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The Regulation of Vertical Relationships in the US Telecommunications Industry

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INTRODUMON

It is well known to students of regulation that regulations can result in substantial hidden costs -products, services or delivery methods that do not arise or cannot be provided due to regulation. In situations in which a regulation is rescinded, it is sometimes possible to quantify the hidden costs. Quantifying the hidden costs due to regulations that are still in place is a more formidable task. The difficulty in quantification does not vitiate the concern that hidden costs may be large.

During the 1980s, the Unites States embarked on a unique course in telecommunications policy. Of course, the regulatory treatment of AT&T had always been relatively unique compared to the more common pattern of government owner ship of major telecommunications services in other major nations'. The Modified Final Judge ment (MFJ) dramatically transformed the United States telecommunications industry. AT&T was required to divest the local exchange services and to organize the seven regional holding companies (RHCs) as the local service providers. This left AT&T as a provider of interexchange services and as an equipment research and manufacturing entity through Bell Laboratories and Western Electric. In contrast, as a consequence of the line-of-business restrictions in the MFJ, the RHCs became almost unique entities as regulated local-exchange carriers that were denied the au thority to offer interexchange services, to engage in information services or to manufacture tele communications equipment. Although over the past decade, portions of these line-of-business restrictions have been modified, [2] the RHCs con-

tinue to be prohibited from self-manufacture of telecommunications or customer premises equipment (CPE), or from participating in joint ventures or from holding hold minority interests in equipment manufacturing firms.

During the period of litigation leading up to the MFJ, telecommunications equipment could be divided into three more or less distinct categories: central office (CO) switches, WPE) including private branch exchange (PBX), and transmission and outside plant equipment. However, technological change during the 1980s has blurred the distinctions between central office and CPE, and between hardware and software, due to advances in semiconductor technology and the rapid decline in the costs of semiconductors. Now certain items that were once hardware have become software, and the intelligence that was in the central office can be found in a business PBX or even smaller office telephone system. Despite the blurring of vertical distinctions, the MFJ continues to make sharp distinction, particularly between equipment and telecommunication services.

It is now well accepted that vertical linkages can be very important in assuring product quality, constraining total value chain costs, and in stimulating and implementing innovations. However, it is largely only relatively recently that the specifics of the advantages of vertical arrangements for innovation and new product development have begun to be fleshed out. In the fields of marketing, operations management and the management of technology, it is now well understood that actively involving customers (and, when possible, end-users) can significantly increase the speed of new product development and result in new

products (and services) that better fit the requirements of customers and end-users. The economics of vertical relationships, focusing on sunk investments and potential opportunism, makes clear that in some circumstances, involving customers in innovation or new product development activities may not be viable without those customers taking an equity position in the activities. Thus, the general outline of the argument that there are significant costs, in terms of reduced or impaired innovative activity and new product development, imposed by the MFJ restrictions on equipment manufacture are clear.

There is a great variety of evidence, much of which is summarized in this paper, indicating that the MFJ restrictions on equipment manufacture is foreclosing a substantial amount of vertical activity involving equipment manufacturing and the RHCs. Just one piece of indirect evidence is that the US telecommunications industry is unique among high-technology industries in the absence of vertical integration, joint ventures, or equity interest between the leading end-users of technology and upstream equipment manufacturing. At present, the RHCs, collectively, are the major providers of telecommunications services in our economy. Although the competitive landscape is rapidly changing, with the entry of new sources of competition in the telecommunications services market, it is likely that the RHCs will remain major providers of telecommunications services. The telecommunications industry is a high-technology industry experiencing very rapid technological change. That major downstream providers of telecommunications services are foreclosed by the MFJ from participating in joint ventures, minority equity participants, etc., in a major segment of the industry, equipment, in which much of the technological change is arising, has significant costs in terms of foregone innovation.

At the time of divestiture, the disintegration of the RHCs from equipment manufacturing may have been of net social benefit due to the state of competition faced by the RHCs in telecommunications services. However, since divestiture, innovation has greatly accelerated, and the RHCs now face much more competition. It is not the purpose of this paper to document the new competitive environment. Rather, our purpose here is to show that there is a great deal of evidence of various kinds indicating that the MFJ restrictions

with respect to equipment prohibit a variety of vertical alliances that could enhance innovation in the US telecommunication industry. The rapid change in technology, the ever-increasing demands on the telecommunications industry by US businesses, and the continuing heightened competitive environment faced by the RHCs, in our opinion, make the case for the MFJ restrictions on equipment no longer viable.

This paper brings together the available evidence bearing on the impact of the MFJ restrictions on equipment manufacture. After a brief summary of recent research on the role of vertical relationships in innovative activities, we examine a number of case studies of telecommunications industries that are not governed by MFJtype restrictions on equipment manufacture: the AT&T system prior to the MFJ, and five foreign telecommunications industries. In addition, we have developed information from our industry experience,' and interviews with some of the RHCs and with Northern Telecom, on activities that the RHCs have not been able to undertake because of the MFJ restrictions, or activities the RHCs would be likely to undertake should the MFJ restrictions be suitably modified. The evidence presented here confirms that the MFJ restrictions on equipment manufacture have a significant negative impact on innovative activities in the US telecommunications industry.

FORMS OF VERTICAL ALLIANCES

There is an abundant literature available on the forms of cooperative linkages and their advantages, much of which is relevant to vertical alliances (see Teece et al., 1988; Teece, 1992; Harrigan and Newman, 1990; Osborn, 1990). The spectrum of alliances ranges from simple contracts to vertical integration. In between lie many forms of contracts with varying complexity and equity positions. The MFJ restrictions on participation in equipment manufacturing prohibit alliances between equipment manufacturers and the RHCs that involve equity participation by the RHCs. It is well known that a variety of factors may dictate that the creation and success of a vertical alliance may require equity participation. Equity participation can be an efficient mechanism of sharing risks and rewards and for enhancing the incentives of the parties to an alliance to

cooperate effectively. Vertical alliances involving equity participation or their equivalent by endusers of technology are very common in all hightechnology industries, including telecommunications industries in most other countries.

Vertical alliances are important for expanding the governance structures that may be relied upon as an alternative to a purely contractual basis of exchange (see, for example, Williamson, 1985). The MFJ basically limits the RHCs to contracting with suppliers for the provision of equipment. For existing technology, a contract can be an acceptable business relationship because the uncertainties are relatively few and are typically describable within the contract document. New technology, especially where a development phase must be undertaken to ready the technology for commercialization, and where commercial success may be quite uncertain, often cannot be incorporated into a simple contractual framework.

A more efficient alternative is an equity position for the potential user of the technology. By making an equity investment, the future customer pre-pays for all or a portion of the transactionspecific capital. The customer also has a stronger interest in the success of the technology because that will result in a future stream of returns from the equity investment. The potential supplier of technology thereby confronts reduced risks if the customer can be an equity partner, due to capital contributions toward transaction-specific investments and the increased incentive for the customer to use the technology if a commercial application is feasible.

The equity position in a supplier of equipment embodying technologically uncertain characteristics offers significant advantages to the customer beyond the potential for a financial return if the program is successful. Equity ownership can also provide the customer a role in corporate governance of the organization developing and implementing the technology. Mowery (1988) discusses the importance of the corporate governance position in either equity joint ventures or direct equity positions, as common alternatives to the pure contract or full vertical integration.

In the equity joint venture, a separate administrative hierarchy can handle general operational and strategic policies and settle disputes that otherwise might directly involve the managers of the parent corporations. This can substitute for at-

tempts to specify a complete set of contractual conditions to govern the relationship. Second, because both partners are full participants there is a reduced incentive for opportunistic behavior. Partners have defined stakes in the joint venture and therefore cannot benefit readily from attempts to re-interpret the agreement, as often happens with clauses in a contract (Mowery, 1988, p. 32).

Direct equity positions can offer another alternative. Joint ventures tend to be complex to negotiate and organize. In contrast, one partner can merely take an equity position in another firm to realize some governance advantages of the relationship. The investor can take a seat on the board of directors as a means of monitoring the performance of the investee corporation. The board position also provides a means of conveying proprietary information that may be necessary for successful implementation of the project. However, while the representation on the board can offer the investor a voice, the ability to implement operational and strategic decisions is not as certain as in the more formal joint venture arrangement (Mowery, 1988, 33).

VERTICAL RELATIONSHIPS AND INNOVATION

The general theory of vertical alliances, including vertical integration, is well developed. In what follows, we will highlight a number of issues that we believe are of particular importance in understanding the need for various types of vertical alliances in the telecommunications industry.

Cost and Risk Sharing

High-technology industries, such as the telecommunication equipment industry, are enormous users of new capital. For a variety of reasons, in some cases capital markets are not tapped, or cannot be tapped, to fund innovative activities. This is one reason alliances between innovative firms with substantial cash needs and firms in related industries with strong cash positions are common in high-technology industries. This is predominantly the case for smaller innovative companies. But collaboration to share cost and risk is also common for large companies (see

Wissema and Euser, 1991, who discuss examples involving IBM, Philips, Sony and Siemens). The predominant form of financial alliances is between firms in different vertical segments of the same industry. The reasons for this are straightforward. A cash-rich company in an industry that is vertically related to a cash-starved innovative company may be in a superior position to understand and bear risks and to share in the rewards of the vertically related innovative activities.

The telecommunications industry is characterized by cash-rich downstream companies (the operating companies) and upstream innovative companies (the equipment manufacturers) that are typically 'capital constrained' (i.e. they have opportunities worth pursuing but are unable or unwilling to tap capital markets to fund them). Such circumstances, along with the potential advantages of involvement of both equipment manufacturers and operating companies (discussed below), make for strong incentives for joint equity participation in some types of projects. Prohibition of such relationships will in some cases inhibit innovative activities that would be undertaken.

One example involves Protocol Engineers, Inc., which is a developer of fast data-transmission products. It discontinued its efforts in 1990 to design products for the public network because of the prohibition on cooperation with the RHCs. Instead, Protocol Engineers has focused instead on private network markets. In a number of cases US innovators have been required to seek financing from foreign companies, when financing would have been available through the RHCs, but under arrangements that would violate the MFJ. For example, Centigram Corp., which develops audiotext provisioning products, sold a substantial portion of its stock to foreign companies, including the Telecom Authority of Singapore, when it needed capital for expansion. Cellular communications is one of the most dynamic and competitive areas in telecommunications today. BellSouth, a major cellular player, was denied the ability to participate in a joint venture with International Mobile Machines (IMM), which designs and develops digital radio transmission products, because of the MFFs manufacturing restrictions. IMM subsequently formed a joint venture with Siemens and Alcatel to make digital cellular equipment. The authors are not arguing against domestic companies entering into advantageous

international alliances. However, it does not make sense to foreclose the option of alliances with the largest US operating companies.

Knowledge Complementarity

Technology companies face technological risks (their innovative efforts may not be technologically successful) and market risks (although technologically successful, the efforts may not be rewarded in the market). With complexities of the recent technological developments, it is difficult for any single firm to maintain competence in all fields. Most new major technology development activities require expertise in different fields such as material science, chemistry, computer science and electronics. Individual firms normally choose one or two fields in which to develop competitive advantage and try to keep abreast of the others. A cost-effective method of accessing technology is through alliances, including vertical alliances. There are many examples of this in the telecom4 munications industry.

The modem literature on innovation highlights the complementarity of technology and market knowledge. In today's fast-moving technology and product cycles, it is very important for technology creation efforts to be well informed about fastchanging downstream user needs. Vertical alliances can play an important role in ameliorating market risk. The technology developer working jointly with one or more technology users can significantly reduce the risk that technology development will not find favor in the fast-changing downstream market. Examples in high-technology industries, including telecommunications are ubiquitous.

For example, Philips and AT&T formed a joint venture to develop digital telephone exchange. It would have been too risky for Philips to undertake this project without assessing the needs of AT&T in the area of digital exchange. And AT&T required Philips' technical expertise to complete the project (Wissema and Euser, 1991). Similarly, NEC and AT&T have formed an alliance to exchange data on application-specific integrated circuits (ASICs). Under the contract the two companies will work together to design AT&T semiconductor products into NEC equipment. Instead of working separately, the two companies found it beneficial to work together (Dambrot, 1990).

The Involvement of Customers in Innovative Activities

In his treatise on the sources of innovation, von Hippel (1988) highlights the critical role of cus tomers in the success of innovation by manufac turers of equipment sold to those customers:

It has long been assumed that product innova tions are typically developed by product manu facturers. Because this assumption deals with the basic matter of who the innovator is, it has inevitably had a major impact on innovation-re lated research, on firms' management of re search and development, and on government innovation policy. However, it now appears that this basic assumption is wrong.

The von Hippel Study documents that in virtu ally all industries innovation users are a signifi cant source of innovation and in some industries users are a dominant source of innovation. For example, von Hippel finds that the dominant source of innovation in semiconductor and printed circuit board processes is the users of these processes-the semiconductor manufacturers. For this reason, von Hippel argues, for example, that public policy concern with the competitive position of US semiconductor process equipment producers relative to foreign producers is mis placed. The likely source of this deficiency, he argues, lies in the semiconductor manufacturing industry, i.e. the users of process equipment.

The exclusion of the RHCs from meaningful participation with equipment manufacturers has created a gap between technology and marketing. One example is Integrated Services Digital Net work (ISDN). ISDN, which holds much promise for the telecommunications network, has been much slower to develop in the USA than in a number of other countries. As are many new telecommunications services, ISDN is dependent upon advanced features of customer premise equipment (CPE).' Successful implementation of ISDN requires equipment suppliers and service providers to coordinate equipment design with network-based services. However, CPE vendors do not have sufficient incentives to produce these features in the early stages of new service provi sioning. Also, since the RHCs cannot directly benefit from the development of advanced CPE, equipment producers are not providing access to RHC research and **development findings on new** service offerings. The result is delay, and in creased the costs of specialized features.

Uad Users

von Hippel (1988) also finds that the involvement of 'lead users' can be very impo~tant in the success of innovative activities. By his definition, lead users are those who

(1) Face needs that will be general in a marketplace, but they face them far before the majority of the marketplace, and
(2) Are positioned to benefit significantly by obtaining a solution to those needs.

As explained by von Hippel, not all users are likely to be equally willing to participate in the innovation process, or equally valuable in their contribution to the innovative process. Many users have narrow internally focused perceptions into the type of new products and processes needed. These users lack vision or knowledge of how the industry is likely to progress. In addition, many individual industrial products have more than one usage pattern. Ideally, users selected for innovation should be able to provide insights into the impact of new technology on a variety of potential end uses. Since not every user can supply all this information, there are two solutions: involve all users or identify some users who can provide most of the benefits of user involvement. But involving all users can be costly and can put proprietary knowledge at unacceptable risk.

One way to create user involvement is the creation of a 'lab', where users and R & D personnel can meet and employ techniques of simulation in order to create real-life situations. This method is beginning to appear in the telecommunications industry. For example, at Southwestern Bell, an advanced Technology Laboratory (ATL) has been created for R&D and marketing personnel to meet. Major vendors and customers of Southwestern Bell are also using this lab to test new equipment and services, discuss their ideas with Southwestern Bell engineers and get their comments on new tests. Another interesting experiment is being carried out at GTE labs. Customer and end-user involvement techniques that are becoming increasingly common in consumer goods

'home banking' (performing financial transactions from a home telephone terminal). Extensive testing and research has shown that new terminals (with LCD displays and other features) are essential ingredients in making service acceptable to consumers. It is critical that these features be designed to work with the network elements, as well as the banking systems. Equipment manufacturers, banking institutions and network service suppliers should be involved together from the beginning in the design of the service and product. However, the MFJ excludes participation from the RHCs with the result that the service is being developed in a sequential, trial-and-effor manner.

T\vo specific examples of the use and advantage of concurrent engineenng come from Canada, in which there are no MFJ-type restrictions. The first example involves the development and introduction of Northern Telecom's *FiberWorld*- a complete family of fiber-optic access, transport and switching products, introduced in 1989. Bell Northern Research (BNR), the Canadian equivalent of Bell Laboratories in the US, prior to divestiture developed the technology underlying *FiberWorld.* The BNR Montreal facility in Montreal conducted deployment studies with Bell Canada and other operating companies for Northern Telecom's *FiberWorld* systems and products.

These studies were used to evaluate the ways in which *FiberWorld* capabilities could best be deployed in the operating companies' access networks, as well as to determine the resulting operational savings and service value. BNR Montreal developed SNAP (Switch Network Analysis Program) which enabled Bell Canada access planners to find the most efficient and cost-effective network configurations for providing services to subdivisions and industrial or commercial complexes. SNAP is an engineering tool that identifies all the equipment and associated costs needed to provision new or upgraded switches. BNR Montreal's R&D in such cutting-edge technologies as digital signal processing, speech recognition, image, and video processing enabled BNR to introduce important new capabilities into Northern Telecom products. At the same time, BNR's close relationship with Bell Canada, along with BNR's experience in operations systems and network planning with Bell Canada, were applied to evolve the public network for real-time operations *(Telesis,* p. 43).

Another example of concurrent engineeringtype activities in Canada involves from BNR's development of digital signal processing (DSP)-an integral part of many important digital products and applications that BNR has developed for Northern Telecom. The direction and scope of BNR's digital signal processing research benefited from BNR's close association with its parents, Northern Telecom and Bell Canada, who supported research in various DSP technologies for some 15 years. By working closely with Bell Canada, and by understanding its services and operations, for example, BNR was able to identify, develop and deploy the key DSP technologies needed by Bell Canada. The technology was then introduced into Northern Telecom products through an efficient technology transfer process in which research, product development and Bell Canada staff worked together as team members. This process allowed Northern Telecom to bring new products ot market quickly, and enabled Bell Canada to introduce new services to customers in timely manner *(Telesis, p.* 81).

Concurrent engineering does not necessarily require relationships approximating joint ventures between technology developers, manufacturers and end-users. However, when there is significant proprietary knowledge involved and when the benefits of innovation are jointly created, economic incentives may require relationships such as joint ventures or equity participation, in order for concurrent engineering to be undertaken.

Supplier-customer Relationships

The modem literature on supplier-customer relationships, which highlights the advantage of various implicit or explicit contractual arrangements between suppliers and their customers, is also relevant to the analysis of the MFJ restrictions on equipment. Where innovative activities are part of the suppliers' necessary function, significantly closer relationships than arm's length will often be required. For example, Walker (1988) concludes that certain risks are inherent in supplier-customer relationships involving innovative activities, and that total or partial vertical integration may be a means of limiting these risks. He highlights three significant risks:

(1) Appropriation, where a firm's returns on an

investment are reduced if the supplier cannot meet the requirements for a successful strategy;

(2) Diffusion, where competitors replicate innovations rapidly when the firm cannot control their use; and
(3) Product degradation, which can arise if 'important product attributes will be distorted or impaired in distribution, marketing or technical service operators' (Walker, 1988, p. 64).

The line-of-business restrictions on RHC involvement in equipment manufacturing appear likely, in some circumstances, to involve all three of these risks for RHCs and their suppliers. In particular, Harris (1990) concludes that the MFJ has impeded the generation and commercialization of innovations in the US telecommunications industry, due in large measure to the inability of the RHCs to engage in 'close' relationships with telecommunications equipment suppliers because of the MFJ.

LITERATURE BEARING ON THE EFFECTS OF MFJ EQUIPMENT MANUFACTURING RESTRICTIONS

In this section we briefly summarize some of the literature bearing on the effects of the MFJ restrictions on equipment manufacture.

Harris

Harris (1991b) finds that the RHCs are less inten- studies. sive investors in research and development expenditures as compared to AT&T, and vertically integrated foreign telecommunications firms. Harris (1990) argues that this impact results from the inability of the RHCs to appropriate the full benefits of research and innovations because they cannot manufacture equipment or invest directly in vertical relationships with equipment manufacturers.

Teece et at.

Teece et al. (1988) argue that the nature of the R&D process in the telecommunications industry lends itself to alliances. They studies 117 joint ventures involving telecommunications equip ment manufacturers and found 50 involved partnerships in distribution or cross-marketing and 15 involved joint R&D or technology sharing. They find that the RHCs are notably absent from such alliances, with MFJ restrictions being a major reason.

Zanfei

A recent article by Zanfei (1993) offers a concise summary of some of the effects of the equipment manufacturing constraints on the research incentives and successes of the RHCs. Zanfei stresses that '...collaborative ventures appear to be a fundamental vehicle for technological change' (p. 31). Even though the RHCs can participate in research and development programs, Zanfei concludes that the equipment manufacturing restriction has three impacts on the incentives and results of any RHC research program:

(1) RHCc cannot ensure utilization of research results through manufacturing.
(2) The present organization of R&D implies considerable involuntary technology transfers by RHCs.
(3) Even considering (1) and (2), the overall R & D expenditures may not be high enough to grant RHCs a competitive edge to enter international markets alone (Zanfei, 1993, p. 32).

Zanfei concludes that because of the MFJ, the RHCs are significantly constrained in pursuing technological programs that include significant hardware developments. We now turn to our case

THE US TELECOMMUNICATIONS INDUSTRY

AT&T Prior to Divestiture

The MFJ dramatically changed the vertical structure of the US telecommunications industry. Operated as a vertically integrated entity-Bell Labs, Western Electric and the operating companies-AT&T operated the largest private research institute in the US, and had a worldwide reputation as a leader in innovation in communication-related technologies. Despite the concerns of the Department of Justice about the effect of an integrated AT&T on competition at all levels

of the US telecommunications industry, at the time of the MFJ, the US telecommunications industry was generally regarded as the leader in the world!

The vertically integrated structure of AT&T undoubtedly had significant advantages that facilitated AT&T`s strong record in telecommunications innovation. Unfortunately, there has been little written about vertical coordination within AT&T prior to the MFJ. This is due, in part, to the proprietary nature of some information about AT&T, and because the historical structure in virtually all countries for telecommunications was vertical integration. We have uncovered some somewhat obscure sources, which along with our industry experience and interviews, allows us to summarize some of the aspects of the role of vertical relationships in innovative activities in AT&T prior to divestiture.

The main public source of information on the vertical. relationships within AT&T is an internal AT&T study (Bode, 1971). Bode makes clear that one of the strengths of AT&T, from Bell Labs, to Western Electric, to the operating companies was the end-user focus of the integrated system (Bode, 1971, p. 102). The R&D agendas of Bell Labs and Western Electric were, except for basic research, driven by the needs of the operating companies. Western Electric systems engineers also provided much of the interface between the Labs' R&D efforts, Western Electric's manufacturing operations and the operating companies. For example, Bell Labs had 'branch laboratories' that were located in Western Electric manufacturing facilities. Western Electric's Engineering Research Center was located near the Labs' main research facility, with the output of the Labs being a critical input to the activities of Western Electric's R & D activities. The relationship between the operating companies and Western Electric was close, with Western Electric systems engineers on-site at all the operating companies. One important aspect of the management system of AT&T was the continual shifting of people throughout the AT&T system. A typical career path would take an executive through a number of parts of the AT&T system. In particular, AT& T executives would have spent time in the operating companies and vice versa. Personnel were also regularly exchanged between the Labs and Western Electric.

Bode (1971, Chapter 7) describes a number of examples of major innovative efforts within AT&T in which cooperative activities of the Labs, Western Electric and the operating companies were important. For example, AT&T developed electronic switching using what is now called concurrent engineering between the Labs and Western Electric, with Western Electric's systems engineers' (who were also the operating companies' systems engineers) knowledge of the needs and limitation of the operating companies playing a critical role. What is now called Beta testing was conducted in an Illinois Bell facility. The integrated efforts of the Labs, Western Electric and Illinois Bell were critical to the eventual successful development of electronic switching.

Thus it is quite clear that AT&T, prior to the MFJ, fully exploited the benefits of vertical alliances in its innovative activities. Without question, the MFJ has prevented fruitful vertical alliances between RHCs and equipment manufacturers, including AT&T, that would otherwise have been formed. Note, again, that we are not saying the original DOJ case against AT&T was without merit. The vertical integration of AT&T combined with the regulatory and competitive structures prevailing at the time of divestiture may have resulted in AT&T inefficiently favoring AT&T equipment over competitors' equipment with losses in efficiency. But the world has changed. Both AT&T and the operating companies face substantial competition from a variety of sources. What we are arguing here is that the history of the AT&T system shows that close vertical alliances, predictably, had substantial benefits in many cases. In the new competitive environment in which competition and local regulation can police inefficient self-dealing, it is no longer wise to prohibit the undeniable benefits of vertical alliances.

The RHCs Post-NWJ

Much has been written about the effects of the MFJ on the US telecommunications industry. We will not attempt to summarize it here. Instead, we will highlight issues and areas in which the MFJ restrictions on equipment manufacturing appear to be binding. The information in this section comes from the sources cited, and from interviews with some of the RHCs.

the network. Given the level of investments in network upgrades and the pace of technological change, absent the MFJ, it is indisputable that the RHCs would enter into some vertical alliances that are prohibited by the MFJ.'0

Examples of Specific Products and Services 77tat May Have Benefited if Alliances between RHCs and Equipment Manufacturers Were Not Prohibited

Earlier in this paper we discussed a number of instances in which innovative activity may have been facilitated if alliances between RHCs and equipment manufacturers were not prohibited. These examples were discussed in the context of specific potential generic benefits of vertical alliances. This section provides some more examples.

ISDN. Integrated Services Digital Network (ISDN) was perhaps the most debated technological innovation in the 1980s and the early 1990s. Offering potentially huge cost savings and new services to customers and network operators alike, ISDN has never reached effective critical mass in the US network. The slow development (and in some cases, the non-development) of ISDN in the network is today generally acknowledged to be a problem of a lack of availability of affordable customer premise equipment (CPE), not network technology or provisioning. There is a pressing need for CPE equipment manufacturers to work closely with network service providers to solve the remaining design issues for affordable CPE. Because of the endless variety of CPE that will be needed for ISDN, much of it will potentially come from small equipment providers, many of whom will have difficulties in financing development costs. Currently the market remains largely undeveloped as vendors and network providers are prohibited from (or lack the incentives to engage in) technical and financial cooperation.

Videotext Services. Although several large trials of videotext services have faded in the USA, it is interesting to note that these services have been successful in France and Canada. Many factors have been posited for the failure of a viable videotext service in the USA, but at least one factor contributing to failure in **the USA is the** lack of availability of a low-cost limited function

terminal. Today, in the USA, expensive and somewhat complicated PCs are the only means to access larger databases and videotext services. (There are low-cost limited-function terminals available in Canada and France, specific to those countries' networks and videotext systems. nose terminals were developed jointly between operation companies and manufacturing companies.) Allowing the RHCs to work with equipment providers to produce a low-cost videotext terminal would remove one of the most substantial impediments to a ubiquitous videotext service offering.

Video Compression. US West's 'in-house' video transmission group improved an 'off-the-shelf video compression product of Concept Communications Corp. (a designer and developer of video compression products). Improving video compression and transmission is critical to the success of the 'information superhighway'. It is believed that US West's innovation would have provided a substantial benefit to Concept Communications and its customers, but the MFJ prohibits US West from selling this enhancement. The net impact is that an innovation was not made available to the market, and incentives for further research and collaboration between US West and Concept Communications are diminished.

International Joint *Ventures*

The RHCs have entered into a number of joint ventures and other vertical relationships with foreign equipment manufacturers, allowing the RHCs to participate in alliances involving equipment manufacturing. Examples include Southwestern Bell and US West with France Telecom, Ericsson with NYNEX and US West, and Pacific Telesis and Northwestern Bell with NEC. For a more extensive listing of major offshore alliances, see Huber (1987, Exhibit G.9). Vertical alliances with foreign equipment manufacturers has also facilitated the improvement of the technological capabilities of the RHCs. As pointed out by Zanfei (1993), the RHCs' technological capabilities, even including Bellcore, are rather limited. Thus far, this deficiency has led in most cases to foreign telecommunications companies having disproportionate control in the RHCs' international alliances, and in some US-related activities.

FOREIGN TELECOMMUNICATIONS INDUSTRIES

Since the litigation leading up to the MFJ, the geographic scope of the telecommunications equipment market has broadened into a truly global market (Huber *et al.*, p. 992). The globalization of the telecommunications equipment market has been, in part, induced by the MFJ. As discussed above, one effect of the MFJ was to unilaterally expand opportunities for foreign equipment manufacturers in the U.S. Some commentators have noted that the MFJ, in effect, was a major unilateral trade concession by the USA (see Pearce, 1993). Although US telecommunication equipment exports increased steadily in the 1980s, the US share of total OECD exports remained unchanged from 1981 to 1990, according to a study by DRI/McGraw-Hill. On the imports side, however, only few major US industries faced stronger import penetration during this period. In 1979, imports accounted for only 4% of US telecommunications equipment purchases; by 1990 this figure had grown to 29% (see Cronin *et al.*, 1992). Import penetration has enhanced competition in the equipment industry by introducing more competition for AT&T, but one consequence has been that the competitive position of international rivals has benefited. The strength of foreign equipment manufacturers in the US is due, in part, to the fact that AT&T is now a competitor of the RHCs in many dimensions. The extent of this competition has grown as technology has evolved. For example AT&T PBX's can directly displace the central-office equipment of an RHC. Because AT&T competes with the RHCs and also is a source of essential equipment, some RHCs may have chosen to substitute other equipment for AT&T technology inherited after the MFJ. Since most alternative sources of equipment are international firms, the net result is to create substitution from AT&T to an international supplier.

Much of the world treat telecommunications as a 'strategic industry'. The USA has traditionally limited government subsidization." In addition, the US is unique in preventing the local-exchange carriers from 'meaningfully' participating in the manufacturing of equipment." interestingly, reorganization of telecommunications services in Europe may have induced more vertical integration following privatization. For example, British

Telecom invested in Mitel, a Canadian PBX manufacturer with a significant position in the US market shortly after its conversion to private ownership. The semi-private Spanish telecommunications monopoly also has numerous investments in equipment suppliers. Similarly, the Italian (partly private but predominantly government controlled) and Swedish (totally private) systems have substantial investments in equipment manufacturing. In fact, the movement in Europe from complete government control of telephone operations to the alternative of full (United Kingdom, Sweden) or partial (Spain, Italy) privatization may result in an increased amount of investment in equipment manufacturing by the resulting entities (Noam, 1992, pp. 320-21)

In the remainder of this section we summarize evidence on telecommunications industries in other countries. Since no other country has regulatory or institutional impediments approximating the MFJ restrictions on the participation in equipment manufacture, the foreign experience is instructive on what sort of vertical alliances might arise in the USA in the absence of the MFJ.

Canada

As the Canadian subsidiaries of the US Bell System until 1956, Bell Canada and Northern Telecom (then Northern Electric) were almost entirely reliant on licensed technology from AT&T. As Surtees (1992, p. 93) describes:

Those ownership links and agreements greatly influenced the evolution of Bell Telephone's [Canada] network. Equipment made by Northem Electric was predominantly of U.S. design. From its incorporation until the late Fifties, 'Northern had been operating as a branch plant of Western in the full sense of the word, deriving its technology totally from the Western Electric Company in the United States,' Donald Chisholm, later chairman and president of Bell-Northern Research Laboratories, stated in testimony to a federal inquiry in 1980. In addition, Bell Telephone's network was built to U.S. specifications, making it a branch plant equivalent of the U.S. Bell system.

Subsequent to its divestiture (Bell Canada to the Canadian public, Northern Electric 100% to Bell Canada), Northern Telecom Limited (NTQ

undertook its own R&D activities with an internal department. That department became a separate subsidiary, Bell Northern Research, 70% owned by NTL and 30% by Bell Canada, in 1971.

The structure of the Canadian telephone system today resembles that of the USA prior to divestiture, with the majority of the service (Ontario and Quebec) supplied by one large, strong vertical relationship (including Bell Canada, Northern Telecom Ltd, and the jointly owned Bell-Northern Research), with the balance served by 'independent' telephone service suppliers owned by provincial and local governments and GTE. Bell Canada is owned by 100% and Northern Telecom Ltd (NTL) about 52% by Bell Canada Enterprises. The majority of the research for both organizations is carried out by Bell Northern Research (BNR). However, NTL undertakes some research in-house. Today, Bell Canada provides telephony consulting services internationally,.and Northern Telecom operates globally, with some 60% of its revenues generated in the USA through its US subsidiary Northern Telecom Inc. (NTI).

Over the past 20 years, Bell Canada-NTL-BNR has been one of the most innovative consortia in the global telecommunications industry. In 1975 Northern Telecom launched Digital World-the first all-digital family of switching transmission and business communications system. The whole system was completed in 1979, one year ahead of schedule. The success of Digital World can be attributed in large part to system engineering expertise, which was built on a unique tricorporate relationship between BNR, Bell Canada and Northern Telecom. BNR worked closely with NTL and Bell Canada to develop manufacturable equipment that created value for downstream customers *(Telesis, p. 11).*

Throughout the 1970s BNR's combination of switching, transmission, business and consumer product development capabilities in Canada built a solid platform of innovative products and system from which Northern Telecom and BNR could pursue business in foreign markets. NTL's digital products now hold a commanding world market share in both central office and PBX switching. Don Chisholm, the first president of BNR, describes how important the vertical relationship was for innovation at NTL:

The early 1970s were an exciting-and

ideal-time for technology. Back then, AT&T was still setting North Americal technology standards, and the structure of telephony was very stable. Northern Telecom was aiming to upset the apple cart. We were betting the ship that we could produce better technology-and win. Taking on Bell Laboratories, the research arm of AT&T, was really a bit of arrogance on our part.

But this was based on some definite advantages we had over competitors. One of our biggest advantages was that we could call on Bell Canada-one of the most advanced operating companies in the world. Bell [Canada] could help us determine realistic costs of product deployment, of equipment depreciation, and even of training operating company staff to use our products. In short, we could sell a product because we knew exactly what it meant to the user *(Telesis,* p. 8).

In the development of its digital switching products, Dennis Hall, predecessor to Chisholm, describes the critical role of an 'in-house' first customer:

We were also very sure of ourselves because we had Bell Canada, a priceless asset. Together with Bell [Canada], we had done an economic analysis for digital switching, so we knew what Bell Canada's operational savings could by going with digital technology and we knew that we had to do in the switch design to ensure they got those savings. It's important that a lab has a discerning customer, like Bell Canada, especially the first time new technology is applied. If the first customer is a softie and doesn't demand that you get it right the first time, you won't be able to develop world-class products *(Telesis,* p. 13).

Prior to the 1980s, most corporate R&D were not really responsible for delivering a product that would be profitable. BNR has always worked closely with a manufacturing division in Northern Telecom and has taken manufacturing issues into account at the design stage. BNR is also unusual in that it is funded, in large part, by Northern Telecom's operating divisions. Most other corporate R&D labs are funded by grants the organizations headquarters. This disconnects advanced technology from

product design, with nobody responsible for making the connection *(Telesis, p. 13).*

Today, the strong vertical relationship helps NTL plan and develop products for world markets, with Bell Canada as its source of customer knowledge. NTL/NBR have 'achieved an understanding of operating company needs that few other facilities can match. Moreover, that understanding has been translated by scientists and engineers at the lab into a vision of network architectures, technology products and services that are of increasing value to telecommunications operating companies' *(Telesis, p. 40).* For example, 'in September 1990, a team from BNRMontreal, together with Bell Canada and Northern Telecom, demonstrated the world's first practical OAM&P application of OSI standards before more than 100 industry experts at an American National Standards Institute (ANSI) forum' *(Telesis,* p. 41).

One of the NT1!s most successful products is Norstar, a small 'switch', known as a 'Key System'. It holds a significant US and world market share in a category with some 80 different suppliers, many from Asia. The introduction of its Meridian Norstar digital key telephone system was announced in 1985 by Northern Telecom. This was the industry' first business communications system to bring the benefits of all-digital technology to the desktops of even the smallest enterprise. The conceptual foundation of Norstar began a year earlier in 1984, when a Northern Telecom team worked with Bell Canada to investigate market requirements for successor to its analog key system, while at the same time a BNR team started assessing opportunities to exploit advances in digital technology for new product offerings *(Telesis,* p. 19).

Telesis describes how the development of crossfunctional expertise from BNR, NTT-, and Bell Canada helped the development of Norstar and As further explained in *Telesis:* other NTI- products and services:

rich mixture of specialists in silicon, software, user interfaces, system architectures, and manufacturing. By pooling their expertise, these individuals, all experts in their own fields, developed a high-quality, low-cost digital key telephone system unlike anything else on the market. Had they been confined to their own functional groups, these specialists would never have been able to develop a product as innovative as Norstar.

To further encourage the mixing an matching of expertise, the staff at NBR-ottawa also works closely with planning and development groups in Bell Canada, Northern Telecom, and BNR's regional laboratories, and works closely with BNR development teams in various countries around the world. Several hundred employee transfers a year occur between these organizations, to ensure a cross-pollination of ideas throughout the company *(Telesis,* p. 49).

Another example of the advantages of vertical cooperation in Canada is Northern Telecom's experience with *Fiber World* (discussed above)-a complete family of BNR-designed fiber-optic access, transport and switching products, announced in 1989. Again, as with Digital World, BNR conceived and developed FiberWorld in close consultation with many of Northern Telecom's major customers, including these who operate global data and voice communications networks. As explained by former BNR president George Smyth:

We've always cherished and built on our relationship with customers. Today, our relationship with our customers has strengthened and expanded, to the point where customer requirements are deeply embedded in BNR and Northern Telecom operating plans and project development strategies *(Telesis, p. 23).*

[BNR-NTL-Bell Canada] ... has also successfully crossed technological and divisional boundaries with the development of Meridian Norstar-a digital key telephone system that entered a very saturated market in 1988, to move quickly to the top ranks in the world. During the development of Norstar, the BNROttawa management team brought together a

FiberWorld is Northern Telecom's vision of the future broadband network, and the company's pledge to deliver the world's first complete family of access, transport, and switching products based on SONET (Synchronous Optical Network) standards. This family of products, developed by BNR, will dramatically increase the simplicity, survivability, and capacity of global telecommun *cations networks.

Much of the success of these two visions is the direct result of the unique relationship between BNR's Systems Engineering (planning) group and Bell Canada and Northern Telecom.
Bell Canada-one of the world's most advanced telecommunications operating companies-plays a dual role in its relationship with BNR. In addition to being a part owner of BNR, Bell Canada is also a major customer of Northern Telecom. As such, Bell Canada joins many other operating companies around the world in providing BNR with information on the day-to-day workings of telecommunications networks, as well as providing feedback on the impact of various deployment strategies and products (Telesis, p. 86).

Japan

The world's largest company (6/30/93) is Nippon Telegraph and Telephone (NTF) with a market value of $127.287 billion (AT&T was second at $84.409 billion). (The world's 100 largest..., 1993). Close vertical alliances characterize the Japanese telecommunications industry. Japan has developed and implemented a national telecommunications policy intended to place Japanese telecommunications companies and their users in a global leadership position. NTT is the largest telecommunications operating company in Japan. KDD is the second-largest carrier, with the rest of the companies being relatively small. KDD is a provider of international telecommunications services. KDD leases domestic lines from NTT. The R&D activities in the Japanese telecommunication industry are characterized by very strong cooperative linkages between the operating companies and manufacturers, which are reinforced in a number of ways by direct or indirect government involvement (Grupp, 1993). NTT has strong alliances with the four major Japanese equipment suppliers, NEC, Fujitsu, Hitachi, and Oki. Although formally, the relationships between NTT and the equipment manufacturers might not violate the MFJ, the nature of these relationships is such that they would be unlikely to be achieved in the USA absent formal joint venture agreements Strong vertical alliances and government involvewith cross-equity positions. As in other industries, ment are also a feature of the French telecommuthe telecommunications industry in Japan, particnication industry. The CNET research institute is ularly NTT, has emphasized development activi- considered the main place for carrying out the ties over basic research. Recently the Japanese R&D work. France Telecom, which has access to

government has moved to reduce this deficiency by participating in the formation and management of the ATR laboratory, which also involves NTT and the equipment manufacturers. This is to some extent an attempt to replicate Bell Labs, within a structure that more closely approximates AT&T prior to divestiture.
A brief summary of recent activities by NTT
involving equipment or software includes:

(1) NTT has formed a technology alliance with Nextel Communications. Nextel will provide the first advanced digital cellular telephone service in the USA. NTT will give technical expertise on the design and management of Nextel's network. The alliance with Nextel is just the first step in NTI"s international strategy which plans other alliances with both service providers and equipment manufacturers (NTT links with Nextel.... 1993). An additional Nextel partner is equipment manufacturer Motorola (Nextel signs up Motorola.... 1993).
(2) NTT will product CD-ROM disks and software in a joint venture with Microsoft (Microsoft: to jointly..., 1994).
(3) General Magic, an American company that develops products and services for personal communications and multimedia, has alliances including ones with NTT, AT&T, Sony, Apple Computer, Matsushita, Motorola, and Philips (General Magic inks..., 1994).
(4) NTT and Sumitomo of Japan together with Lam Research, a Fremont, California-based microprocessor producer, developed advanced technologies for chip known as Epic (Lam CVD targets.... 1993).
(5) NTT, Siecor and Fujikara are joint equity partners in US Conec, a Hickory, NC, company that makes multifiber connectors for North American voice, fiber, video, data and specialty applications (U.S. Conec begins.... 1992).

Prance

the knowledge of market needs by being the service provider, participates heavily in deciding R&D structure. In 1980s, vertical integration activity became strengthened by an acquisition of CGE subsidiary Alcatel (Noam, 1992; OECD, 1992).

France Telecom is perhaps most notable in the global telecommunications industry for its *Minitel (6)* system. France Telecom has stimulated consumer use of its videotex services largely through the policy of providing the terminal equipment to consumers at little or no charge. Over time, the company has introduced a wide range of innova- (7) tions based on the Minitel system (McClelland, 1991). During the 1970s and early 1980s France invested in network expansion and modernization. This has resulted in a very high degree of digital equipment in service, which is the basis on which the Minitel service could be offered. 'In a number of areas such as network digitisation, ISDN, packet-switching and cardphones, France is in a position of technical leadership' (OECD, (8) 1992).

A brief summary of recent activities by France Telecom involving equipment or software includes:

(1) France Telecom has invested in General Magic, a software company attempting to create a world standard for certain communications software (France Telecom entre dans.... 1994).
(2) France Telecom, along with two venture capital companies, has invested in electronics component suppliers (for voice recognition devices, an emerging telecommunications and computer technology) Acsys and its subsidiary Joule (Macif participations reprend.., 1994).
(3) France Telecom is active in the US market, offering network services in conjunction with AT&T, for such clients as the Los *Angeles Times- Washington Post* News Service (Tanzillo, 1994).
(4) AT&T will bring its equipment and telecommunications service expertise to bare in its alliance with the Deutsche Bundespost Telekom and France Telecom. The three companies plan to offer 'one-stop shopping' for global customers. Potential services offered include international frame relay and Asynchronous Transfer Mode (ATM) services, among the most advanced central office

switching services offered by ATM equipment groups (Carriers negotiating..., 1993).
(5) AT&T and France Telecom are part of a consortium with UK equipment and service provider Cable & Wireless (C&W) to supply submarine cable in the Eastern Caribbean (Cable and Wireless..., 1994).

France Telecom appears to be attempting to build presence in the US market as one of two principal advertisers on Canal Plus, a French-language TV service now available to viewers in the USA (Toumarkine, 1993b).

France Cables & Radio has taken a 'significant' position with Keystone Communications, a US provider of video transniission for broadcasters and businesses. France Cables and Radios is also the majority owner of Cylix Communications Met, a Memphis, Tennessee-based provider of data network services, equipment, and monitoring services (France Cables & Radio.... 1993).

France Telecom, along with the French government, IBM and Nippon Electric Company (NEC), jointly own Bull, a *$6* billion computer and telecommunications equipment supplier. Among other activities, Bull is a supplier of equipment to the RHS, long-distance telephone companies, and cable operators (Lambert, 1993).

France Telecom has developed and is selling its 'smart card' and Eurocrypt system to US cable operators. It is a set-up converter box to handle pay-per-view TV (Toumarkine, 1993a).

United Kingdom

Prior to 1981, telephone services were provided through the General Post Office as a government monopoly. In 1981, British Telecom was created as a public enterprise and in 1984, 51% ownership of British Telecom was sold to the public. The remaining government ownership was divested in 1991 (OECD, 1992).

During the period of the government monopoly, there was no direct involvement between the telecommunications service and equipment manufacturing. Since privatization, British Telecom has invested in vertical integration to develop a role in equipment manufacturing. Most notably, British Telecom acquired Mitel, a manufacturer of PBX equipment, following approval by the Monopolies and Mergers Commission (Noam,

1992). 'From the paternalistic role adopted by the state monopolist, who had a hand in influencing virtually all telecommunications-related technologies, British Telecom has become an aggressive private concern which has become increasingly vertically integrated and operates businesses worldwide, whether services or appliances' (Grupp, 1993, p. 198).

The other major change in British telecommunications during the 1980s was the creation of Mercury, an alternative to British Telecom in long-distance service. Mercury has a strong position in business service due to its installation of high-volume optical-fiber transmission. Initially, Mercury was formed as a joint venture among Barclays Merchant Bank, British Petroleum, and Cable and Wireless. Eventually, Barclays and BP dropped out of the venture (Butler and Carney, 1986).

Mercury's initial license was granted in 1982. It quickly began construction of a microwave and fiber-optic system connecting major urban and business centers in the United Kingdom. One of Mercury's decisions was to rely on Northern Telecom for switching systems instead of the traditional British manufacturers GEC and Plessy. Further, Mercury also entered into a joint venture with ICL, Britain's largest computer company, to develop specialized data-communications and value-added services. Mercury is currently a service provider to 37% of major telecommunications users in Britain, including seventeen of the eighteen largest financial institutions (Noam, 1992).

A brief summary of recent activities by BT involving equipment or software includes: (13)

(1) BT and MCI have formed a partnership to offer new products and technologies and to construct and operate a worldwide network to link global business centers (MCI/BT's.... 1994).
MCI is in a joint venture with Northern Telecom, Nokia (a Finnish telecom manufacturer), Ericsson, General Electric and others to form a $10 billion mobile telephone network in the USA.
(3) BT has entered into a strategic relationship with equipment manufacturer Scientific Atlanta to develop Very Small Aperture Terminals (VSAT) satellite network (The European.... 1994).

(4) BT North America, subsidiary of BT, developed and markets portable videoconferencing products. (BT to unveil..., 1993).
(5) BT North America is also developing object database software (Object databases .... 1993).
(6) BT is an aggressive supplier to the US telecommunications user through its partnership with MCI and its various other equipment and services businesses (North American success .... 1993).

(10)

(11)

(12)

(7) BT and the Du Pont Co. jointly owned BT& D Technologies formed to exploit fiber-optic component technologies. BT&D was sold in 1993 to Hewlett-Packard (HP buys.... 1993).
(8) BT, MCI and AT&T are among the supporters for a Microsoft software system, Microsoft at Work, which aims to control office and telecommunication equipment (Supporters sign up..., 1993).
BT North America has teamed up with Sun Microsystems and Hewlett-Packard to develop technologies to manage complex networks (BT gets the jump..., 1993).
BT North America manufacturers and markets a line of security devices for data networks (Gareiss, 1993).
BT North America develops and markets a set of electronic data interconnection (EDI) products (BT unit takes the wraps off..., 1993).
BT North America is participating with Motorola in the development of MoNet, a mobile networking product line (MoNet paints.... 1993).
A BT subsidiary based in Atlanta, Syncordia, designs, provisions and maintains networks for large organizations (Syncordia..., 1993).
(14) BT, Motorola and IBM are jointly developing a system for world-wide videoconferencing (Watch out for ..... 1993).
(15) BT has an arrangement with IBM to develop IBM's NetView for telecommunciations network management applications (IBM will extend.... 1993).
(16) Motorola and BT have developed and are selling three computer chips for multimedia desktop applications.

Germany

In 1989, new legislation reformed the Deutsche

Bundespost Telekom (DBT), a traditional government PTT department. The new legislation created three public enterprises as the operational entities: **DBT, DBT** Postdienst and DBT Postbank. Under current German law, ownership of these public enterprises cannot be transferred to private ownership. The reform legislation was designed to implement a new principle of policy: 'Competition is the rule, monopolies are the exception requiring justification' (OECD, 1992). DBT continues as the monopoly provider of network, telephone service and radio installation. All other telecommunications services and terminal equipment can be provided under competitive conditions. DBT can participate in this competitive arena. In addition, the government can also issue special licenses for private enterprises as co-competitors of DBT in the reserved monopoly areas. Such licenses have already been granted for some services (OECD, 1992).

.Equipment procurement by the DBT has historically relied on close coordination with private enterprises, particularly Siemens. The procurement system operated through the research and development arm of the DBT, which would typically collaborate closely with a chosen supplier to develop the products. Almost 60% of the procurement contracts were awarded through this research and development department, with other manufacturers typically serving as subcontractors to the chosen developing manufacturer (Noam, 1992).

Regular ISDN service was established in 1989, but acceptance of the service has been low. To stimulate demand in a manner similar to the French Minitel, DBT expanded its service plans by including free distribution of 50 000 microcomputer boards to service users. In 1990, the DBT videotex service had 100000 subscribers and 3000 information providers (Noam, 1992).

A brief summary of recent activities by DBT involving equipment or software includes:

(3) DBT, AT& T and France Telecom have signed a memorandum of understanding to better serve the voice and data service needs of global businesses in Europe and the USA (Carriers negotiating..., 1993).
(4) DBT is cooperating with Apple Computer in the development of Newton, a personal digital assistant, a portable communications device (Telekom. and Apple.... 1993).

SUMMARY AND CONCLUSIONS

The decade under the MFJ has seen major changes in technology, globalization of the telecommunications industry and increased competition at all levels of the industry. Vertical alliances between operating companies and equipment manufacturers have been the norm historically under all sorts of industry organizations (across countries). Only the USA are such alliances prohibited. Evidence on the importance of vertical alliances in innovative activities, in general, along with evidence from pre-divestiture AT&T and an examination of vertical relationships in other countries indicates that efficient vertical alliances are being prohibited by the MFJ. This creates a chilling effect on the current and future innovativeness and competitiveness of US telecommunications service and equipment suppliers. We also have documented a number of examples in which innovative activity has been foregone, slowed down, changed, or pushed offshore, because of the MFJ. The fast, and expensive pace of innovation in the telecommunications industry, and the heightened competition at all levels of the industry, makes continued imposition of the MFJ restrictions on equipment manufacture unwise.

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(1) Deutsche Bundespost Telekom (DBT) is in a joint venture with Electronic Data Systems Corp. to provide interactive publishing services in Germany (Blau, 1994).
(2) DBT has formed an 'intensive cooperation' agreement with computer chip manufacturer Intel to distribute Intel's ProShare data and video conferencing products (DBT, Intel mar**ket..., 1994).**

NOTES

1. The common model in Europe has been known as the 'PTr' system, designating the government authority that provided postal, telephone and telegraph services. Japan also followed the European

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12.

pattern of government provision of telephone services. See Noarn (1992) for a historical review and discussion of current developments in European telecommunications policy.

Most notable is the removal of restrictions on the provision of 'information services' provided by RHCs (Kellogg *et al.,* 1992, Section 6.4).

For many years, Oliver was an executive with Northern Telecom, and now consults with a number of telecommunications companies.

4. Just one example is the joint venture between Coming Glass and Siemens, Siecor Optical Cables, formed in 1977 to develop and market optical fiber cables. Coming glass had expertise in ceramic and glass manufacturing and Siemens had expertise in electronics and communication equipment. Combining the complementary expertise of both companies brought the product from the lab to the market quickly and easily (Teece *et al.,* 1988).
5. For ISDN, 'enhanced feature voice sets'.
6. For a number of papers highlighting the desirability of integrating R&D efforts with marketing in the telecommunications industry, see Saghafl and Gupta (1990).

   For example, through concurrent engineering, Hewlett-Packard reduced the development time of its computer printer from 4.5 years to a mere 22 months (Duffy and Kelly, 1989), Deere & Co. reduced the development time for its forestry equipment to 60% and incurred 30% savings in development cost (Port *et al.,* 1990).
8. The authors of this report had no role in the antitrust litigation against AT&T.
9. Some of these innovations include a huge video screen that flashes life-size pictures, a super efficient battery and an electronic snooper than can find fuel leaks.
10. Evidence contrasting the differential approach of the RHCs and independent operating companies provides confirmation of this assertion. See Zanfei (1993).
11. See Harris (1991a). All countries studied by Grupp (1993) show some direct or indirect government involvement in research and development. In the USA this involvement has come through military spending, which may spill over to civil telecommunications.

    An OECD study of telecommunications policy in 23 countries, including the USA, indicated numerous instances of liberalization and privatization in the telecommunications industry during the 1980s. However, none of these countries, other than the USA, pursued any restrictions on investment in equipment manufacturing. Several countries are noted for establishing subsidiaries or joint ventures to participate in the manufacturing of telecommunications equipment. For example, in German, DBP Telekom was organized as a public enterprise from a previous role as a government department and was to compete in providing services and terminal equipment against private firms in designated por-

tions of the industry. Similarly, New Zealand ended its public telephone monopoly in 1987 and split the former government entity into several parts, including joint ventures for equipment manufacturing. Norway created a self-financing public enterprise in 1990 and set up a subsidiary of that enterprise to compete in the liberalized terminal equipment segment. Turkey has undertaken a policy of joint ventures between its government-owned service and domestic manufacturers to create an equipment manufacturing sector (OECD, 1992).

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