech Network Communications as the Transmission Division's US

[9] A pseudonym

subsidiary was renamed in 1996) as Group President and COO in 2002 when he filled the position vacated by Ron Finch, until then COO of JNC, who had that year left to join Cisco Systems, Inc.

From 1984 until 1987, when he joined JAI, Ron Finch had headed up Rockwell International's DLC development program. Rockwell International was a new entrant into the new DLC market, and succeeded in becoming the second main supplier of DLC products behind AT&T with its LMS-3192 by 1987. However, Rockwell International's main corporate focus was on the aerospace industry, and it essentially had but a single product strategy in relation to the RBOCs, compared to the integrated supplier strategy of AT&T and Northern Telecom.

So, in recruiting Ron Finch, JTech hired somebody with a track record of success and credibility with the RBOCs, both from his AT&T/Bell Laboratories' background, and also from his success at Rockwell International. His experience and track record, upon his appointment to JTech, formed the basis for early credibility in working with development engineering in Japan. This provided a context of trust at an interpersonal level that diffused into the respective functional areas in the US and Japan. Moreover, Ron Finch was identified as somebody with a strong personal commitment to a strategy of being a supplier of non-proprietary products to the RBOCs, who could then mix and match among suppliers rather than being tied to a single supplier, either AT&T or Northern Telecom.

Ron Finch moved for a combination of reasons. A problem for him was that Rockwell International was dominated by a "defense mentality" from having defense as its core businesses, so that telecommunications was something of "a hobby and a sideline" for the firm. As Ron Finch said:

> "They weren't really dedicated to it [transmission] and I was a telecommunications zealot and I wanted to go and do something with my talent and my experience where I was going to have the full backing of the resources available from the company. At the same time JTech called me and they wanted to enter into a similar program, to enter a digital loop carrier program. My last assignment with AT&T had been here in Texas and my family liked it here, so I came and talked to them and so I came to work here in 1987. I was hired as the Director of Product Planning. I was the first American Product Planning person that they hired and it was a concept that was fairly foreign to the Japanese."

The last sentence speaks to the fact that NTT did its own product planning, though not within a designated function of that name.

As for the decisions over recruitment, an American interviewee recalled that at the time it was a key executive in the Japanese organization who:

> "...recognized, I think much to the opposition of Japan, that he needed somebody in the organization who had developed a product, taken it to market, sold it competitively against other competitors, and knew how to price the product, knew how to position it in the market-place, knew how to prioritize features and benefits, and quantify the feature-benefits to the customer in a way that they could perceive that you were solving a problem for them. None of that existed in JTech. None of it."

The relationship between JTech, as equipment vendor, and its principal customer in Japan, NTT, had some similarities with the way that the RBOCs in the US had been served by Western Electric, the AT&T subsidiary and historic monopoly supplier of the RBOCs' equipment prior to divestiture of AT&T. JTech's Transmission Division could only bring in the new product planning routines that it needed for the new transmission equipment marketplace if it recruited executives who both knew the customers, their work routines, and their networks well, and who knew product planning routines.

These routines did not exist in Japan, but could only be drawn in through recruitment of individuals with experience from transmission equipment suppliers outside Western Electric in the US, such as Siemens or Rockwell International. As a former Western Electric interviewee who went on to work for Transmission Division's US subsidiary described the pre-1984 Western Electric-RBOC relationship compared to the equivalent relationship in Japan:

> "It [at Western Electric] was a very closed society or a closed organization, and we didn't have to compete for business. If we developed a product at Western Electric, we at AT&T forced our operating companies to use these products, so there was no sales and marketing that had to go on, so when we developed a product we really didn't have to be market sensitive. There wasn't any competition. So, the relationship that existed in Japan between NTT and the development organization there at the time I came to work here was very similar to the relationship that had existed in AT&T with its operating companies prior to divestiture, meaning that there was no real product planning because there wasn't any market initiative that was needed."

The JDLC was the first product which JTech's Transmission Division sold to the RBOCs, and its success reinforced the identity of the US new venture in opposition to NEC. As an American interviewee put it:

> "Different than in other parts of JTech and also in other companies like NEC is that, I guess, we established some level of credibility with the engineers in Japan. They say, 'Well these people in [JAI] know what they are talking about and we should work together and make it happen"...I think it is based on credibility. I guess in my working with JTech Japan engineers and the Japanese people in general... I think it is a lot based on credibility. You know, Ron had a lot of credibility working on the JDLC product line, which was our first-generation DLC. He came into JTech and worked with Japan on getting the JDLC approved in BellSouth and Ameritech and it was commercially successful. So, I think that JTech in Japan had a lot of trust in Ron."

In addition to working with RBOC customers and the Japan organizational network across subsidiaries, the Transmission Division built a second network in the US in the JDLC Age, but at a different level. This was a managerial and personal network.

JTech had been introduced to BellSouth, its first JDLC and RBOC customer, in 1983, at the instigation of the owner of an earlier JTech joint venture partner. JTech was recognized by the RBOCs as the only Japanese transmission equipment manufacturer to have been working with Bellcore on interoperability and standards issues, from 1984. The corporate-level relationship with BellSouth was cemented by strong personal relationships between key executives who shared a dislike of AT&T as the then monopoly equipment supplier of transmission equipment. This personal network underpinned five years of collaboration and cooperation between JTech and BellSouth through which JTech learned about the RBOC operating environment and culture. The result was the first shipment of the FDLC product to BellSouth in December 1988.

JTech's association with the compelling moral cause – if not crusade – of an open architecture and interoperability seems certainly to have combined with the commitment signaled by JTech's Transmission Division having relocated to Texas and refocused away from relatively low technology products (the Mickey Mouse modem *par excellence*) to have done more than anything to legitimate its identity claim as a new venture for the new environment. Furthermore, among the aspiring new transmission equipment suppliers such as Rockwell International, JTech was considered a company for which transmission equipment was a core strategic thrust, rather than a peripheral adjunct to other more central activities.

During the 1980s, JTech was a distant fourth in transmission equipment sales volume to NTT in Japan, behind NEC, Oki, and Hitachi. This had the dual advantage of JTech's US transmission business as coming within the umbrella of "Japanese-ness" based upon the general Japanese reputation at the time for developing high reliability products (see section 3.2.2 “Reliability and Creativity”). Yet, JTech was not encumbered in the US by having a dominant home country market share. JTech knew that the only way to make further inroads into NTT in Japan was to first succeed outside Japan.

JTech was apparently aware of the negative perceptions of other Japanese transmission equipment suppliers in the US, such as NEC, for having no effective US control. JTech succeeded in getting the message out to prospective employees that it was “not NEC”, an organizational identity constructed by distancing rather than embracing (Snow & Anderson, 1987). As Baron, Hannan, & Burton (2001) found in their study of young high-technology companies in Silicon Valley, firms’ identities for their key audiences of scientists and engineers were constructed based upon their particular employment relations and respective firm organizational cultures. JTech’s US organization’s newly appointed transmission equipment engineers brought into the organization the routines of product planning and retained ownership and control of them. This was so within JTech’s new venture, but was not the case in Japanese subsidiaries.

It is worth reiterating that JTech came to the post-divestiture US institutional environment without any particular technological advantage in relation to developing and supplying the JDLC to US customers. It was its *identity work* (Snow & Anderson, 1987), such as through changing its organization, that enabled the legitimate claim of an organizational identity as a new venture, which shaped the organizational capabilities that were evident in JTech’s US business at this time. When JTech’s US employees acted as entrepreneurs, not as employees of a Japanese subsidiary, they simultaneously enacted the new venture identity and reinforced it, as stories of enactment of the new venture identity – such as of breaking the rules – were told. This enabled JTech’s Transmission Division’s US organization to strategically, rapidly, and innovatively construct opportunities to develop a new business as they enacted the ongoing changes in the US telephone service and equipment institutional environment. It was with this newly established new venture in the US that JTech’s Transmission Division sought to rapidly expand its business in the US through developing a different, and more challenging set of products.

5 Terminal Products' Development (1986-1989)

5.1 Introduction

The JDLC product, described in the last Chapter, was designed for the so-called local loop of the RBOCs' transmission networks, where the network interfaced with customers' premises. At the same time, a different set of more complex standards were being negotiated for the main "highways" of the RBOCs' transmission networks, over which content (e.g., voice, data) had to be transmitted. During the process of transmission, such content is multiplexed and refreshed many times en route from sender to receiver. At its simplest, multiplexing equipment (especially multiplexers) permits the simultaneous transmission of two or more trains of signals or messages over a single channel. One way to picture this is to think of a wide highway with many kinds of traffic merging from slip roads onto a motorway with, perhaps, a smaller number of lanes – a multiplexer is a piece of equipment that optimally selects different vehicles and puts them into the best lane (e.g., lorries in one lane, supercars in another) to optimize use of the motorway.

Now, if in place of one central authority or monopoly operator (AT&T – or a central government highway authority to continue my analogy) determining the criteria (or standards in the telecommunications case) for sorting vehicles into lanes, suppose that the network is broken up into interlinked parts managed by different operators (the RBOCs), with different equipment suppliers competing to supply. Then such a system could only function effectively if there were standards in place according to which the traffic was sorted into lanes and if all highway operators adopted the same standards. Failing this, to continue my analogy, supercars and lorries may merge into the same lane, perhaps travelling in opposite directions, or perhaps in a different lane in another part of the highway.

It was to avoid such problems in the deregulated transmission network, a new environment of multiple transmission network owners (the RBOCs) and competitor entrants, with a new cohort of equipment suppliers, that equipment standards became very important. The key standards for multiplexers in the US were contained within an emerging set of protocols known as Synchronous Optical Network (SONET), which was related to a standard known as Synchronous Transmission (SYNTRAN). SONET is simply a standard format for transporting a wide range of digital telecommunications services over optical fiber.

There was great uncertainty in the environment about the content of the evolving SONET standards, which were in ongoing flux. Potential suppliers had to make a strategic choice over whether to develop to an early version of the standard (so-called SONET Phase I) or to wait and develop the more complex technologies that would provide the added functionality to meet SONET Phase II standards' products. Participants in the standards setting process were trying to influence the evolving standards in ways that were favorable to their own technological resources or networks.

JTech made the strategic decision to get to market early with Phase I SONET products, but offered purchasers a migration path to a Phase II-compatible product. The organizational structure remained similar to that for the JDLC development, but the clear division of responsibilities between the US and Japan became paramount – it created no opportunity for one side to question the other as they did not have data that could form the basis of any reinterpretation and, hence, negotiation. The US side set aggressive targets, both technically and in development time, and this suited the Japan side since, relative to the US, targets in Japan were always more aggressive as they were also organizational – part of the motivation system. If the story of the last Chapter was about identity construction in the US, the story of this Chapter is about putting the cross-border collaborative system to work.

JTech's Transmission Division and its US new venture were strongly committed to the standards setting process, with the Transmission Division in Japan pushing strongly to develop new products for a changing environment. Perhaps motivated by its desire to enhance its image in the eyes of NTT, it was the Japan side rather than the US executives who pushed for the strategy of developing an entirely new leading-edge product in the form of a SONET-compatible multiplexer. The US executives running the new venture instead had initially preferred a product less ambitious technologically that was similar to products being introduced by competitors.

The development engineering resources needed to develop the Terminal Products were very substantial, requiring what can perhaps most aptly be described as a massive gamble on the part of the Transmission Division in Japan, with the dispersed networks of development engineering organizations significantly contributing to the collective development effort through what was known in the Transmission Division as "job sharing". While JTech had some advantage in core technologies developed for NTT, many key new technologies were developed in Japan to specifications set by the product planning team in the US new venture. It is certainly not the case that JTech simply transferred or adapted technologies for NTT into the North American marketplace.

The effectiveness of the development organization and its attendant processes that were put in place, especially the design of non-overlapping functions across borders with the US side retaining exclusive control of product planning and marketing, was contrary to findings of the greater effectiveness in new product development of heavyweight product managers and integrated problem solving by cross-functional groups in much of the new product development literature (Brown & Eisenhardt, 1995; Clark & Fujimoto, 1991). It seems to have been precisely the non-integration and the absence of an overarching heavyweight leader that bolstered the identity claim of a new venture for the US organization. In turn, this separation constituted an integrative capability that reproduced the sense that the Transmission Division's Texas headquarters was a new venture.

5.2 The Enacted Environment

Since the development of multiplexers to the emerging SONET standards was such a significant part of the story of the entry of JTech's Transmission Division into the North American marketplace, it is important to understand some of the technical, institutional, and societal background to this.

When voice or data traffic leaves a local telecommunications network (such as a home or small business), a carrier or telephone service provider (e.g., an RBOC) takes on the task of sending it over an infrastructure of comprising, at its most basic layer, fiber optic cables. Without signal enhancement, however, fiber optic cabling does not have sufficient bandwidth capacity to transmit the required volume of voice and data. Since it has proved uneconomic to lay additional cables, telecom service providers have instead relied upon technologies that increase the amount of data that a single piece of fiber can handle. This is achieved by multiplexing signals. Multiplexing is a way of sending two or more signals over the same channel, or path between two points. A multiplexer is a device for combining several channels to be carried by one line or fiber. How is this achieved?

Early telephony multiplexing systems used Frequency Division Multiplexing (FDM), which multiplexed multiple signals by assigning different channels to each signal. However, the growing demand for more bandwidth made more stages of multiplexing necessary. FDM was therefore superseded in mainstream telephony by Time Division Multiplexing (TDM), which assigned different time slots to each signal. Synchronous Optical Network (SONET) is a physical-layer standard developed and used to transmit optical telecommunications signals that relies heavily on TDM.

SONET defines the standards for a technology for carrying many signals of different capacities through a synchronous, flexible, optical hierarchy. It defines a synchronous multiplexing format and a synchronous structure. Synchronizing the multiplexing format for carrying digital signals means that digital transitions in the signals occur at the same rate. In contrast, signals transmitted using pre-SONET asynchronous multiplexers were not synchronized, so that signal transitions did not necessarily occur at the same nominal rate. Synchronization has greatly simplified the interfaces among transmission equipment such as digital cross-connect switches and add/drop multiplexers (ADMs). While SONET is best considered as an agreed set of protocols, or a standard, its development was enabled by technological advances in semiconductors and fiber optics. SONET was the transmission standard gradually adopted by the US transmission industry.

Before SONET, earlier generations of fiber optic systems in the public telephone network used proprietary architectures, equipment, line codes, multiplexing formats, and maintenance procedures. The RBOCs and the long-distance interexchange carriers (IXCs) were pressing Bellcore to define standards that would enable them to mix and match equipment from competitive suppliers, since they considered that this would both reduce equipment costs and enhance innovation. Beyond this, SONET was expected to provide other advantages to the RBOC and IXC service providers including:

Higher transmission rates. Transmission rates of up to 10 Gbit/s became standardized in SONET systems, which enabled providers to better cope with increasing demands for bandwidth.

Simplified "add/drop" function. "Add/drop" is the process where part of the information in a transmission system is de-multiplexed (dropped) at an intermediate point of transmission and different information is multiplexed (added) for subsequent transmission, with the remaining traffic passing straight through the multiplexer without additional processing. Prior to this, it was necessary to de-multiplex and then re-multiplex the entire asynchronous multiplex structure, which was complex and costly.

High availability and capacity matching. Network providers can react quickly and easily to the requirements of their customers, such as by switching leased lines. This reduces management costs and enables the providers to offer enhanced services to their customers.

Reliability. SONET includes various standardized back-up and repair mechanisms to cope with system faults, so that failure of a link or a network element would not lead to failure of the entire network. Automatic protection switching ("APS") allows a network element to detect a failed working line and switch the service to a spare (protection) line. A linear protection system is used in point-to-point connections and a so-called ring protection mechanism is used in ring structures. In unidirectional "path switched rings," traffic is transmitted simultaneously over both the working line and the protection line so that an entire virtual ring is required for each path. In bi-directional "line-switched rings," the overall capacity of the network can be split up for several paths, each with one bi-directional working line. Not only would network failure be a financial disaster for the service provider, but providers may charge customers more for the higher reliability.

Platform for new services. SONET is a platform that enables providers to add new, higher value-added services, including ISDN, mobile radio, and data communications.

Interconnection. SONET makes it easier to set up gateways between different network providers and to Synchronous Digital Hierarchy (SDH) systems, a transmission standard based on a different transmission rate used in Japan, Europe and the ASEAN countries. The result is a reduction in equipment costs compared with pre-SONET equipment.

SONET networks are principally made up from four different types of network elements – regenerators, terminal multiplexers, add/drop multiplexers ("ADMs"), and wideband and broadband digital cross-connects. Terminal multiplexers essentially combine lower bit rate signals into higher bit rate signals. ADMs enable a telecom service provider to drop lower bit rate signals from, or insert them into, higher-rate SONET multiplexed signals, without completely demultiplexing the signal. ADMs were the building blocks of SONET-based ring networks. ADMs additionally incorporating a ring structure were the major objective of the RBOCs, and the development goal of transmission equipment vendors.

I described in section 4.2 how, upon divestiture from AT&T in 1984, the RBOCs had formed a separate research organization, called Bell Communications Research (Bellcore). Bellcore was the vehicle for the development of SONET standards in collaboration with its sponsoring RBOCs and transmission equipment suppliers. Rather than a rational search for some technologically superior or economically optimal solution, the final SONET outcome has generally been described as an outcome of 'skirmishing' over the content of the evolving standards. During such skirmishing, vendors would strategize over whether and what to build, in what was an evolving, unstable and uncertain environment both for equipment suppliers and their customers. Each industry participant sought a definition of the emerging standards that matched its relative strengths or weaknesses in the underlying technologies.

Bellcore had been working on developing the SONET standards from 1984, when the idea was proposed by the international standards body now known as the

International Telecommunication Union-Telecommunication Standardization Sector (ITU-T). It also had the early support of the Interexchange Carrier Compatibility Forum and the long-distance carrier MCI Communications. At Bellcore, the leaders in SONET standards' development included Rob Ostermann[10] and two colleagues. Rob Ostermann was, at the time, a district manager for Bellcore, where he was a principal contributor to the SONET standards project. He was also co-chairman of the key committee at the time, the American National Standards Institute's ("ANSI's") T1X1.5 Working Group, which was responsible for formalizing the SONET standard. This Working Group, part of ANSI's T1X1 Committee would decide critical definitional issues, such as the adopted nine-row format for the Network Network Interface (the User Network Interface was the responsibility of ANSI's T1D1 Committee). Bellcore proposed the standards and they were formally issued as ANSI standards. However, as in the case of the eventual ring structure standard, ANSI would not necessarily ratify what Bellcore proposed in its Technical Advisories.

The evolving standards were formally issued in what most industry participants at the time, including Rob Ostermann, recognized as three general stages. The initial US standards on optical interfaces, commonly referred to as SONET Phase I specifications, were issued as ANSI T1.105-1988 and ANSI T1.106-1988. These defined SONET signal construction, multiplexing, optical parameters and payload mapping, thus setting up the interface that allows the equipment of one manufacturer to communicate with the equipment of another. As a result, one vendor's multiplexer is able to exchange data with another vendor's multiplexer, whether the data is a so-called DS1 or DS3 signal. Phase I, however, did not standardize the operations and maintenance functions that must also be exchanged between network elements.

A principal function of the SONET Phase II standard was to define standards for operations, administration, maintenance and provisioning ("OAM&P"). Because SONET has an embedded operations channel – the data communications channel – a standard protocol could be defined so that network elements from one vendor could talk to another. Finally, SONET Phase III standards addressed the information model and message set.

Most of the value for equipment users came from incorporation of Phase II product features. As an American interviewee at the Transmission Division's US subsidiary put it:

> "Those of us in the standards body knew that Phase I and Phase II was a complete misnomer. It was something that somebody latched onto. Those of us on the standards body… whenever somebody would bring up Phase

[10] A pseudonym

I and Phase II, we would look at them and go, 'You know, I am not exactly sure what you are talking about.'

"The problem was that the Phase I standard – if everybody wanted to call it the Phase I standard – was just an evolution to go to where we really wanted to go. And so the Phase I standard was something that was sitting over here that we knew you had to commit certain things to LSI, but knowing enough about what had to be committed to LSI, getting to Phase II was just software. So, everyone was going back and forth saying, "Shall we do Phase I or Phase II." Those of us who knew what we was going on were like "What is the big issue here? We don't understand." Because we did this is in such a way very consciously because some of us were equipment designers at the time, and I knew what the design people were having to go through. We were trying to make this as a continuum."

Uncertainty over the evolving SONET standards and their phased introduction resulted in a diverse set of strategies among both potential SONET equipment buyers and suppliers. Equipment buyers, the telephone company service providers, were concerned to adopt a migration path to SONET equipment for their networks. Most network planners were expecting the SONET interface to be introduced in two stages.

In the first stage (so-called SONET Phase I), equipment vendors were expected to introduce the SONET standard into point-to-point systems, in terminal multiplexers. In the second stage (so-called SONET Phase II), optical interfaces would be integrated into network elements, such as DLCs, digital cross-connect switches, and ADMs.

It is difficult to disentangle the strategies of the principal SONET equipment buyers, the RBOC telecom service providers, from the varying strategies of the SONET equipment developers and vendors. In this period of uncertainty, there were close relationships among prospective customers and equipment suppliers – a complex interlocking of rival networks at the inter-organizational level.

One way of identifying equipment vendors' strategies for developing SONET multiplexers is by timing, from which I have identified two general strategies:

Phase I SONET equipment developers (earlier entrants with Phase I SONET products). These included Alcatel, JTech, and NEC.

Phase II SONET equipment developers (later entrants with Phase II SONET products). These included the pre-SONET proprietary equipment providers AT&T and Northern Telecom. The Phase I SONET equipment developers generally developed Phase II multiplexers as replacement or upgrade products.

The principal proprietary equipment provider and market leader before SONET, AT&T, was reluctant to embrace the emerging SONET standard. As an American interviewee at the Transmission Division's US subsidiary with close knowledge of the emerging SONET standard put it:

> "AT&T/Bell Laboratories had been working on a product they called Metrobus… and they had actually tried to get it standard, but they were so arrogant about trying to get it standardized that they didn't give the standards body enough information. And, they didn't give anybody else enough information [so] we rejected that standard for more of an open one… They thought that they owned the world. They thought that they could dictate to the entire world what this kind of a thing was going to be. They were trying to impose consensus."

Other than being reluctant to cannibalize existing market shares, the incumbent vendors of pre-SONET proprietary asynchronous fiber systems had the additional difficulty of providing a migration path from their existing equipment to the SONET standard. In terms of equipment redesign, this was technically more difficult than designing new products.

SONET equipment users, the telecommunication service providers, had varying deployment strategies for SONET equipment. In contrast to a strong agreement among RBOCs as to the desirability of adopting the SONET standard, evidenced by the fact that all seven RBOCs had SONET planning committees by 1991, RBOC SONET standards' implementation strategies varied significantly across two dimensions:

Deployment extent and timing. They varied in the stage and extensiveness with which they decided to deploy SONET equipment. Many RBOCs chose to wait until SONET Phase II compatible products were available, even though they were very keen to deploy SONET equipment as early as possible. Those RBOCs deploying Phase I SONET equipment did so mainly as replacement products in point-to-point fiber deployment, as network terminals. ADMs began reaching the market in 1991, but ring capabilities weren't available in ADMs until 1992.

From reviewing their comments before deployment, at least five factors appeared to explain the variation in the deployment timing of SONET equipment by RBOCs, namely differences in:

1. Interpretations of the value of SONET Phase I equipment.
2. Confidence about the upgradeability of Phase I equipment to Phase II SONET-compatible equipment without major hardware changes.

3. Depreciation schedules for already installed equipment – they could not easily write off substantial parts of their existing installed networks.
4. Threats of entry into their respective local and regional markets from competitive local exchange carriers ("CLECs"), such as GTE Telephone Operations, United Telecommunications, and the Eastern Group.
5. Demand from customers for the higher reliability and value-added services that the SONET standards were designed to enable.

Numbers of suppliers. With regard to the number of suppliers from which they would purchase SONET equipment.

As one example of these two dimensions to RBOCs' SONET implementation strategies, JTech's second RBOC customer for the JDLC, Ameritech, was a strong vocal proponent of more open systems based upon industry-wide standards in place of proprietary systems such as those supplied by AT&T and Northern Telecom. Nevertheless, Ameritech decided both against installing early SONET Phase I equipment and to adopt a single supplier policy for Phase II equipment.

While all the RBOCs were involved in SONET equipment trials, by March 1991 only Bell Atlantic and US West had deployed SONET equipment compatible with Phase I of the standard. Bell Atlantic had deployed several hundred SONET multiplexers, primarily in the local loop part of its network.

5.3 Organizational Identity

The development period of the Terminal products overlapped significantly with the development of the JDLC that was the subject of the last chapter, and the development of the Terminal products continued to be underpinned by the Texas facility's claim to be an internal corporate new venture. It will be recalled from the last Chapter, that while this organizational model co-existed with the growth of venture capital in the external environment up to the Stock Market crash of 1987, the defining characteristics of the model were greater autonomy for managers and the difference of the internal corporate new venture from other divisions within the large corporation.

JTech's Transmission Division in Japan had been closely monitoring the emerging SONET standards in the US, and the Division was strongly identified with Bellcore's effort to develop standards that allowed equipment interoperability from a multi-vendor network. Participation in the standards setting process (see section 5.5) in a changing institutional environment of uncertainty and ambiguity over new standards to which the next generation of products should be developed helped perceptions of the organization as being entrepreneurial. Incumbent suppliers had become illegitimate in the eyes of their customers, and the Texas-based organization had more space in which to carve out and claim its new, distinctive identity.

I suggested at in section 4.1 that at times JTech conveyed the image of being a new venture in virtue of its relatively late founding, and this was especially true of the Transmission Division, as evinced by its culture of entrepreneurship. This was evident during the development of the SONET standards' products, in which JTech placed huge bets on the emerging standards by committing massive development engineering resources to unproven technologies for customers who had not yet committed to any particular standard. In this particular phase of the evolution of JTech's US transmission business, the image conveyed to this researcher was one of two new ventures collaborating, JTech's Transmission Division in Japan and its US organization in Texas.

5.4 Organizational Capabilities

Although the Transmission Division's first RBOC customers for Terminal products were different to those for the JDLC, it was undoubtedly the case that it was through the development of the JDLC, which slightly preceded the Terminal products, that JTech's Transmission Division developed routines of working with the RBOCs and with Bellcore. While JTech's Transmission Division in Japan had had much direct contact with Bellcore as standards evolved, it must be stressed that this did not overlap with the product planning activities that were solely the responsibility of its US operation. There were different, largely non-overlapping layers of scanning, consistent with research on scanning in the strategic management literature (Elenkov, 1997), and so the organizational identity of the Texas organization was not threatened or undermined.

JTech had developed a good understanding of the particular specification needs for products of the RBOCs through its development and sales of the JDLC product. It had also developed and refined routines of working with the RBOCs, and developed routines of collaborating internally, both among designated functional areas within the US and between the US and Japan-based JTech organizations.

These routines were valuable to JTech in its ongoing North American business, and JTech subsequently strategically applied these routines to capture business with NTT, away from its home country arch rival, NEC. By making use of the organizational capabilities of product planning and being more active in working with its US customers than had hitherto been the case in Japan, JTech was able to better respond to changes in the Japanese marketplace some years later. This was probably more by coincidence – not exactly random but not completely determined either (Becker, 1997) – but is nevertheless worth a brief explanation.

Organizational capabilities are too often identified with the benefit of hindsight, and it would be wrong in this case to say that, for example, JTech acted strategically in developing an organizational capability in the US so that it could subsequently transfer this back to Japan to catch up with NEC. While JTech was not setting out deliberately to create an organizational capability, they did develop one.

During the 1980s, JTech's principal customer for telecommunications equipment in Japan and globally was NTT, although it was a distant fourth place supplier of transmission equipment to NTT, behind NEC, Oki, and Hitachi. Up to the 1980s, the relative ranking of equipment vendors with regard to NTT correlated with, and was argued by Japanese interviewees to have been determined by, the relative age of the companies. In sum, the company with the longest history had the most entrenched relationship and the biggest market share of NTT sales. NTT set one price for its purchased products, and orders were allocated compared to the newly competitive US marketplace. NTT effectively managed the development effort and all suppliers worked to the same product development specification. As I explained in section 4.4, NTT operated a so-called *goso-sendan* (convoy) system for its equipment suppliers, which classified the top four equipment suppliers as (preferred) makers, and smaller or newer companies as second-tier suppliers, mainly for less technologically advanced equipment. NTT allocated market shares to its suppliers.

As fourth suppler to NTT, JTech had adopted a strategy to try to catch up with the top three suppliers by developing higher quality and higher reliability products, a classic "best product" strategy (Hax & Wilde II, 2001). Nevertheless, as JTech interviewees readily acknowledged, JTech's NTT products lagged those of its three main rivals across many dimensions, including quality, technology level, and price. JTech had to "catch up." NTT documentation did not describe reliability and quality, which were assessed in a totally different way to the US marketplace.

Because the installed (optical) fiber in Japan was higher quality than cabling in the US, NTT worked to a different standard from the US in developing its transmission equipment. This was known as synchronous digital hierarchy (SDH) fiber-optic transmission rates, which was also adopted by the European Telecommunication Standards Institute (ETSI). Yet, the Japanese version of SDH differed from the ETSI version of SDH. SDH was a derivative standard of SONET that was tailored to Japan and Europe, but compatible with a subset of SONET. In particular, at lower transmission rates, below so-called STM-1 (150 Mbit/s), SDH and SONET hierarchies are different. However, NTT was able to deploy SDH equipment ahead of the deployment of SONET in the US. It should be noted that before the new SDH series products were introduced to NTT in 1989, the earlier era of equipment was still synchronized equipment, but an earlier and superseded version of SDH.

The way of working with customers in the newly competitive US transmission equipment market was very different from how JTech worked with NTT in Japan at that time. In the 1980s, NTT would provide its top four suppliers with a very detailed product specification, following which it would negotiate a final product specification with vendors, and only then would JTech endeavor to negotiate a price with NTT. Agreeing the specifications with NTT might take six months to a year.

Unlike the US RBOCs or IXCs, NTT had its own technology research arm (NTT Laboratories), which liaised directly with JTech Laboratories. As a customer, NTT was very technology-driven. The laboratories within NTT had significant power in deciding the transmission equipment that was deployed in NTT's network. In contrast, the US market was much more customer driven, by the needs of the telecom service providers' end users, such as the RBOCs' large telephony service user customers.

Over time, as fundamental, or basic, technology within NTT and the activities of NTT Laboratories were cut back, JTech Laboratories was left needing to find its own research direction. It was from around the time of the completion of the development of the Terminal products that JTech Laboratories began to forge a more intensive relationship with the Transmission Division to find out how to do this. Put simply, JTech Laboratories needed to shift from reactive to proactive in planning new products for NTT.

However, just as JTech Laboratories now needed to learn from the Transmission Division and its US new venture organization how to plan new products, a further twist was that NTT also needed to learn from JTech's Transmission Division.

This was because, during the period when the SONET standards were being negotiated and settled in the US, NTT was under increasing pressure from threats of foreign and domestic competitor entry into a newly deregulating telecommunications marketplace in Japan. While JTech was only the fourth supplier to NTT, JTech's unique international experience and relationships meant that NTT needed it to establish the SDH specification in Japan ahead of worldwide carriers. There is no doubt that JTech's privileged position in these discussions was because of the fact that JTech had better connections than its other three leading preferred suppliers to the US, to other international carriers, and to the international standards' bodies that had been involved in establishing SDH and SONET. Especially, JTech appeared to have better international connections than NEC because of its international subsidiaries, particularly (at that time) its operations still formally under the US country subsidiary JAI's umbrella. For possibly the first time, JTech had a strategic advantage over its domestic competitors in Japan and was elevated to take equal status with NEC in discussions on standards with NTT.

The SDH standard having been more-or-less decided by the dominant market supplier NTT, the process of implementing SDH in Japan was more rapid than the evolution of SONET in the US. Even though SDH was derivative of SONET, JTech was able to develop SDH transmission products for Japan that were deployed ahead of SONET-compatible products for the US marketplace. Having developed SDH products for NTT, JTech transferred some of these technologies to the US market to be used in SONET products. These technologies were primarily optical technologies – especially lasers, filters, and receivers – and integrated circuit technologies (e.g., assembly). However, other core technologies specific to SONET and the US had to be developed from scratch for the US market, most notably the ring topology used in multiplexers. So, if we unravel the story, we can see that while JTech did transfer into the US marketplace some technologies that it had developed for NTT in Japan, in fact the origin of those technologies was the standards that JTech's Transmission Division had participated in developing in the US both directly and through its US new venture.

5.5 Strategy

The crucial strategic decision to start the development of SONET-compatible products within JTech was taken by agreement of all attendees in a joint meeting between the Japanese development engineers and the American product planning team held in Japan. There is a consensus among accounts of this meeting that it was the Japanese development engineers who proposed and argued in favor of developing SONET products as a next generation system.

While the decision to pursue SONET was reached by agreement, meeting attendees considered that responsibility for the decision lay with Mr. Matsuura[11], a development engineer who argued strongly in favor of SONET-compatible product development, and who went on to head the development engineering team in the Transmission Division's headquarters, in Kanagawa. Had JTech's entry into the SONET market subsequently failed, while there is little open ascription of blame in JTech, Mr. Matsuura would probably have felt most responsible for such a business outcome. In fact JTech's development of its Terminal and ADM SONET products as a program of work was successful.

In the key discussions in this crucial meeting, the American product planning team initially argued against developing products for SONET, preferring a strategy of developing a so-called "135 system" to compete with products currently available in the market, including from Rockwell International. The Japanese development engineers contended, however, that the 135-system market was already crowded and that it would be hard to compete in that space against companies like Rockwell. After much

[11] A pseudonym

discussion, the American product planning team was persuaded to accept the proposal of the Japanese development engineers to develop a family of products compatible with the embryonic SONET standard.

Upon further investigation, I learned that the Japanese development engineers had been closely monitoring the development of standards including both SONET (which defines DS-3 speed as 51.84M bit/sec) and a potentially rival standard known as Synchronous Transmission (SYNTRAN), which had been developed by AT&T several years prior to SONET. While Bellcore was promoting the SONET standards, a different group within Bellcore had been working on SYNTRAN, which was designed to synchronize the previous asynchronous system based upon T-3 (defined by SYNTRAN as 44.736M bit/sec) signals, to create what would effectively have been a synchronized asynchronous transmission system, SYNTRAN. For a while, SYNTRAN equipment, such as add/drop multiplexers, was developed and sold, although SYNTRAN did not become standard and the eventual standard, SONET, was not backward compatible with SYNTRAN equipment. What this does highlight, once again, is the very high degree of uncertainty that existed at the time, and an environment in which strategic choices were almost analogous to placing huge bets upon outcomes in the institutional environment that were still far from resolved.

It was in 1984 that Bellcore had proposed a new architecture for transmission, called SYNTRAN. Crucially, JTech was included in the group examining this proposed standard. JTech's contribution to this standards setting process was led by two key Japanese development engineers, Mr. Hayashi and Mr. Matsuzaki[12], who contributed knowledge on feasibility and on how to develop and manufacture SYNTRAN equipment, including building a prototype. JTech had initiated its involvement in the SYNTRAN standards setting, and it was the only Japanese company to be so involved. Through this, Bellcore came to rely on JTech, since it did not itself have a production division, being a research organization focused upon interoperability and standards.

JTech engineers estimate that this involvement with Bellcore on SYNTRAN at such an early stage gave it a lead of about a year on other companies when the standard was replaced by SONET.

A Japanese interviewee described the background to this crucial decision to develop SONET products as follows:

> "We ordered and chased after papers issued from academic associations and from Bellcore. Through this, Mr. Kanagawa, who is now in the Software Department, and I went after SONET and SYNTRAN at that

[12] Pseudonyms

time. SYNTRAN did not appear to have the logic or the fit for a next-generation system. So, we gave it up and focused upon SONET. While we were studying SONET, Ron Finch's group came and asked us to develop a 135 Mega (asynchronous) system for them. We argued fiercely about that and, since we had nothing to abandon [discontinue] in that market, we talked about attacking the market with a new product. The US-based product planning people did not object to that argument and they replied "Surely that is right, so let's do that." Ron Finch quickly agreed and as a result hired a group of people who were familiar with the requisite [SONET] knowledge."

At the time, there were few people with any knowledge the evolving SONET standard. JAI hired an executive who had the requisite knowledge and developed a product plan for what would be the Transmission Division's first SONET product, the TP 50/150 line terminal equipment multiplexer.

It will be recalled from the previous chapter that JTech had broken into the RBOC market with sales of its JDLC product to BellSouth and to Ameritech. For SONET-standard equipment, however, BellSouth was a later adopter, as it was concerned about problems of synchronization and with operations, administration, maintenance, and provisioning ("OAMP"). Neither was Ameritech in the first group of RBOCs to deploy SONET-compatible equipment, but was more than a year behind the pioneer SONET Phase I equipment purchasers, the RBOCs Bell Atlantic and US West.

The last chapter also described the JDLC development period as an important precursor to that of the Terminal products. This was primarily because JTech in Japan had learned to trust Ron Finch and his JAI Transmission Division product planning team, since the Americans had succeeded in getting JTech's JDLC local access product approved in the RBOCs BellSouth and Ameritech. This gave the Americans significant credibility within Japan and provided a platform for the next stage of the relationship between the Transmission Division's headquarters in Japan and its subsidiary, development of the Terminal products.

The Transmission Division in Japan and JAI had also learned about how to work with the RBOCs and their particular requirements during the JDLC development period. They applied this in planning and developing the Terminal products. A Japanese interviewee spoke to this organizational learning as follows:

"JDLC was the first equipment that we could sell into the RBOC marketplace. The RBOCs were very conservative at that time. They had their own specification. You could not fully understand that specification if you were not experienced in that marketplace. It is the same situation in

Japan in that if you are from overseas it is difficult to understand the NTT market characteristics from a foreign country. After we had entered the market, we could understand that specification. We could finally understand such things as the customer's way of using equipment. We were able to study this because of our presence in selling the JDLC product to the RBOCs. We could know this for the first time.

For example, take access products. Access equipment must operate at temperatures from –40 degrees Celsius to an upper limit of +65 degrees Celsius, a range of more than 100 degrees Celsius. We were able to introduce specifications such as this into our SONET products. In addition, we learned how to establish the necessary protocols between our communication equipment and the [RBOCs' network] management system and about delivery. RBOCs require quick delivery, so that access products, especially, must be delivered within 20 hours. We learned many such things. We incorporated all of this knowledge into the development of our SONET products, and the SONET 50/150. I think that there was much that we learned as output from our JDLC experience. Since we were a follower with our [JDLC II] and JDLC products we could not capture this access market. Nevertheless, I think that these products nevertheless provided an important base."

JTech was first to market and sell SONET transmission equipment, in the form of SONET Phase I compatible terminal multiplexers. JTech developed its first SONET standard compatible product, the TP 50/150 multiplexer, which was completed and available on the market in 1988. JTech's first customer was US West, who deployed this equipment in October 1988, although JTech did not have a volume contract with US West. JTech's major breakthrough was winning a two-year multi-million dollar deal from Bell Atlantic in December 1989 for the supply of the TP 50/150. A member of the Technology Planning Department at Bell Atlantic explained its decision for early deployment of SONET Phase I equipment as follows:

"We are serious about SONET and if a vendor has SONET Phase I product and will offer a Phase II upgrade at minimal cost or no cost, we will try it."

JTech's victory in winning the Bell Atlantic contract was a major blow to its competitor Alcatel Network Systems. In December 1989, only JTech and Alcatel – both MNCs with home countries in Japan and France respectively – had SONET multiplexer equipment available. They were ahead of AT&T and Northern Telecom, which were preparing to launch SONET products in 1990. Other vendors were waiting until the standards settled, and were likely to release products onto the market only in 1992, after SONET Phase II standards had been settled.

By March 1991, JTech was the sole supplier of SONET equipment to Bell Atlantic, with its TP 50/150. US West, likewise, had deployed JTech's TP 50/150 and higher-capacity TP 600 multiplexers for a year and had subjected them to technical and operational analysis.

JTech's strategy at the time was to get into the market ahead of competitors and to achieve SONET visibility, even with a product that did not have the principal ADM and ring features that RBOCs were ultimately seeking from the SONET standard. As an interviewee put it:

> "Once we introduced the 150 and the 600 we started development of the add-drop versions of the 150 ADM and the 600 ADM. So, we really never had any intention that those were going to be long-term products, but they got us in… They were the things that differentiated us. They were the products that allowed us to get into the market because they were SONET."

JTech's most important SONET equipment sales were these sales to these two RBOC customers, which together gave JTech an enhanced image and credibility among other prospective RBOC customers. These two sales were not straightforward, but they were crucial to JTech's subsequent success in the US marketplace.

An interviewee told me the story of how JTech had achieved the first SONET equipment sale in the US, to the RBOC Bell Atlantic:

> "We put a cost model together based on SONET because what SONET really allowed [the RBOCs] to do was to eliminate back-to-back multiplexing. We didn't have to take everything back down to its base bandwidth in order to pull out one circuit. And, that is what we had to do with asynchronous multiplexing up to that time. If you had 28 circuits coming through and you wanted to get one of them, you had to de-multiplex all 28 of them and then multiplex the other 27 back up into a higher rate again and ship them out. And, so it required back-to-back multiplexers. SONET allowed us to go in and pick off each one of those channels independently. And, we could show on paper that if you buy this product, we could eliminate half your cost for you in virtually every application. So, we started to get people's attention, and then the standard started to solidify a little bit more. And, we talked Bell Atlantic into taking a chance on buying our product, and the only way we were

able to do that was we had to give them a written guarantee that every time the standard changed, if it meant an equipment change, we would pay for it – that we would hold them harmless and we would protect their investment. Free upgradeability. And, then once that started to work a little bit, the word got out because the RBOCs were still very close knit at that time. Bellcore was still controlling their standards, so there was a lot of intercommunication, and pretty soon US West found out about it..."

JTech's second customer for its Terminal Age SONET products was US West. In his words, this is how an interviewee described the story of the first sale to US West:

> "This is kind of an interesting story. There was an engineer out there by the name of David Robbins[13]. And, he was kind of a maverick engineer. And he had a long-haul network that he wanted to put in between... and I can't remember the other location... and some other town out in New Mexico I believe it was. And, he had heard about Bell Atlantic buying these SONET products from us. So, he called me on the phone one day. And, I took a trip out there. And we met him in a central office – me and an engineer who worked for me by the name of Mike Belway[14]. And, Mike was with us until about a year ago when he left and became a President of an Israeli-based start-up here in Dallas. But, he was the guy who really architected the first SONET multiplexed product working for me.
>
> So, he and I got together and we got on an airplane and we met David Robbins in Denver, Colorado. We talked to him for about two hours, from 8 a.m. until 10 a.m. in the morning. And he, at that point, kind of abruptly interrupted the meeting. He said look guys, I am sorry, I apologize my daughter has got a kindergarten play that she is in. I am going to be gone for an hour or an hour-and-a-half. I will be back here and if you can give me a price for this product I will order two of them, one for each end of our network. And, I will get one-time approval for it.
>
> We hadn't priced this product for US West at all, so Mike and I basically came up with a price on a napkin. He came back. We gave it to him. He wrote us a purchase order right there on the spot. And, that was our first multiplexers that we sold in US West.
>
> They had a big heatwave out there not too long after that, and a bunch of their AT&T DDM-2000's failed in this heat, and our product continued to perform. And, boy, that was it. After that, the phone didn't stop ringing.

[13] A pseudonym
[14] A pseudonym

They couldn't order those things fast enough and we became the standard lightwave multiplexer product supplier. That was US West.. But, that was really how we got started in US West. And, it was just breaks like that.

And, once US West started using us and Bell Atlantic started using us, people started looking around and going: well, what is wrong with us? These two companies are using these guys, and..."

If JAI's Communication Division was a "Japanese subsidiary," we would be surprised to hear a story such as this, about selling to US West, because the Americans acted unilaterally and took risks. They bypassed usual procedures in that they did not seek prior approval from their Japanese manager for this crucial sale. Ron Finch and Mike Belway broke the rules and exceeded the scope of the discretion allowed in their positions. However, such actions are not at all surprising if it they are working for a new venture – and it was the new venture organizational identity that shaped the capabilities and actions that employees took in their everyday work.

Crucially, however, they subsequently gained the support of the senior Japanese management:

"We got into a lot of trouble. A guy by the name of Yurimoto[15] [with a sales background who went on to become President and CEO of the Transmission Division's US subsidiary] was here in charge of our business planning group at the time, reporting to Nakajima[16]. When I came back and told him what I did, he said: 'You had no right to do that. You had no authority to do that. I don't support that price. We can't support that price.' I said: '... I know for a fact that we are selling a product at approximately the same price to Bell Atlantic.' And, he goes 'Yes, but that is under market and we are just doing that as...' And, he had all these excuses why we couldn't afford... that we had no margins, that we were going to be negative margins with US West. I said: 'Look, I know we are going to cost reduce this thing.'

And, so, we got into a big controversy over that. But, ultimately Nakajima again supported me. I said, 'Look we are after market penetration here. We need to do something to get ourselves into the market.' And, Nakajima supported me. We gave him the price and subsequently... In fact that system is still in use out there today. But, subsequently we got the cost down and it all worked out. But, that is basically what happened."

[15] A pseudonym
[16] A pseudonym

The new venture identity influenced, it seems, even the pricing strategy adopted by the Transmission Division's US organization.

Turning to the US new venture's relationships with other organizations in its organizational field (DiMaggio & Powell, 1983), JTech's Transmission Division and JAI's Communication Division had adopted a strategy of actively engaging with a wide range of actors, including competitors, to which it told stories to craft its organizational identity and seek out conferral of legitimacy and gain the resources (Lounsbury & Glynn, 2001) necessary to succeed in the new SONET world.

There was no more effective way of symbolically and practically showing strong commitment to openness (interoperability of equipment) than collaboration with competitors. Additional motivation for such showcasing of interoperability was that some RBOCs, including Nynex, were seeking to purchase an entire range of products and were encouraging suppliers to cooperate. For example, soon after completion of the development of the Terminal products, in May 1990, JTech and Alcatel – a key potential competitor in the multiplexer market – demonstrated a SONET mid-span meet between their SONET Phase I TP 50/150 and TM-50 multiplexers, respectively, at an industry showcase at the Contel Technology Center in Chantilly, Virginia. At the same event, JTech showed compatibility between its then two-year old SONET Phase I TP 50/150 multiplexer and AT&T's SONET Phase II DDM-2000. JTech also collaborated with suppliers of complementary (non-competitive) equipment, such as in the March 1992 Baltimore WAVE '92 conference test of a SONET mid-span meet between JTech's TP 50/150 multiplexer and the Titan 5500 digital cross-connect from Tellabs Inc.

The RBOCs were also testing and demonstrating interoperability of equipment, such as Bell Atlantic's WAVE '92 demonstration of a fiber ring connecting the SONET equipment of Northern Telecom, JTech, Alcatel Network Systems, AT&T, and NEC. NEC's SONET product appeared to have technical deficiencies and was rejected early on by carriers such as Nynex, while Nynex accepted JTech's equipment. This was despite the fact that NEC Transmission Systems in the US was working with Northern Telecom and AT&T Network Systems to complete standards both for line-switched rings and for interconnectivity of path-switched and line-switched rings (see Chapter 6).

5.6 Organizational Structure

The organizational structures that JTech put in place to implement its strategy were again shaped by JTech and the US organization's identities and by the capabilities that they had, including the capability for dispersed development across networks of subsidiary organizations. This was especially important in developing the Terminal products, for which hardware was the most significant development activity.

It will be recalled from the last section that the intention of Bellcore was that the early SONET standards would fix the hardware element (so-called Phase I SONET) to which Phase II SONET functionality could be added by software. In fact, the subsequent SONET releases did require some changes to hardware, mainly to the large-scale integrated circuits (LSIs), but the bulk of the development effort was in firmware (software embedded into hardware) and software.

Indeed, the most significant component of the development effort on the Terminal products was hardware development. The specification of the Terminal products was both different from, and much more challenging than, the specification of products developed by JTech in Japan for NTT or other customers in the home country, Japan. JTech's Terminal products were based upon two key hardware technologies that were not required by NTT or other Japanese customers. Together with a brief background, these were as follows:

20,0000-gate ASIC to satisfy space constraints.

Transmission equipment developed to the SONET standards in the North American market had to be housed in 23-inch (58.42 cm.) wide racks of standard height shelves. This modular rack design was SONET-standard, enabling telephone carriers to mix and match multiplexers from multiple vendors. This compared with the so-called INS specification 60 cm. wide bays used to house NTT transmission equipment and 19-inch (48.26 cm.) width transmission equipment housing used in the European Telecommunications Standards Institute (ETSI) markets of Asia (excluding Japan), Europe, India and Russia.

Relative to products developed for NTT, the new SONET products had to be more compact for three reasons. First, the NTT system products had a wider housing compared to SONET specifications. Second, NTT's use of bays meant that transmission equipment supplied to NTT did not have the same height constraints as the SONET standard. Third, in transmission equipment supplied to NTT, the optical module is positioned at the rear of the system on a shelf, and is accessed through what is known as the 'back bay' by fixed-length straight optical cable. Different to this, in North American SONET equipment, the optical module is positioned at the front of the system placed on a shelf, and the optical fiber connection takes up more space because it is coiled inside the equipment. This coiling enables operators to pull out various lengths of cable connecting to the optical module, as needed.

The effect of this was that, while multiplexers supplied to NTT were based on 10,000 gate application-specific integrated circuits (ASICs), because of the different widths, shelves/racks versus bays, and the design and positioning of the optical module in the US SONET specification, SONET Terminal equipment supplied to the North American carriers had to be developed based upon 20,000 gate ASICs. This was a huge, very compact ASIC in the mid to late 1980s.

Laser diode module to satisfy North American temperature constraints.

As I discussed in section 4.4, NTT's transmission equipment was housed in air-conditioned central offices, while the RBOCs' transmission equipment was installed in non-air conditioned boxes located some distance from the RBOCs' central offices. For this reason, the SONET standard specified that the 150-megabit laser diode module developed for the North American had to operate within the temperature range of between –40° C. and +85° C., a required environmental maximum temperature of +65° C. plus 20° C. for inside the cabinet. This was a far more exacting temperature specification than that required by NTT.

Figure 5.1 shows the organizational structure between Japan and the US within JTech during the period of development of the two Terminal products, the TP 50/150 and the TP 600. The organizational structure changed during the development of the SONET Phase II functionality ADM products (see Chapter 6), in which JTech added Phase II functionality to its successor ADM family of multiplexers, through principally firmware and software development.

The placement of a thick dividing line between the US and Japan in this Figure is to emphasize the separation (non-integration) of activities between the two countries. Moreover, such a separation existed between designated departments within the US and within Japan. Market research, sales, and product planning were based in the US, with development dispersed across Japan. The control and management of development in Japan was handled by the Transmission Division's Kanagawa headquarters, which also took direct responsibility for unit backboard design and part of the hardware design. JTech in Japan relied upon Product Planning in JAI's Transmission Division for product specifications, based upon the emerging SONET standards and customer requirements. JTech in Japan had no direct information on customers' requirements

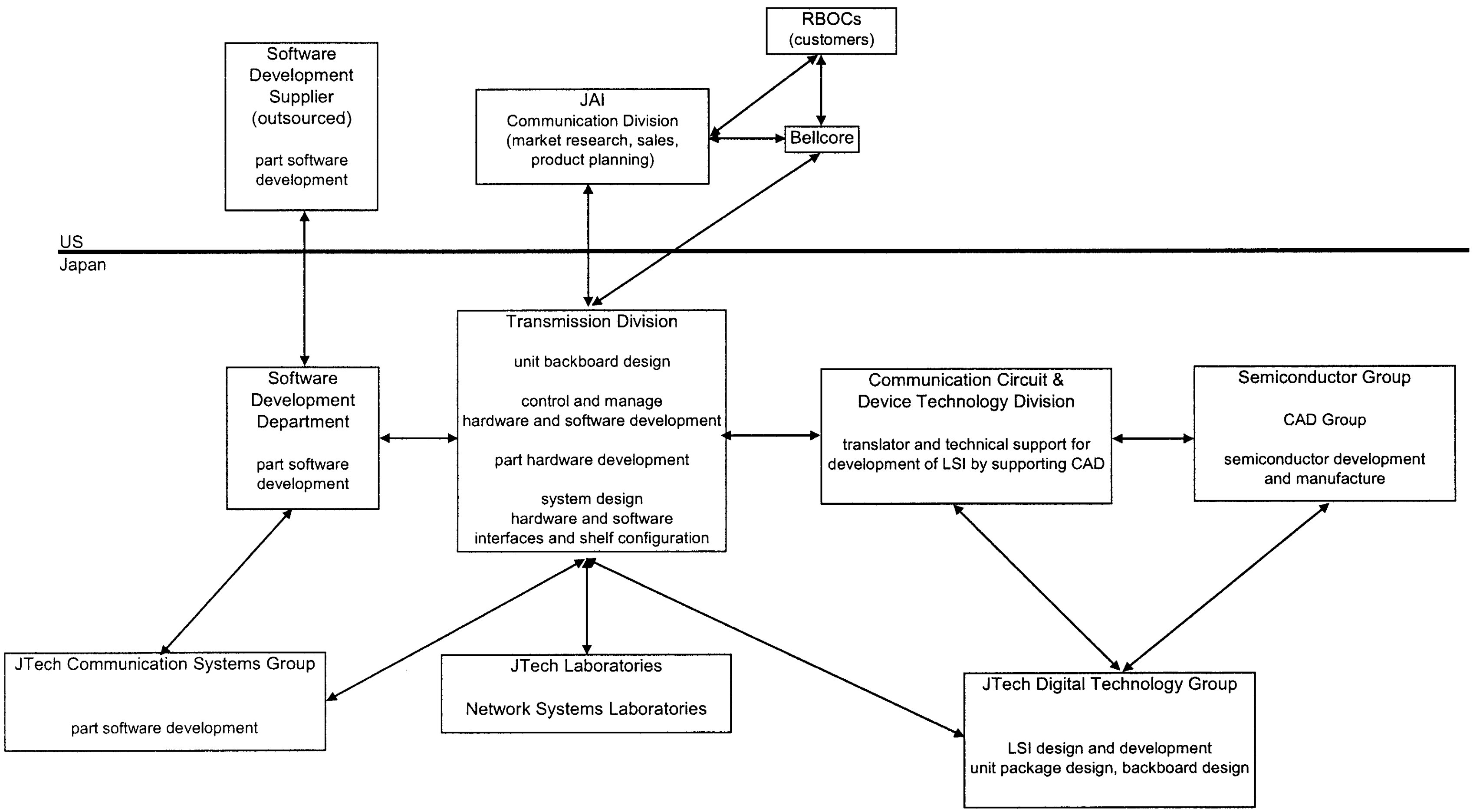


Figure 5.1: Organizational Structure for Development of "Terminal" Products

During the development of the Terminal products, the new Product Planning group under Ron Finch at JAI's Transmission Division took responsibility for working with RBOC customers. Based on a comparison of how Transmission Division worked with NTT and with customers in the US, a Japanese interviewee with experience of working both on NTT and US customer requirements considered that there was an important advantage in the clear separation between product planning in the US and Development in Japan in the case of developing products for the US marketplace.

Ron Finch explained this as follows,

> "In this case, the US Product Planning Group doesn't need to consider how difficult it is to develop, how complicated, or how... so they simply request to JTech to develop this product, and this... so I think this role is separated, so they focus upon the question of 'What is an excellent product?' If they had to talk with the customer, design, and test, they would be very busy...
>
> In Japan, there is a tied relationship with NTT, so the engineers are able to think more widely about testing, about many things. In the US, the product planning group has a clear mind – it just focuses on customers and competitors... We were only successful in SONET product because the product planning group strongly requested us to develop this faster than competitors. So, we developed this by very hard work, and worked through the night on many occasions.
>
> Ron Finch strongly requested us to develop this product, otherwise we would never succeed in the US. So, Mr. Matsuura agreed with him to develop hard in that case. Never abandon, or give up, this product. It was a very, very difficult situation – a small number of engineers, small budget, and very difficult technologies. But, he promised Ron Finch to develop by then, the delivery date. But, actually we could not develop fully the system, but we sent part of the system to the customer. At that time, the product planning group negotiated with the customer to get more time to complete the system. This was very good support for us. They negotiated very hard. If they received many complaints from customers, they never told us. This was the trust that existed between JNC [a later name for JAI's Communication Division] and JTech at that time."

Some Japanese interviewees recalled, however, that they had been concerned that "the US side" had not considered how seemingly small design changes sent to development engineers in Japan by product planning resulted in very substantial revisions to product architecture.

Much of the hardware development work on the Terminal Products was carried out by the domestic hardware development subsidiaries within JTech Digital Technology Group ("JDTG") and distributed across Japan. JDTG was responsible for some 80% of the ASIC design work on Terminal Products. However, the Transmission Division had established a separate division, known at the time as the Common Technology Division, to act as an interface group between it and the hardware development teams. The Common Technology Division is shown on Figure 5.1 by its subsequent name, Communication Circuit and Device Technology Division (CCDTD), which is part of Transmission Division. While the Transmission Division in Japan had a direct relationship with JDTG, it was supported in this relationship through CCDTD. The need for this interface group within hardware development within Japan contrasted with the absence of any need for an interface group between product planning in the US and development engineering in Japan.

While the cross-border relationship between the Transmission Division in Japan and its US organization in the development of Terminal products was generally without tension and very effective, cross-boundary collaborative relationships within JTech within Japan were more mixed in outcomes. For hardware development, the Transmission Division in Japan had to collaborate both with JTech's Semiconductor Division, as well as with its dispersed network of hardware development engineering subsidiaries across Japan.

Turning, first, to the relationship with the Semiconductor Division, interviewees in Japan described CCDTD's primarily role as being to act as a 'window' on the Semiconductor Group, because the Transmission Division did not have much expertise on semiconductors – which is interesting because neither did the Transmission Division have much expertise on product planning but no window was deemed necessary on the US. CCDTD had two additional roles – to liaise with JDTG and to assist in design, especially of the laser diode module.

Although it was the Transmission Division that had set up and controlled CCDTD, there was some conflict between Transmission Division headquarters and CCDTD. At the time of the development of the Terminal products, 20,000 gate ASICs were uncommon, although gate densities have since increased substantially to well in excess of 100,000 gates. They had not been extensively used in applications before. There was considerable resistance within the Semiconductor Group and CCDTD to using this technology, which they considered to be experimental. Probing suggested that the issue may have been that the Semiconductor Group preferred to allocate development resources to developing technologies for computers, for which the scale of demand was far higher than for the most custom-built ASICs for the Transmission Division that would only ever be manufactured in relatively small quantities.

The relationship between the Transmission Division and the Semiconductor Group was generally good, but two factors caused some strains after the basic Terminal product architecture was decided. First, additional information on customers' demands was continuing to be transferred from JAI's Communication Division in the US to the Transmission Division in Japan, whereupon the architecture had to be reconfigured, which caused delays to the schedule. Second, the computer-aided design (CAD) system was not very effective, which added to the delays in the completion of the LSIs.

JDTG was responsible for LSI design and development. The relationship between Transmission Division and JDTG was very smooth, evidently for three reasons. First, JDTG had been established by the Transmission Division and both were committed to development of transmission technologies and products – whereas the Semiconductor Division had a far wider scope of responsibility (e.g., developing devices for computers). Second, the Transmission Division and JDTG had a history of collaboration that preceded development work on SONET products. Third, Transmission Division involved JDTG in the earliest stages of the project, when the Terminal products were at the initial stage of development.

At this early time, Transmission Division gathered all the key engineers in Kanagawa, dedicated a project room to SONET, and set up study meetings there, attended by JDTG engineers and managers. Many JDTG engineers came from Tochigi, some 120 kilometers away; they lived near to the Transmission Division's headquarters in the Kanagawa area for up to two months during this early project stage. Japan-based interviewees stressed that the communication between Transmission Division and JDTG was not just at the same level, but across levels. For example, Mr. Matsuura headed the development team in the Transmission Division but spent much time communicating with lower level JDTG employees. Considerable effort was spent in Japan resolving conflicts between the demands of BU headquarters, fed from the US product planners, and the resources available in the distributed development centers across Japan.

Software development work was managed through another 'window,' Transmission Division's Software Development Department ("SDD"), shown on Figure 5.1. SDD subcontracted most of the software development to an associated software development company based in New Jersey, USA.

Development of the key technologies in the Terminal products was technically difficult and there were many design changes that had significant implications for the development. A Japan-based interviewee recalled his experience of hardware development this way:

"SONET was very difficult at that time. We had to tackle such things as how to increase the counter and the pointer action and other asynchronous functions. When returning from an address to the origin we had a very difficult time incorporating this return function within the LSI, because it was difficult to simulate the dynamic actions of LSI. We failed at this seven times. Usually, in such cases, we would let the responsible team for such problems get on with it. However, in this case, we did not do this. Mr. Matsuura, Mr. Takabayashi, Mr. Furuta, [all from Transmission Division headquarters] and others gathered at Tochigi[17]. We discussed and found a solution to the problem. Anyhow, with everybody working to fix problems such as this, we made teamwork. I think that it was teamwork that did it. In those days, when we simulated an LSI, the output was by line printer and the simulation result used a lot of paper. The volume of output from the M780 mainframe computer was enough to fill a small truck. We reviewed the output and discussed what was wrong with the results. It was a huge LSI at that time. That is why, even today, people who worked on it remember that we remade the LSI seven times. Seven times, and it made me want to cry. Sharing the M780, it took around five days for the computer to generate the answer from one LSI simulation. Mr. Matsuura asked Mr. Morita[18] [head of the Transmission Division] to buy an M780 mainframe computer at that time, since it was terrible unless we did so. We argued with the CAD Group a lot on account of this being so very slow, 'Why is this thing so slow?'

The M780 mainframe computer was high-end. After the engineers had entered the job into the computer, they could not do anything for five days. This doesn't seem terribly efficient, does it? We had to share the M780 at Tochigi at that time. That computer had to handle various other work in operations, such as production planning and MRP, in addition to our LSI simulation jobs. While the LSI simulations were running, there was no answer for a week. During this time, other work came to a halt. Since this kind of situation was so bad, Mr. Matsuura negotiated the procurement of another computer. Senior management understood very well our needs for this kind of tool. Mr. Morita, who later became Executive Vice President [of JTech.], accepted Mr. Matsuura's request. I think that everybody in JTech was very cooperative."

The smooth and effective relationship between product planning in the US and development in Japan, and between the Transmission Division in Kanagawa and its

[17] These personal names are pseudonyms

[18] A pseudonyrn

distributed Japanese development locations was complemented by strong links to customers and to the standards-making bodies. Interviewees suggested that the success in these relationships was a source of significant relative advantage compared to Northern Telecom and Rockwell International.

Another result of the organizational structure that reflected the organization's new venture identity was the competitive advantage that came from the willingness of the development engineers to rapidly and flexibly respond to numerous design changes. An excellent example of the importance of this came from the need to make design changes to the row formatting midway through LSI development.

JTech in Japan was midway through LSI development based upon a 13-row format, when this was changed to a nine-row format at an important standards–setting meeting in Seoul. Northern Telecom and Rockwell International were developing their products to an earlier version of the standard, known as the 13-row standard. When this standard changed at the Seoul meeting, following pressure on the international standards body CCITT (see section 4.2) from the European standards-setting body ETSI (see section 5.4), for whatever reason Northern Telecom and Rockwell International evidently failed to change the specifications of their products.

JTech, on the other hand, made the design change so that, on release to the market, the Terminal products met the actual standard. In the words of a Japanese interviewee recalling this development:

> "Regarding the 13-row and nine-row story, at first everyone was working on the basis of 13 rows. Indeed, we ourselves also started with a design based upon 13 rows. However, maybe halfway through our progress on the LSI, it was changed to a nine-row format at the Seoul meeting. From our perspective, if we had to change that was fine. We changed. At any rate, when there were modifications to the design, our attitude was to follow them. Mr. Matsuura was constantly telling us, 'When there are changes, change the design. If you make a mistake, fix it quickly. Nothing can be done about mistakes. If we make a mistake, we respond and fix it quickly. In places where we go wrong, we must respond effectively to these mistakes, as it is pointless getting anxious over it, so we should just fix it. When our customers express some dissatisfaction, fix it quickly.' Mr. Matsuura kept on saying. 'Fix it quickly.'"

A further important contributing factor to the development success was the supportive relationships among the senior executives. Mr. Matsuura was head of the development team at Transmission Division headquarters in Kanagawa. He reported to

Mr. Fujimoto, who in turn was under Mr. Morita[19]. In the US, Ron Finch was Director of Product Planning and reported to the Senior Vice President of country subsidiary JAI's Transmission Division, Mr. Nakajima. The central tripartite working relationship at a senior management level in day-to-day strategic decisions was among Mr. Nakajima, Mr. Ron Finch, and Mr. Matsuura. However, their work received more senior level support in Japan from Mr. Fujimoto and Mr. Morita. In the opinion of the American executives, it was the trust among members of this personal network of relationships that was crucial to the success of the US business.

Several US interviewees talked about just how much the Japanese executives with responsibility for the development of products for the US went out on a limb in Japan, deliberately breaking rules, to develop the US business. The Japanese executives were locally responsive – to use the language of Prahalad & Doz (1987) – to the North American marketplace in two ways, first to customers' requirements and, second, to American work and human resource management practices. The Japanese recalled many occasions when senior Japanese executives and engineers argued with their Japanese colleagues in support of positions held by the American executives.

The American executives gave a lot of credit to their Japanese counterparts for the success of the US business for this reason, as the following comments indicate:

> "I mean historically we can look back in retrospect and say it worked very well. I think that there were three key pieces to the model. One was Matsuura, my counterpart in the development side in Japan, and Nakajima. And, together, I think number one is that Matsuura and I became very good friends and developed a mutual admiration I think for each other, and Nakajima supported me against public opinion in Japan. And, I think that the thing that enabled that was that he was at an age that he didn't have to play the games… he wasn't climbing the corporate ladder any longer in JTech. So, he was able to take positions that were unpopular. He supported me and we were able to accomplish things. So, I think that he gets a lot of the credit.
>
> I think that Matsuura deserves a lot of the credit because, ultimately, he was the guy that developed the products that I was writing specifications for over here, saying that, 'If you can make this box this size, paint it this color, and incorporate these features on it at this cost, I can go sell it and I can sell it to these customers.

[19] These personal names are pseudonyms

> Matsuura supported me from the development side. He was willing to go develop the things… For example, one of the big issues was connectorized back planes. I told these guys early on that everybody was wire-wrapping back planes. And, I said that is very labor intensive and you are dealing with a bunch of outside craft people here who don't know to do wire wrap terminals. We need to do 25 pair press fit connectors on the back plane and allow these guys to plug cables into the back. And, that was a very new concept and nobody wanted to do that. But, Nakajima agreed with it and finally we convinced Matsuura and we developed it and it was very successful. It was one of the things that really differentiated our product."

Finally, in contrast to the clear line separating product planning in the US and development engineering in Japan, Figure 5.2 illustrates the institutionalized and embedded pattern of personnel transfers that supported cross-functional integration between different organizational subunits within JTech in Japan. Two key constraints on this pattern were the speed of technology development and JTech's relationship with NTT. It was into this development cycle that development engineering on products for the different specifications of the US market had to be accommodated.

At the time of development of the Terminal products, the underlying bit rate (the number of units of data transmitted per unit of time) in telecommunications would quadruple every three years or so, for bit rates over 150 Mb/s. Hence, the TP 600 was roughly four times faster in transmitting data than the TP 150. This translated into the organization and the institutionalization of development cycles as shown in Figure 5.2 below.

Figure 5.2 shows that, following two years of research by JTech Laboratories, some engineers would move from Transmission Division during the third year to develop a prototype, which would be followed by two years of field trials with customers. At the end of the five-year period, the Transmission Division's engineers that had moved to JTech Laboratories after the second year would move back to the Division, accompanied by some researchers from JTech Laboratories. The transferred researchers would stay in the Transmission Division for the rest of their careers, initially working as project managers developing a commercial system from the project that they worked on in JTech Laboratories and which they accompanied in the hand off to the Transmission Division. In addition, at the end of the third year, two researchers would be assigned to start research into the next (four times faster) technology.

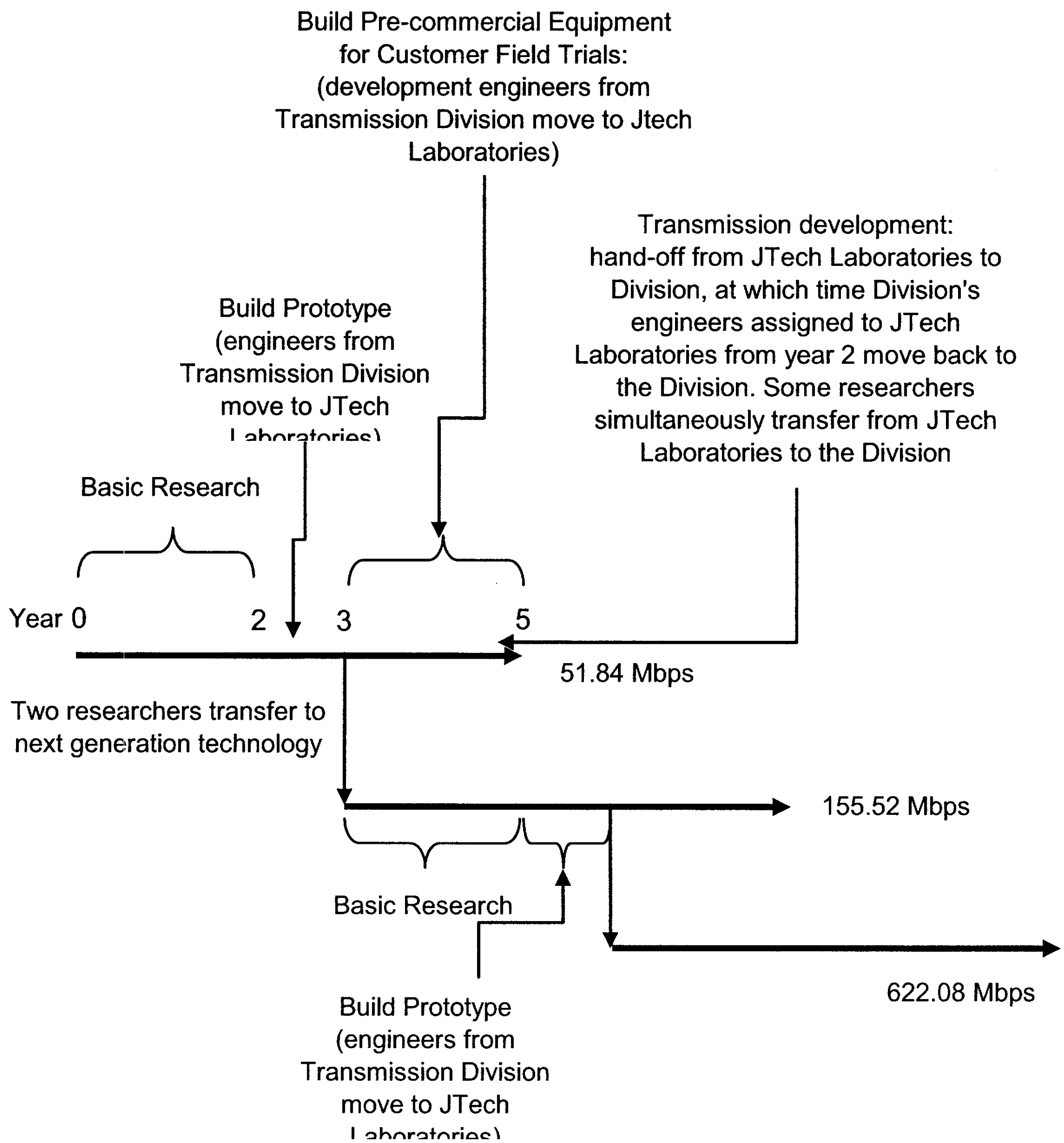


Figure 5.2: Managing Advances in Electrical Communication Technologies

This five-year development cycle had become institutionalized during collaborative work while JTech Laboratories and the Transmission Division were working with NTT. At the time, NTT itself had a strong research arm in NTT Laboratories, and the relationship between JTech Laboratories and NTT Laboratories was very close. NTT Laboratories played a strong role in developing new technologies, often requesting specific technological research. In contrast, as I have said, the North American RBOCs had little or no research activities in the underlying communications technologies. They needed to replace a reliance on Bell Laboratories if they were to change equipment vendor from Western Electric (Lucent Technologies).

The development of the Terminal products involved the commitment of massive development engineering resources by JTech's Transmission Division in Japan, across its network of development subsidiary organizations. It was not only the amount of resources that were involved that was indicative of a high-risk strategy, but also the fact that there was a high degree of uncertainty over definitions of the evolving SONET standards. That the Japan side made the strategic decision to invest in SONET speaks to the identity of the Transmission Division in Japan at that time, which was clearly itself acting in a highly entrepreneurial manner. The Division was also willing to flexibly and rapidly respond to critical changes in the emerging SONET standard, such as the shift to a nine-row format.

While the development resources committed to the Terminal products would in any case have been necessary to develop the higher-functionality ADM products for the US marketplace described in the next Chapter, which products contained ring protection topologies subsequently introduced by NTT East and NTT West, there is no evidence that this commitment to development for the US marketplace was a stage in some longer-term strategic plan to develop and adapt technologies and US products for sale to NTT at a later date. When JTech's Transmission Division did eventually persuade these two Japanese local telecom service provider customers to adopt ring topologies, it was only after a substantial marketing effort including explaining the advantages of ring topology networks to its relatively uniformed Japanese customers. Furthermore, in any case, the ring topology network equipment was of no value to JTech's long-haul telecom customer NTT Communications, which had a mesh network that – while inferior to a ring topology – did largely obviate the need for a ring topology network (see Section 7.2).

While JTech Japan placed huge bets on developing technologies to an emerging standard, the Transmission Division's US organization only achieved its first critical sales to US West and to Bell Atlantic and– different from its JDLC customers BellSouth and Ameritech – because of the unilateral commitments made by the US executives. They committed JTech to providing full and free upgradeability and achieved their first sale to US West through pricing up "on a napkin" while the customer went to collect his child from kindergarten. Then, in a heatwave, having learned to develop products to extreme temperature tolerances not required by NTT – which equipment was housed indoors – JTech's equipment continued to function effectively during a heatwave while that of AT&T failed. The nonoverlapping design of the organizations involved in developing the Terminal products was successful in that it did not undermine the organizational identity as a new venture claimed by the North American organization. While the parent made the call to develop the Terminal products, the decision was supported by the Americans. That the Transmission Division in Japan was also acting in a highly entrepreneurial manner seems to have worked to strengthen the new venture idenity claimed by US organization members, since it was behavior that was opposite to what would have been expected from other Japanese parents.

6 ADM Products' Development (1989-1993)

6.1 Introduction

The primary focus of JTech's North American business for the period from 1989 through 1993 was development of the ADM multiplexers, which would incorporate the additional SONET features that were especially valuable to the RBOCs, including ring protection in addition to the ability to add/drop transmission signals. There remained, however, very significant uncertainty and ambiguity over the definition of the standards of various product components, so JTech and its competitors had to decide whether and how to make product specification decisions in advance of final standards' definitions. Much of the added functionality of the ADM products over the earlier Terminal products was the result of firmware and software, rather than hardware.

During this period, a number of external and internal changes led organizational members to question the internal corporate new venture identity that had been salient during the development of the JDLC and Terminal product families. Externally, the available external model of the new venture in the North American corporate environment changed, especially after the 1987 Stock Market downturn (Chesbrough, 2000) from when interest in new ventures generally waned. Second, the way that the SONET standard architecture had been enacted by vendors, with vendor proprietary software controlling only their respective equipment, had the effect that in fact the RBOCs could not mix and match among different vendors' equipment, but were locked in to a vendor in a way that seemed to be reminiscent of the earlier pre-SONET era in character, if not in degree.

There were also internal stresses on the earlier internal corporate new venture identity, especially the increasing headcount of the organization, its greater emphasis on development engineering, and the move to a newly acquired 100-acre campus. These further challenged the feeling amongst organizational members that they were a new venture. The transfer to the Presidency of the newly named JNTS, as the North American organization was to be known from 1993, of the key Japanese development engineer who had led the earlier JDLC and Terminal product family development efforts in Japan aligned with the expansion of development engineering in the US to focus JNTS employees on the role that their organization had assumed as a development engineering organization.

The expansion of JNTS's development engineering activities outside Japan combined with the reputation it has for being innovative as a new venture to enable JNTS to expand its recruitment of key top-level executives. Almost all of these key hires were personally known to existing executives, with whom they earlier been colleagues, and so recruitment was largely through deep networks. As the new senior executives were brought in, they were given lead responsibility and control over particular activities within the US organization, such as Sales & Marketing (Business Management), Development, and Product Planning. Even the language at the Texas facility spoke to differences among these activity areas, which were referred to as separate "organizations," for example, "the Development organization." These internal JNTS "organizations" were spread across different parts of the new Texas headquarters, separated by long corridors and on different floors. The pattern of dispersion of activities within the Texas facility was at least analogous to the dispersion that had characterized so much of JTech's organization, such as its domestic networks of subsidiaries. It was as though the separation and physical distance within the new campus was being used to maintain smallness and distinctiveness, to preserve the feeling of JNTS members that they worked for a new venture.

One of the effects of these changes was an increase in formalization of the means of integration, especially across borders, largely to respond to the increased scale and scope of interaction and to reduce misunderstandings. In these new circumstances the claim of a new venture identity by JNTS proved more difficult to sustain, and the development engineering role identity emerged almost to support the new venture identity and to avoid reversion to the (still maligned) identity in the environment of what it meant to be a "Japanese subsidiary."

Almost perversely, the organizational changes put in place to cope both with the strategy of developing ADMs, as well as with the success-led growth of the US organization based upon its earlier organizational capabilities and identity as a new venture, seem to have undermined this organizational identity that had been the basis of the earlier success of the North American business. It was with the development of the ADX products described in the next Chapter, especially, that the role identity of development engineering organization was most strongly enacted, underpinned by JTech's ability to hire good engineers on account of the job sharing practices that JTech had learned in Japan and that had evidently been transferred and adapted to the US context.

6.2 The Enacted Environment

In Chapter 5 (sections 5.1 and 5.2) I explained how synchronous optical network (SONET) standards were being negotiated and gradually introduced into the US transmission industry, as the industry giant AT&T, hitherto provider of proprietary systems through its Western Electric equipment provider, was broken up. This process was fraught with both ambiguity and uncertainty for potential transmission equipment suppliers, including JTech. The RBOCs considered that the greatest value from SONET would come when they incorporated what was known as SONET Phase II standardized features – that were missing from JTech's (Phase I SONET standard-compatible) Terminal products. Most notably, it was envisaged that features designed to provide Phase II SONET functionality would have two advantages for telecom service providers.

First, they should enable the RBOCs to reduce their equipment and operating costs, for two reasons. On the one hand, interoperability held out the promise of mixing and matching equipment provided by different vendors in a competitive marketplace, based upon a standardized signal hierarchy. It was this add/drop functionality that was the early motivation of SONET standards' development. More than this, however, ADMs should allow the RBOCs to add and drop part only of signals in add-drop multiplexers ("ADMs"), with the remaining traffic passing straight through without additional processing.

Second, ADMs should allow the RBOCs to increase revenues by offering more reliable, higher value services to their customers. Phase II SONET achieved this by setting out standards for a ring architecture and ring protection of signals. This became more important during the 1980s, both because of a few noted signal 'outages' due to fires and other disruptions to carriers' services, and as data transmission grew in importance as a proportion of traffic carried through the carriers' networks. For example, Unisys had its order entry and inventory control systems concentrated in a single center and had signed a five-year contract with the RBOC US West to obtain the benefits expected from the higher reliability services offered by SONET Phase II equipment.

So, ADMs products differed from Terminal products in that they provided this add/drop capability and incorporated ring protection architectures. ADMs varied by speed, in part dependent upon whether the product was to be deployed in the local access, inter-office, or long haul sections of the transport network.

The significant added value from ADM products to the RBOCs' customers led to a huge increase in demand for these new products. To try to secure sufficient products to offer their customers, the RBOCs began to practice so-called double- and triple-booking. This is more common in the semiconductor industry, but occurs when equipment manufacturers doubly or triply book the quantity of parts that they actually require. Buyers will do this if they foresee shortages, and the practice typically inflates contract prices. When lower actual orders materialize, there may be a steep price fall. This was very different from the environment of inventory management that existed in Japan, in which NTT allocated orders to its suppliers through the power it enjoyed as the dominant single purchaser of transmission equipment. It was in the context of these two different environments that two specific and major inventory management problems arose between JTech in Japan and JNTS in the US, in 1993 and 1999, with the earlier of the two requiring JTech corporate headquarters in Japan to bail it out of what would otherwise have been certain bankruptcy (see Section 6.6 below).

The incorporation of ring protection created additional uncertainty that affected both equipment vendors' product development strategies as well as RBOCs ring-capable ADM deployment strategies. There were three dimensions to this uncertainty.

First, there was a great deal of uncertainty over which ring architecture to deploy in Phase II SONET products, even as late as mid-1991. Path-switched (unidirectional) rings required no new standards work, but line-switched (bidirectional) rings required new SONET protocol standards. Line-switched rings had efficiency advantages for providers, in that they allowed bandwidth reuse, and for this reason line-switched rings were generally considered a preferred option for longer-distance, interoffice traffic.

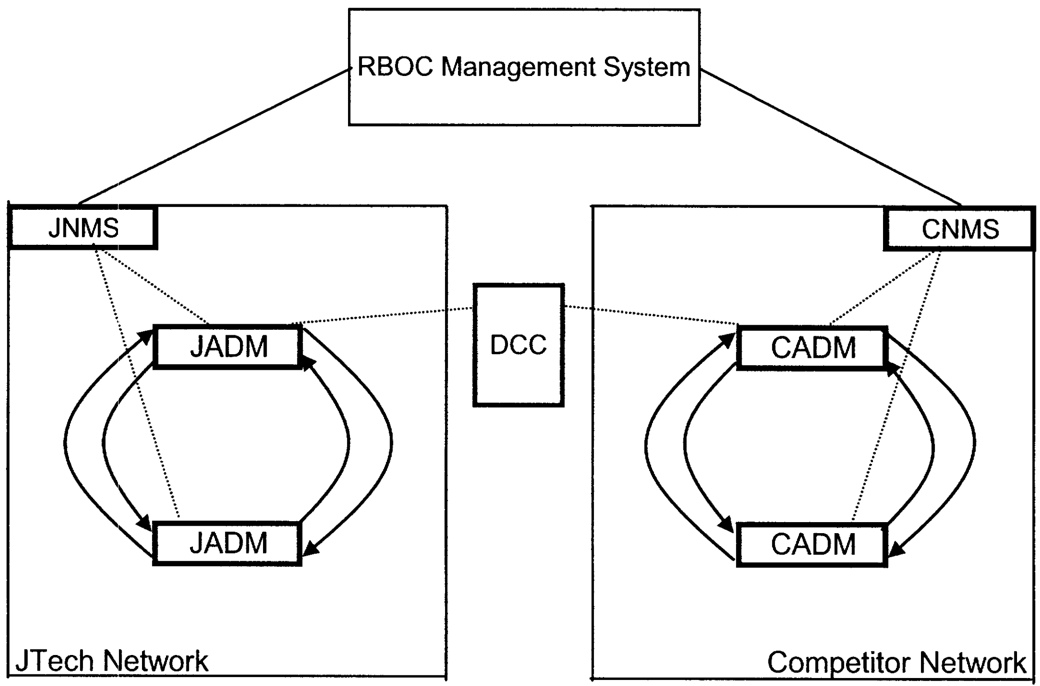
Most industry participants appeared to favor path switching in the local access portion of the network. However, there was disagreement. For example, the RBOC US West, JTech's Terminal products' customer, was a strong proponent of deploying line switching, even in the local access portion of its network. On the other hand, the RBOC Nynex was arguing in its contributions to the ANSI T1X1.5 Standards Subcommittee that path-switched rings would be more economical than line-switched rings in many interoffice applications.

Second, the evolving standard was unclear. Bellcore Technical Advisory 496 had opted for path-switched rings, even though the view of Bellcore at the time was that multiple types of ring products would emerge. However, ANSI's T1X1.5 Standards Subcommittee letter ballot in late 1992 deviated from Bellcore's Technical Advisory 496 and proposed standardizing bidirectional line-switched rings. By then, many vendors, including JTech, had already developed products based upon path-switched rings.

Third, additional complications arose from the need to interconnect disparate types of rings and there was disagreement on whether two-fiber or four-fiber architectures would be more efficient. Some carriers, such as Ameritech, preferred the additional robustness of protection from four-fiber line-switched rings. Other carriers preferred the cheaper option of deploying a second two-fiber ring. These differences principally reflected, first, variation in the degree to which RBOCs' own customers were demanding higher reliability of service from SONET ring protection and, second, variations in the threat of entry into RBOC local markets by CLECs.

There was also a more subtle issue in relation to SONET that some vendors, at least, would have been aware of, which would continue to give them some market (pricing) power even after SONET had been introduced. While SONET provided standard transmission rates and promised interoperability among different vendors' transmission equipment, in fact SONET could not provide complete interoperability across vendors' equipment. The reason is that equipment vendors, including JTech, had proprietary network management software that was required to operate their respective families of multiplexers.

Figure 6.1 below shows indicatively how JTech's network management software (JNMS) would have be used as a graphic user interface to manage an all-JTech equipment ring of linked ADMs.



Legend:
JNMS: JTech Network Management System
CNMS: Competitor Network Management System
ADM: Add-drop multiplexer
DCC: Digital cross-connect
JADM: JTech add-drop multiplexer
CADM: Competitor add-drop multiplexer

Figure 6.1: JTech's Network Management System

The Figure also shows the ring of a competitor, such as Nortel Networks, with its own proprietary network management system. The network management software systems of each vendor then connect to the RBOC's own telecommunications management network. The key point to understand is that all equipment within a ring had to be supplied by the same vendor.

This made it more difficult for RBOCs to mix and match ADMs, upgrades and replacements, among vendors, to which the RBOCs became to a degree locked in. Digital cross-connects (DSCs), which steer and repack traffic, are the interconnecting devices for SONET rings. DSCs did not have to be supplied by the same vendors as the rings to which they connect. Indeed, the dominant SONET DSC vendor in the $3 billion North American DSC Market in 1999, with a 47% market share, was Tellabs, which had no market share in SONET multiplexers.

This limit to interoperability across vendors' equipment was no more clearly illustrated than in the allocation of local areas in Japan among vendors to supply ring architecture SDH OC-192 ADMs to NTT East and NTT West in 2000. Japan was divided up geographically, with equipment vendors JTech, NEC, Hitachi, and Nortel being allocated the bulk of the country. Because of the limits to interoperability, for example, NEC equipment may not be deployed into an area alongside JTech's SPARK 192J multiplexers, which are managed by JTech's proprietary network management software, which in turn is linked to NTT's transmission management network.

The previous chapter described two key dimensions of difference in RBOC strategies with regard to SONET equipment deployment – deployment timing and numbers of suppliers. These differences remained with the ADM products. The principal impact of the additional uncertainty from choice of ring protection was on timing. For example, the RBOCs BellSouth, Pacific Bell, and Nynex were relatively cautious in deploying ADMs with ring protection. The leading industry trade journal of the time characterized RBOC customers as follows:

> "Polling the planners, strategists and product managers at the major telephone companies normally reaffirms that the local exchange carriers are no monolith. Their opinions, plans and sense of timing are almost as diverse as the flags waving outside United Nations Plaza." (Warr, 1991)

This uncertainty was also reflected in varying ADM deployment strategies among equipment vendors. Many vendors, including NEC Transmission Systems, Northern Telecom and AT&T Network System developed product plans for both path-switched and line-switched rings. Other vendors made a choice. For example, Telco Systems decided to feature unidirectional path-switched rings in its products for the local access segment of the market.

The first ADMs with ring capabilities delivered to market incorporated unidirectional path-switched rings. These were followed by releases of products incorporating bidirectional line-switched ring architectures. Because bidirectional line-switched rings were considered to be more suitable for larger, interoffice networks, they tended to appear on 2400 MB/S (so-called OC-48) speed products, which appeared from 1994 onwards. The first bidirectional line-switched product vendors for 2400 MB/S (OC-48) products were Alcatel, AT&T, Northern Telecom, and NEC. NEC was offering a full range of products, with ring capabilities, in its IMT-150, ITS-600, ITS-2400 products. Some vendors, such as Alcatel, adopted a flexible strategy of offering both bidirectional line-switched ring and unidirectional path switched ring capabilities on their higher-speed products, to respond to RBOC customers' requirements for flexibility and upgradeability.

6.3 Organizational Identity

The period of the development of the ADM SONET multiplexers was one in which JTech's US organizational members initially amplified their claim among themselves and to relevant audiences that they were a new venture, but this identity was becoming increasingly stressed, both because of changes in the environment and also as a result of internal changes.

From the environment, following the Stock Market downturn in 1987, the earlier interest by large North American corporations in internal corporate venture programs waned and such initiatives were generally discontinued (Chesbrough, 2000). The result was that the organizational model of an internal corporate venture that was available in the early- to mid-1980s, principally characterized by the autonomy that it gave its managers compared to other divisions within the firm, no longer a major feature of the external environment.

Second, the holy grail of a competitive industry structure replacing the earlier dominance of industry incumbents AT&T and Northern Telecom was being threatened by the way that SONET equipment was tied to particular vendors' equipment. Once a vendor was a supplier, it would become established as a supplier in a similar way to the supply relationships that existed with earlier incumbents, since RBOC customers were tied to it for upgrades, replacements, and for other equipment within the same SONET ring. This was quite a different reality to the guiding vision of a truly open architecture, interoperability, and a competitive market structure that drove the North American organization of JTech during the JDLC and Terminal development periods.

From its internal organization, in some ways the North American organization still acted like the earlier organizational model of an internal coporate new venture in that it controlled the development process through its exclusive management of SONET customers and product specifications, pulling in the products and underlying technologies from Japan to meet its customers' requirements. Crucially, it retained autonomy in the areas of product planning and in sales and marketing. Interviewees strongly remarked that, in this, the amount of control exercised by the American managers was in complete contrast to the situation that prevailed within JTech's principal competitors at the time, including NEC, Nortel, and AT&T.

Yet, as the Communication Division of JAI expanded its activities during the development of the ADM product platform, seven identifiable internal changes and events began to stress its new venture identity.

First, JAI's Communication Division relocated to a newly built headquarters on a newly purchased 100-acre site in Texas in 1990 that it bought outright, freehold. Documents and reminiscences made much of the fact that JTech owned its site outright, and the symbolic value of this cannot be over-emphasized. There was a hugely symbolic tree planting ceremony on the new site, with the President and senior executives of JTech flying over from Japan for the ceremony. The new building seemed to mark some change in the identity of the organization to all involved.

Second, in 1991, the Communication Division of US country subsidiary JAI was separately incorporated and renamed as JTech Network Transmission Systems, Inc. (JNTS). JNTS was established as a direct subsidiary of the Division in Japan, having broken away from JTech's US country subsidiary JAI. The effect of this was, perhaps, ambiguous. On the one hand, the country subsidiary might have offered some protection for its Communication Division from further integration into JTech's Transmission Division in Japan. On the other hand, freedom from the country subsidiary undoubtedly did allow JNTS a clearer focus on its transmission equipment business.

Third, JTech had been first to market with, and to sell, its Terminal products, and this enhanced its identity claim as a new venture. With the ensuing ADM's, however, JNTS was not a new supplier, but an incumbent. Moreover, fourth, JNTS began to take on greater responsibility for development engineering, especially for the cabinets that housed the equipment and for software development. Fifth, that this was the start of a period of expansion of development engineering in the US was confirmed by the 1993 appointment and relocation of the head of development engineering in Japan, Mr. Matsuura, as the new President of JNTS in Texas. This lost JNTS an important ally in Kanagawa, but installed a President strongly associated with the successful development engineering effort of the JDLC and Terminal product families.

Related to this, sixth, there began to emerge misunderstandings over key practices, most notably inventory management, which led to greater coordination and integration with the Japanese organization. Again, related to the appointment of the new

President of JNTS, in the context of a rapidly growing JNTS organization, it was increasingly difficult to continue to rely solely on strong personal relationships to secure agreements. It was from the start of the development of the ADM products that JNTS's headcount began to accelerate relative to revenues. The US and Japan sides implemented four organizational changes to their cross-border management system to try to manage the growth of the organizations and the business, other than responses to specific problems such as the inventory management problem.

It had become increasingly difficult for the new JNTS members to claim a legitimate identity as an internal corporate new venture. Increases in formalization and the other changes led to a period of questioning, of identity work to try to make sense of "who we are" as an organization and the results of this would, in turn, influence the organization's strategy and structure and define its capabilities.

It appears that the new JNTS assumed a somewhat ambiguous identity to its members at the time, best characterized as the co-existence of a fading and increasingly difficult to sustain identity as a new venture, brought forward from an earlier period, which sat alongside an emerging claim to be a development engineering organization. As the development engineering organization expanded more relative to its initial size relative to other departments, and since development engineering – as more directly knowledge work or R&D – was seen as qualitatively different from other activities, so JNTS undoubtedly saw development engineering as central to their organization's new role, and efficacy at development engineering became a strong role-based source of identity. In turn, this shaped the way that JNTS enacted its capabilities at development engineering, such as in dispersed development engineering and job sharing discussed in Chapter 7.

6.4 Organizational Capabilities

During the development period of the Terminal products, discussed in the last Chapter, I drew attention to the organizational capabilities to collaborate effectively both internally across functional boundaries, both within the US new venture and with Japan, as well as with customers. JTech's Transmission Division had also brought in an organizational capability in product planning, the underlying routines for which had been developed in Rockwell International, the principal competitive supplier of non-proprietary transmission systems to the telecom providers during the 1980s. Put simply, when JTech hired Ron Finch from Rockwell International, he brought in and implemented more-or-less the same routines for product planning as existed in Rockwell International.

This was probably the most important organizational capability possessed by JNTS during the development period of the ADM products – the ability to recruit effectively in the US job market and to build internally these transferable organizational capabilities. JNTS was helped in this by the illegitimacy of many of its competitors, because their organizational identities were tied to other core businesses (aerospace for Rockwell International), to proprietary systems and strong headquarters' control (Northern Telecom), or to a form of cultural illegitimacy (NEC). Put differently, had competitors created the conditions to claim identities as new ventures for their organizations, would JTech have been able to recruit a core cadre of top and middle-level executives? The answer can only be guessed at, but is probably in the negative. Some of the context for JNTS's ability to bring in the individual-level skills and group-level routines that formed the basis of its organizational capabilities was illustrated in the interview quote from a senior JNTS American interviewee written up in Section 4.3.

From my interview transcripts, several factors appear to have assisted in this recruitment process. One was the location of the Transmission Division/JNTS in Telecom Corridor in Texas. Many of the JNTS/JNC top management team had spent a good part of their working lives in the local area. Related to this were the embedded personal networks that had developed over many years; I was told that nobody was hired into JNTS unless she was already well known by others who worked there. At JNTS, the entire American management top management team was well known to each other *before* they came together again at JNTS. It was the strong new venture identity of the organization that convinced many potential recruits that they would have control over their designated activities, so that they would not have to go back to Japan to make key decisions. It was in this way that the organizational identity shaped the capabilities, which in turn shaped JNTS' strategy – infused with the meaning of the organization's identity and its capabilities – and the organizational structures put in place to implement the strategy. As JNTS expanded its development engineering activities in the following product development period, discussed in Chapter 7 (section 7.4), a different set of capabilities became important in bringing in lower level engineers.

The heads of the core activity areas – what my JNTS interviewees called "organizations" – of Product Planning, Development, and Sales & Marketing – and the heads of the next levels down from this (e.g., Account Management, Business Management, and Proposals in Sales & Marketing) – had known each other in many cases since their early 20s.

I discussed how Ron Finch, at the time head of Product Planning and also of Development, had worked at Rockwell International, and before that at Western Electric. His boss at Rockwell International was George Hunt, who joined JNTS in 1990 as head of Sales & Marketing. In other words, the three principal activity areas related to new product development – aside from manufacturing – were headed by two senior executives who had worked closely together at Rockwell International for almost a decade. This was one reason why JNTS was able to separate so clearly the activity areas, since they were complemented by strong personal connections. Indeed, Ron

Finch and George Hunt had earlier worked together at AT&T for many years. The capability of hiring and the personal networks that existed area illustrated by considering the careers of four other senior JNTS executives.

Rob Ostermann

I mentioned earlier that Rob Ostermann was, during the mid-1980s, a district manager for Bellcore, where he was a principal contributor to the SONET standards project. He was also co-chairman of the key SONET committee at the time, the American National Standards Institute's (ANSI's) T1X1.5 Working Group. He had originally joined Bell Laboratories in North Andover, Massachusetts, having graduated in electrical engineering (specializing in communications theory) from Texas A&M University, in 1980. He joined Rockwell International, but was based at Richardson. At Rockwell, he met Ron Finch, George Hunt, Doug Soldier and others who either worked at, or went on to join, JTech. He also knew Will Paulson[20] (see next page) through his work on one of the standards bodies. He was approached by Ron Finch and joined the strategic planning team at JTech in 1989.

By 1999, Rob Ostermann was Vice President of Business Management at JNC, the 1996-established successor to JNTS. Business Management was the interface between the Sales & Marketing and Product Planning organizations at JNC, which is a key relationship for the purpose of product planning and development.

George Hunt

George Hunt has a BSEE and an MBA, and initially worked for Western Electric, which became AT&T Network Systems and then Lucent Technologies. He spent the first eight years of his career in a variety of functions, including test equipment engineering, designing test equipment, supervising the shop floor, industrial engineering, and procurement. In 1978, he moved to the Western Electric sales organization, primarily selling loop electronics to Southwestern Bell. He worked for Western Electric for 16 years, the first three based in Oklahoma City and the rest in Dallas. In 1985, he joined Rockwell, where he spent five and a half years, five of them in Chicago, where he was Director of Product Planning at the Wescom Telephone Products Division of Rockwell International. At Rockwell, he also ran its DLC program and ran one of its sales organizations.

George Hunt had known Ron Finch when they had both worked at AT&T during the 1970s and, it will be recalled, Ron Finch worked for George Hunt at Rockwell for three years. Ron Finch hired George Hunt into JTech in 1990. He joined as Senior Vice

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[20] A pseudonym

President of Sales & Marketing, where he remained until he left JTech in 1999, by which time he was Executive Vice President of the Sales and Marketing organization at JNC, the immediate superior of Rob Ostermann. He subsequently rejoined JNC as Group President and COO in 2002 to take over from the former COO, Ron Finch.

Will Paulson

Will Paulson joined Bellcore after graduation, in 1984, where he worked on transmission and SONET standards development (especially SONET operations' standards). He subsequently worked at Siemens for three years, until 1990 when Siemens decided to abandon their attempts to develop a SONET multiplexer family to compete with that of JTech. He joined JTech in 1990, because of his knowledge of JTech from his former Bellcore colleague Rob Ostermann, who joined JTech a year earlier, and from another former colleague, Will Monkton[21], who worked at JTech. In his first position at JTech, he worked in the strategic planning group, but did more tactical product planning, working with two key engineers in Japan to define the operations capability of the ADM series multiplexer products. By 1999, Will Paulson was Vice President of the Product Planning organization at JNC (the renamed JNTS), reporting to Ron Finch. He went on to become Senior Vice President, Sales & Marketing, at JNC, the position formerly held by George Hunt.

Karl Best[22]

Following graduation in electrical and electronic engineering, Karl Best joined Rockwell and held several positions at Siemens between 1980 and 1990. It was at Siemens where he first started working on transmission system development and where he became acquainted with William R. Paulson. Having worked at Alcatel between 1990 and 1992, he joined the one-year old JNTS in December 1992 to replace a previous head of the Development organization that had left a year earlier. By 1999, Karl Best was Senior Vice President of Development and Strategic Planning at JNC. He left JNC in 1990 to take on a role as COO and CTO at Xtera Communications, where he remained until 2004 when he joined Tellabs as Executive Vice President with responsibility to access transmission products.

In sum, the JNTS organizational identity enabled it to hire in a network of experiences industry professionals who had known each other through working most recently at Siemens and at Rockwell International. The advantage to JNTS of recruiting at the network, as opposed to individual, level was that it could more easily transfer in to its organization work routines that had been developed in the non-proprietary system

[21] A pseudonym
[22] A pseudonym

sector of the industry – excluding AT&T/Western Electric and Northern Telecom – routines such as product planning.

6.5 Strategy

As with its Terminal product TP 50/150, JTech's strategy with regard to the key ring feature of the ADM products was to be first to market. JTech offered ring capabilities to the RBOCs in early 1992, ahead of AT&T, Alcatel, and NEC, who only unveiled their ring-capable ADMs in late 1992. Northern Telecom was a further year behind this. The first ADM products JTech launched included standard-compliant path-switched ring capabilities on its ADM 150 and ADM 600. These were lower speed than ADM 2400 and were more suited for the local access part of RBOCs' networks. In choosing a path-switched option JTech had, like most other vendors, followed Bellcore Technical Advisory 496 specifications. It was ahead of all other vendors, whose strategies were to wait for greater certainty over both the final form of the ANSI standard and customers' preferences.

JTech subsequently developed a higher-speed 2.4 Gbit/s (OC-48) product, the ADM 2400. According to Ron Finch, when the ADM 2400 was developed, "we were not targeting it for our BOC customers. The target market was the IXCs. Just the opposite happened. We can't make enough for our BOC customers. The same thing will happen with the [higher speed] OC-192."

JTech's unidirectional path-switched ring ADMs were initially deployed by Cincinnati Bell, in February 1992. In explaining its early deployment of ring-capable ADMs, Cincinnati Bell noted the pressures to implement ring functionality into its network ahead of competitor local market entrants. At the time, Cincinnati Bell explained its purchase of JTech's ring standard-compliant ADM by the fact that JTech had the product available when others did not. Cincinnati Bell had invited 12 vendors to bid on its project for a downtown fiber ring. While all 12 vendors responded, only JTech had the products available that met Bellcore's TA-496 standards for local access path-switched SONET rings.

JTech's subsequent strategy was to stick with path switching. However, as the industry was moving to adopt either path-switched or line-switched rings, JTech innovated in developing so-called virtual ring (or logical ring) architecture products, instead of physical rings. These routed two separate signals on paths cleared through a mesh network and would RBOCs an early solution to protecting their service.

The outcome of this strategy was that, by 1996, JTech led the market in supplying SONET equipment to the RBOCs with around a 35% market share, ahead of

Lucent Technologies (the renamed Western Electric) with a 29% share, Nortel Networks (formerly Northern Telecom) with a 17% share, and Alcatel with a 13% share.

JTech worked closely with the RBOC US West on SONET equipment trials, with the result that, by mid-1992, U S West had already deployed SONET-based ADMs and terminals into its network. At the time, U S West claimed to have more SONET multiplexers in operation than any other RBOC. In June 1992, it awarded a contract to JNTS to supply it with SONET equipment, which it planned to deploy in fiber optic rings in the major cities it served, namely Denver, Minneapolis, Phoenix, Portland (Oregon), and Seattle. The award was the result of a request for proposals issued by U S West in March 1991 for transmission equipment that operates at the SONET speeds of 155 megabits per second (OC-3) and 622 megabits per second (OC-12). The equipment was compatible with the Phase II SONET standards. At the time, Gary Ames, U S West's president and CEO, commented that "SONET will provide U S West the ability to offer our customers the network of the future-seamless, virtually error-free broadband data transmission." The SONET set of standards for transmission was for speeds ranging from 51.84 mbps to more than 13 gigabits per second. At that time, no SONET equipment operated at higher than the OC-48 speed of 2.488 gigabits per second.

Jerry Kerschner, Executive Director of Advanced Communications Services at US West elucidated US West's procurement strategy,

> "As we evolve to Asynchronous Transfer Mode, we want to have a SONET-compatible structure for multiplexers, and equip the network with SONET capabilities. Some of our customers are giving us their architecture plans and service needs and would like to have today's products and services compatible with SONET. Point-to-point services will be the first SONET-based services U S West rolls out."

JTech beat out five other vendors for the contract. According to U S West, they were Alcatel Network Systems, AT&T Network Systems, DSC Communications Corp., NEC America Inc.'s Transmission Group and Northern Telecom Inc. The equipment involved in this first ADM product sale were JTech's TP 50/150 and ADM 600, Sonet-based terminals for interoffice and loop applications; and JTech's ADM 150, ADM 600 and ADM 2400s.

JTech's sales of its Terminal products peaked in 1991, and then gradually declined over the following seven years. With the first sales of its ADM products having been made in 1992, in 1993 the dollar value of sales of ADM products was more than seven times higher than JTech's Terminal products. Sales of ADM products took off as Terminal products began to lose their relative appeal to customers.

6.6 Organizational Structure

There were a number of changes to JTech's US transmission business organization in the US during the early 1990s, especially to cope with the increase in size of the US-based activities.

Up to 1989, the headcount of the Transmission Division of JAI had increased slowly, to reach some 250 people by 1989. However, between 1989 and 1990 the headcount increased to nearly 750 people in a single year, exceeding 1,000 employees by 1992. Up to 1989, the growth in headcount had more-or-less matched changes in revenues, which relationship continued from 1993 onwards. However, during the four years from 1989 to 1993, while developing its ADM products, JNTS was building an organization, the costs of which do not appear to have been supported by sales revenues. Part of this growth related to manufacturing – JNTS had for many years had some US-based manufacturing – but the major part of this was related to the higher value activities of sales and marketing, product planning, and development.

In response to this, in October 1990, JAI's Transmission Division relocated within Texas to a new building on a 100-acre campus that JTech had bought outright. Following this, in 1991 JTech's Transmission Division in Japan took direct control of its US operations away from JAI. The growth was matched by a change in presidency of JNTS as the longstanding President Nakajima was replaced by the former head of development engineering of products destined for the US market, Mr. Matsuura, who transferred from Kanagawa to Texas in 1993. Mr. Matsuura was highly respected by the Americans at JNTS because he was credited with having led the development engineering effort on the earlier JDLC and Terminal products, as well as the ADM products.

In terms of his career, one crucial factor about his transfer to Texas was that the new President Matsuura of JNTS had been effectively overlooked for a crucial promotion in Japan that would have moved him up to one level below head of the entire Transmission Division. Having missed that promotion, Mr. Matsuura (and almost everybody else I talked with) knew that he would effectively never climb any higher in the JTech Transmission Division hierarchy, so in some ways his move was a sideways move. The key point about this is that, from his base in the US, with a legacy of having fought for the US side in keeping to the specifications set out in earlier product planning documents, he had nothing to lose from non-cooperation with Japan. In fact, he proved to be more pro-JNTS and its expanding local interests than any American President could have been.

Figure 6.2 shows the most important lines of communication and collaboration between the US and Japan during the development period of the ADM products.

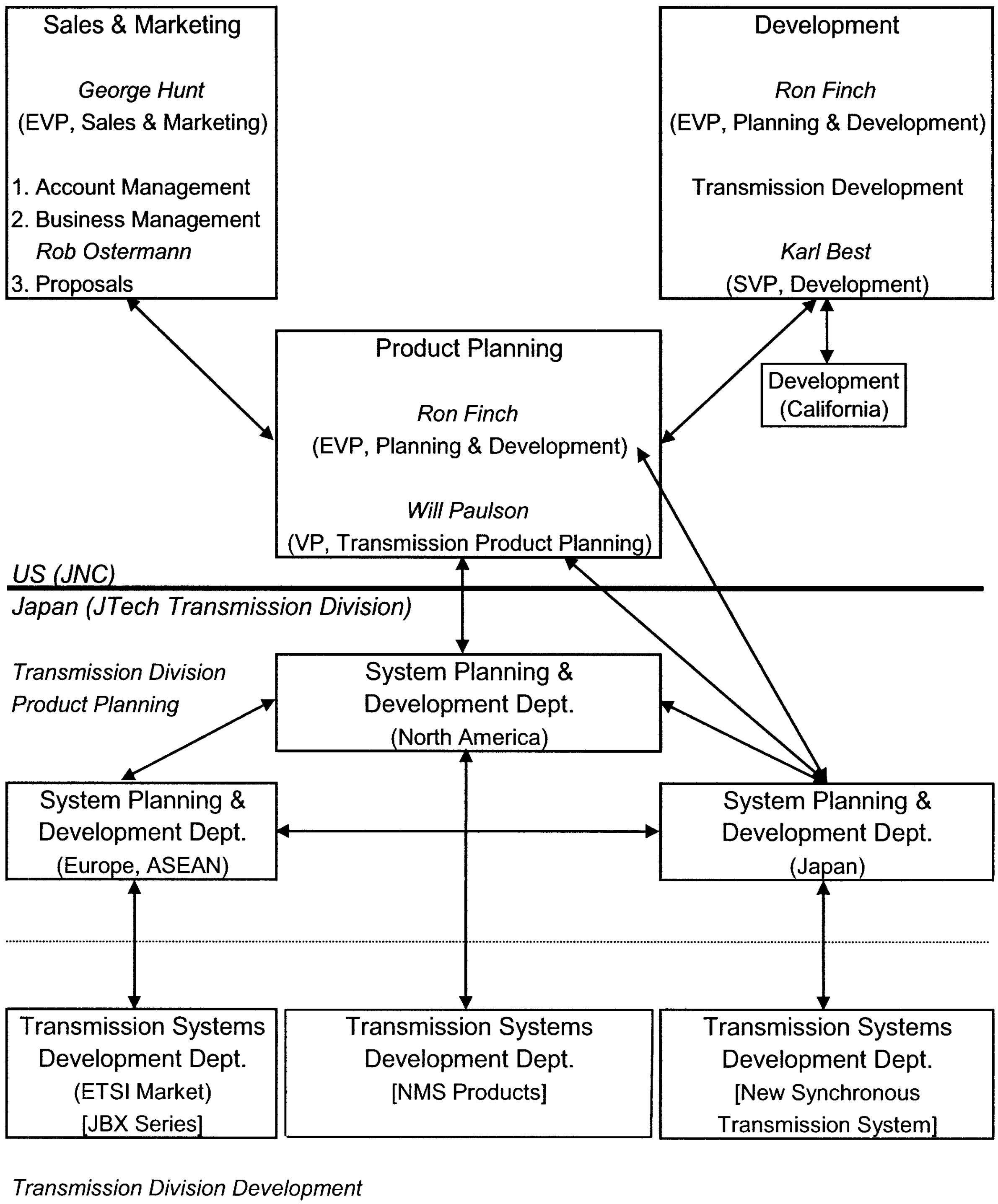


Figure 6.2: Core Product Planning:
Development relationships during ADM Product Development

Many aspects of the organization design shown in Figure 6.2 were responses to pressures to manage a greater number of products for different markets during the period of the development of the ADM products. During ADM product development, both Systems Development & Planning Department in Japan and Development in Japan were split three ways, with separate departments responsible for each of the North American market, the home country market in Japan, and the ETSI markets of Europe and the ASEAN countries. It was during this period that the two Departments in the Transmission Division in Japan developed separate identities and career tracks. An increasing proportion of engineers had only ever worked on North American products, while earlier on engineers working on products for the North American marketplace were almost all transferees from NTT domestic projects.

At the middle manager level, below Mr. Matsuura and Ron Finch, the Product Planning team in the US developed a good working relationship with the engineers in Japan. Product planners and engineers described the design reviews on the ADM Age products as very productive. Decisions on design issues were made very quickly and at a personal level, the relationship between the people was described as being very good. The separation of the North American activities into different departments in Japan, shown on Figure 6.2, was a response to increasing difficulties in defining the product specification in developing the ADM products. This was one of two collaborative problems that emerged during the ADM development period, the other one being in relation to inventory management.

The Americans succeeded, only with difficulty, in persuading the Japanese development engineers to design and develop ADM products specifically for US customers, rather than modifying a product adapted for sale to NTT. Instead of portraying this as a rational trade-off between being locally responsive (to US customers) versus achieving economies from global integration, in the language of (Prahalad & Doz, 1987), it is better understood as a political battle between serving the principal domestic customer, NTT, or the US marketplace. An American interviewee in JNC described the situation as follows:

> "The Product Planning organization made the calls in terms of the feature content and priorities and release schedules. So, the problem was never making the calls, it was convincing Japan that they were the right calls and to put resources behind those decisions.
>
> Well, it was most of the design engineers over there that worked for Matsuura, and they didn't want to do most of these features. Basically, what they wanted to do was to develop a product that they could sell to NTT and then just send it over here and have us sell the same thing. But, US markets and customers are much more demanding than NTT and the

Asian customers. And, it is even true today, and they know that. And, Cisco has found this out as well... if you can be successful in North America, you can take your product and sell it any place else in the world. The converse of that is not true. If you can be successful in Japan, it in no way ensures success in the US.

But, that is what they wanted. They wanted to develop products for NTT and then with very few modifications give those to us and have us sell them over here. And we told them, 'That will not work. If you want to sell products in this market, you have to compete against the companies whose primary markets are in the US first. And, if that means developing a totally different product from that which you sell to NTT, then that is what you have got to do. And, they were very, very reluctant to do that, because it was more money and more resources, and more risk."

An American development engineer recalled that one way that they became aware of these conflicts was that the Japan-based development engineers required what, to the Americans, was a surprising amount of proof:

"And, Japan was very funny, because they always wanted proof of everything. They always wanted to know: 'Well, how do you know that? Show me how? How do you know that this customer will buy this if we do this?' And, of course, there is no proof for that. It has got to be based upon experience and trust and understanding of the marketplace, and a certain amount of risk taking. And, they always wanted assurances for everything. And, you can't have assurances, you know. 'But, what I can assure you is that if we don't do this we will fail. Can I assure you that if we do do it we won't fail? No, but I can assure you that if we don't we will never have success.' And, so those were the battles."

As discussed in the next Chapter in relation to transferring ideas from the Transmission Division's North American business to Japan, Systems Development & Planning Department (Japan) communicated with its namesake in Japan for the North American market, which in turn collaborated with a key Japanese assignee in Product Planning in JNC. These relationships were to prove important in transferring knowledge from the US to the Japanese marketplace.

As the number of products increased and in an effort to avoid misunderstandings, such as those arising from language differences, JNTS and the Transmission Division in Japan designed and implemented four organizational changes to their relationship, focused upon Product Planning in the US and Development in Japan. These were:

Interface group in Japan

First, the Transmission Division in Japan established a Product Planning & Project Management Department (PPPMD) in Kanagawa to interface between the product planners in the US and the system integration teams and development engineers in Japan. This was staffed not just by English speakers, but by Japanese individuals who had previously been assigned to, and spent several years working in, the US subsidiary. These individuals, who are Japanese but who are known by both Japanese and American variations of their names, know the key Product Planning individuals in the US, and understood the way that the US subsidiary worked. These individuals were insiders in both systems.

North American Development Department in Japan

Second, the development team working on projects for the North American market in Kanagawa was separated into a dedicated department, separate from NTT projects. Initially, development engineers in the North American development team were individuals who had worked on NTT projects, but in time only the senior engineers, managers and directors had ever worked on NTT projects, as younger engineers in Japan developed Japan-based careers from experience of having only worked on projects for the US marketplace. These became two development groups, both staffed by Japanese and located in the Division's headquarters in Kanagawa, but with very different approaches to work. An American interviewee described it this way:

> "The North American market is extremely competitive and aggressive, and in Japan you can go see that on the 11^{th} floor there. They are a very aggressive group. And, I don't think that the rest of the NTT group is nearly as aggressive. They are a different type of group. They think that the North American group works very quickly, it makes decisions quickly, and is very aggressive with schedules and pricing. NTT [group] is much more focused upon meeting the expectations of one customer and that one customer, by the way, is going to provide you with a complete spec. on exactly what needs... There is definitely more focus on marketing, and understanding the market for the US base, where for NTT the market is well defined."

Formalization of product-level specification agreements between collaborating locations by documentation

Third, JTech in Japan and JNTS in the US developed a system of documentation to standardize and formalize procedures. From around 1990, they instigated a system of

Product Specification Agreements (PSAs) and Release Specification Agreements (RSAs) to define product features and to anchor the relationship between Product Planning in the US and system engineering and Development in Japan. While this was initiated in response to emerging cross-communication problems (so-called *gotchas* between Product Planning in the US and Development in Japan), it was legitimized because the US RBOC customers were, through Bellcore, introducing quality standards that required more formal documentation of processes. Related to the international ISO 9000 standard the key Bellcore standard was known as Customer Satisfaction Quality Program (CSQP) and the RBOCs, through Bellcore, required their equipment suppliers to be CSQP registered for their products. This meant conforming to a Bellcore standard, known as SR 3535, which specified quality standards in the relationships between customers and their suppliers, and within suppliers' own development and manufacturing activities. Eventually, the standard would migrate from CSQP to a telecom version of ISO 9000, known as TL 9000.

The PSA was prepared by Product Planning at JNC (then JNTS), and it captured the network applications, features, functions, interfaces and high level requirements foreseen throughout the life of a product. The PSA was intended to define the scope and functional bounds of the whole product throughout its life. The RSA followed the PSA and identified the features, functions, and interfaces required for the first (and subsequent) releases of a product.

The systems of managing through PSAs and RSAs evolved in response to particular problems. The most notable of these was a compatibility problem in respect of a feature known as FASTLANE on Release 11 of the ADM 150 and ADM 600 – whether or not it should be backwards compatible with Release 10. Under the existing system, there were two RSAs in circulation for Release 11. The US version, from JNTS, said that it had to be backward compatible with Release 10. The development team in Japan sent an RSA back, saying that it was not possible to make it backwards compatible. The product that went out was not backward compatible and resulted in a major recall. After that experience, a procedure was instigated by which all features on a single RSA had to be signed and countersigned by both parties, Product Planning in the US and Development in Japan.

Prior to the PSA and RSA documentation system, Product Planning in the US and Development in Japan had relied upon less formal means of communication, especially by e-mails and design reviews.

A resource prioritization procedure for multiple products

Fourth, just after the end of the main ADM development period, from around 1994, JTech in Japan and JNTS in the US commenced a twice-yearly series of Project

Priority Meetings to manage resource allocation as the number of products was increasing. The objective of these meetings was to prioritize projects for development, after the business case for a product had been prepared. A Japanese interviewee explained the origin of the Project Priority Meetings as follows:

> "When [JNTS] said that it needed several products so as to generate sales revenues from a range of products, the Japan side explains that because they have limited resources, and because they can't (therefore) do everything, we should make only small changes (on JNTS's request). Since we can't all reach a reasonable agreement on everything, we should first of all make a product plan for the basic product. We make such a product plan for each individual product showing how to make it exactly. After this, we decide which products to prioritize for development in a twice-yearly Project Priority Meeting.
>
> We started the Project Priority Meetings not so long ago. We started using PSAs about ten years' ago, and the Project Priority Meetings were started about four years' ago. In short, as sales in America became high, and because the number of products we are developing has increased, reliance upon such documents as the PSA and RSA that were based upon individual products led to confusion. So that things could go more smoothly, we started a Project Priority Meeting so that we could make adjustments across our entire set of products, so we could make a large scale assessment of all our activities."

As JNTS' sales of transmission equipment increased from $100 million in 1990 to $307 million in 1992, managing this expansion generated a different set of misunderstandings between Japan and the US, especially between Sales in the US and the sales and manufacturing groups in Kanagawa and Tochigi. This created a crisis in 1990, the details of which I should explain.

JNTS sales of transmission equipment had increased from $100 million in 1990 to $307 million in 1992, but managing this expansion proved difficult. In December 1990, JAI's Communications Division did not possess the equipment in an order that it had promised to BellSouth, and so it froze new orders until this order was met. In the meantime, there was a sales slump and this environmental shock further reduced orders. However, new orders picked up and customers were insisting on relatively short delivery periods of one to four weeks following new orders. The problem for JTech was forecasting volatile demand. JNTS's margins on its transmission sales to RBOCs were low, and it was facing strong competitive pressures in its smaller cellular mobile telephone business from Motorola and Nokia. JNTS over-ordered transmission equipment due to difficulties in correctly forecasting demand, so that by September 1993 consolidated inventory had reached $213 million, equivalent to six months of inventory. Moreover, JNTS had accumulated losses of $68 million and it had over $100 million of arrears in payments to its parent, JTech.

In December 1993, the President and senior executives of JTech established a JNTS Reconstruction Committee, which started work in January 1994 to rectify the problems. Its countermeasures included credit management of the delayed payments to JTech, having a clear out of inventory and establishing a new inventory management system, and dispatching from Japan a new Chief Administrative Officer to oversee inventory in the US. The result was that, by 1995, JNTS achieved profitability and stability of operations.

How had this situation come about? One story locates the reason at the level of the environment, as resulting from different inventory management practices between those of NTT in Japan and JNTS's RBOC customers in the US, as I explained in Section 6.2. This explanation casts the problem as one of differences in industry practices across borders and of cross-border learning.

However, in 1999 JNTS in its new corporate form of JNC faced a second major inventory problem that points to a somewhat different explanation for excessive inventory build ups in the US than that of exogenous environmental differences and learning. In this later problem of an excess of inventory, JNC had built up a $35 million inventory of goods that it had planned to ship to Level 3, a rival to AT&T in the long-distance segment. The explanation given for this inventory build up by JNC's American executives had three aspects.

First, interviewees blamed the fact that the principal industry market research analysts, RHK, had over forecast demand by $2 billion. Second, however, the cause of the problem was attributed to differences in risk-taking between the Japan and US businesses. Within Japan inventory was called "cost" (to be minimized), but in JNC it was called "risk capital." An American interviewee explained:

> "We [at JNC] are very inventory-driven as a Company, so we make trade-offs as to whether we are going to take risks as to how much inventory we may or may not have. Right now we know that Nortel is having equipment shortages. And, we have customers who would love to be able to purchase things from us. And, we don't have any additional inventory to be able to sell them, and it is because we tend to run things real real tight. And because the supply chain can't react very fast, the forecast has to try to predict...

> If we had predicted that we needed this equipment five months' ago, we would have it today. But, I am not sure we would have had it because our inventories would have been building up and I would have got pressure not to build so much inventory. So, we are risk averse. We don't like to take risks. We took a risk with Level 3 and the reason is that every now and then we will get them [JTech Japan] to take a risk. Every now and again we will get them to take a risk. And, Level 3 chose Nortel. And the reason Level 3 chose Nortel is that Nortel is worried about us and Nortel cut their prices by 50%. 50%. Can you imagine walking in with a brand new product that you haven't delivered before and just dropping the price, that I am sure was not priced to have any margin in it. And, they dropped it 50%. I mean, what customer is going to go with us?
>
> Now, we attempted to counter and we got real close, but because of some network management issues and some other things we didn't get it. But we sure hurt Nortel.
>
> I am going to sell it [emphatic tone] I am not worried about it. I will sell it. Give me a little bit of time. It is a cash flow problem right now. I know it is. I am focused on it. Give me an opportunity. I will sell it."

A second American executive at JNC talked about the cross-border inventory management problems more emotionally:

> "Either we have too much inventory or we don't have enough, or they [JTech Japan] are afraid we are going to build too much or we are mad at them because they didn't build enough, so it is… You know, my comment is that every time we go from too much inventory to not enough or not enough to too much, there is a moment of equilibrium that lasts about three and a half seconds, and it is three o'clock in the morning, on a Saturday morning. You leave on Friday and you have shortage, and you come back and you have excess inventory, or the other way round. So, that is a constant, a constant problem.
>
> $35 million of Level 3 product. But, see, the difference is – and it is a matter of viewpoint. And, I don't want to be cavalier about this. But, I think it is part of the issues we struggle with. That was $35 million in inventory OK. We built that inventory as a hedge that we were going to win this Level 3 business, because if we won it, the demand was going to be like this [hand articulates a rapid increase].

Now, they [Level 3] gave us a lot of local access business, which was different from this. We are going to do $2 billion. To me, $35 million is a nit. It is a nit. It is a risk we took. I hope we can sell it. But, the world isn't going to end. But, to Japan, that is the only thing that they can see, is we have this inventory we haven't sold and somebody in finance is probably on their ass every day.

And, so that is the mindset. I mean, I am trying to run the business from a big point of view, solve all the problems, keep the customers happy, manage the inventory. You have to take risks to get ahead. And, every once in a while, by the nature of the definition of risk, it is going to lose. But, they don't get it. They have a different mindset here [in Japan]. And, that is something we have learned to deal with in the ten years... So, I just let them be upset. I do what I think is right."

The third aspect of the inventory build up was that the production lines in the factory in Japan were not designed to flexibly and rapidly respond to changes in demand. NTT demand was rather more planned, and the production line and planning of procurement from parts suppliers was designed around NTT practices. While the sales and production organizations had established a quarterly set of meetings, so-called "Joint Meetings" with JNTS/JNC and had put in place a "four-month inventory" agreement with the US subsidiary, differences over interpretations and inventory content continued.

Collectively, the various changes put in place to manage collaboration between Japan and the US marked an increase in formalization, which went hand in hand with a reduction in the importance of personal relationships. This increasing formalization and substitution of impersonal inter-departmental role relationships for personal relationships would have been predicted by the literature on developmental processes in interorganizational relationships (Ring & Van de Ven, 1994). The previous communication media of e-mails and design reviews were supplemented by formal documents, that were fully signed off by all senior executives within both the US and Japan. This, coupled with the rapid growth of the organization in the US, especially in development engineering, made it very difficult for JNTS organization members to sustain its identity as a new venture. JNTS was increasingly a development engineering organization engaged in "knowledge work," with a significant designated R&D function, and development engineering as a role identity seemed to sit in uneasy tension alongside the new venture identity imported from the earlier product development periods.

Most notably, however, the organizational changes put in place to try to implement the new strategy were undermining the organizational identity that shaped

JNTS's earlier success, that of a new venture. These changes, that had the objective of smoothing the cross-border relationships did, through their formalization, inadvertently stress the claim that JNTS was a new venture and undermine the basis of the earlier success. The new identity claim, that of an organizational identity for JNTS as a development engineering organization, began to be voiced and to took shape through the enactment of job sharing as an organizational capability, as I describe in the next Chapter. The enactment of this role identity, in an attempt to compensate for stresses on the earlier constructed new venture identity, seems to have been effective in having enabled JNTS members to successfully avoid their organization's identity reverting to the still illegitimate and universally undesirable organizational identity, the default of being a "Japanese subsidiary."

7 ADX Products' Development (1995-1999)

7.1 Introduction

It was from 1995 that JTech commenced development of an enhanced SONET ADM product, as it sought to extend the capability of its ADM products to handle the special characteristics of data transmission. The new SONET multiplexers were known as the ADX family, and began to be sold from around 1999. At the same time, transmission equipment based upon an entirely different technology, that of dense wavelength division multiplexing (DWDM) – a fiber-optic transmission technique that employs light wavelengths to transmit data parallel-by-bit or serial-by-character – began to be adopted by telecom carriers. There was much technological innovation, especially in universities, and SONET products based on new, significantly more efficient, architectures, began to appear. As this innovation occurred in the US, the US market became increasingly recognized as the global lead user market, even by NTT, which began to introduce products based upon technologies and protocols used in the North American marketplace.

Within Japan, JTech caught up NEC as joint lead supplier to NTT by the end of the decade, although the overall importance of markets shifted to the US as NTT's overall spending on transmission equipment fell, as that of the US market increased. JTech's US organization, JNTS (renamed JNC in 1996) gained in status in the Transmission Division overall, both because of the increasing importance of the North American market – with some 80% of Japan-based manufacturing of transmission equipment in the Tochigi factory destined for the US – and because US customers were transmission technology, protocol, and product global lead users based upon the simple fact that NTT and European countries and companies increasingly sought to emulate the US.

For a number of reasons, JTech shifted the balance of the development engineering effort from Japan to the US during ADX product development. For the first time, JTech in the US – through its renamed subsidiary JNC – was involved in mainstream hardware and software development engineering work on the core product modules that went into transmission systems' products. As development engineering grew in size relative to the rest of JNC, as well as to JTech in Japan, and especially since JTech was contributing development engineering on modules containing newer technologies, this bolstered the claim by JNC organizational members that they were a development engineering organization and this sat somewhat ambiguously alongside the earlier but increasingly in-credible identity as a new venture.

As a now well-established SONET equipment supplier, well ahead of NEC in terms of market share and reputation, the distance of JNC from NEC was proven. Instead, JNC members increasingly focused upon building up their development engineering activities which became a compelling basis for a role identity for their organization. This was supported by the competence and efficacy with which JNC carried out development engineering, underpinned by organizational capabilities such as job sharing across dispersed locations. This contrasted with the earlier new venture identity, which was based more on membership of a class of other organizations in the environment and through which identity claims brought legitimacy. In short, the new role identity was more associated with competency, while in the early phase of founding JTech's US organization members were seeking an identity that would provide legitimacy – which had largely been achieved as a result of the product market success of the ADM products discussed in the last Chapter.

The most important capability shaped by the new role-based development engineering identity was that of what, within JTech, was known as the evolving practice of "job sharing." JTech in Japan had, as I discussed in section 4.4, developed a home country capability of development engineering across distance within Japan, focused upon two domestic clusters of development organizations, JDTG for hardware and JCSG for software. JTech's pattern of job sharing within Japan was transferred and adapted – or recontextualized in the language of Brannen et al. (1999) to collaboration among a dispersed network of development engineering organizations within the US. Originally shaped by JTech's relatively late founding and to the particular social situation of the Transmission Division within JTech, this pattern of organizing within the US was both enabled by its new role-based identity, but also reproduced and reinforced JNC's organizational identity as a development engineering organization as JNC succeeded in recruiting the key engineers with skills in new technologies that it needed to develop the ADX products.

JTech's business strategy for the US was strongly influenced by this capability, and consisted primarily of the development of an enhanced version of its ADM family of products, known as ADX products. The ADX products contained much of the functionality of the ADM products, but had a much greater capability of transmitting data through added new technologies such as such as Asynchronous Transfer Mode (ATM). JNC was only able to adopt a strategy of developing ADX products because of its organizational capability of job sharing across dispersed locations, which enabled it to establish a development facility for ATM modules in New York, where it could recruit the skilled labor needed by being able to offer potential recruits good quality development engineering work from the date of their start.

JTech also brought (late) to market its first DWDM products, and the broader set of products that it now was able to offer customers led JNC to shift from a product-based strategy to more of a network solution strategy – offering several products together as a portfolio to meet customers' broader network needs. Within Japan, however, JTech also sought to introduce some of the key features of merit of products developed for the North American market into products for NTT, as it sought to overtake NEC as principal transmission equipment supplier to its core home country customer.

Implementing this strategy necessitated greater cross-border organizational and project-level integration across the various organizational networks in Japan and the US. On the one hand, the Division in Japan sought a common platform approach to products for NTT and the North American marketplaces by merging development groups under a newly merged global Product Planning & Project Management Department. This led to a subordination of product specifications for the US market to a global platform approach, driven by the logic that economies of scale could be achieved from developing a common technology platform for products that would serve the three key markets of the US, Japan, and ETSI (Europe). This also worked to undermine the new identity of JNC in the US. On the other hand, the cross-border organizational and project-level management systems put in place to implement the new strategy led to additional problems that in turn worked to undermine JNC's new identity claim and also the capabilities on which the development of the ADX products had been based. Once again, these organizational changes increased the stress on the identity claimed for the US organization.

At the same time, two new start-ups entered the SONET product market space with radically new SONET architectures that directly threatened JTech's and JNC's products and architectures. These companies, especially Cerent and Cyras Systems, increased the feeling in JNC that they were the establishment, and JNC organizational members looked somewhat enviously at the new entrants.

7.2 The Enacted Environment

7.2.1 Increased Demand for Bandwidth

The principal change in the environment facing the telecom and its supplier transmission equipment industries during the 1990s was the acceleration in the demand for transmission capacity and the emergence of strong competitors capable of supplying that increased demand. This was especially due to an increase in the requirements for bandwidth for data transmission, which presented additional challenges to transmission systems equipment suppliers due to the special characteristics of data, for which SONET was not a good standard.

While semiconductor speed doubled every 18 months or so, consistent with Moore's Law, Internet usage – and associated data traffic – was doubling roughly every six months. In turn, this led to pressures on electrical technologies and products, such as multiplexers, to keep up with traffic capacity, such as by using ever higher performance semiconductors. The problem was how to transmit higher capacity over the existing infrastructure of laid cable and fiber. JTech's customers, the telecom service providers, could not economically solve the problem of increasing bandwidth demand by laying extra optical fiber in the ground. The costs of laying the fiber, plus the associated equipment costs of managing such a more complex network, would have been enormous.

Industry analysts Ryan, Hankin, Kent (RHK) estimated that during 1999 alone, the long-distance interexchange carriers (IXCs) experienced voice traffic growth of 15% and data traffic growth of 60%, while the RBOCs saw voice traffic increase by 10% and data traffic by 50%. This growth of data transmission relative to voice transmission led to telecom service providers shifting their equipment expenditure from switching equipment to purchasing additional transmission equipment to increase bandwidth. The demand for bandwidth was forecast to continue to increase, driven by increasingly bandwidth-intensive applications and Internet usage. During the 1990s, telecom carriers in the US continued to deploy SONET ring architecture multiplexers to try to cope with the increase in demand. RHK estimated that the market for SONET equipment at $7.7 billion in 1999, an increase of 76% over the previous year.

Related to this was a further change. Having largely abandoned the IXC market when JNTS/JNC focused upon the RBOCs from the late 1980s, during the 1990s the IXCs returned to market with a vengeance. In contrast to earlier years, the bulk of telecom service providers' spending on SONET equipment was from IXCs, who accounted for $3.3 billion of purchases, compared to $1.5 billion by the RBOCs. Some two-thirds of this expenditure by the IXCs was accounted for by just three potential customers, AT&T, MCI WorldCom, and Qwest. Especially, IXC spending growth on SONET equipment in 1999 was stronger than RBOC spending, up by 88% over the year compared to an increase of 45% by RBOCs from 1998. IXC spending was forecast to continue to dominate spending by other customer categories on SONET equipment.

From the mid-1990s, equipment suppliers such as JTech continued to introduce releases of ADM products, providing incremental feature enhancements, but also began to introduce products to the marketplace based upon fundamentally new technologies – there was more radical innovation. The technology meeting SONET standards relies upon time division multiplexing (TDM), which assigns different time slots to each signal in transmission. In consequence, a problem that SONET presented for some carriers, especially the IXCs, was the difficulty of increasing capacity beyond 2.5Gbit/s. because of the particular transmission characteristics of their laid fiber. A second problem was accommodating the particular characteristics of data transmission.

There were two responses to this during the second half of the 1990s. First, so-called next generation SONET products were developed. Second, products based on photonic technology, notably wave-division multiplexing (WDM) instead of TDM, also became available to service providers. It is instructive to say something about each of these two innovations from the institutional environment, beginning with SONET.

7.2.2 Higher Bandwidth SONET and Next Generation SONET Equipment

Turning, first, to SONET. There were two notable developments in SONET technologies and products. First, 1996 saw the introduction of higher bandwidth, OC-192 (10 Gbit/s) SONET equipment, based upon electrical communication technologies. Nortel Networks (the new name for Northern Telecom) was the first equipment provider to come to market with OC-192 SONET equipment, ahead of JTech and other providers. Second, 1999 saw the introduction of so-called next generation SONET equipment introduced by start-ups such as Cerent and Cyras Systems, based upon radically new SONET architectures. I consider these in turn.

Nortel Networks' first OC-192 customers were the IXCs MCI WorldCom and IXC Communications, competitors to AT&T in the long-haul segment of the network. These carriers initially deployed Nortel Networks' OC-192 equipment in point-to-point architecture, with the expectation of converting the routes to four-fiber bidirectional line-switched rings when upgrades ADM upgrades became available, which was later in 1996. Nortel Networks' key OC-192 customers subsequently additionally included the IXCs Sprint, Qwest, and Williams Communications.

The lead users for this higher bandwidth SONET equipment were not therefore the RBOCs, JTech's focal customers, but were a different customer segment entirely, consistent with the patterns of disruptive technology introduction predicted by Christensen (1997). The IXCs operate in the long haul segment of the network, while JTech's principal customers for its ADM family of products, based upon transmission rates of up to OC-48 (2.4 Gbit/s), had been the RBOCs, operating in the inter-office and local segments of the network. IXCs were the 'lead users' (Von Hippel, 1988) of OC-192 multiplexer equipment and were the first to deploy OC-192 transmission equipment into their networks. Nortel Networks introduced its first commercial OC-192 product, S/DMS TransportNode OC-192 SONET in 1996, using the same S/DMS TransportNode product platform as for its OC-48 product. Lucent followed by releasing WaveStar Bandwidth Manager, its OC-192 product, in March 1998.

There were several contending explanations given for Nortel Networks' lead in OC-192 equipment, especially for its being ahead of Lucent in introducing OC-192 SONET products, and it is impossible to disentangle which story – or combination of stories – is more plausible.

First, Nortel Networks had collaborated closely with universities in developing the technologies and was first with the key underlying optical laser technologies that were part of OC-192. Second, Lucent made a strategic decision to develop a 10 Gbit/sec platform from scratch, rather than base it on its then existing OC-48 platform, which new platform development took longer. In contrast, Nortel Networks' OC-192 product was based on its existing TransportNode product platform. Third, there had been doubts about whether OC-192 equipment would work with older fiber, known as dispersion shifted fiber (DSF), which had high polarization mode dispersion (PMD) values. However, much of this DSF had been replaced with nondispersion shifted fiber (NDSF). New IXC entrants such as Level 3 had primarily deployed NDSF. Lucent Technologies, in its pre-1996 corporate form of Western Electric, was preoccupied with the particular problems of its captive IXC customer AT&T with its legacy of DSF fiber, to which OC-192 was unsuited. Instead of OC-192 SONET equipment, Lucent Technologies was focusing on developing an eight-channel wavelength division multiplexing (WDM) system (see next section) for AT&T.

OC-192 equipment gradually took an increasing proportion of the SONET market, relative to the OC-48 equipment predominantly bought by JTech's main customers, the RBOCs. JTech only released its SPARK 192 10G (OC-192) product in 1999, targeted initially at its RBOC customers and IXCs, as well as MCI WorldCom's local network. The marked shift in the share of spending on SONET equipment from RBOCs to IXCs was associated with a shift from OC-48 to OC-192 equipment. This was then reflected in the changing vendor market shares of SONET equipment from 1998 to 1999, over which period the total market size increased by more than 70% to $7.7 billion. While JTech's share of the overall SONET market changed little, from 22% to 21% over the year, with Lucent Technologies falling from 28% to 27% and NEC halving from 6% to 3%, the market share of Nortel Networks increased from 34% to 41% of the larger market in 1999.

1999 was also the year that a start-up, Cerent, entered the SONET market, capturing just a 1% market share. In a transaction announced in November 1999, Cerent was acquired by Cisco Systems for $6.9 billion. While incumbent carriers Nortel Networks, Lucent Technologies, and JTech were focused upon overcoming the technological hurdles associated with developing faster OC-192 products, Cerent entered the SONET market with a novel SONET technology and product architecture, with what was known as a next generation of SONET ADMs. The technologies and products introduced by Cerent and subsequent start-ups, such as Cyras Systems, were based upon SONET, but allowed service providers to integrate data, voice and video transmission signals.

Cerent's equipment allowed carriers to map voice and data services over SONET backbones. In contrast, then current SONET ADMs, including JTech's ADM products, were designed for low-bandwidth voice traffic at fairly predictable traffic volumes in the inter-office segment of the network, dominated by RBOCs. The high-volume, high-flux data traffic coursing through the Internet challenged the traditional SONET performance and business model. The so-called next generation "bit-rate agnostic" SONET systems – such as introduced by Cerent – accommodated multiple services and SONET bit rates on the same platform, on either end of the network. They were smaller than traditional SONET systems, consumed less power, and interoperated with both traditional SONET systems and existing operations support systems.

Thus, in its SONET market, JTech was both being out-innovated by larger firms with closer ties to the university innovation system in the US focused upon the needs of a different customer segment to JTech (e.g., Northern Telecom) as well as by start-ups with newer technologies (e.g., Cerent).

7.2.3 Dense Wavelength Division Multiplexing (DWDM)

The second wave of innovation in the ADX product development period came from products based upon wavelength division multiplexing (WDM) instead of time division multiplexing (TDM). WDM presented an alternative solution to the capacity constraints in fiber relative to increasing demands for bandwidth based upon a different set of technologies, photonics, which use light to maximize the potential of fiber optics. In contrast to SONET, based on TDM, optical WDM enables multiple channels to be transmitted over a single fiber because they are sent at different wavelengths. The first prototype WDM equipment was released in 1995 by Lucent Technologies and Ciena, followed by other suppliers, including NEC in 1997. Dense wavelength division multiplexing (DWDM) is technically similar and has subsumed WDM.

WDM was first announced by Lucent Technologies in 1995. It will be recalled that Lucent Technologies became completely independent from AT&T in September 1996, when AT&T distributed its remaining shares in Lucent Technologies to its shareholders as dividends. Bell Laboratories, the research arm, became a division of Lucent Technologies. During the early 1990s, the equipment predecessor of Lucent Technologies, Western Electric, had been working on the particular problems of its captive customer, AT&T, a long-haul service provider. AT&T had particularly poor quality DSF fiber and Western Electric was seeking a way to overcome this handicap to increasing transmission bandwidth, which led it to focus on WDM. AT&T's fiber could not readily accept SONET OC-192 transmission, due to signal dispersion. In short, AT&T

had special needs from the particular characteristics of its installed fiber, the solution for which (i.e., WDM), once developed, became more widely applicable across other carrier networks.

Following initial deployment in long-haul point-to-point networks by IXCs such as Qwest Communications and IXC Communications, WDM was subsequently adapted for use in metropolitan markets, the RBOCs traditional territories. DWDM systems became an alternative option for RBOCs, although the deployment of DWDM equipment by JTech's SONET customers, the RBOCs, was slower. For example, RBOC Bell Atlantic announced short-haul WDM deployment plans in April 1998. While JTech and Lucent Technologies shared the SONET ADM component of a March 1998 Bell Atlantic request for proposals (RFP), based on 10 Gbit/s. (OC-192) SONET technology, Ciena was the announced supplier for short-haul, point-to-point metropolitan-area DWDM and Lucent Technologies was to be a supplier of DWDM products. This was DWDM supplier Ciena's first RBOC business. At the time, Bell Atlantic considered that 10 Gbit/s. (OC-192) SONET ADMs were six months behind DWDM products in terms of availability from suppliers.

Some industry observers considered that SONET and WDM were two different schools of thought on how to build bandwidth (O'Shea, 1997) – the "oceans of SONET" school or the "towers of WDM" school. As the Bell Atlantic RFP suggests, many customers saw DWDM and higher speed SONET products as coexisting. DWDM complements SONET as well as replaces it for some applications.

By 1998, DWDM costs and functionality were already superior to 2.4 Gbit/s. (OC-48) or 10 Gbit/s. (OC-192) SONET TDM in long-haul point-to-point connections, although both 10 Gbit/s. (OC-192) and DWDM products remained attractive to carriers. New entrants developed variations of DWDM products specifically for metropolitan area markets. Fortunately for JTech, DWDM systems were perceived by the RBOC and CLEC inter-office service providers as relatively costly to purchase, install, and maintain in their networks, and they required SONET interoperability with existing equipment. Nevertheless, it was expected that DWDM would penetrate into the inter-office and local access markets.

WDM and DWDM were technologies developed for the North American transmission marketplace, which contained 89% of worldwide DWDM equipment shipments in 1998. According to industry analysts Ryan Hankin Kent, $3.1 billion was spent on optical networks in 1999, including DWDM equipment but excluding SONET equipment, with ten IXCs, led by AT&T and MCI WorldCom, accounting for 89% of that spending. IXC spending on DWDM was forecast to increase to $10.2 billion by 2003, with the local metro and interoffice DWDM market growing to just $1.1 billion by 2003.

Based on data from Ryan Hankin Kent, in terms of market shares of the $3.1 billion DWDM US market in 1999, with the exception of entrant Ciena (20%), the other leading DWDM equipment suppliers – Nortel Networks (37%) and Lucent Technologies (29%) – were established suppliers of SONET and pre-SONET transmission equipment to the US RBOCs.

Some established transmission equipment suppliers sought to accelerate their entry into supplying DWDM equipment, such as Nortel Networks' January 1999 acquisition of WDM multiplexing start-up Cambrian Systems Corporation. In December 1999, having acquired next-generation SONET product supplier Cerent a month earlier, Cisco Systems announced its $2.15 billion acquisition of Pirelli's optical systems business, leaving Pirelli with its tire business interests.

The relationship between SONET and DWDM was not straightforward. To manage a situation in their networks where traffic exceeds the capacity of a SONET ring, network operators have three options. First, they can lay more fiber and build another ring; second, they can upgrade the ring to operate at a faster speed; third, they can use DWDM. The first two options are too costly, so operators were beginning to install DWDM equipment around the ring, thereby expanding the number of channels. This produced a set of virtual SONET rings running over a single fiber. The virtual SONET rings share the same fiber, but each required its own set of ADMs. This is known as "SONET over DWDM." It contrasts with other approaches in next generation systems, which try to strip out the SONET layer, preserving only the SONET header to frame the data.

The increasing deployment of SONET over DWDM required SONET and DWDM interoperability. Both to achieve cost savings and to ensure greater interoperability, many telecom service providers chose to buy SONET equipment with integrated DWDM interfaces.

There was a significant cost (or technology) advantage available for DWDM suppliers that were also strong in SONET in virtue of the interoperability between these technologies, as shown in Figure 7.1 below. Equipment suppliers with a strong position in SONET technology have an enhanced interface card that they may use to connect with their proprietary DWDM systems, avoiding the need for an optical/electrical – electrical/optical conversion module in their DWDM systems.

The enhanced interface card in the SONET ADM of the integrated SONET and DWDM configuration has the effect that SONET and DWDM are more easily able to interoperate in these closed systems. What is critical to understand is, however, that the enhanced interface card would not interoperate with DWDM from a different vendor. Effectively, this placed a severe restriction on DWDM market participation for vendors who are not also strong in SONET transmission products, since DWDM from an integrated SONET vendor provided telecom carriers with lower cost and power-usage solutions. In the integrated solution, provisioning, maintenance and monitoring would be provided through a SONET software management system, such as JTech's JNMS product (see section 6.2).

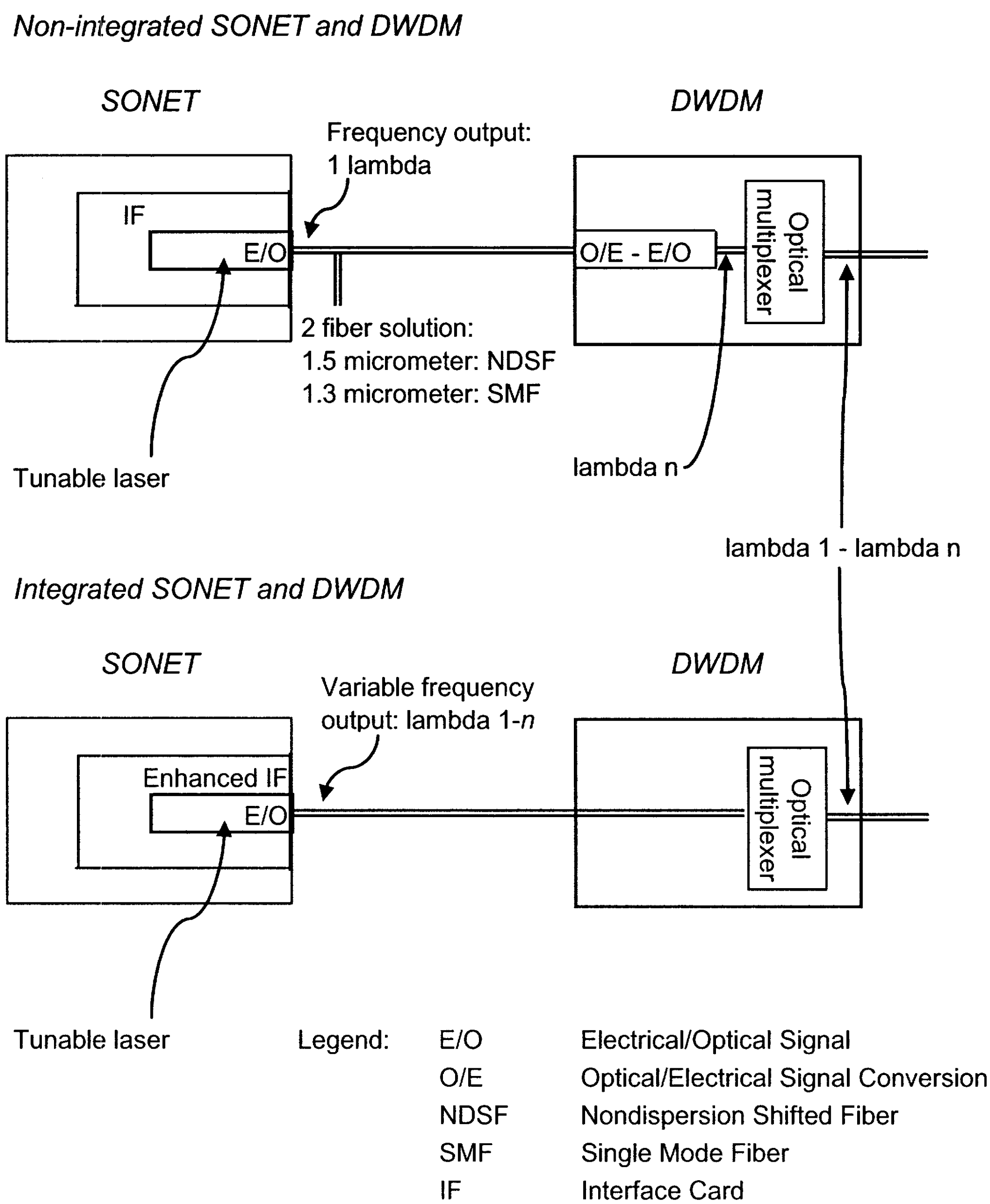


Figure 7.1: Non-Integrated SONET and DWDM and Integrated SONET and DWDM

It is for this reason that while Nortel Networks led in overall DWDM equipment shipments and increased its lead the DWDM market from 1989 to 1999, it dominated the market for integrated SONET and DWDM, with a 1999 market share of 80% (Pirelli 7%, Lucent Technologies 6%), based upon data by RHK. In contrast, according to RHK, Lucent Technologies led in the unbundled SONET and DWDM market with a share of 47% (Ciena 26%, Pirelli 13%, Nortel Networks 2%). There was growing importance attached to the interoperability between products based upon the two technologies and the complementarities between features of the two technologies. It is also important to recall the proprietary nature of SONET equipment (see Figure 6.1 and the associated discussion), despite ostensibly being an open standard, and the different strategies between equipment vendors (of being integrated across technologies or specializing in just one).

Nortel Networks was the incumbent cross-technology integrated supplier of SONET and DWDM, and its integration strategy was being followed by Cisco Systems, through the latter's acquisition of Pirelli's optical networking business and of Cerent's next-generation SONET equipment. In contrast, Lucent Technologies' strategy of focusing upon open (non-integrated) DWDM reflected its historical relationship as equipment supplier to AT&T, from which it split only in 1996. As a long-haul carrier, AT&T had particular problems in its fiber which it sought to resolve through installing DWDM transmission equipment. Moreover, as an IXC, it was more focused upon point-to-point transmission in its networks for which SONET's ring protection topology provided little value. While Nortel Networks had a late start in DWDM, lagging Lucent Technologies and Ciena, it overcame its handicap by its integrated technology strategy of being able to leverage into the DWDM market using its OC-192 SONET product lead.

Interoperability among equipment from different vendors was critical to service providers. Almost a decade after the development of the first SONET products, the Terminal products, Clive Dunsey, Vice President of Network Planning at RBOC Bell Atlantic was quoted in the April 6, 1998 edition of Telephony as saying, "The initial promise of SONET was interoperability between all suppliers" but that this promise had not come true ten to twelve years' later. In addition to interoperability, RBOCs continued to emphasize price, reliability, survivability, feature availability, and product availability when selecting their equipment suppliers. For integrated SONET and DWDM equipment vendors, the promotion of an integrated solution also had the effect of protecting their existing SONET businesses and of limiting the penetration of pure DWDM competitors, such as Ciena.

7.2.4 The US as Global Lead User Market and the Internationalization of JTech's Customers

During the 1990s, there was increasing convergence in global transmission systems. There were three principal drivers of this convergence. First, many more countries opened up their telecom markets to new entrants, both service providers and equipment suppliers. Second, some of the newer technologies were transferable globally, especially photonic technology. Finally, progress continued to be made on international standards by the International Telecommunication Union-Telecommunication Standardization Bureau (ITU-T), the Telecommunications Standardization Sector of the International Telecommunication Union (ITU) – see section 4.2 – as it leaned on regional standards' bodies, such as the European Telecommunications Standards Institute (ETSI).

More-or-less in tandem with these changes, both telecom service providers and their equipment suppliers began to globalize their businesses, offering the potential for greater returns to scale from more widespread use of their products. Increasing global scale had three potential benefits to equipment suppliers. First, they could receive a greater return on their fixed R&D costs from contributions from a higher volume of sales. Second, unit manufacturing costs in transmission equipment generally decline significantly as volume increases – the learning curve effect as production experience creates knowledge that improves productivity (Arrow, 1962). Third, equipment suppliers could transfer globally their knowledge about how to manage the product development and supply process. Especially, participants in the North American marketplace had many leading edge management practices and concepts, such as product planning, which were not widespread among the newly deregulating national telecom systems. Equipment suppliers honed in competing in the US were able to use their knowledge of managing competitively in foreign countries.

The global marketplace for telephone service provision had historically been highly fragmented, with each large country having its own national telephone service provider. For example, just as Western Electric used to be the monopoly supplier of transmission equipment to AT&T, Alcatel was the principal supplier of telecom equipment to France Telecom, Northern Telecom (Nortel) the Canadian national telephone carrier, and British Telecom equipment was supplied by its captive equipment supplier in the UK. These national monopoly supplier relationships led to deep tacit understandings between national carriers and their respective monopoly suppliers on such factors as testing, quality, and the intricacies of national wire/fiber networks. For example, I described in section 5.4 how European countries had adopted a different standard to SONET, known as synchronized digital hierarchy (SDH). European carriers had been less motivated to introduce standards because, through the 1980s, each country's Public Telephone & Telegraph (PTT) service provider was a monopoly that also had its own national monopoly equipment supplier, with no concomitant need for standards of interoperability among equipment from different suppliers.

While the future technology model continued to be uncertain, by 1999 US service providers were migrating to photonic technologies as a supplement or replacement for SONET-compatible products, because of the shortage of fiber and the rapid increase in fiber-based Internet usage. Therefore, compared to the past, future work on SONET products was expected to be limited to releases and upgrades of existing products, although Nortel Networks was testing a 40 Gbit/s. (OC-768) system. In other countries, such as Australia, new markets were emerging for DWDM. For example, in June 2000, the Australian carrier Cable & Wireless Optus, which has a fiber optic network consisting of over 8,600 km of inter-city cables linking Brisbane, Sydney, Melbourne, Adelaide and Perth, plus 9,600 km of cable in metropolitan and CBD areas, announced plans to increase its capacity 40-fold using DWDM technology supplied by Nortel Networks and JTech.

7.2.5 JTech, NTT, and the Changing Environment in Japan

As national carrier, NTT's network in Japan is broken down into two main segments, known as the local network and the long distance network. The long distance network in Japan is equivalent to the long-haul network of the North American market, while the local network in Japan is equivalent to the combined inter-office and access segments of the North American network.

On July 1, 1999, NTT was reorganized into a holding company structure. For the purpose of providing telephony services, NTT was split into three separate units. NTT East (including the Tokyo metropolitan area) and NTT West (including the Osaka metropolitan area) were to operate domestic local telecommunications networks, while NTT Communications was charged with operating the group's long-distance domestic and international calling services.

NTT had been deploying equipment based upon SDH in Japan from around 1988, although it will be recalled that the Japanese version of SDH varied from the European version, including in transmission rates. There were also differences in the quality of fiber laid. NTT's fiber network is generally of far higher quality than that of AT&T, so that it has had less pressure to use advanced technologies such as photonic technology, especially DWDM, to boost the transmission capacity of the network in Japan. In June 2000, NTT had still announced no migration path to DWDM. It was under no pressure to do so because (1) it had plenty of wire fiber; and, (2) a significant portion of Internet usage in Japan is from mobile devices, using wireless access technology such as i-mode. In contrast, most Internet access in the US was by wired connection.

The situation facing transmission equipment suppliers in Japan was in many ways the opposite of that of the US. In the US, the long haul carrier AT&T had poor quality fiber in its long haul network, while NTT Communications had much better fiber in its long distance network. Since AT&T had been unable to deploy 10 Gbit/s (OC-192) SONET TDM equipment in its network, it had alternatively been an early mover in adopting WDM technology to boost transmission capacity. In contrast, NTT Communications had an abundance of available bandwidth in its long-haul segment, and was only required to install multiplexers at a transmission capacity of 25% of that of the US, using 2.4 Gbit/s (OC-48 multiplexers). Not only did NTT Communications not even require 10 Gbit/s (OC-192) technology, neither did it need ring protection topologies in its network because it has a mesh network. A mesh network enables communication from source to destination by a number of possible routes, providing a dynamic re-routing of traffic when a line goes down. However, in the event of a fiber cut in a mesh, it would take longer than the 50 milliseconds taken to restore a SONET ring, since traffic is re-routed by a different route in a mesh. This would have been unattractive to US carriers for whom guaranteeing a delivery time for traffic was important.

On the other hand, in the local network, NTT East and NTT West faced greater capacity constraints and were upgrading their networks in three ways, each drawing from technologies developed for the US marketplace. First, both NTT East and NTT West were migrating their networks to 10 Gbit/s. (OC-192) capacity equipment based on technology developed for the US market by adapting SONET products to the Japanese SDH standard. Whereas the long-haul carriers in the US were the lead users of OC-192 SONET equipment, its lead users in Japan were the two local network carriers. Second, NTT East and NTT West began to introduce higher protection and quality of service ring topologies into their networks, the standards and technologies for which were first developed in the US marketplace. Third, the local companies in Japan started to introduce ADX SONET-type equipment into their networks, technologies also developed for the US marketplace.

7.3 Organizational Identity

In section 6.6, I discussed how the relationship between JNTS in the US and JTech Transmission Division in Japan had become more formalized, in response to specific problems that had arisen as both the Japan and US organizations had grown. There was a substitution of formal documentation for personal agreement, e-mails, and faxes, and an extension of JNTS's representation in the Transmission Division in Japan to protect JNTS's interests against the incursion of NTT. The newly established Product Planning & Project Management Department (PPPMD) in Kanagawa acted as an interface between the product planners in the US and the system integration teams and development engineers in Japan. It was staffed by Japanese individuals who had previously been assigned to, and spent several years working in, the US subsidiary. A dedicated North American Development Department was established in the Transmission Division in Japan.

In the language of Carlile (2004), we can think of this substitution of formalization in at least three ways. First, it can have served a purpose of transferring information, and certainly the volume of information had increased to a level where some additional more formal organizational arrangements for collaboration were required. Second, the new organizational arrangements can be seen as being needed to translate, or transfer meaning between JNC and the Transmission Division in Japan. Finally, the new arrangements would serve the purpose of protecting – or even promoting – JNC's interests against incursion by competing interests, such as those from groups aligned with NTT which may prefer to prioritize features on products that would suit NTT more than North American customers. The changed relationship seemed to fulfill each of these needs, but especially and increasingly the need to protect the North American interests after the transfer of Mr. Matsuura from Japan to his new role of President of JNC.

Early growth in employee numbers had been in manufacturing, and then in sales and marketing and in product planning, as designated functions (or "organizations" as they were called by JNC employees). The overall headcount at JNC (formerly JAI's Communication Division and then JNTS) was 250 in 1989, 750 in 1990, around 1,200 in 1994 and 2,587 in 1999, plus some 250 or so employees at a related company in the US. While data on earlier numbers are not available, by March 1999 there were 609 engineers at JNC, spread across a number of development centers in the US. The growth in these numbers, and the establishment of the development centers, is some evidence of the increasing importance of development engineering at JNC.

Given these changes, and the increase in size of the organization, it was difficult for employees to continue to enact the earlier identity of JNTS, renamed JNC in 1996, as an internal corporate new venture. Yet, the struggle continued to avoid attribution by organizational members to their organization that they were the default, a "Japanese subsidiary." With legitimacy in the US market having been awarded through its successes with its JDLC and ADM products, and with a very substantial increase in development engineering as a designated activity in North America, the identity continued to be ambiguous, torn between the fading earlier new corporate venture identity and an identity oriented around its expanding role in development engineering. JNC had, at this time, become the establishment through its success with products developed to SONET standards.

Supplementing the organizational model of an internal corporate new venture with autonomy as a motivation as a social form that had been available in the North American environment, the motivation for the claim as a development engineering organization seems more to have been about competency and capability. Nevertheless, JNC members continued to compare their organization to other development engineering organizations, especially the new, dispersed development engineering centers that were located near to other development organizations. To a large degree, these two identities as a development engineering organization and as a new venture appeared to coexist for some years from around 1995 through 1998, but as the extended North American bull market of the 1990s gained momentum, large US corporations again reintroduced corporate venturing actitivies, but based upon a different organizational model.

Within the transmission equipment industry, private equity significantly influenced the definition of what it was to be an internal corporate new venture. The sudden appearance of private equity funded new ventures, especially Cerent and Cyras Systems, would provide new challenges to designing internal corporate new ventures, as did initiatives in internal corporate new venturing by companies such as transmission industry incumbent Lucent's New Ventures Group (see next Chapter).

7.4 Organizational Capabilities

The crucial underpinning of the development engineering organizational identity came from an organizational capability that had been learned in Japan and recontextualized to the North American institutional and cultural environment, that of so-called "job sharing." It was the job sharing organizational capability that really made JNC and reinforced its identity as a development engineering organization, which in turn enabled JNC to hire the key development engineers it needed to develop the ADX products. Let me describe some of the context and background to the expansion of development engineering in the US and then describe how the pattern of job sharing evolved as it moved over time from Japan to the US context.

I can identify from my data four contextual factors that are background to the increase in development engineering in the US and to the concomitant shift in the overall balance of development work from Japan to the US.

First, there was an issue of resource availability. JTech in the US was generating significant sales from its ADM products, reaching more than $2 billion in 1999, while JTech's sales to NTT were declining (as it share of those sales was increasing). At the time, up to 80% of Tochigi manufacturing in Japan was dedicated to production for the US marketplace. It seems that JNC was able to fund its own expansion within the US. Second, Japan had entered a long recession that became commonly known as the "lost decade"; economic expansion came to a halt in Japan during the 1990s. There were resource constraints within JTech in Japan, and JNC was able to overcome these by building a local development organization in North America. Third, NTT spending on new capital equipment fell significantly, so even within Japan development engineers within Japan shifted to work on US products, by joining the North American Development Group within Japan. However, this was not enough and many of the engineering skills that JNC needed for the ADX products were only available within the US. Skills in technologies such as Asynchronous Transfer Mode (ATM), for data transmission to supplement SONET in JTech's ADX products, were not available in

Japan. For ATM skills, JNC expanded in the US to New York to tap into a local pool of ATM engineering talent, largely in the form of ex-Lucent Technology employees.

Even had an ATM talent pool existed in Japan, JTech would have been unlikely to have been able to tap into it. Large Japanese firms are generally unable to recruit laterally and bring in the additional skills and experience to meet increasing demand. For example, it was almost unheard of for JTech to recruit mid-career engineers from its competitors. Equally, large Japanese firms are more likely to rotate engineers among projects to adjust resources to meet fluctuations in demand. I mentioned an example of this above, when as NTT transmission equipment purchases declined, development engineers – whom one presumes would have been laid off in the US – were transferred to work on products being developed for the North American market. One effect of this is that, while engineers in Japan gain a broader experience than in the US, they have to learn on the job in a new development field, whereas as US firm may more rapidly hire in staff with the requisite skills and experience. In a sense, the internal transfer of engineers without the requisite experience of developing products for the North American market to work on developing JTech products was an incapability.

There was one further factor related to the build up of development engineering in North America that is directly relevant, apart from the capability to do so. As an apparent result of political struggle among senior executives in JTech headquarters in Japan, while the highly centralized personnel department in Japan (*jinjibu*) had tight control over human resource management (HRM) policies in Japanese domestic operations, its control over overseas operations was severely restricted. Its overseas power was more-or-less limited to a single executive who was on the front line of Japan HRM in trying to carve out at least some role for *jinjibu* in overseas operations. To illustrate the limits of his work, he could take initiatives such as centralizing payroll operations across subsidiaries from different development divisions within the same country so as to achieve economies of scale – but even this was only with the consent of the respective subsidiaries.

On the other hand, within Japan, HRM as a designated function has more-or-less equal power with the business groups, reflected in senior board level appointments. This is a weaker level of power relative to older, more established large firms in Japan due to the particular history of JTech (see section 3.2). In the older firms, HRM is relatively strong compared to JTech in its home country.

In JTech, the only corporate headquarters control on overseas recruitment was indirect. The business groups would send their budgets for approval to the accounting group in JTech corporate headquarters, where it was the accounting function that indirectly controlled overseas headquarters headcount through reviewing and approving their business plans. This was considered by Japan interviewees to be a "softer constraint" on overseas hiring, since the accounting department looked at the overall business. Moreover, the head of the accounting group in JTech headquarters, an Executive Vice President, was more senior than the head of JTech's HRM function at Board level. Crucially, therefore, at the time of a hiring freeze in Japan, JTech was nevertheless able to continue to hire internationally if such hires were included in business plans submitted to JTech's accounting group and approved. The drive to reduce Japan headcount coupled with the softer constraint on US headcount was a significant aspect of the build up of development engineering within the US.

Now, the period following the development of the ADM products had been one of significant growth in the transmission equipment industry in the US, with significant excess demand for the development engineers with the requisite knowledge and experience to develop leading-edge transmission products. It might have been thought that this would have placed JNC in the US at a disadvantage relative to its US competitors, such as those with a non-Japanese parent company or from start-ups. Had JNC been a "Japanese subsidiary," this surely would have been the case.

Yet, enabled by its identity as a development engineering organization, JTech was able to successfully hire the engineers in the US to build up its development engineering capability. To rapidly grow its North American development organization, JTech needed to hire very good engineers. When I asked managers and engineers an unstructured question about what motivated good engineers to change employers, none of the US interviewees mentioned salary or remuneration. Instead, the consistent answer was that crucial to the ability to hire good engineers was being in the position to offer the engineers good work from day one. This is supported by a central finding of Gideon Kunda's ethnographic study of engineers and engineering culture, that members of high tech firms invest heavily not only their time and effort, but also their thoughts, feelings, and self-conceptions into their work (Kunda, 1992). While in many jobs people view work as a way of providing an income, work identity is more crucial in knowledge work (Alvesson, 2004), which includes development engineering.

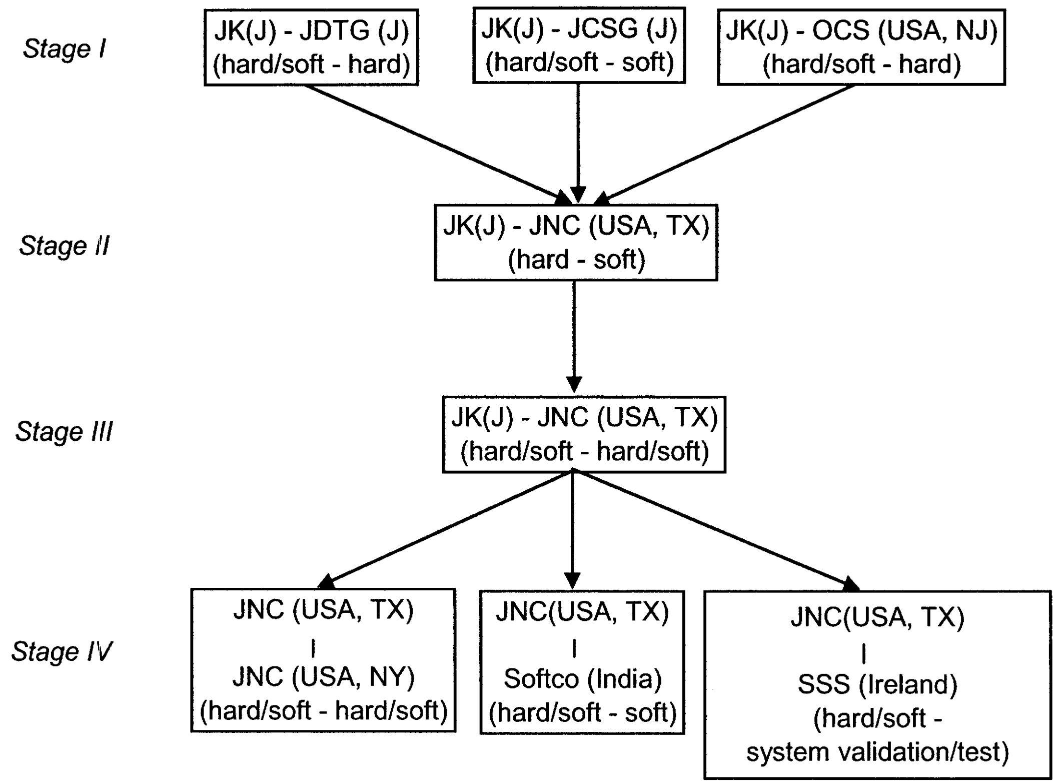
Since I was only interviewing employees of JTech, I cannot rule out sample selection bias, that perhaps monetary rewards were more important than my interviews admitted, but that those for whom it was more important went to work for other firms where they were more amply rewarded. Similarly, perhaps I was picking up respondent bias – people don't like to admit that they are motivated by money. However, senior managers were passionate in their belief during the development period of the ADX products JNC had successfully recruited some of the best engineers in the industry. How?

During the development period of the ADM products, the then JAI Communication Division and its successor JNTS had successfully hired in a highly regarded cadre of senior executives, as I discussed in section 6.4. Its organizational identity as a new venture had strongly shaped that capability, but the capability was distinct from that identity (i.e., not conflated) and based upon a number of contributing factors, such as location and giving control to employees.

During the development of the ADX products, that JNC had hired well was evidence of the organizational capability, but it was not the capability. Equally, the organizational identity as a development engineering organization was distinct, and must not be conflated with the organizational capability. In the language of my interviewees, JTech was able recruit as effectively as it did through a set of practices that were known as job sharing in development engineering. The critical organizational capability was *job sharing*, which means the effective management of collaborative development engineering across dispersed locations. This was, it will be recalled, a capability that JTech Japan had learned in the 1980s among collaborative development among between and among the Transmission Division's headquarters and its network of hardware and software development subsidiaries, JDTG and JCSG (see Section 4.4). Having learned job sharing within Japan, the Transmission Division was then able to adapt and transfer the practices underlying job sharing internationally. Job sharing was closely related to job partitioning. Interviewees described how job sharing within development engineering had evolved through four identifiable stages of collaborative new product development. The *meaning*, *scale* and *scope* of job sharing changed across each successive stage. The four stages are shown in Figure 7.2.

During State I, development of the Terminal products, the Transmission Division in Kanagawa had learned to collaborate with its hardware and software development subsidiaries, JDTG and JCSG respectively, across various locations within Japan (see section 4.4). From its headquarters in Kanagawa, the Transmission Division also outsourced software development to a software development company based in New Jersey, USA, which I call OCS.

In Stage II, JTech's Transmission Division started job sharing on the development of a local access product, JDLC II (the successor to the JDLC discussed in Chapter 4, with JNTS/JNC in Texas. However, this first case of job sharing was unsuccessful.



Legend:
JK: JTech Kanagawa
JDTG: JTech Digital Technology Group
JCSG: JTech Communication Systems Group
JNC: JTech Network Communications
Softco, OCS, SSS: Pseudonyms
hard/soft: hardware/software

Figure 7.2: The Recontextualization of "Job Sharing" across International Borders

The reason that Stage II job sharing was unsuccessful was that it had transferred imperfectly from the home country environment, in large part because the reasons for the success of job sharing within Japan were not explicitly understood. When hardware and software were developed across distance in Japan, the development process was managed through two interface departments, shown on Figure 5.1 (above) as the Communication Circuit & Device Technology Division and the Software Development Department, respectively. Both interface groups belonged to the Transmission Division. The existence of these interface groups meant that hardware and its associated software could be (and was) developed in different geographic locations. However, a critical difference in Stage II job sharing between the Transmission Division in Japan and JNC was that, while software and hardware were developed in different locations

(Texas and California, respectively), there were no interface groups. This basis of a technology split, without the interface groups, turns out to have been ineffective. What the collaborating organizations learned in Stage II, the development of JDLC II, was that in the absence of effective interface groups, job partitioning involving a geographic separation of hardware from its embedded software fails.

With this experience, in Stage III, the development of the ADX 600 and SPARK 192 10G (OC-192) products, the development engineering organizations in the US and Japan redefined job sharing as requiring the co-location of development work on processes (software) with their respective processors, in a more modular approach requiring job partitioning.

Once this had been learned, in Stage IV JNC in the US applied this knowledge to collaborative product development across different locations within the US and between the US and India and between the US and Ireland. Job sharing in development engineering was managed both across borders and within the US by formal written documentation, primarily a Project Plan and a Job Sharing Agreement.

By the time JNC in the US had adopted and institutionalized job sharing in development engineering within Japan, the content of this practice was different to job sharing within Japan. The absence of an organizational membrane of interface groups in collaboration between Japan and the US, coupled with cross-border differences in management systems (see below), led to the changes.

In contrast to how both US and Japanese engineers had interpreted the experience of job sharing within Japan, the appropriation of the label *job sharing* to the US context and its redefinition within the context of development projects dispersed across the US in Stage IV meant conformity with the following three JNC explicitly established rules for partitioning work:

1. Keep software development for a unit (or processor) co-located with hardware development of that unit at all times.

2. Match skill sets of sites and the local area e.g., the technologies underlying the SONET standards in Texas and ATM in New York.

3. For outsourcing portions of software only, software need not be co-located with the corresponding hardware development.

The learning of job sharing and its evolution went hand in hand, during which process the meaning of job sharing changed in two senses. While job sharing began as a means of sharing work across dispersed and distant locations, its meaning was subsequently expanded to include its being a practice for the purpose of hiring new employees. Second, job sharing had limits defined by the embeddedness of software and hardware technology. Job sharing came to mean a tool for hiring based upon the capability of sharing work, within certain technological limits. The *scope* of job sharing also changed, as it was adapted to collaboration across different contexts, from within Japan in Stage I to within and from the US in Stage IV. Finally, the *scale* of job sharing changed in the sense that, once used in a project, it was used for other projects in the same collaborative organizational relationship.

An interviewee within the US nicely summarized the organizational capabilities of the development periods of the ADM and ADX products, respectively, when he described the importance of job sharing in development engineering this way:

> "When we started building the organization, we started job sharing. And, in fact… I talked before about how difficult it was to attract people in here [Texas]. And, the thing that you really need to attract good people is, first of all you need to start with a core of good people. So, fortunately we could do that because of our ties to Siemens. But, then you also you need good work. And, even though we were still very small, the job sharing allowed us to put some really high tech work in front of people."

The same interviewee also spoke to the strategic implementation of job sharing, when he described how JNC had applied this organizational capability in setting up its New York development organization:

> "And, then it got all the way to ADX 150, which is done entirely in the US, between Texas and New York. So, actually we just moved the job sharing thing around – it is still job sharing – between different locations. But, it is just the US locations now. So, even there we were able to do the same thing. Start an organization from scratch, with brand new people, and they immediately got to do some very challenging work, because they got to work with the people in Texas here. *So, the models worked pretty well.*" [emphasis added]

Ron Finch had put it this way:

> "The challenge of finding sufficient numbers of talented engineers has slowed our growth, but not resulted in significant delays to product rollouts. Within the past three years, I've been forced to open R&D centers in California and in New York, because I had to take the mountain to Mohamed."

Job sharing appears also to have been a unique capability of JTech's Transmission Division. One interviewee, with substantial industry knowledge learned through a lifetime of experience and contacts, spoke to this:

> "We are actually I think, certainly as far as I know, the only Company that has really figured out how to do that [job sharing] well. I know that Lucent does it, but in New York we have quite a lot of Lucent people, and I know it is a struggle within Lucent."

> "I have seen job sharing being attempted in Siemens and at Alcatel, and like you said, Europe is a lot of little places right, so culturally there is no problem, although with Alcatel between the French and Germans there is always a problem, right? Definitely culturally there is no issue. But, from a technical perspective they never really figured out how to do it. It was always these big global systems... So, anyway, we figured out job sharing."

One of the difficulties experienced by JNC in job sharing may be attributed to learning, or adapting to job sharing from co-location of development. Japanese organizations have been noted for their dense patterns of communication relative to US organizations. Yet, despite this, a US interviewee made the following observation:

> "I think that Japan works in a very distributed environment. You basically get together as a group during a design review, you set direction, and then they go off and they may assemble back two months later, whereas in the United States there is a constant need for communications. You know, 'how well you are doing?' And, we almost want to know almost every day the status of things, and it requires a lot of coordination and communications and that is how we kind of work."

7.5 Strategy

The business strategy adopted by JTech's Transmission Division and JNC during the 1995 to 1999 period comprised two strategic thrusts, based upon its effects on the US-based organization. Within the US, JNC's business strategy was strongly influenced by its host country organizational identity as a development engineering organization and by the organizational capability of job sharing that this enabled. I consider this in section 7.5.1. Further, however, it was also evident that the organizational capabilities of JNC influenced the Transmission Division's business strategy in relation to NTT in Japan (discussed in section 7.5.2 below).

7.5.1 Strategy for the US Market

During the mid-1990s, JTech made no significant new transmission product introductions into the US marketplace, although its sales of ADM products increased dramatically. However, at the 1999 SuperComm transmission industry conference and trade show in Atlanta, Georgia, JTech made a series of new product announcements of products that had been under development since around 1995. These were:

- The SPARK 192 10G. This OC-192 SONET ADM product was initially designed to meet the high-capacity needs of long-distance carriers, the IXCs. It was effectively a higher speed extension of the earlier ADM products – OC-192 – compared to a maximum OC-48 on the ADM 2400.

- The SPARKWAVE 320G DWDM system, also aimed at meeting the high-capacity needs of the long-distance carriers, the IXCs. JTech subsequently offered an inter-office version of its DWDM product, SPARKWAVE Metro, targeted at its key RBOC customers.

- The ADX 150 and ADX 600, targeted at its traditional RBOC customers. These were the first two of a family of integrated SONET and Asynchronous Transmission Mode (ATM) ADMs. This was the first part of a new generation of SONET and data transport multiplexer. The ADX 600 incorporates SONET, asynchronous transmission mode (ATM) and Internet Protocol (IP) data interfaces, the latter two standards and technologies more suitable for the transmission of data. For lower bandwidth transmission, the ADX 150 product family similarly incorporated a variety of data interfaces, including ATM. JTech subsequently announced the OC-48 model, the ADX 2400, at SuperComm 2000.

By way of explanation, ATM is a different communication protocol from SONET, more suitable for transmitting the "bursty" character of data. "Bursty" means that the ratio of the peak data transmission rate to the average data rate is high. A problem with transmitting data over SONET is that SONET always consumes the peak rate. ATM is an asynchronous technology, which means that it works with a variety of bit rates and manages bandwidth accordingly. It is, therefore, more suitable for data transmission than SONET. By using ATM, service providers can avoid paying huge amounts for data pipes that are mostly idle except at peak usage times or suffering long delays at peak times with a less-expensive small data pipe. Traditional synchronous transmission protocols, such as SONET, are highly intolerant of timing variations on transmission.

JTech's ADX products were bundled into, and marketed as, two separate "solutions" for its two customer categories, the IXCs and the RBOCs. These so-called solutions were simultaneously a vision of the future of the public network, a vision that saw a continuing role for both SONET and DWDM.

Turning, first, to the long-haul segment of the US public network, operated by the IXCs, JTech's offered a long-haul solution. This comprised a long-haul transmission network based on SONET and DWDM, using JTech's ADM 2400 product and its ADX products. JTech's long-haul solution set included multiple possible network architectures, but it was a vision of the transmission network with integrated SONET and DWDM. In addition, the ADX 600 would enable telecom service providers to offer a wider range of services to their customers, especially services using more data in transmission. The underlying products were designed to be upgradeable.

Turning next to the inter-office segment of the US public network, operated by the RBOCs and CLECs, JTech offered a heavily SONET-based inter-office solution for RBOCs and CLECs, but with options to include WDM in the form of JTech's SPARKWAVE Metro product. Interconnection between the SONET and WDM elements was emphasized in the design.

I described earlier in this Chapter how JTech was the only one of the three dominant SONET equipment suppliers not to have presence in the DWDM equipment market by 1998. By 1999, JTech had a 1% share of the DWDM market, accounted for entirely by its presence in, and 3% share of, the integrated SONET and DWDM market. In contrast, NEC, with no SONET market presence, had gained a 7% share of the DWDM market where SONET and DWDM are not bundled, reflecting NEC's relative weakness in SONET products and underlying technologies.

With regard to its first wavelength division multiplexing product announced in 1999, the SPARKWAVE 320G DWDM system, JTech was late to market, though it had been early to innovate with the technology. There was much discussion within JTech, even at JTech Board level in Japan, about why JTech's Transmission Division had been late to market with its first DWDM product.

JTech had not been significantly behind Lucent Technologies in developing DWDM technology, but it lagged the leaders to market with its first DWDM products in the US, SPARKWAVE 320G, by four years. Lucent Technologies and Ciena had announced their first WDM products in 1995, four years earlier than JTech. During this four year period, JTech continued to focus upon adding features to its existing ADM products, designed for the RBOCs, with successive product releases incorporating feature enhancements.

WDM was developed by JTech Laboratories around 1992/3, some two to three years before it first appeared in the US, introduced to the US marketplace by Lucent Technologies and Ciena in 1995. A JTech Laboratories' interviewee explained that it had good early information that Lucent Technologies, in its pre-1996 form as Bell

Laboratories, was serious in developing WDM technology. This information came direct to Japan from conferences and from component vendors, not from JTech's transmission business division. So, JTech had not been significantly behind its competitors in developing the underlying WDM technologies. The lag was in developing and introducing products based on WDM to the US marketplace, the responsibility of the Transmission Divison and its US subsidiary.

My data revealed the existence of two stories of possible explanations for this delay that circulated within JTech – I suspect that either and probably both played a part. The two stories were:

The Transmission Division's (Japan's) strategic focus and attention on NTT

It will be recalled that Lucent Technologies developed WDM technologies to overcome AT&T's bandwidth constraints from high dispersion (distortion of waves on transmission) on its installed fiber, which made high-speed transmission difficult. Since AT&T's fiber has polarization mode dispersion (PMD), it could not deploy higher-speed OC-192 TDM equipment. In contrast, NTT's network generally has higher quality fiber with low PMD values, and so NTT did not need WDM technologies. The first story purporting to explain JTech's lag in introducing WDM into the US marketplace was that the Transmission Division was increasingly preoccupied with the needs of NTT in Japan and for this reason did not promote the development of DWDM products. WDM was not a high priority for NTT in Japan.

JNC (US's) strategic focus and attention on the RBOCs

In the US, JNC was focused upon meeting the needs of its RBOC customers in the inter-office network. The RBOCs were not the DWDM lead users. DWDM lead users in the US were AT&T and other IXCs in the long-haul segment of the network. Neither JNC, with its RBOC focus, nor the Transmission Division, with its increasing NTT focus, was motivated to develop a DWDM product in 1995, despite the fact that the underlying technology was available in JTech Laboratories. So, the story goes, divisional headquarters in Japan and its US subsidiary were both focused on other business. This is supported by the fact that, according to JTech Laboratories, neither the division in Japan nor its US subsidiary requested WDM technology.

When the Transmission Division eventually started to focus on DWDM, it was for two reasons. First, in the US products based on DWDM technology began to migrate from the long-haul segment of the network, where the IXCs had first used it, to the inter-office segment of the network operated by the RBOCs; JNC's traditional customers began to ask for a product that JTech had not prioritized. Second, market forecasts of equipment purchases in the US from around 1996 were beginning to indicate that future expenditure on transmission equipment would be much higher in the long-haul segment of the public network than in the inter-office segment. This resulted in JTech making a strategic shift to focus more on the IXCs as customers, customers of DWDM technology products.

RBOCs were faced with a situation in 1997 with still having 30%-65% asynchronous architectures in their local networks. A major focus for the RBOCs remained replacing these asynchronous structures with SONET rings, with products such as JTech's ADM products. It was the RBOCs competitors, the CLECs, which were the lead users of DWDM in the inter-office networks. Many local carriers were seeking to combine TDM and WDM equipment, such as by combining higher channel WDM at lower SONET bit rates, such as OC-12 (0.6 Gbit/s.) and OC-48 (2.4 Gbit/s.).

To try to mitigate the effects of being late to market with its WDM products, JTech attempted to provide enhanced functionality compared to competitors' products. For example, SPARKWAVE 320G WDM allowed carriers to transmit further without regeneration than any competitor WDM product then available on the market. JTech offered a long haul, high capacity DWDM version of SPARKWAVE 320G WDM and a WDM product called SPARKWAVE Metro for local area networks.

7.5.2 Strategy for the Japan Market

For many years, NTT had expressed no interest in the additional functionality provided by features of products that JTech developed for the US market. For example, interviewees in Japan explained that NTT had not requested ring topology in its local network. Eventually, however, it was JTech among NTT's various equipment suppliers that had conceived of, introduced to and promoted within NTT East and NTT West the concept of ring protection architecture.

This idea originated within the Transmission Division's Systems Development & Planning Department (Japan), which was different from the similarly named Department in Japan that interfaced with JNC Product Planning (see Figure 6.2). To learn more about how the ring architecture worked, Systems Development & Planning Department (Japan) sought information from two sources. First, it collaborated with its namesake in Japan for the North American marketplace. Second, it worked directly with JNC Product Planning, where Systems Development & Planning Department (Japan) had assigned a Japanese employee to work under Ron Finch and Will Paulson.

While the ring topology was a concept that could be marketed as attractive to NTT as a carrier, JTech in Japan had also clearly understood the business model implicit in the reconfigured technology. NTT's local network in Japan had been a point-to-point topology. Using terminal multiplexers, a telecom carrier can mix and match vendors' equipment at either end of a line. For example, an NEC multiplexer might have a JTech multiplexer at the other end. In ring topologies, however, as Figure 6.1 shows, all the multiplexers in a ring need to be supplied by the same vendor.

JTech in Japan learned from JNC not just the technology and the ability of a telecom carrier to charge clients higher fees for more reliable services. It also learned that the competitive model in equipment sales changes with ring topology multiplexers. In the US, vendors are selected by geographical area. For example, one part of Bell Atlantic's local and interoffice network might have all JTech equipment, and another geographical area might have all equipment supplied by Nortel Networks. The Transmission Division in Japan learned from its US experience the transmission equipment business model that SONET deployment in rings provides added protection to carriers' networks, but effectively creates a market structure of local monopoly equipment suppliers in each geographical area.

Systems Development & Planning [Japan] Department did not approach NTT Communications about a ring topology, because NTT Communications had a mesh network for protection, and this point-to-point topology provided many of the advantages that would have been provided by a ring architecture. Further, NTT Communications had adequate bandwidth, and did not require 10 Gbit/s. (OC-192) equipment, but was content with 2.4 Gbit/s. (OC-48) equipment. To service NTT Communications, JTech had adapted its ADM 2400 product that had been developed for the US market, removing the ring functionality to create an JLM 2400 LTM ("line terminal mode") point-to-point product tailored to the needs of NTT Communications.

The needs of NTT East and NTT West were quite different. JTech worked at many levels within the NTT East and NTT West organizations to promote the idea of a ring protection topology, with the result that NTT East and NTT West divided up their areas into prefectures and awarded exclusive equipment supply contracts for each area to single suppliers. JTech primarily achieved NTT's acceptance by meetings, seminars, and presentations targeted at lower level NTT employees. Traditionally, NEC, JTech, Oki, and Hitachi had supplied NTT local and long distance equipment in Japan. However, of these four only JTech was one of the leading SONET equipment vendors in the US marketplace. Other than JTech, with a 21% SONET market share in the US in 1999, only NEC had a SONET presence, with just 3% of the North American market that year.

NTT East and NTT subsequently invited proposals and awarded contracts to supply 10 Gbit/s. (OC-192) ring topology equipment to the local networks in Japan. Crucially, JTech was able to adapt its SPARK 192 10G (OC-192) product developed by the North American teams in Japan and JNC to create a product for the NTT local carriers called SPARK 192J. As explained in section 7.6, the development of SPARK 192J and SPARK 192 10G for the US market was eventful.

In the prefecture-based allocation of geographical areas in Japan, NTT East awarded JTech the contract to install SPARK 192J in the Tokyo metropolitan area, and NTT West awarded JTech the contract to install SPARK 192J in the Osaka metropolitan area. These were the two most important local markets in terms of value of equipment to be deployed into the local networks. Interviewees estimated that the effect of JTech's success with SPARK 192J was to change market shares in selling transmission equipment to NTT as a whole (the three NTT service providers) so that, having lagged NEC (40%) with a 35% share of NTT's expenditure on transmission equipment around 1997, but 2000 both JTech and NEC had equal 35% shares of that market. JTech had used its US experience and knowledge to catch up with NEC in its home country marketplace. The transmission equipment market size in the combined local and long distance NTT networks was some $12 billion in 1999.

7.6 Organizational Structure

The challenge of implementing these new dimensions of JTech's Transmission Division's strategy, given the underlying capabilities on which it was based, led JTech to make three key changes in the Division's organizational structure and inter-organizational collaborative relationship between JTech and JNC. The effect of these changes was, however, once again to stress the organizational identity that was claimed for JNC and this created an unsettled period for JNC and the Transmission Division.

The first change in organizational structure was in the home country organization. The Transmission Division had adopted a strategy of developing similar products for the US and Japan markets, namely the SPARK 192J for NTT East and NTT West, and the SPARK 192 10G for the US market.

While adapting products between SDH and SONET standards involves major design changes in firmware and software, changing from SONET to SDH also requires some minor changes in hardware LSI design. The Transmission Division in Japan had developed the point-to-point hardware component of OC-192 and had the knowledge of how to design the associated hardware for the ring architecture through its having developed this functionality on the earlier ADM products. Therefore, the Development Group in Japan worked on the design of the additional hardware components for the ring architecture tailored to the specific needs of NTT, in conformity with the SDH standard.

Figure 6.2 shows product planning in Japan as broken down into separate departments, by geographical area of responsibility. It was only after commencement of development of OC-192 for the North American market that the Transmission Division's Systems Development & Planning [Japan] Department approached NTT East and NTT West, NTT's two local operating companies in Japan, and sought to persuade them to deploy OC-192 equipment in their networks. They argued that this would provide both higher quality of service through the ring architectures and higher transmission capacity, at OC-192. These were among the very same reasons that SONET had been adopted within the US.

To manage this broader development effort of OC-192 products, the Transmission Division redesigned its home country organization to that shown in Figure 7.3 below, which can be compared with the core product planning and development organization and relationships in the earlier ADM product development period, shown in Figure 6.2.

The first important change in the current development effort, of ADX and associated products, was that that the Kanagawa-based development departments for the North American and European markets merged, as the Transmission Division sought to use the trigger of the acceptance of a ring topology into the local network in Japan to create a global platform approach to development. The second was that the activities of system development and planning were now integrated into a global Product Planning & Project Management Department. The first product planned to pass through this new organization design was Release 4.1 of SPARK 192 10G, intended as a global platform product, projected to achieve economies of scale and scope in development.

The second change to the organizational structure was that JNC established its own network of development engineering centers, dispersed across the US, in California, New York, and Massachusetts. The New York facility was newly established in an area in which many ATM-specialists worked for Lucent Technologies, the California facility was similarly in an area where many engineers skilled in Internet Protocol lived and worked. JTech made one acquisition, in 1997, when it acquired a 1995 start-up, Newco, a Massachusetts-based computer networking firm. Newco had developed the first telecom carrier-class ATM switch. JTech's reasoning was that by acquiring Newco it would not have to develop an equivalent technology itself and could bring such a switch to market more quickly.

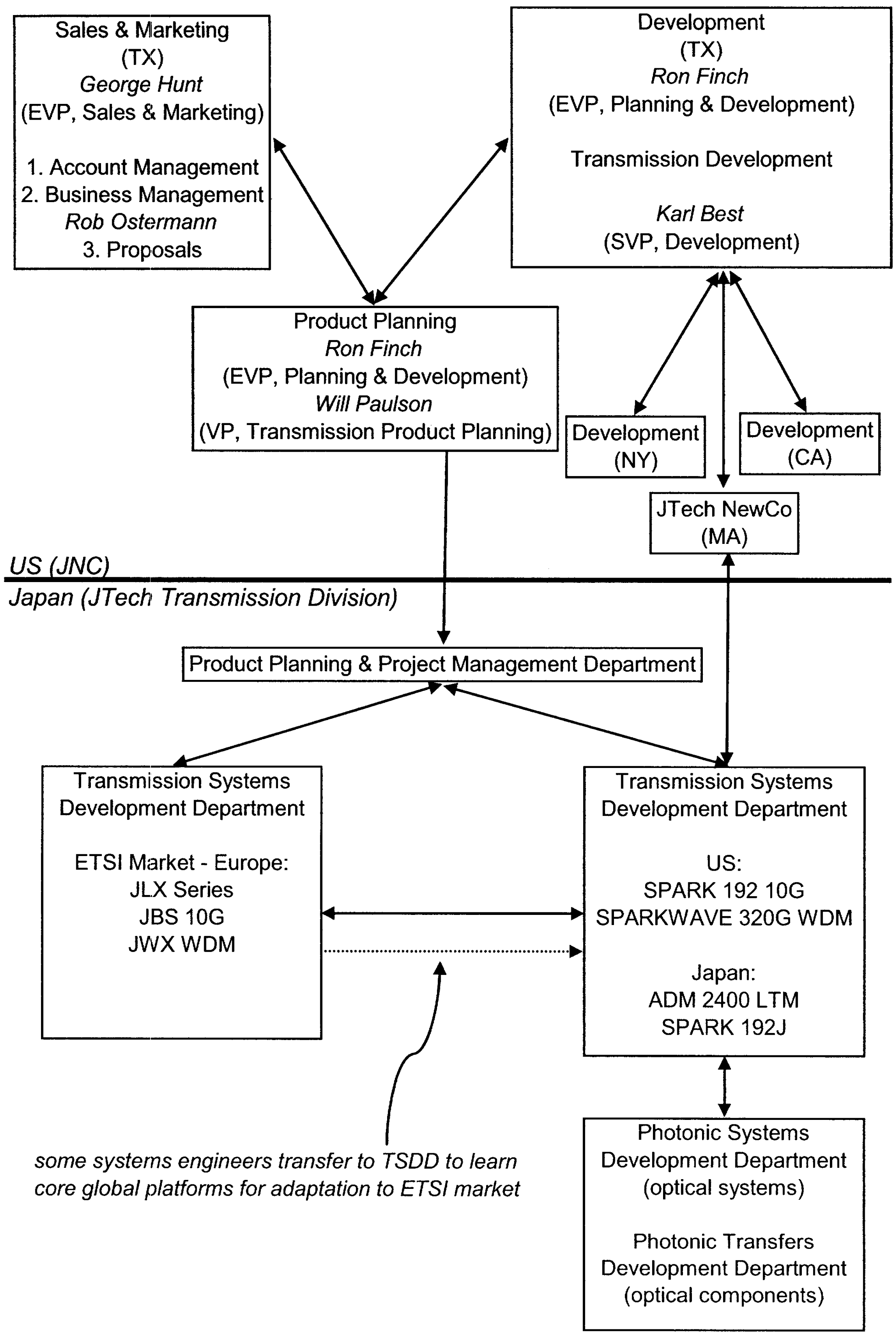


Figure 7.3: Changed Organizational Structure and Relationships from 1996

The final major organizational change was that new organizational structures were put in place to deepen the relationship between the Transmission Division, its US organization (JNC), and JTech Laboratories, the part-corporate and part-division funded research arm of JTech that was responsible for longer-term research. I mentioned in section 5.4 that, since NTT and NTT Laboratories had cut back their transmission activities, JTech Laboratories increasingly needed to develop a capability to define their own direction. At this time, many of the new technologies underlying new products being introduced to NTT were based upon technologies such as photonics, for which the US was the strong home base. In this context, there were two significant changes in the relationship between the Division and JTech Laboratories during the period of developing the ADX products

The first of these was an increasing depth and frequency of contact between the Transmission Division in Japan and JTech Laboratories. During the ADM products' development, JTech Laboratories and the Division held a major twice-yearly executive meeting to discuss strategy, of some three hours' duration. Other divisional or departmental level meetings were more frequent. Technology transfer from the Laboratories to the Division was a gradual process. Prior to hand-off to the division, engineers from the business side move to JTech Laboratories, where they develop a prototype system. At the time of handoff, the divisional engineers and some JTech Laboratories engineers move to the division. Subsequently, the JTech Laboratories engineers do not return to the Laboratories, but remain on the business side, where they become leaders. This relationship between JTech Laboratories and the Transmission Division in Japan deepened during the ADX products' development period, reflecting a greater need for technology to respond to the pull from the market, especially lead customers.

The second change was that JTech Laboratories and JNC in the US established their own direct relationship, which by-passed the Transmission Division in Japan. During development of the ADM products, information from JNC in the US was passed first to the Transmission Division in Japan, and then part of this was sent on to JTech Laboratories. However, the increasing pace of change in optical networking technologies in the US created a need for unfiltered and faster communication between the US subsidiary and JTech Laboratories. During the ADX products' development period, JTech's Optoelectronic Systems Laboratory, Network Systems Laboratory, and JNC in the US established a system of twice-yearly weeklong meetings, *excluding* the US organization's parent, the Transmission Division in Japan. JNC was also considering directly funding the development of key technologies in JTech Laboratories, by-passing the Transmission Division, apparently for two reasons – for fear that resources may otherwise be diverted to other areas and to speed up new technology development.

The establishment of a direct relationship between JTech Laboratories and JNC was interpreted by one interviewee as resulting from a conflict between JNC in the US and the Transmission Division in Japan over control of the research direction of JTech Laboratories, especially whether to focus on developing technologies that are important for the US market or for the market in Japan. The Division in Japan would coordinate requests for new technology across the various world markets, while JNC was concerned primarily with the US market and the global activities of its US-based customers. In setting up a direct relationship with JTech Laboratories, JNC hoped, first, to influence the direction of the research effort and, second, to perhaps fund research from its own resources. It was considered by some in JNC that JTech Laboratories may prioritize developing technologies for the domestic market and for the particular needs of NTT.

Each of these changes to the organizational design was, on one level, consistent with the organizational identity claimed for JNC, that of a development engineering organization. For example, the global platform approach to development, influenced by the Transmission Division's job sharing capability and implemented through its dispersed network of development centers across the US, enabled JNC to engage in a broader scale and scope of development engineering activities for products destined for global markets. Equally, both practically but especially symbolically, the direct link between JNC and JTech Laboratories enhanced JNC's role and status as a development engineering organization, on a par with the Transmission Division itself in Japan.

However, these organizational changes led to a number of events that threatened JNC's identity as a development engineering organization. One of these was triggered by collaborative development engineering between Japan and the US on the first global platform product to be developed, Release 4.1 of SPARK 192 10G. After the decision to develop a global platform, the newly merged Transmission Systems Development Department (TSDD) in Japan continued to rely upon JNC to deliver the basic and application software for Release 4.1, to which it planned to add features specific to the needs of NTT Communications. However, TSDD in Japan requested JNC to make certain modifications to the software that would make the basic software layer more of a common platform that could be subsequently be managed for both NTT and US customers. On top of this basic software platform, software development engineers in each country would add the software application layer tailored to the differing needs of each country. The assumption underlying TSDD's plan was that it would be more efficient to manage, maintain, and upgrade a common "global" software platform across the two countries than two separate basic software platforms.

However, JNC indicated that that it did not have the resources to undertake the work, so the Division in Japan sent software engineers from Japan to the US to assist in the software development.

It has been difficult to confirm the extensiveness of the development changes requested to JNC in developing this Release 4.1 global platform product, the feasibility of making the changes within the timescale agreed between the Division in Japan and NTT, and the precise cross-border resource and revenue arrangements. However, an American interviewee involved in the development project in JNC in the US described the situation that arose as follows:

> "At some point, the control issues started rearing their ugly head. And along with that... and it really ties into this first thing, which is the scheduling. We got to the point where a new Release was scheduled, and this all kind of zeros in on this Release 4.1, which is famous here. It was a big development. James Greenhalgh[23] was responsible for SPARK 192 development, for all the software. So, he said this is what the schedule is going to be. Japan just couldn't accept that and our customers certainly wanted it sooner. Customers always want it sooner. So, that plus the fact this was at the time when all this reorganization was going on [merging development groups – the North America and Japan development groups in Japan] so there was a whole new set of people...
>
> If it was all Mr. Matsuura on that side, I think... he was wise enough to know that we did things a little differently, they did things a little differently, and the way job sharing works is you kind of live together, right. But this whole new group of people was coming in, so the people we were now negotiating with were kind of the people that hadn't worked with us, that hadn't worked really with anybody outside of Japan. And here we were... and this was a huge development... we were trying to justify these schedules. And, really it got to the point where James said 'Hey, you know, they want this thing in such-a-such a time.' And, specifically it was a year-and-a-half versus less than a year. 'They want this thing in less than a year. They think that they can do it in less than a year. They want to take all the software back.'
>
> So, we decided OK... it is not that we were going to be unemployed if we gave it back to them because there were lots of other things to do. So, we decided to give it back to them. And then we actually gave it back to them because it wasn't just a year-and-a-half versus less than a year. But, it

[23] A pseudonym

was a year-and-a-half for us for a North American product versus less than a year for something that was going to be for the whole world – global. So, they took this thing and very quickly realized it wasn't going to happen, so they split it back off again. In the process they changed a lot of things.

So they actually took all of our software and ended up rewriting all of the software, because we had written it – it was object-oriented. They didn't have the skills to do that, so they just rewrote the whole thing. In the process of rewriting all the software, the whole thing now looked different from a Network Management perspective and Network Management controls the software in all of the products we have, so they had to redo a lot of things. So, from my perspective they didn't finish when they said that they were going to. And, again, that is the culture. Nobody expected them to. They probably aren't going to finish it any time before James said he was going to finish it.

At the time, there were maybe 350 people working on US stuff. The same number working on Japanese stuff, so if you can have 700 people working on one product, it makes perfect sense. Well, it didn't. So, it just doesn't work. It is perfect on paper. It makes a lot of sense. And, actually when they did this schedule, when they were arguing with James about 'We can do this in less than a year', they knew how many people… they had tons and tons of people. They actually threw 200 or 300 people on this. But that actually didn't help. It was just totally unmanageable. So that is something that really blew up."

Some of the problems in this story of differences in schedules, deadlines and the development environment – and the control over these issues – were supported by my Transmission Division interviewees. From the perspective of the Transmission Division in Japan, it had become evident to the Transmission Systems Development Department in Japan in 1998 that the basic software being developed by JNC, the specification for which had been adjusted to incorporate the amendments requested to meet NTT's requirements, would not be completed in time to meet its committed NTT deadline. The Department then separated the project back out into separate projects tailored to the needs of the North American and Japan markets. The Japan Development Group took back development of the basic software, and developed it itself for NTT through its software development subsidiaries in Japan.

JTech's introduction of its OC-192 product, SPARK 192 10G, into the US market would in any event have lagged Nortel Networks, but the effect of collaborating in trying to develop a global product platform was that the US introduction was further delayed. In addition, the basic application layers in the US version and the NTT version of the product were separately specified and developed, and would have to be managed going forwards using additional resources than would have been the case had collaboration succeeded in developing a single, global basic software layer. The application software layer remained tailored to each country's carriers' needs, as planned.

What was clear is that having to hand back development engineering to Japan was inconsistent with, stressed, and even threatened JNC's claimed identity as a development engineering organization, supported by its organizational capability of job sharing so as to offer good work on day one to new hires at its dispersed development centers.

While the difficulties that arose at this stage of cross-border collaboration between the Japan-based and US-based organizations were observable at the project level, such at the level of the cross-border development of Release 4.1 of SPARK 192 10G, their underlying causes were more directly traceable to the different institutional contexts in which the two development organizations were based – Japan and the US.

Reading through the interview transcripts and with some follow-up investigations, I have classified these difficulties in collaborative development engineering between the Division in Japan and JNC in the US into seven buckets of issues, namely differences across borders in functional boundaries, schedules and deadlines, feature content, risk taking, working protocols, development tools, and resource allocation. Taking these in turn:

First, turning to functional boundaries. Relative to the US, boundaries among different functions in Japan were not as clearly defined as were the inter-functional boundaries in the US. From the perspective of the US, in the language of Hatakenaka (2004), the Americans' perception was that functional boundaries in Japan were "fuzzy" as opposed to clear. From the perspective of the US subsidiary, clear functional boundaries assisted the management system in two ways. First, clear boundaries and responsibility meant that it was easier to hold people accountable, to pin responsibility on groups and on individuals. Second, clear boundaries facilitated tracking the source of emergent problems, which was especially important in a fast-paced business environment undergoing rapid change and discontinuities. In contrast, the Americans perceived that fuzzy functional boundaries within Japan led to difficulties in identifying the sources of problems in new product development.

From the perspective of Japan, it was the more rigidly demarcated functional boundaries in the US that were a barrier to collaboration, for two reasons. First, the Japanese considered that they constrained inter-functional collaboration and communication. Second, they reflected a more rigid organizational structure that was relatively inflexible and less able to adjust to changing priorities and work demands. As I discussed in section 7.4 in the context of job sharing, one way that the US side reduced the need for such denser communication was by designing the cross-distance collaborative work practices to co-locate software processes with their associated hardware processors.

These differences between the US and Japan were to some extent compensated for by differences in patterns of cross-functional communication. Within the US, functional boundaries were more formally managed by intense communication, such as by through a system of formal weekly inter-functional project status reviews. In contrast, software and hardware development in Japan, distributed across a domestic network of subsidiaries, were managed by less formal means. American interviewees mentioned that they were regularly surprised to see that, at US-Japan cross-border product development design reviews, the hardware and software groups within Japan often transferred to each other vital information that would have been shared in a US context at a much earlier stage.

Probing further into these differences in perspectives, I compared the development process documentation used in the US with that used in Japan, especially to compare the formal allocation of responsibilities. By the time of developing the ADX products, the Transmission Division and JNC's product development processes were managed according to different standards. In particular, the Division operated to a TN ("Telecommunication Normal") Standard Qualification in Japan, while JNC worked to a DSN Standard Qualification in the US.

Each Standard Qualification specifies a different numbers of "gates" for projects. The Transmission Division's TN Standard Qualification in Japan specifies three gates, namely after completion of:

The project development plan.
The original design.
The development system evaluation.

The allocation of responsibilities is not clear in the Japanese development plan.

In contrast, JNC's DSN Standard Qualification has a finer granularity in that it specifies seven "Project Review" gates, from PR0 through PR6:

PR0: Determine completion of product specification, overall project scope, schedule, and Go/No-Go decision. Obtain commitments only for PR1.
PR1: Determine the product/systems specification, detailed project plan, schedule and Go/No-Go decision.

PR2: Determine the completion of High Level Design.
PR2.5: Determine the completion of Critical Design Review 1 (CDR1).
PR2.8: Determine the release of Prototype Build EB1 (Engineering Build 1) to Manufacturing.
PR3: Determine completion of Hardware unit verification and Hardware development.
PR3.5: Determine the release of EB2 Design to Manufacturing and the transition of Software Integration Test (SIT) to Software System Integration Test.
PR3.8: Indicates completion of product verification (Hardware/Software/ASICs). Determines completion of Software System Integration Test.
PR4: The decision is made to release the system to manufacturing for limited production runs. The Engineering Change Order (ECO) process is complete.
PR5: To determine the completion of System Test and First System Availability (FSA).
PR6: Validation is completed and the system is ready for Limited Quantity (LQ).

Between each of the Project Review gates, there are specific tasks that are formally allocated to designated groups. For example, gate PR2.5 follows a specific set of activities that must be completed between gate PR2 and gate PR2.5, together with an allocation of responsibility to a particular functional group of Hardware, Physical Design, Cabinet/Configuration, Design Realization, Manufacturing Engineering, and the Quality & Project Management.

What is crucial to understand is that, at a second level of difference, the *meaning* of a gate differed between development engineering in the two countries. In the US, the meaning of the Project Review gates can be best understood as being related to timing of hand-off of responsibility from one group to another. There is a Design Review at each Gate, involving all functions. In Japan, on the other hand, the meaning of each gate is defined by a stage of completion of a project, and is not necessarily linked to a hand-off of responsibility, which is unclear.

On job sharing in development engineering, there is some overlap between the TN and DSN Standard Qualifications. For example, Gate 3 on TN Standard Qualification is identical with gate PR6 on DSN Standard Qualification, so that the final Gates in each Standard Qualification are the same. For the ADX 600 project, this was realized through a joint one-day meeting in October 1998.

The second area of difficulty in collaborative development engineering between the Division in Japan and JNC in the US concerned schedules and deadlines, which my interviewees had identified as the source of the problem in collaborative cross-border development of Release 4.1 of the SPARK 192 10G. Again, the key problem was differences in *meaning* across borders – schedules and deadlines meant very different things in Japan compared to the US. This problem was magnified in managing reciprocal interdependent job sharing in development engineering the ADX products. An American interviewee narrated his perceptions of the differences (and difficulties) this way:

> "In Japan, it was not unusual at all to miss a committed schedule. You know, you wait right up until the day until when you are supposed to deliver a product to let's say NTT, and something goes wrong, and you tell them the day you are supposed to deliver it, 'Oh, I am sorry, but it is going to be two months' late.' And, for a long time Japan tried to do the same thing with us.
>
> And, their theory was, or the thinking was, that if we are two months away from the delivery date, and I tell you that I have got a problem, I am admitting defeat. I am admitting to you that there is no hope of me ever recovering that schedule. Therefore, I am not going to tell you that because it demoralizes my development group. So, I am going to make sure that before I tell you we are going to slip a schedule that the schedule *has* [emphasized] slipped. And, the only way that they could do that was to tell you the day before. So, their theory was that if I tell you ahead of time, then that is admitting defeat.
>
> Our argument was number one – you have to objectively quantify the effort that is needed and then you have to *diligently* [emphasized in original] assign the resources to it and dedicate those resources to that project. It is no different to building a building or a bridge or a highway or anything else. You have to determine the amount of resources that are necessary to deliver the product at the time that you have committed to deliver it. And you can't just assume that if you don't do it that you can come negotiate with the customer and make everything OK. In the United States, they will kick you out for that. In Japan you can go have a few beers and everything is OK."

Within development engineering in Japan, it appeared that deadlines were an important source of motivation. Interviewees talked of their strong desire to avoid *shikaru* (scolding) from superiors, a kind of public humiliation in front of workplace colleagues, and of working to deadlines. A deadline meant a *target* to be achieved if everything went well, or the most optimistic scenario.

In contrast, the Americans would define deadlines by *expectation*, based upon what appeared feasible. An employee's career and position was then dependent upon meeting that committed date. Hence, for US Product Planning, the frustration with the US Development side would invariably occur at the start of a project, because Development would be reluctant to commit in advance to deadlines that it considered infeasible. In contrast, for US Product Planning, the frustration with Development in Japan was at the end of a project, because Development would commit to schedules and deadlines that subsequently had to be amended.

The result of these differences in meaning was that the Americans expected deadlines in Japan to be met whereas the reality was that too often they appear to have been missed. This led to problems in job sharing when software engineers were waiting for hardware to be delivered, hardware that had not arrived on the predicted date. From the perspective of the Transmission Division in Japan, deadlines in the US were not always achieved, such as in the development of SPARK 192 10G (OC-192).

Conflicts over deadlines occurred regularly, such as over the delivery dates of hardware by Japan to JNC in the US. As I have described, one of the most significant examples was the development of Release 4.1 of FLASH 192 10G. In the context of relatively greater flexibility in shifting resources, the Division in Japan wanted the software development of a global platform within a year, because of commitments it had made to NTT and a renewed focus on global product platforms. JNC had estimated a development time of a year-and-a-half, which was unacceptable to the Transmission Division in Japan. The Division in Japan, therefore, took back the software development and developed it in Japan. In part, this was because of different software development methodologies, so that Japan had to rewrite a lot of the software and the product took longer than Japan had estimated.

The third set of difficulties between Japan and the US in collaborative development engineering concerned feature content – features for NTT, US customers, or for a global platform? It was only with great difficulty that the Americans succeeded in persuading the Japanese development engineers to design and develop products specifically for US customers, rather than modifying a product adapted for sale to NTT or developing a global platform. It did not seem that this was the rational trade-off between being locally responsive (to US customers) at the cost of loss of potential economies from global integration, as described by Prahalad and Doz (1987). Rather, it seems to have been a more political battle for resources between serving the principal domestic customer, NTT, or the US marketplace.

One American interviewee put it like this:

"The Product Planning organization made the calls in terms of the feature content and priorities and release schedules. So, the problem was never making the calls, it was convincing Japan that they were the right calls and to put resources behind those decisions.

Most of the design engineers over there didn't want to do most of these features. Basically, what they wanted to do was to develop a product that they could sell to NTT and then just send it over here and have us sell the same thing. But, US markets and customers are much more demanding than NTT and the Asian customers. And, it is even true today, and they know that. And, Cisco has found this out as well. I mean, if you can be successful in North America, you can take your product and sell it any place else in the world. The converse of that is not true. If you can be successful in Japan, it in no way ensures success in the US.

But, that is what they wanted. They wanted to develop products for NTT and then with very few modifications give those to us and have us sell them over here. And we told them, 'That will not work. If you want to sell products in this market, you have to compete against the companies whose primary markets are in the US first. And, if that means developing a totally different product from that which you sell to NTT, then that is what you have got to do. And, they were very, very reluctant to do that, because it was more money and more resources, and more risk."

What at first appeared to be incomprehensible specification battles evolved into a greater recognition and understanding by the US side that what was at stake was Japan's desire to build global product platforms versus the desirability by the US subsidiary of not diluting the needs of US customers in the design of products.

The emerging specification battles and tensions between JNC in the US and the Division in Japan were not limited to the local versus global dimension. In developing the ADX 600, the original specification submitted by Product Planning did not include ATM functionality. However, Product Planning in the US subsequently changed and added it to the product specification, much to the annoyance of the Japanese lead project manager in development engineering; the requisite ATM hardware and software was developed by JNC at its New York development center. When developing the ADX 2400 (see Chapter 8), TSG in Japan was told by JNC Product Planning, once again, that an ATM fabric was not needed by customers in this product. However the Division in Kanagawa overrode this and tried to include ATM functionality, because of its prior ADX 600 experience of having initially been told that ATM would not be needed, with its later incorporation into the product specification.

Fourth, collaborative development engineering between the Division in Japan and JNC in the US was adversely affected by differences with regard to risk taking. The

American felt that the Japanese had become risk averse in development, while the Americans would rather take on, but manage, risk. This issue also arose elsewhere in the relationship between Kanagawa and its US subsidiary, such as in inventory management. This conservatism on the Japan side was in contrast to the situation that existed at the time of the development of the Terminal products, when it was the Japan side that was pushing for the development of products based upon the new and emerging SONET standards at a time of great associated uncertainty (it could of course be argued that this was a less risky strategy given that the alternative would have been to develop a product for a very competitive market).

Fifth, there were issues over evidence and trust. While it was unclear if this was due to mistrust or lack of credibility, the Japanese development engineers required what, to the Americans, was a surprising amount of proof:

> "And, Japan was very funny, because they always wanted proof of everything. They always wanted to know: 'Well, how do you know that? Show me how? How do you know that this customer will buy this if we do this?' And, of course, there is no proof for that. It has got to be based upon experience and trust and understanding of the marketplace, and a certain amount of risk taking. And, they always wanted assurances for everything. And, you can't have assurances, you know. 'But, what I can assure you is that if we don't do this we will fail. Can I assure you that if we do do it we won't fail? No, but I can assure you that if we don't we will never have success.' And, so those were the battles."

Sixth, the development tools used in Japan and the US were different, reflecting the different institutional contexts in which JNC and the Division in Japan were embedded. JTech in Japan tended to use proprietary design development tools, such as in ASIC design. Use of proprietary tools was feasible in an organization in which personnel turnover was low – employees trained up in the proprietary system and had no need to learn any other way. In contrast, it was important for JNC in the US to use industry-standard development tools, so that it could recruit effectively in the job market. For example, in ASIC design, because JNC adopted the industry standard VHDL, an open system, as a development environment, it was able to hire engineers who would not otherwise have retrained to use a proprietary system because of the costs learning and lack of value outside the firm. This difference was also significant in software collaboration, in which JNC used object-oriented tools and the Division in Japan used other development methods.

The seventh difficulty in collaborative development engineering between the Division in Japan and JNC in the US concerned how to allocate resources. With regard to resources, the Japanese organization appeared to the Americans to be focused more upon minimizing cost rather than maximizing profits or revenues. In addition, when available resources changed, rather than being out in the open, reduced funding in Japan would only become apparent to the US side when projects were slow-rolled. To the Americans, it was never black and white. As an American interviewee put it:

> "They kind of want to have one foot in the water and one foot on dry land. So, if a project is going to cost... If I come to you and you are my Japanese counterpart in Japan and the guy who controls the purse strings and I say '...I need $500 to do this project' and you say to me 'Well, why do you need $500?' And, I say 'Well, that is because I need to hire five people and I need to deliver the product in this length of time' and so they will nod their heads and you will go away and what they will do is they will put $250 on the project. And then they will finesse it and say 'Well, maybe we can push it out just a little bit here, and maybe we can cut this feature out of it.' So, that was the dollar argument always.
>
> But there was a specific reason for asking for an amount of money and it was tied to market and market windows and being at the right place at the right time with the right product and the right features.
>
> In Japan, it was never that black and white. They would just start slow-rolling things and you would go over there and you would notice that progress wasn't being made and you would start to dig in and 'Well, this engineer – we had to move him over here on this project...'"

On the other hand, from the Japanese point of view, shifting resources around was a reasonable and flexible response to managing unforeseen problems. For example, when a particular problem arose in a particular area, everybody would cooperate to try to overcome it. In fact, the Japanese considered this flexibility to be a relative advantage of their development organization and project management system. At a broader level, as NTT spending on new capital equipment fell significantly, so development engineers within Japan shifted to work on US products, by joining the North American Development Group within Japan.

Collectively these emerging difficulties, all evident in the collaborative development engineering effort and with their source in differences in organizing and in the wider institutional environment, stressed the development engineering organizational role identity claimed for JNC in the US. This identity had been supported by its success in establishing new development centers across the US and in hiring good engineers to work for the organization. Once again, from around 1997, JNC was threatened with slippage to its default unappealing organizational identity as a Japanese subsidiary.

8 Enhanced SONET ADM and Optical ADM Products' Development (1997-2000)

8.1 Introduction

I described in the last Chapter how, during the period 1997-1998, there appeared a number of difficulties in collaboration within development engineering between JTech's Transmission Division in Japan and its US-based JNC organization. These became amplified during the period from 1997 through 2000 on account of changes in the environment to which JTech's Transmission Division sought to respond. The most important of these was the threat to the identity of JNC came that from the availability of a new organizational model in the transmission industry environment in North America strongly associated with the emergence of new technologies that promised to transform the transmission network.

The new organizational model was that of internal corporate venturing that utilized venture capital structures to motivate employees to become more entrepreneurial and to take more risk (Chesbrough, 2000). Such initiatives were no more directly visible than in the New Ventures Group established in Lucent in 1997. The reason for the introduction of this new model of internal corporate venturing in large firms at the end of the 1990s was, in turn, the threat to innovation within large, established firms that came from venture capital funded new technology ventures within the transmission industry. Valued employees within JNC could now move either to a new venture and receive significant stock options or to a large established firm and receive so-called phantom options. It became important to offer a strong incentive system that was financial, such as through stock, in place of the 1980s model of the internal corporate new venture characterized by autonomy and equity with other divisions within the large firm.

Much of the new transmission technology that was being developed in the late 1990s was based upon research initially carried out in North American universities into technologies that would provide a so-called rich photonics' transmission network. This was almost a vision of a far more efficient transmission network through all optical transmission, avoiding the need for electrical/optical and reverse signal conversion. Many of the technologies and products based upon the new scientific research from US universities were being developed within venture capital backed start-up companies, often spun out of universities, as well as within Lucent Technologies. The start-up companies within the transmission industry of the late 1990s represented a new model of a new venture that had high visibility and legitimacy, as it was associated with new technologies, had substantial venture capital backing, and promised to further improve the transmission capabilities of JTech's customers.

It was almost as though the past fifteen years had come full cycle – JTech's North American organization had been the new venture that had fought the establishment from the late 1980s through the early- to mid-1990s, but it had increasingly become "the establishment" that it had sought to overturn. Instead of distancing from NEC or the model of a subsidiary, the new "new venture" model was strongly identified with substantial resources, new and innovative technologies, stock options, and invariably designed for sale to larger incumbents who had the complementary reliability and quality competences in manufacturing that RBOCs and other transmission equipment customers required. The creation by Lucent of phantom stock within its New Ventures Group magnified the threat to JNC, as the new almost hybrid organizational model seemed to provide a way forwards for JNC members to secure significant additional resources, as well as to retain the reputation for high quality and reliability of a large organization such as JTech.

In the US, JNC's mixed identity as a development engineering organization and new venture had been severely stressed by the events that I described in section 7.6, which boiled down to differences in organizational approaches to managing new product development projects. JNC retained its organizational capability of job sharing, through which it was able to recruit good engineers from competitors in local areas in which specific transmission technologies and protocols were embedded, such as ATM in New York and IP in California. The changes in the organizational models available in the environment were an external source of stress that compounded this.

The Transmission Division's business strategy in this environment was to continue to release SONET-based products, but with a greater data handling capability through ATM, but also to focus upon developing the optical technologies that would go into a future rich photonics transmission network.

JTech's Transmission Division sought to address two separate issues as it again redesigned its organization. These were to overcome the threat to JNC and to its relationship with the Division in Japan represented by the difficulties at collaborative new product development across borders, and also to respond to the shift to a rich photonics network and to the new organizational form of a new venture that appeared. JTech's organizational redesign had two key elements. First, the decision was made to co-locate product development by product family, giving JNC more of a global mandate for product families that it controlled. Second, of some substantive and greater symbolic consequence, JTech Laboratories established its first overseas Laboratory based at JNC's Texas headquarters.

The result of these changes was that JNC's organizational members felt that they now had greater independence, both organizationally from the Division and more generally in terms of having far greater control over product families which were now under its sole global mandate to develop and to market. Moreover, this global responsibility had the effect that JNC projected the identity of an emergent MNC, rather than a Japanese subsidiary or a role-based identity as a development engineering organization. The addition of a research capability, though limited in substance in measured by resources, represented a step change for JNC, as it gave JNC the appearance of having an entire value chain in the US, its home country, with the enhanced direct links to JTech Laboratories in Japan, substituted in place of having this relationship mediated by the Transmission Division, being consistent with greater control by JNC.

Overall, the combined effect of the changed environment and these organizational changes – put in place to solve the threats to development engineering role identity and to preserve the value of organizational capabilities such as in development engineering from job sharing – was to lead to JNC making a claim for an organizational identity as a "new venture" to match the new model available in the North American environment.

The motivation for this was also pragmatic. In the changed environment of increased investment in R&D into new technologies such as those underpinning the development of an all photonic transmission network, JNC needed more resources if it was to rival competitors such as Nortel Networks and industry new venture entrants. JNC needed resources that could not be provided by its parent but that were potentially available in the external capital markets in the US, resources both to fast-track development of new technologies, whether developed in-house or brought in through engaging in mergers and acquisitions, and to reward employees through stock options. Consistent with greater independence from the Division in Japan and with its global leadership identity, JNC devised a plan to gain greater independence from JTech through an equity carve through an initial public offering (IPO) of shares in a separately incorporated JNC. This plan was rejected by JTech's corporate office in 2001, shortly after which transmission equipment expenditure by telecom service providers was drastically cut back, and JTech took back greater control of JNC enforcing drastic cuts in its US-based workforce, especially in development engineering.

8.2 The Enacted Environment

While focusing upon continuing sales of ADM products and building sales of its ADX, SPARK and SPARKWAVE families of products, including adding features, from around 1999 the attention of JTech in Japan, as described in its mid-term (five-year) business plan, in common with others in the industry was looking forwards and enacted an emerging "industry vision" of photonic technologies as the foundation for a future all-optical public network. As perspective, for the preceding fifteen years, new technologies and products in transmission equipment had been based upon a network requiring the conversion of electrical signals to optical signals to transmit, followed by a conversion of the transmitted signal from an optical signal to an electrical signal. Relative to an all-optical network, this conversion process was inefficient.

The alternative vision that JTech's Transmission Division enacted was of a photonic network in which many of the network functions, such as switching of signals, would occur without the need to convert and reconvert signals between electrical and optical. The underlying science and technologies included light emission, transmission, deflection, amplification and detection by optical components and instruments, lasers and other light sources, fiber optics, electro-optical instrumentation, related hardware and electronics, and sophisticated systems. For example, a photonic switch would use photonic devices, rather than electronic devices, to make or break connections within integrated circuits. DWDM is a photonic technology (see section 7.2.3).

The enactment of this vision of a future transmission network was in synch with a more-or-less consensus view across the transmission industry that optical technology would be the only technology with the capacity to keep up with bandwidth demand, as the balance of transmission continued to shift away from voice to data traffic. Eventually, it seemed likely to JTech in Japan that the core of the network would be provided by DWDM, initially with SONET running over it, but later without SONET. Such a transition from the current network of SONET rings and point-to-point links to an all-optical mesh network, using optical switches, routers and cross connects would nevertheless require the development of many new technologies and products, and would take time.

While JTech's vision of the future did not envisage a place for SONET, JNC had located in Texas, where for the reasons described in Chapter 4, SONET standards had become geographically centered and embedded through the development of an industry network following the initial location there of Collins Radio. Much of the knowledge underlying the SONET standards, many of the key individuals on the relevant committees of Bellcore, the development engineers who worked on those standards and their early primary customers, and some of the long-distance telephone companies were focused upon the Telecom Corridor area. One way to portray this would be to cast Telecom Corridor as the spatial manifestation of a master, or grand, narrative of the future of transmission in the US, a narrative developed and shared among SONET engineers in a network.

SONET was widely considered to be more appropriate for transmitting voice, but it was inefficient at handling data transmission because of the latter's transmission characteristics, especially its "bursty" nature and the higher bandwidths required (see section 7.5.1). ATM (Asynchronous Transfer Mode) and IP (Internet Protocol) are both protocols for transferring data between computers and computer networks, and had become more significant as the volume of data transmission had grown relative to voice transmission; the former overtook the latter around 1996. ATM and IP are not alternative protocols; each provides functionality that the other does not.

ATM was originally proposed by Bellcore and so became the preferred protocol of the telephony carriers, with IP preferred by the computer industry. These different protocols became embedded in fundamentally different communities and industries. Just as SONET technology was embedded in the social networks in Texas, ATM technology was embedded on the US east coast, and was a key underlying reason for JNC having established its New York development center. Likewise, JNC had established its California development center in a region steeped in the IP protocol. While IP and ATM offer different relative advantages and disadvantages, the battles between the entrenched interests of their respective protocol proponents overrides any rational analysis based solely upon technological differences.

Many of the core technologies needed for optical switches and for a rich photonics network were being developed in universities in the US, by a number of small but well funded start-ups located in the US, and by JTech's competitor Lucent Technologies, into which the research capability of Bell Laboratories had been combined in 1996 (see section 4.2).

Especially, it was the new venture start-ups in this technological space, including Lightera Networks and Omnia Communications, both of which were subsequently acquired by Ciena, that defined the new environment for JNC. Underlying this, what was different in the new environment from 1997 was, first, that there was an increase in resources for transmission equipment being provided by the external capital markets in the US and, second, that much of this was being channeled into optical technologies in which there were a number of scientific and technological breakthroughs, as described in section 8.2. The effect of this was that a number of new ventures entered the transmission industry in the US, many of which were spin-outs from leading US universities such as Stanford University, and were funded by US equity groups.

Omnia Communications, founded in June 1997, was a provider of access and transport products that enable public network operators to deliver integrated communications services over fiber optic access networks. It was financed through private investment from James Dow and venture capital from Charles River Ventures, Bessemer Venture Partners, Atlas Venture, and STAR Ventures. These new ventures were typically small and had little to offer other than core technologies and prototypes considered to be key to an emerging all optical network. Their owners were heavily incentivized with stock options. This was a new model of a new venture that was highly visible in JTech's environment.

Of JTech's two principal competitors for SONET-based products, Lucent Technologies was further ahead than Nortel Networks in the underlying photonic technologies. For example, Lucent Technologies was one of a number of companies developing micro-electronic mechanical systems (MEMS) technology, which used tiny mirrors embedded in a chip to steer lightwaves. The reason for the lead of industry incumbent Lucent Technologies in photonic technologies was its history of having addressed the particular needs of its captive customer, the long distance carrier AT&T. This is also why it had been the first of the large companies to develop WDM equipment, which is based on a more limited set of photonic technologies.

To try to catch up with Lucent Technologies, JTech's second major competitor, Nortel Networks, had implemented a strategy of acquisitions as a way into the new technologies and made three key acquisitions of start-ups in the photonic technology area in 2000 alone. These were its:

1. January 2000 acquisition of Qtera for $3.25 billion in stock. Qtera was a leading start-up developer of ultra long haul DWDM systems, which extended the range before signal regeneration is required from 600 km to more than 4,000 km by using Raman amplification. Qtera's customers included the IXC Qwest Communications. Qtera and Nortel Networks combined their technologies to sell their OPTera Long Haul 4000 Optical Line System to IXC Global Crossing.

2. March 2000 acquisition of Xros (pronounced *kairos*) for $3.25 billion in stock. Xros had a solution to the so-called scalability problem in MEMS.

3. March 2000 acquisition of CoreTek for $1.43 billion in stock. CoreTek was a developer of MEMS technology, and had developed a vertical cavity surface-emitting laser.

Nortel Network's justification for these acquisitions was to reduce time to market. As Fahri Diner, CEO of Qtera, explained:

> "Highly valued is a relative term... Nortel realized that it's all about having a six- to nine-month advantage over competitors - it's about establishing a footprint in the optical network." (Ryan, 2000)

It was the particular characteristics of the US transmission network, especially the limited availability of optical fiber and the growth of wire-based Internet-related data transmissions, which had led US telecom carrier customers to deploy products based upon photonic technology and which promised higher bandwidth transmission over existing installed optical fiber. DWDM was the first stage of this. Other companies sought to make acquisitions of new ventures in the optical transmission area as a means of entry. For example, Cisco, which had developed the first Internet Protocol (IP) optical router in 1985 and was closely associated with the Internet, bought Cerent for $7 billion and Monterey Networks for $400 million in late 1999. Other new ventures did initial public offerings (IPOs), such as the 1999 listing of Sycamore Networks, that was worth $24 billion by March 2000, with quarterly revenues that fell short of $20 million. These new companies with their promise – often based on prototypes – of being able to lead the development of the all optical transmission network challenged incumbents such as Alcatel, Nortel Networks, Lucent Technologies, and JTech.

Within Japan, JTech's main home country customer, NTT, continued with its introduction of JTech's ADX products into the local access portion of its network. However, NTT had not yet announced a migration path to products based upon photonic technologies, both because of the greater availability of optical fiber in Japan and because of the greater relative use of wireless transmission for Internet and data, from mobile terminals. Photonics and an all-optical network was primarily a vision for overcoming the constraints on transmission in the North American network.

8.3 Organizational Identity

As described in section 7.3, JNC's earlier organizational identity as a new venture had been severely threatened by a number of changes that had been made to the organization of work activities across borders, to implement the Transmission Division's strategy for developing global platform products. The US organization had something of an ambiguous almost hybrid identity in the mid-1990s, seeming to compensate for stresses on its earlier new venture identity by adding a role-based identity as a development engineering organization.

With both of its earlier organizational identities, as a new venture and as a development engineering organization, SONET protocols and their underlying enabling technologies had always been central to JNC. To this, JNC had broadened the scope of its activities by building a capability for developing products incorporating both ATM and IP protocols and technologies, which had been made possible through the earlier structuration of the relationship between its organizational identity as a development engineering organization and its organizational capability in job sharing.

The increasing attention paid to photonics and to products based upon new optical technologies, coupled with the availability of a new organizational model of a new venture in the environment, afforded the opportunity for JNC members to alleviate the stresses from living with the ambiguous identity that resulted from the uneasy coexistence of a role-based identity of a development engineering organization and the internal corporate new venture identity based upon the earlier model that had autonomy as a key characteristic.

Many of the newer technologies were technologies that – if developed – would replace SONET. Moreover, with the exception of Lucent Technologies, many of these technologies were being developed in either venture capital new ventures (external capital markets) or in Lucent's New Ventures Group (internal capital markets). The former new ventures were usually subsequently acquired by JNC's competitor incumbents, including Nortel Networks and transmission entrant Cisco, as they sought to compete against Lucent. It was becoming increasingly difficult for JNC to sustain a legitimate organizational identity merely as a development engineering organization, when it was relatively under-resourced, and its earlier autonomy-based model of an internal corporate venture was now illegitimate.

8.4 Organizational Capabilities

JNC had successfully dispersed and integrated across a network of development engineering centers in the US to tap into local pools of specialized labor in technologies that complemented its core in SONET, which was focused in Texas (see section 7.4). However, JNC's organizational capability in job sharing was *in*capable of bringing in the skills needed to develop the new photonics technologies.

First, many of these were being developed across the US in several universities, rather than being focused in one location (e.g., ATM near to Lucent Technologies in New York). Second, nor did JNC have the capability to hire the skilled engineers who could develop these technologies since the stock market was willing to reward them at higher levels than could JNC, especially through stock options. Third, it was extremely difficult to effect collaboration among engineers working on different technologies. For example, communication within JNC between engineers from a SONET background and from an ATM background was difficult, for reasons that interviewees attributed to the different cultures in organizations steeped in each of the technologies.

8.5 Strategy

JTech's home country represented a disadvantage in developing photonic technologies, since the lead users of products based upon photonics, the core photonics technologies, and funding for photonics were all located in the US. Moreover, NTT simply had no need to expend resources on products based upon photonics' technologies, since there was higher quality installed optical fiber in Japan than was found in the North American network.

Yet, despite this, drawing on funding from corporate sources rather than on project-based funding from the Transmission Division, JTech Laboratories had been very much aware of the growing importance of photonic technologies from the early 1990s, through having participated in global science and technology academic and research networks oriented to transmission. Further, JTech Laboratories had allocated some resources to developing a limited set of the underlying technologies. However, JTech Laboratories, with its corporate funding from JTech and shorter-term project-based funding from the Transmission Division, could not commit sufficient resources to compete with US venture capital-backed start-ups in the photonics field. Many of these had spun out of US universities. Nor could JTech's Transmission Division compete with the scale of funds that would be required from its internal capital market to compete with funds being provided to single-industry focused Nortel Networks by the North American capital markets. In consequence, JTech and JNC lagged Nortel Networks and Lucent Technologies in developing or procuring the ability to offer products based upon photonic technologies.

In the late 1990s, JNC also started to prepare its own business strategy documents. Strategic management and planning was not a designated function, like development or product planning, but was added to the responsibilities of the head of product planning. While the Transmission Division in Japan had a business plan that envisaged a world of transmission beyond SONET, ATM, and IP by 2002 – all photonics – the 1998 ten-year strategic plan of JNC in the US unsurprisingly – given that its activities centered around the SONET protocol – had quite a different vision of the transmission network of the future. While acknowledging the increasing importance of photonic technologies, JNC's network vision for up to 2010 included a central and continuing role for SONET, ATM, and IP. These were the protocols and standards around which its technologies and products were focused; they were the very reasons for JNC's existence.

Notwithstanding these evident differences in business strategy, JTech and JNC continued with development of new products and follow-on releases of its SONET/ATM and its DWDM transmission equipment products. Around the turn of the millennium, this led to JTech announcing four new products, aimed both at the RBOCs and at the IXCs, in which something of this blended business strategy was apparent. These were:

1. FLASH 2400 ADX, a 2.4 Gbit/s. (OC-48) high-end ADX series product, announced at SuperComm 2000. This was a faster transmission speed addition

to the ADX family of ADX 150 and ADX 600. It was developed later and, unlike its lower capacity family members, in Japan, due to resource constraints.

2. Two photonic technology products intended to be next generation DWDM products in JTech's SPARKWAVE family, the Passive Optical Add Drop Multiplexer (POADM) and the Dynamic Optical Add Drop Multiplexer (DOADM). These were optical ADM products built around advances in tunable laser technology, which would enable carriers to double the distance over which they could transmit without having to regenerate signals.

3. An enhancement to the first release of its SPARKWAVE DWDM product, SPARKWAVE 320G (WDM). The latter had a transmission capacity of 10 Gbit/s x 32 λ (32 waves) to give a total transmission capacity of 320 Gbit/s. The second release of its DWDM product, under development, was to have a transmission capacity of 10 Gbit/s x 170 λ (170 waves) to give a total transmission capacity of 1.7 Terabit/s. This represented an attempt to catch up with the leaders in DWDM, making use of technology developed in JTech Laboratories. JTech had received a commitment from then potential customer MCI WorldCom to test this equipment provided that a laboratory version could be made available by October 2000.

4. An Internet Protocol Transfer (IPT) network management software application in a JNC project led by Karl Best and his team in Texas. IPT is a kind of multi-protocol label switching (MPLS) that converts ATM switches into IP routers and forwards ATM cell packets using the switch fabric. It was intended to overcome then current weaknesses in IP protocols and used ATM. The product had been pre-marketed to the RBOCs.

In addition, JTech continued with incrementally adding features to its existing ADM and ADX products, available in new releases.

8.6 Organizational Structure

The reorganization of its activities that JTech put in place to adjust to its new strategy and in the changed environment had a number of elements, which comprised three changes to the organizational relationship between the Transmission Division in Japan and JNC, its US subsidiary. These changes, in turn, threatened the organizational identity as a development engineering organization that had been claimed for JNC from around 1992.

First, the Transmission Division implemented a plan to co-locate product development at the country level by product family, which was consistent with JNC continuing to co-locate hardware and software development engineering based upon protocols (SONET in Texas, ATM in New York, and IP in California), as described in section 7.4. JTech in Japan now designated itself as the technology and development center for the expanding research effort into optical communication technologies, which had led to the products that were part of the SPARKWAVE family. JNC, in the US, was to become the technology and development center for ADX and SONET standard products, which products were in the SPARK family.

In consequence of this reorganization, in what was to become a source of some stress in the relationship between JNC and the Transmission Division in Japan, JNC assumed responsibility for developing products that could be adapted from its SONET products for sale into the European Telecommunication Standards Institute (ETSI) market, since the SDH protocol standards adopted in Europe were derived from SONET (see section 5.4). However, overall responsibility for product planning and for transmission system development for the ETSI markets was still held by the Transmission Division's headquarters in Kanagawa, Japan, as shown in Figure 7.3.

Second, JNC was reorganizing its activities to better serve those of its longstanding US-based customers which were expanding outside the US, such as to South America, and to which customers JNC claimed that it had global geographic responsibility for products and sales. There were two examples of this. First, JNC announced the introduction of a full line of SDH add/drop multiplexers (the so-called JLX series) for sale to its telecom carrier customers as they expand outside of North America. It simultaneously announced the JBX 10G, an OC-192 add/drop terminal multiplexer and the JWX WDM system, with a transmission capacity of 10 Gbit/s x 32 λ (32 waves) to give a total transmission capacity of 320 Gbit/s.

The products were given their debut at the National Fiber Optic Engineers Conference in Chicago, in September 1999. Second, while the Transmission Division in Japan had for many years had subsidiaries in European countries, in March 2000 JTech Network Services (JNS), a division of JNC, announced the opening of its first office outside the US, in Amsterdam, the Netherlands. JNC had established JNS as a separate division to provide network services, including engineering, project management, network design, network operations, and systems integration, as well as installation and maintenance of any manufacturer's telecommunications equipment, to its North American customers. Continuing the pattern of separation of locations within the Transmission Division generally, JNS had its head office at a different location to JNC in Texas. This internationalization by JNC – albeit through its JNS division – conflicted with the Transmission Division's global organization, with the Netherlands being served by a different divisional subsidiary.

Third, JTech Laboratories made the first steps in the internationalization of its organization. In a first transfer overseas of research capabilities, the Transmission Division, JTech Laboratories, and JNC collaborated to establish The Photonics

Networking Laboratory at JNC's US headquarters in Texas, in March 2000. The Senior Vice President in charge of the Laboratory had been the first scientist to achieve the milestone (in 1986) of transmitting at one terabit (one trillion bits) per second over fiber. He arrived in Texas in March 2000, and expected to build an initial staff of 13 to 100 within five years. Of the first 13 staff, eight were Japanese assignees from JTech Laboratories in Kanagawa. Its mission was applied research into advanced optical areas including high-speed WDM, optical add/drop multiplexing, optical switching, and passive optical network technologies. In terms of control, the new Laboratory in the US was not supervised by JTech Laboratories in Japan, but by Ron Finch, the American who headed up development and product planning in the US (see section 4.6). Control was local.

This new Laboratory in Richardson had three designated roles. First was that of technology monitoring for the purpose of helping JTech Laboratories in Japan to more quickly and more accurately make sense of changes in photonic technologies in the US, the lead country for this technology. Its second role was to assist JNC's Product Planning and Development departments to more easily keep track of trends in photonic technologies, with information flowing both from the US marketplace and from JTech Laboratories to JNC. Third, it was intended that JTech Laboratories would work with customers, such as in testing new technologies before development in customers' laboratories.

I described in section 7.6 how JNC and JTech Laboratories had gradually established a stronger and direct relationship, with JNC directly funding its own research projects from JTech Laboratories. It was generally felt by both sides that the indirect communication through the Transmission Division may not have been as effective, with a feeling within JNC at least that the Division may prioritize research spending on projects more favorable for the domestic market in Japan than for the North American marketplace. The establishment of JTech Laboratories of its own facility within JNC's headquarters in Texas was an extension of this general trend in their relationship.

While substantively this new Laboratory in Texas was small, with just 13 staff, symbolically the meaning attached to this was out of all proportion to the size of resources involved. With their own research capability in Texas, JNC projected an identity of having a complete set of support activities across the entire value chain (Porter, 1985) in North America. The Laboratory had high visibility, not simply immediately in the industry and press comments, but JNC subsequently began to make in-depth technical presentations that had been peer reviewed at major national and international conferences, such as The National Fiber Optic Engineers Conference held in Dallas, Texas, in 2002.

The combined effect of these three aspects of the Transmission Division's, JTech Laboratories, and JNC's reorganization in the period of the development of the enhanced SONET ADM and optical ADM products was that JNC began to have the look and feel of an integrated and independent firm, with a full set of value chain activities in-house and with global responsibility for customers and markets. These changes rendered obsolete the earlier development engineering identity, and JNC members now sought to maintain their threatened legitimacy by emulating the new model of a new venture that had become visible in their environment.

Further, JNC had much greater control across a complete set of value chain activities, which it was able to use to serve markets and customers internationally, such as in Central and South America and in Europe. This gave it thirst for funds to better serve its customers who were expanding abroad from the US.

JTech members' desire for their organization to emulate the new venture model that had recently emerged formed the basis for JNC pushing forward with plans for greater independence from JTech in Japan by means of an equity carve out through an initial public offering (IPO). JNC began to explore the possibilities of an IPO of its shares as part of a strategy to assume greater independence from JTech. Three of the conditions that led to this step were in direct but unintended consequence of the reorganization of activities explained above, that of JNC developing products that could easily be adapted for other markets, the internationalization of JNC's customers, and the establishment of a research facility in Texas controlled by JNC.

To these steps taken must be added three steps not taken – or a failure to redesign the organization in ways consistent with the new business strategy. They each had the same underlying theme, that of JNC considering it was under-resourced relative to competitors.

First, relative to its available resources, JNC considered that it was spread too thinly across too many identifiably separate technology and product areas in the US marketplace relative to what is perceived to be its better resourced and stronger competitors Nortel Networks and Lucent Technologies. For example, JTech could not fund corporate acquisitions being made on the scale of those by Nortel Networks described in section 8.3 above. Second, JNC could not secure sufficient resources from the Transmission Division internally to develop products to catch up with its main competitors across the broader scope of products that were now its responsibility.

The third and most significant threat to the earlier organizational identity as a development engineering organization was that JNC was unable to keep up with changes in the institutional environment that brought about new mechanisms of rewarding transmission systems' development engineers, through the use of stock options. By 1998, the use of stock options to remunerate executives had become a significant element of compensation packages industry-wide, and JNC considered that it could only continue to recruit good engineers in the new environment by being in a position to award them stock options linked to the value of JNC as an independent firm.

Remuneration practices had never featured strongly in earlier phases of JNC's growth. The consistent explanations for JNC's ability to recruit effectively in earlier periods are nicely summarized by my interviewee's comments in section 7.4, initially that of strong ties to Siemens, followed by the organizational capability at job sharing that allowed, as my interviewee put it, JNC to "...put some really high tech work in front of people on day one. The ties to Siemens were effective, of course, only for the reason that JNC members could communicate to former colleagues that JNC was "not NEC."

By 1998, however, remuneration mattered. It mattered because JNC could not match the demands from the new institutional environment for stock options. Nobody was more aware of this than the President of JNC who had led the development engineering activities in Japan so successfully during earlier periods, President Matsuura. JNC brought in consultants to make recommendations on how an independent JNC could be organized, including the use of formal contracts to replace the less formal relationships on which the relationships between JNC in the US and the Transmission Division and JTech Laboratories in Japan had been based up to now. It was not just President Matsuura's development engineering background prior to his transfer to be made President of JNC in 1993 that made him side so strongly with the JNC side for an IPO, but as I described in section 6.6 he himself had been bypassed for a promotion with the Transmission Division in Japan and the rest of his career was aligned with JNC. He knew that he would never return to Japan in a strong career position. Nobody – not even the Americans – was arguing more strongly for the IPO than JNC's President Matsuura.

JNC's request for an IPO was turned down by JTech corporate headquarters, following which many of the key executives left JNC to join other firms in the industry. With resources further constrained by recession in Japan and with a downturn in the US transmission equipment marketplace, the Transmission Division drastically cut back its development engineering activities outside Japan, including at JNC. Development engineering became more centralized within Japan, and in 1992 President Matsuura was replaced by a new President from a sales and business development background. JNC was, from that time on, a Japanese subsidiary.

9 Conclusions and Implications for the Theory of the Evolution of the MNC

9.1 Introduction

I began this dissertation by recounting how interviewees in foreign-owned subsidiaries of MNCs had often remarked that in order to operate effectively in host country environments, their organizations had to have an identity that was meaningful to them and that was both recognizable and legitimate. I have therefore defined the term organizational identity as this system of meaning through which organizations' members made sense of their worlds and of their own, and their organizations', actions. I see organizational identity as the answer to the question posed by organizational members, "Who are we as an organization?"

I was especially interested to try to understand how the organization's identity related to other concepts used in international management, especially to organizational capabilities, strategy, and organizational structure. I have defined organizational capabilities as the ability to integrate knowledge, both from elsewhere within the firm as well as from external sources. I have used the term strategy at the subunit level, to mean the important decisions made by managers over developing product families, such as the customer segment to focus upon and whether to aim to be first to market or a follower. I have defined organizational structure as the way that the firm is formally organized, including the organizational location of its various activities, which may arise as an outcome of either planned changes or a political process. This would include, for example, decisions such as whether to locate particular development activities within Japan or the US, and whether to co-locate or disperse activities. This, in turn, would have implications both for the way that the organization aligned these activities with its strategy, as well as for how it managed linkages among the groups.

I expected to find that an organizational capability at integration would somehow be shaped by the organization's identity and that capabilities, in turn, may form the basis of identity claims about "who we are" as an organization. Further, many scholars of organizational identity, as well as of organizational capabilities, have seen these as changing very slowly, if at all, and I wanted to explore whether and how change occurred. Further, I wanted to understand how the organizational identity and capabilities' relationship influenced the evolving strategy of the organization and the organizational structures and processes put in place to implement the strategy.

To explore these issues, I selected the case of the evolution of a US subsidiary of a Japanese high technology MNC, which had responsibility for activities related to the development and sale of transmission equipment into the US. I analyzed this subsidiary's internationalization over a fifteen year period, ending in 2000, during which period it played a changing and significant role in the development of five product families, discussed in the last five chapters. Analysis of the development of these platforms provided a window on the organization's identity, through which I could try to understand how the organization's identity evolved with changes in the environment, organizational capabilities, strategy, and organizational structure and processes. Figure 9.1 summarizes the important changes in these components in the case that I have studied over the period from 1985 until 2000.

What we have seen in the previous five chapters is that the subsidiary began in 1985 with an organizational identity as a new venture, the principal feature of which was the almost complete autonomy that this gave to a new venture's managers. This identity evidently served the purpose of distancing the subsidiary from the unattractive model of a "Japanese subsidiary" typified by, and highly visible in the form of, home country rival NEC's transmission equipment subsidiary in the US. The construction of this new venture identity was enabled by the availability within the organizational field of large North American firms in the 1980s of an organizational model of an internal corporate venture. This model of an internal corporate venture was based upon divisions of larger firms within which managers were given autonomy, but with executive compensation levels equivalent to the rest of the firm. The internal corporate ventures of the 1980s were often set up to bring internally-generated new technologies to market by creating a new, entrepreneurial unit to develop a new business model and new organization. This fitted JTech's strategic need and organizational challenge at this point in time.

From having this initial new venture identity, the subsidiary went through two stages of punctuated identity change up to 2000, first to a period of identity ambiguity, and then to a period of a new model of a new venture. First, in response both to internal stresses on the initial new venture identity, as well as to the discontinuance of corporate venturing activities in *Fortune 500* firms following the US Stock Market downturn of 1987, the initial new venture identity gave way to a period of identity ambiguity which lasted from around 1992 until 1998. This was a period when the subsidiary's members seemed to be searching for, but could not find, a clear and coherent identity model for their organization. During this period, the earlier new venture identity model seemed to be becoming increasingly stressed and to be muddied by an emerging role-based identity, that of a development engineering organization. This was brought about by the changing capabilities and strategy of the organization.

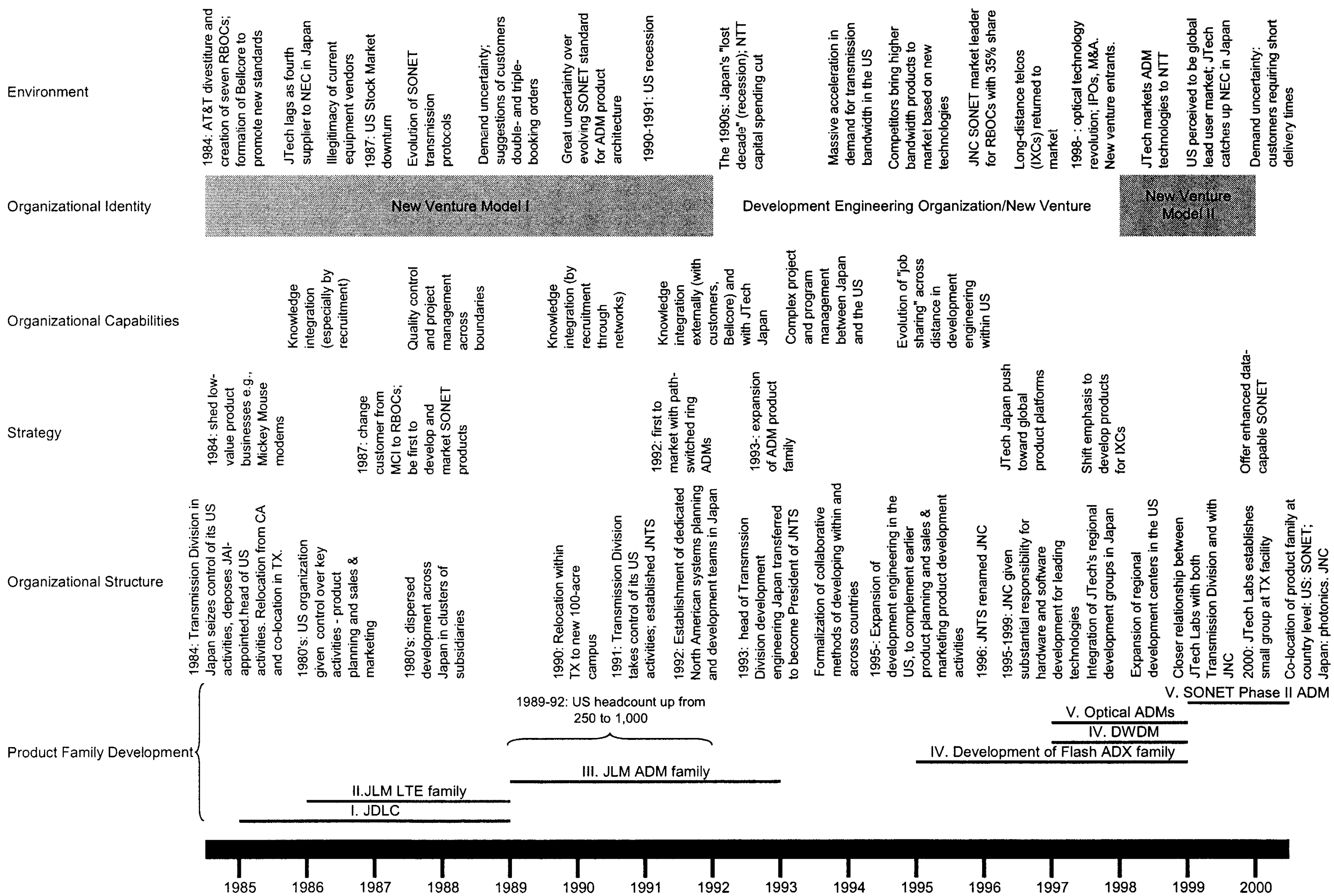


Figure 9.1: The Evolution of JTech's US Transmission Subsidiary

Subsequently, from 1998, this period of identity ambiguity itself gave way to a clearer organizational identity model, triggered by the availability within the North American environment of a revised model of what it meant to be a new venture. The dominant model was no longer a venture within a larger firm; instead, it was a newly-established firm which started small but could often grow to a substantial size, like Cisco Systems, one of JTech's key competitors in the late 1990s. One of the features that distinguished this revised model was the compensation mechanism put in place through venture capital funding, which promised managers high rewards for success in new ventures. Especially salient for JTech's US subsidiary members was the effect that this venture capital model of a new venture had on incumbent large firms in the transmission equipment industry in North America, especially the response of Lucent, which created a New Ventures Group in 1997. This subunit included a hybrid compensation system that broke with the earlier internal corporate venture model of internal equity across corporate divisions (Chesbrough, 2000).

It was not so much the private venture capital funded competitors that stressed the identity of JTech's US subsidiary, but the incorporation of elements of this into its MNC competitors in a move to a "phantom world" of stock options (Chesbrough, 2000). This revised new venture identity, in turn, interacted in interesting ways with the subsidiary's organizational capabilities, strategy, and the organizational structure and processes put in place to implement the strategy. In particular, the executives in JTech's North American transmission subsidiary, including its senior Japanese expatriate staff and the Japanese subsidiary's President, embraced this new model for their own organization. Their efforts to import this identity led to pressures to redesign the structure of the organization by means of an initial public offering through an equity carve-out from JTech. This initiative was rejected by JTech's corporate head office.

From understanding the patterning of these changes, it seems that the dynamics of organizational identity are different from how changes occur in capabilities, strategy, and organizational structure. Moreover, organizational identity plays an influential and perhaps the key role in the evolution of the organization.

In this Chapter, I consider each of these three identity phases in turn, and conclude with some suggested implications of my findings for the field of international management and some ways in which further research may build from my study.

9.2 Organizational Identity I (1985-1992)

Over the period from 1985 to 1989, which included the development of the FDLC and Terminal product families and the early development period of the ensuing ADM products, up to around 1992, the organizational identity of JTech's US transmission subsidiary was that of a new venture. This organizational identity was defined by the strong autonomy that it gave the subsidiary's managers to act in entrepreneurial ways, with the principal motivational mechanism being the chance to continue to lead the new venture in the event of success.

The model of a new venture identity had been available from the 1970s in the organizational field of large corporations in the US, such as Exxon, in the form of internal corporate venturing programs (Chesbrough, 2000). What characterized these internal corporate ventures was the complete autonomy that they gave the new venture's managers, with motivational mechanism for executives taking the form of incentives to head new divisions in the event of internal new venture success, rather than enhanced compensation, so as to maintain internal equity across divisions (Block & Ornati, 1987). Internal corporate ventures at the time were designed and introduced by top management to allow viable entrepreneurial initiatives to change the corporate strategy (Burgelman, 1983).

A significant contributing factor in the construction of this new venture identity was that JTech's Transmission Division redesigned its North American organization by taking control of its US activities from JTech's country subsidiary, JAI, by relocating the organization to a new location in Texas, and by appointing and granting autonomy within the North American organization to American executives with deep experience of the transmission equipment industry. These executives were given almost complete control over key activities within the new subsidiary organization, especially product planning and sales and marketing. The new venture identity was strengthened by focusing the Transmission Division's North American strategy on higher value transmission equipment, so shedding lower value and lower status products such as the development and manufacture of Mickey Mouse modems.

The effectiveness of this new venture organizational identity on JTech's North American transmission equipment subsidiary was enhanced by the distance that it allowed its American executives to create for their organization from the unattractive model of a "Japanese subsidiary." This alternative identity was especially visible in the transmission industry at the time in the form of the North American subsidiary of principal home country transmission industry competitor NEC, in which JTech's American interviewees perceived that the American staff had little or no control.

JTech's Transmission Division's earlier history of organizing its activities across Japan suggests that it may have been more aware than other Japanese MNCs of the importance of the cultural dimension to building an effective organization. This was evident, for example, in the way that the Division organized its domestic networks of software and hardware development organizations, JDTG and JCSG (see Section 4.4 above). Further, both JTech and especially its Transmission Division seemed to be relatively tolerant of identity work in local subunits dispersed across Japan.

Within the US from 1985, the Transmission Division's US subsidiary's new venture identity strongly shaped the organizational capabilities of the organization and enabled the Division to adopt a more innovative strategy in the US marketplace than would otherwise have been the case. The identity led to greater knowledge integration through JTech's ability to recruit top executives to lead its US organization, which in turn enhanced the working relationships between the US organizational members and their Japanese counterparts. The new venture identity allowed the US-based organization to draw in from its parent the capabilities and products needed to compete effectively within the US marketplace, without sacrificing the new venture identity. This was a defining feature of the model of internal corporate ventures in large firms more generally around this time: successful internal new venture managers were given autonomy and ran their own divisions.

Had there been greater overlapping across designated functions and activities between Japan and the US at the time, then this could have undermined the new venture identity, and shifted the organization's identity towards the then illegitimate organizational form of a (Japanese) MNC subsidiary. In contrast, the Transmission Division's US-based subsidiary organization during this period was led by individuals who were entrepreneurial and not afraid to challenge the traditional management system and authority.

The business and functional strategies implemented during this period were shaped by the new venture identity and these capabilities, most notably through the strategy of developing innovative new products for a new category of customers, the Regional Bell Operating Companies (RBOCs). This was the case because the new venture identity gave the US executives license to be entrepreneurial in building the business and organization that was necessary to compete in the newly deregulated US transmission industry environment at the time.

The strategic opportunity to enter the market to supply transmission equipment to the RBOCs was occasioned by the 1984 divestiture by AT&T of its regional operating services and the creation of seven RBOCs, coupled with associated changes such as the establishment of Bellcore. These changes in the environment opened up the local and regional segments of the telecommunication equipment market to new suppliers of transmission and switching equipment. The RBOCs were keen to purchase equipment from new suppliers and to promote standards that would enable interoperability among multiple vendors' systems in a newly competitive transmission equipment industry.

The first two product families developed during the period that the American executives considered that their organization had an identity as a new venture were the JDLC the Terminal products, with the latter being the first product developed to the newly emerging SONET standards. The development of these product families is described in Chapters 4 and 5, respectively. The successful development of the JDLC product had the outcome that JTech learned the RBOCs operating conditions and equipment specifications. Moreover, success amplified the organizational identity of the US organization.

As with the development of the JDLC, JTech's US organization controlled the relationships with the RBOC customers during the development of the Terminal products, since it had demonstrated that it understood the RBOCs and their requirements. The US organization's members enacted their new venture's identity through controlling the product planning process and product specification, and by pulling in the technologies from Japan that would provide the functionality promised by SONET. While the underlying technologies were being developed in Japan, both Japanese and American interviewees talked of the US organization as "owning" the products, even while they were being developed. Whatever the Americans specified, the Japanese would "just do it" – the watchwords of the head of development engineering in Japan at the time.

The effectiveness of the new venture identity was illustrated by the story of how JTech's equipment proved its superiority over that of industry incumbent AT&T. JTech's strategy in entering the SONET equipment market was to be first to market. In the context of great uncertainty over the specification of the emerging SONET standards, two examples are indicative of the effectiveness of the new venture identity at the time, based upon the effect it had on the American executives' actions.

First, the new venture's American executives offered free upgradeability to customers in the event of changes in the SONET standards. Second, as described in Chapter 5, the Americans achieved their first sale of Terminal products by working out the price for their product on a napkin. This shows how the organizational identity influenced the actions of the American executives.

Especially notable, however, was the effect that the new venture identity had on shaping the collaborative organizational capability between Japan and the US in new product development. This was evident in the superior performance of the first Terminal equipment that JTech sold, relative to equipment supplied by industry giant and incumbent AT&T's Western Electric transmission equipment subsidiary. Having sold its first Terminal product, JTech's equipment continued to function in the extreme temperatures of a heatwave, while that of the establishment and incumbent vendor, AT&T's Western Electric, failed.

The effectiveness of the new venture identity was further evident on the Transmission Division in Japan, whose development engineers had committed massive resources to developing the underlying technologies, especially LSIs, of which 80% of the development work was distributed across the Transmission Division's domestic network of subsidiaries across Japan. The development engineers in Japan had rapidly and flexibly responded to the frequent requests for changes to the development specification necessitated by the changing standards made by the US product planning team in the North American new venture. JTech's competitors failed to make some of these crucial changes, such as the change from the 13-row to a nine-row format of LSI development, as I discussed in Section 5.6.

The result of JTech's US transmission organization having based its organizational identity on the model of a new venture was that it successfully entered as a supplier of transmission equipment into the RBOC market, and eventually went on to capture the dominant market share of SONET equipment sales to RBOCs, a 35% market share by 1996.

9.3 Organizational Identity II (1992-1998)

From the late 1980s, two sources of stress began to affect the new venture organizational identity of the Transmission Division's North American subsidiary that had been salient to its members since 1985. One source of stress was the environment, with the other being internal, resulting from changes in strategy, changes to the design of the organization to manage its success, and changes in organizational capabilities. The result was that from 1992 to 1998 the identity of the US organization seemed to its members to be a combination of an increasingly illegitimate new venture alongside what appeared to be a role identity as a development engineering organization. This somewhat muddied period of organizational identity shaped the design and capabilities of the US subsidiary during this period.

The first sources of stress on the new venture identity of the subsidiary came from the external environment. One was that corporate venturing activities by large American corporations were largely discontinued after the Stock Market downturn in 1987, with the result that the model of the internal corporate new venture as an organizational form no longer dominated the environment from this time (Chesbrough, 2000). It was only as the extended Stock Market bull market of the late 1990s in the US gained momentum that corporations re-introduced corporate venturing activities, but this was to be a new and very different model of an internal corporate venture (see Section 9.4).

JTech's subsidiary's success in selling its equipment to the RBOCs itself challenged its new venture organizational identity, as managers perceived that their North American subsidiary had become "the establishment." This was something that they had fought against during earlier battles to establish SONET standards of interoperability and a competitive market structure open to new entrants, in which customers could mix and match equipment from different suppliers. The way that SONET equipment was incorporated in ring topology ADMs itself included a monopoly element (see Figure 6.1 and related discussion) that was in some ways reminiscent of the earlier industry structure of the vertically-integrated suppliers Western Electric and Northern Telecom. Despite this, JTech's US subsidiary's members continued to rally against these incumbents, such as through highly symbolic demonstrations of compatibility with competitors' equipment at the principal North American transmission equipment industry trade fairs.

Other stresses on the earlier new venture identity were largely internal, principally resulting from organizational design changes implemented to manage the growth of the organization. The first of these was the design of more formal organizational structures to manage collaborative relationships and activities. These represented more formal controls on the capacity of the North American organization's members to act, such as by adopting formal documents whereby changes to product specifications in the development of the ADM products had to be signed and agreed by all involved, including the development engineers in Japan. This was different from product development of the earlier product families, in which development engineers in Japan developed products to specifications provided by the American product planners in the US.

A second internal stressor of the earlier new venture identity resulted from changes in the design of the North American organization associated with increases in its headcount, especially in development engineering as a designated activity. Until 1989, the headcount of the Transmission Division of JAI had increased slowly, to reach some 250 people by 1989, to 750 people by 1990, and then to in excess of 1,000 people by 1992. This, in itself, changed the look and feel of the organization to its members. Much of this was accounted for by increases in the number of employees in sales and marketing, in product planning, but especially proportionately within development engineering.

Further changes in the design of the organization were made to accommodate this growth. In October 1990, JAI's Transmission Division relocated within Texas to a new building on a 100-acre campus that JTech had purchased freehold. While the organization remained within the Telecom Corridor area, it moved into newly constructed buildings. The sheer size of the new organization – though dispersed into small clusters across the new campus building – meant that it was hard for the organization's members to continue to claim that the 1991 renamed JNTS was "the new kid on the block." This was despite the change in overall responsibility for JNTS having shifted from US country subsidiary JAI to the Transmission Division in Japan in 1991.

The increased focus upon development engineering at the subsidiary in Texas was given an impetus when the former head of development engineering in Japan during the successful development of the JDLC and Terminal product families was appointed President of the US subsidiary in 1993. The subsidiary had for a number of years had some responsibility for development engineering, but mainly for the cabinets that housed transmission equipment and for some software, such for transmission network management software.

These organizational design changes pointed to the expanding role of the US subsidiary in development engineering. In part, this organizational redesign had also been a response to the difficulties that JTech confronted in lateral hiring of experienced engineers within the Japanese institutional context of graduate recruitment and within-company career trajectories. This difficulty was compounded by the severe economic downturn in Japan during the 1990s – often referred to as Japan's lost decade – which had led for a while to JTech putting in place a hiring freeze in Japan.

In trying to make sense of who they were as development engineering expanded, organizational members searched for a new identity for their organization. They seemed to find one in a somewhat opaque role identity as a development engineering organization, which sat alongside the increasingly illegitimate identity as a new venture. In turn, this somewhat muddied organizational identity, as a new venture *cum* development engineering role, influenced the subsidiary's strategy, affected the design of the organization, and shaped its capabilities in the following way.

That JNC maintained its identity as a new venture in this period was evident in the way that it influenced behaviors, especially in relation to the willingness to take risks. This was exemplified in the continuation of differences in inventory management between Japan and the US (see Section 6.6), with JNC members referring to inventory as 'risk capital' and a 'hedge,' while for Japan-based members of the Transmission Division it meant 'cost.'

First, from around 1995 JTech's Transmission Division adopted a strategy of enhancing its SONET products by adding two protocols and technologies more suited to the 'bursty' transmission needs of data, ATM and IP. These technologies were being developed in the US, embedded in parts of New York (near Lucent) and California (the 'home' of IP), respectively. In order to build this data functionality into its products, JTech would need to hire in engineers with the respective skills, which could best be achieved if it was located in these areas in which the respective skills were embedded.

This led the US subsidiary to expand its activities in development engineering through the establishment of separate development engineering organizations in locations distant from Texas, but in which it could hire engineers skilled in these particular technologies. To this end, it established a new development engineering organization in New York in 1997, in the middle of an area known as InfoComm Corridor.

The establishment of this new organization represented an organizational capability at hiring, which was evident from the successful recruitment of engineers with the requisite skills in developing ATM technologies to be incorporated into JTech's SONET products. The existing California software development organization was similarly expanded, as it could hire engineers skilled in IP technologies from Stanford University, the University of California, and from many software tools providers located in the Bay area.

The way that the new venture element of the organization's identity influenced these organizational changes was through the implementation of a capability of knowledge integration through what organization members called 'job sharing' (see Section 7.4). An earlier version of this approach to dispersed and collaborative new product development had been developed by JTech's Transmission Division within Japan. What the US subsidiary did was to take this earlier model and to shape it in a way consistent with the new venture's defining characteristic of autonomy. This meant that the New York organization was given complete control over development of an entire ATM module. The actual wording used in documents referred to the need to keep software development for a unit (or processor) co-located with hardware development of the same unit at all times, as well as matching skill sets within the organization to the local area.

Co-location (*organization design*) focused upon the level of the module made it easier to hire engineers (*organizational capability*) but was shaped by the muddied *identity* of the time of a development engineering role and a new venture. This, in turn, enabled JTech's Transmission Division to implement a *strategy* of incorporating improved data handling functionality within its product line through product platforms such as the ADX family of multiplexers.

Just as the US organization had earlier controlled the development engineering activities of its Japan parent by preparing product planning and design specifications, the autonomy that was associated with its fading new venture identity additionally led it to establish a closer and more direct relationship with JTech Laboratories in Japan for the purpose of better controlling the direction of research activities. This was in part brought about by a shared frustration with JTech Laboratories that the Transmission Division in Japan had delayed committing resources to develop products based upon dense wavelength division multiplexing (DWDM), a fiber-optic transmission technique that employs light wavelengths to transmit data parallel-by-bit or serial-by-characters.

Whatever the reason for the Division's failure to develop DWDM products – and speculation on this was rampant across JTech even at the level of the President in the late 1990s – increased control of development engineering resources to JNC meant greater strategic control and less risk of resources being diverted to such activities as customizing products for NTT. This was the more important since NTT East and West were introducing variants of products developed for the US marketplace, and the US subsidiary, renamed JNC in 1996, was at the time battling the Transmission Division in Japan to control the specification of products for what it perceived to be its North American global lead users in transmission equipment over pressures to develop global product platforms with attendant reduced costs from economies of scale.

Especially, however, it was the expansion of development engineering across the US in dedicated purpose development organizations, subsidiaries of JNC, which defined this period of a somewhat muddied organizational identity for JNC's organizational members. Symbolically important, these separate organizations were JNC's own subsidiaries, as JNC was emulating being a parent. The expansion of development engineering activities and responsibility for this new role strongly influenced the identity of JNC. This co-existed with, and seemed almost to compensate for, the struggle that organization members increasingly had in claiming that their organization continued to be a new venture in this period when the available organizational model for corporate venturing activities in large firms in the North American environment of large firms was almost invisible.

9.4 Organizational Identity III (1998-2000)

JTech's Transmission Division's organizational members had, from the mid-1980s, used a model of a new venture to shape the identity of their subsidiary, of 'who they were' as an organization. This model of a new venture had been based upon the internal corporate venture as an organizational form available for emulation from the field of large North American firms in the early 1980s. These ventures had continued to be a feature of the corporate environment in the US until the Stock Market downturn in 1987. The key characteristic that defined the venture form was the autonomy that it gave managers who ran the respective venture unit, with motivation in the form of the opportunity to run a growing division if the internal venture succeeded. Financial rewards were equivalent to other divisions across the firm, except that executives in a new venture division could expect more rapid promotion if a venture succeeded and grew rapidly. This model of a new venture had also been important to the Transmission Division's US subsidiary members during the 1990s, although it was increasingly being stressed from a number of sources, including its lack of legitimacy from the environment during this second period.

From 1998, the new venture identity experienced a birth and resurgence for organizational members of then JNC. However, the revised new venture identity was based upon a different model of a new venture that had become available in the North American organizational field and institutional environment. The model was especially salient for JNC's organizational members, since many of its direct competitors were identified with this organizational form.

The key difference in the new model from the old was the fact that the revised new venture model was constituted in the shadow of a dramatic expansion of venture capital funded new ventures in the US in the 1990s. In almost a reversal of the earlier model, the new model of what it meant to be a new venture in the venture capital world heavily incentivized its key executives and was coupled with much tighter control from venture capital funders. Chesbrough (2000) cites data comparing the $300 million raised by venture capital in the 'cottage industry' period of eighteen months to 1978 with the $21 billion raised by venture capital in just the first nine months of 1999. Moreover, he cites other data that venture capitalists would visit their companies an average of 19 times each year, with over 100 hours of direct contact with the managers of the venture.

Venture capital funded competitors appeared in the transmission industry in the second half of the 1990s, both within JTech's SONET-based product area and within the technology space that was represented by the image of a new, all-optical transmission network (see Chapter 8). These were competitors to JNC, but did not threaten the identity of the organization to JNC's members.

What did threaten JNC's organizational identity was the response of large, established firms within JNC's organizational field and industry. This organizational response of the larger firms had two elements. First, as discussed in Chapter 8, transmission equipment suppliers that were quoted in the Stock Market, including Nortel Networks, were acquiring and integrating these venture capital funded transmission equipment start-ups. Many of them in fact had little more than working prototypes of products and were led by entrepreneurs who were selling a concept and technology, but were not focused upon building a business in the way as JNC executives were. JNC did not have the means of competing to buy these new firms through issuing stock.

Some of these new entrants appeared with radically new SONET architectures, most notably Cerent and Cyras Systems. With only a 1% market share of SONET equipment sales, Cerent was acquired by longstanding JNC competitor Cisco Systems for $6.9 billion in 1999. Cisco Systems had developed the first Internet Protocol (IP) router back in 1985, and was strongly identified as a heavyweight seeking to expand into the transmission equipment marketplace. Cyras Systems was similarly acquired by DWDM specialist and incumbent Ciena Corporation in a stock-for-stock transaction valued at some $2.6 billion in 2000.

Other new entrants offered newer technologies associated with what some saw as a revolution in transmission, the shift from electronic to an all optical network, there were a number of new venture start-ups with key technologies that were also acquired by transmission incumbents. Ciena Corporation, for example, acquired optical switching companies Lightera Networks and Ominia Communications in 1999, for $552 million and $449 million, respectively. Acquisitions by incumbents were described in the press as a "land grab" and JTech's closely watched and major competitor Nortel Networks sought to effectively speed up its development of new products by a series of acquisitions of new ventures in 2000 totalling some $8 billion (see Section 8.2).

More salient, however, was the response of some of JTech's larger competitors who sought to emulate the incentives offered to managers by private venture capital by putting in place hybrid compensation schemes, such as phantom stock. Indeed, along with senior executives from JTech's corporate head office, I was taken to visit Lucent in New Jersey in 1999 to have the principles of its 1997-established New Ventures Group, a hybrid constructed out of a pure venture capital organization and a large technology-based company, explained. Lucent itself had designed this internal technology venture model through having studied its implementation within other large companies in its organizational field, including Intel, 3M, Raychem, and Xerox (Chesbrough, 2000). One of the properties that characterized Lucent's New Ventures Group was its hybrid compensation system, which provided greater rewards to managers than commonly available in other divisions, especially Bell Laboratories, but that did simultaneously impose some risk on employees involved in the new venture. In return for forgoing an annual bonus, the employee would receive 'phantom stock' that would pay off only if the venture succeeded (Chesbrough, 2000).

JNC's second major competitor, Nortel Networks, was not only buying venture capital funded new ventures, but additionally had a phantom stock scheme that awarded entrepreneurial employees and teams who volunteered for special, high-risk projects. The way that this worked was that Nortel promised to 'buy' these projects as if they were companies in a sort of internal initial public offering. Team participants were to get paid in chits redeemable for cash when a product was finished and again when it had been on the market for a year. Some 17 projects were funded at Nortel this way, but like other new venture initiatives in large North American firms such as Procter & Gamble, this program was discontinued after the collapse of the telecom bubble in the early 2000s (Tucker, 2002). The growth of new venture initiatives in large firms in the late 1990s seemed again to follow the booming Stock Market.

JNC's organizational members seized upon these large firm models of innovation as a solution to the earlier period of identity ambiguity. Here was a new model of a new venture, highly visible and legitimate in new firms, which could form a basis for a strategy of acquiring firms with new technologies to complement – or replace – JNC's SONET-based products, as well as compensating employees well. It wasn't only the American employees at JNC that embraced the new model, but its most ardent supporters included some of the locally-based senior Japanese expatriate staff at JNC, most especially the subsidiary's President. The new organizational model represented an organizational identity that they sought to import into JNC.

Seeing this revised new venture organizational identity as legitimate and appropriate in the new world from around 2000 of exploding growth in telecom and transmission equipment, JNC executives commissioned an independent firm of accountants and management consultants to report and advise how JNC could be redesigned in a way that it could construct a similar identity. The final report having been prepared, it formed the basis for pressures by the Japanese President of JNC directly on the Transmission Division and on JTech senior corporate executives to redesign the structure of the JNC organization by means of an initial public offering through an equity carve-out from JTech. While receiving some support within the Transmission Division itself, this initiative was rejected by JTech's corporate head office for which transmission equipment had been redesignated as core to JTech, compared to its earlier status within the firm well-captured by the expression often made to me in head office that transmission equipment was 'just parts.'

At the same time as JNC members sought to redesign their organization in a way that would enable them to enact an organizational identity of a new venture based on the revised new model that was available in the environment, two other internal changes generally worked to support the new identity claim.

First, JTech Laboratories established a small laboratory at JNC's Texas facility, primarily as a listening post to better understand some of the changes that were occurring in technologies as the industry appeared to move toward an all-optical network. The symbolic importance of this to JNC organizational members was out of all proportion to the actual size of the commitment to JNC by JTech Laboratories, and was echoed in the local press through the announcement that the new Texas research laboratory would "mirror" the "renowned" JTech Laboratories in Japan.

This strengthened organization members' revised new identity claim, since Lucent and Nortel Networks had substantial research activities, which had been completely absent from JNC. Its organization's members now saw that their organization had a complete set of support activities across the entire value chain (Porter, 1985) in North America.

Second, the decision was made to co-locate the development of product families at the country level, with JNC having responsibility for products based upon the SONET standards with which it was so closely identified. Since its RBOC customers were moving abroad, such as to Central and South America and to Europe, JNC sought to follow them and use their global product platform to develop and sell derivative products from SONET to their traditional customers. This second organizational change had the same effect as the first, in that it made JNC look more like its principal establishment competitors Lucent and Nortel Networks, both of which had significant overseas operations and sales. This reinforced the push for the fundamental organizational redesign through an IPO.

This change to a management system based on the principle of regional responsibility for global product platforms was also a response to the challenges of cross-border new product development engineering that I outlined in Section 7.6. It was considered that these changes would reduce the stress on the US organization's identity. With its earlier organizational identity closely associated with its expanded role in development engineering, JNC had begun to notice differences in the development systems between Japan and the US, many of which, while evident at the project level, were organizational in origin or resulted from broader differences in the respective institutional environments. These had become visible through differences across borders in the meaning of functional boundaries, schedules and deadlines, feature content, risk taking, working protocols, development tools, and resource allocation. It was the context of JNC's strong identification with development engineering that heightened and made more salient these cross-border differences. The redesign of the organization that put JNC back in control of product platforms was expected to further enhance organizational members' claim that JNC was a (revised) new venture.

9.5 Conclusion and Next Steps

It seems clear from my study that the establishment of a subsidiary has identity implications that are significant and that the organizational identity that members construct interacts with changes in the organization's strategy, structure, and design in ways that affect a number of outcomes. In my study of JTech's Transmission Division's North American subsidiary, it was clear throughout the fifteen year period of organizational identity construction and two punctuated changes in identity that occurred up to 2000 that the subsidiary was desperately trying to be something different, something other than the identity of being a Japanese subsidiary. Organizational identity was not an option; it was always there, to be recognized and understood.

Moreover, 'what' – or 'whom' – a subsidiary is trying to be is conditional upon the organizational models that are available and legitimate in the organizational field within the institutional environment at any particular time. The salient organizational identity represents a system of meaning through which organizational members enact their environment, with the value of organizational capabilities dependent upon the organization's identity being recognizable to its members as belonging to a legitimated organizational form.

One implication arising from this is that the way we think about strategic intent could be broadened to include the construction of an appropriate and legitimate organizational identity, as well as building a technologically-capable firm. When a firm internationalizes, in addition to designing its strategy or building from its developed capabilities, foreign direct investment – which by definition comprises involvement in some form of organization – it is also creating or changing the identity of the host country organization. The opportunity to create an identity may be greater in greenfield site establishments than in alliances, joint ventures, or acquisitions of established firms, since it may be easier to build a new organizational identity than to change an existing organizational identity.

It also seems that the organization's identity changes in a punctuated way, responding either to internal stresses or to changes in the enacted environment. To illustrate the first point, it becomes increasingly difficult for an organization's members to maintain an organizational identity as a new venture if the organization suddenly grows in size and there is increased formalization. It may be that the enactment of an increasing availability of resources through external capital markets is likely to be more significant in a subsidiary operating in an environment of constrained internal capital markets than for a subsidiary with resource munificence. What I have found is that pressures for a new identity may cumulate, both through internal events and through changes in the environment, and that at some point there is sufficient pressure for a rupture to occur, when the organization's identity changes.

The environment for a subsidiary includes the home country organization of the MNC and other host country subsidiaries, and these organizations also have identities that are changing over time. For example, at the beginning of my study JTech's Transmission Division was the fourth of four top tier suppliers of transmission equipment to NTT, but by the end of the period it had managed to catch up with NEC in sales to NTT, and even to overtake NEC in some key areas. In this case, the identity of the home country organization also changed, and further work could consider the interaction between these changing identities. An MNC may be more or less tolerant of identity work by overseas subsidiaries, dependent upon its home country identity. In the case of JTech's Transmission Division, for example, it was undoubtedly more tolerant of identity work in its subsidiaries because of its identity at home.

Useful though it is to understand changes in strategy or organizational structure or practices, it seems that these changes are enacted and made sense of by an organization's members through the lens of the organization's identity. It is important also to understand the meaning of a practice to an organization's members. This turn to a more idealist and constructivist approach is evident in more recent work by international management scholars studying the transfer of practices across borders, notably by Kostova (1999).

Further, the concept of organizational identity turns a focus on individual management practices on its head by suggesting that it may not be the meaning of a particular practice *per se* that is important, but the effect of that practice on the meaning of the organization as made sense of by its members. This sensemaking constitutes the core of the organization's identity. To illustrate with a simple example, take a practice of transferring engineers from a divisional headquarters in Japan to a US subsidiary. The outcome of this practice depends upon the meaning it has mediated by the organization's identity. If it results in the identity of the host country organization being so stressed that a rupture occurs and organizational members construct the alternative organizational identity of a Japan-dominated subunit, it is that meaning that defines the effect that the practice has on a capability to integrate technical knowledge across borders. If, on the other hand, the transferees are all junior engineers who are relocating to work on projects directly managed by local host country managers, then the same practice may not lead organization members to question the salient organizational identity, in which case the practice would have a different meaning. In my study, I showed how the loss of a low status business activity such as manufacturing Mickey Mouse modems had an effect at the cultural level on the organization's identity.

Finally, my finding of the importance of an organization's identity is particularly salient in MNCs, but could be used to deepen our understanding of organizational evolution and change within countries. An organizational redesign involving, say, the addition of a new laboratory to an existing organization may have implications for the organization's identity that are not straightforward. Such changes occur across organizations within countries.

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