AUGUST 1994

# INDUSTRY TRADE AND TECHNOLOGY REVIEW

UNITED STATES INTERNATIONAL TRADE COMMISSION

Office of Industries

# PREFACE

The *Industry, Trade, and Technology Review* (*ITTR*) is a quarterly staff publication of the Office of Industries, U.S. International Trade Commission. The opinions and conclusions it contains are those of the authors and do not necessarily reflect the views of the Commission or of any individual Commissioner. The report is intended to provide analysis of important issues and insights into the global position of U.S. industries, the technological competitiveness of the United States, and implications of trade and policy developments.

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# COMPUTER OUTSOURCING SERVICES: TELECOMMUNICATION REGULATION AFFECTS GLOBAL COMPETITIVE POSITION OF U.S. FIRMS

Computer outsourcers manage in-house data-processing centers for client firms or perform data processing and other services for clients in off-site locations. Off-site computer outsourcing is increasingly popular because consumers, often large enterprises with global operations, are endeavoring to reduce personnel, data processing, and facilities costs. Computer outsourcers generated global revenues of $58 billion in 1993, accounting for over 30 percent of all computer service revenues (figure 1). U.S. firms, such as Automatic Data Processing Corp. (ADP), Computer Sciences Corp. (CSC), Electronic Data Systems (EDS), and International Business Machines (IBM), are the global industry's largest providers of computer outsourcing services. However, competition from foreign competitors, like SHL Systemhouse (Canada), is increasing.

Computer outsourcers compete for contracts principally on the basis of price and must continually seek to minimize costs. For off-site computer outsourcers,[1] telecommunication costs are key because these firms receive raw data and deliver processed data through telecommunication networks. In addition, many computer outsourcers reportedly derive competitive advantage by pairing data transmission services[2] with voice telephony. The cost and availability of telecommunication services are affected extensively by government regulation. This article briefly examines the regulatory dilemma stemming from advances in telecommunication technology, existing regulations that most affect computer outsourcers, competitive implications for U.S. firms, industry proposals to reduce regulatory impediments to outsourcing, and future prospects for the industry.

## Technology and Telecommunication Regulation

The extent and pace of technological innovation in the telecommunications field during the past two decades have created a regulatory dilemma. Telecommunication firms traditionally have been highly regulated because voice communication has been perceived as a public good that was economically provided only by monopolies on account of the high cost of telecommunications infrastructure.[3] Because monopolies have incentive to reduce provision of telecommunication service and increase prices in order to maximize profit, governments have regulated telecommunication firms to ensure that the service was provided to essentially all citizens ("universal coverage"), at more or less reasonable prices. By contrast, firms that provide data transmission services have operated without extensive government regulation principally because the service has not been perceived as a public good and because entry barriers in the computer service industry are low.

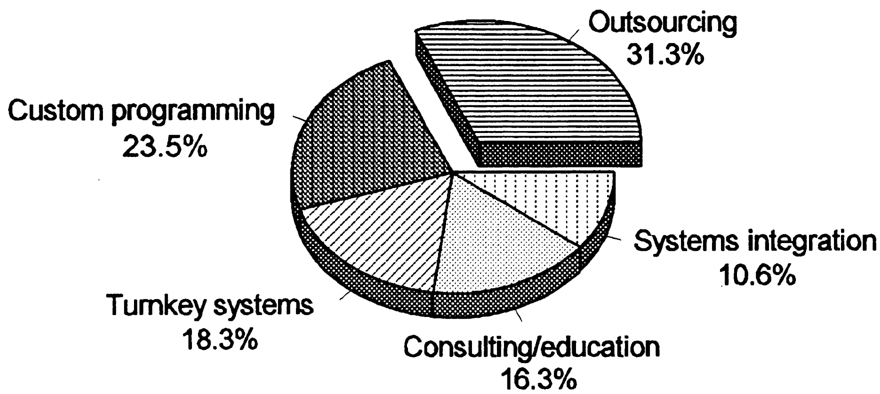
Because of recent advances in switching and transmission technologies, however, voice communication is now virtually indistinguishable from data communication. Moreover, the justification for monopoly provision of telecommunication services has dissipated as new technologies, particularly wireless communication technologies, have reduced dramatically the cost of telecommunication infrastructure. Consequently, extensive regulation of telecommunication service providers, which presently compete with computer

[1] For the remainder of this report, "computer outsourcers" refers to those firms that provide processing services in off-site facilities.

[2] Data transmission services include the manipulation and transport of data over telephone lines from one location to another.

[3] So-called natural monopolies occur when the technology used to produce a good is subject to increasing returns to scale, wherein per unit costs decrease as output increases.

Figure 1
Computer services global market, 1993




Source: USITC estimates derived from INPUT, Inc. data.

service providers among others, has become less feasible and, perhaps, less desirable.[4]

In response to this dilemma, most countries generally have charted a course toward less regulation. However, in doing so, they have proceeded at different speeds and have employed different methods, with significantly different effects on the competitive position of telecommunication and computer service firms. Most important for computer outsourcers, countries have differed with respect to allowing outsourcers to construct private telecommunication networks[5] and also to provide voice telephony to client firms on these networks.

## Private Networks

Private networks, usually composed of leased lines, allow service providers to reduce telecommunication costs. Private networks are most economic when dedicated lines are leased from public telecommunication operators (PTOs)[6] at flat rather than volume-sensitive rates and when companies using leased lines have the freedom to resell excess capacity to other companies.[7]

Although leased lines are available in most technologically advanced countries, they remain accessible only from monopoly providers in many

[4] Data transmission services are now provided by many types of firms, including computer outsourcers, telecommunication providers, and computer hardware producers.

[5] For the purposes of this report, constructing private telecommunication networks principally refers to putting together networks of leased lines and interconnecting them with public switched networks. Firms have to connect their private networks to public lines in order to have universal calling ability.

[6] PTOs are state-sanctioned monopoly telecommunication providers. Most were created by local governments to provide postal and telecommunication services.

[7] For more information on the advantages of private networks, see Andrew Adonis, "Company Cash Filters Through Political Bars," *Financial Times*, Mar. 17, 1994, p. 15; and U.S. Congress, Office of Technology Assessment, *U.S. Telecommunications Services in European Markets* (Washington DC: U.S. Government Printing Office, 1993), pp. 56-57.

countries, including Austria, France, Germany, Italy, and Spain.[8] Leased lines are usually available on a flat-rate basis, but installation delays and high tariffs often inhibit the use of such lines. For example, in 1993 a survey of 34 countries revealed that 22 of them required more than 30 days to provide leased lines. Furthermore, 25 of these countries reportedly leased lines at prices that appeared to bear little or no relationship to cost.[9] U.S. firms with operations in Europe claim that high-grade leased lines are typically scarce, PTO billing is inaccurate or irregular, and leased lines generally are not interconnected with the fastest data networks.[10]

Government restrictions on data flow over international leased lines pose additional challenges to outsourcing firms. National data protection laws sometimes interfere with data transmission across international borders. For instance, Fiat SPA (Italy) experienced difficulties transferring employee data from France to Italy for processing because of prohibitions on transmitting confidential employee data across international borders. Fiat's problem was resolved eventually, but similar difficulties reportedly will persist. Many U.S. outsourcers are concerned that the European Union's (EU) privacy directive will hinder their ability to provide services across international borders.[11] The EU initially drafted the privacy directive in 1990 and is currently considering a third rendering of the legislation.

Without the right to construct and use more cost-efficient private networks, computer outsourcers must use public switched networks that are subject to prices set by the PTOs. This may place outsourcers at a competitive disadvantage with PTOs that are able to use and control network access when bidding against outsourcing firms for service contracts.

## Voice Telephony

Although most computer outsourcers focus solely on data transmission, voice telephony services are becoming more important. Outsourcers state that customers increasingly prefer to grant data processing contracts to firms that also may provide voice transmission services.[12] For instance, when Ultramar, a petroleum refining company based in Connecticut, wanted to outsource its computer and telecommunication operations, it reportedly awarded the contract to SHL Systemhouse because, in part, SHL could provide both services.[13]

Computer outsourcers have incentive to transmit voice as well as data over private networks because a greater volume of information transmitted over leased lines increases the cost efficiency of their private networks. In addition, real-time voice services[14] are a natural extension of the data transmission and value-added services[15] these computer service firms may currently offer.

Real-time voice services continue to be severely restricted in most countries. In practice, less than 10 countries worldwide now permit competition in voice service markets.[16] The above mentioned survey of 34 countries reveals that 23 rely on monopolies to provide basic voice services.[17]

Competitive conditions are improving, however. Many countries are in the process of liberalizing

[8] International Telecommunication Union (ITU), *World Telecommunication Development Report 1994* (Geneva: ITU, 1994), p. 58.

[9] Kenneth W. Leeson, IBM internal report, *Changing Telecommunications Structures; A Global Status Report*, Aug. 30, 1993, pp. 13. The data are current as of January 1993.

[10] U.S. Congress, Office of Technology Assessment, p. 7.

[11] For the positive and negative implications of such legislation, see M. Nanette Di Tosto, "International Data Protection Landscape," July 23, 1993, pp. 1-4.

[12] Industry sources, interviews by USITC staff, Apr. 14, 1994.

[13] This does not mean that SHL Systemhouse is competing directly with the telecommunication firms for all voice services. SHL Systemhouse has control of the company's private networks that are connected to public lines. *SHL Systemhouse Annual Report 1993*, p. 21.

[14] Real-time voice service is the transmission of voices as conversations occur.

[15] Value-added services provide collection, selection, formatting, processing, or selective delivery of transmitted material. They provide "value" to otherwise basic transmission of voice or data over telephone lines. U.S. Congress, Office of Technology Assessment, p. 1.

[16] ITU, p. 60.

[17] Basic voice services include public switched voice telephony and basic data transport, including pure resale of existing capacity as well as the physical equipment for local or long distance service.

restrictions on voice and data communications. Figure 2 shows the current relative status of regulations in several countries. As a result of a June 1993 directive, EU member states are required to fully liberalize voice services by 1998.[18] Outside Europe, such emerging markets as Indonesia, Malaysia, the Philippines, Singapore, Taiwan, and Thailand, all of which severely restrict competition in telecommunications, are also considering telecommunication reform.[19]

## Computer Outsourcers' and Users' Policy Proposals

In response to efforts intended to liberalize telecommunication regulations worldwide, computer outsourcers have made several suggestions regarding future policies. First, they recommend nondiscriminatory access to public switched networks by all firms. This measure would allow outsourcers to take fuller advantage of the cost efficiencies afforded by private networks. In addition, outsourcers naturally are encouraging nondiscriminatory cost-based pricing of leased lines.[20] Current pricing, usually based on call volume, allows the PTOs to confer disadvantages on computer services firms that are quickly becoming their competitors. Because PTOs and outsourcers increasingly compete with one another, outsourcers also are seeking prohibitions on cross-subsidization of competitive business with funds from monopoly business.[21] Lastly, outsourcers propose more timely and transparent notification of technical changes required by companies operating private networks to access the public network. This would greatly enhance outsourcers' business planning.

Whereas some progress toward regulatory reform has been achieved,[22] outsourcing providers are anxious to see further progress.[23] User groups, such as the International Chamber of Commerce, the Information Technology Association of America, the International Telecommunications Users Group, and the European Virtual Private Network Users Association, continually encourage further liberalization globally.

## Prospects

Industry analysts forecast that global computer outsourcing revenues will reach $91 billion by 1997, reflecting 12 percent average annual growth during 1993-97. Further telecommunications liberalization likely will contribute to additional growth in demand for outsourcing. The cost advantages associated with outsourcing would increase because of greater capacity utilization of outsourcers' leased lines and related facilities, which would reduce average transmission costs. Greater competition among computer and telecommunication outsourcers would induce these firms to pass cost savings along to clients. Among the principal beneficiaries of telecommunication liberalization would be U.S. outsourcers, which have had much experience in competitive telecommunications environments and would likely enjoy strong competitive positions in newly liberalized countries.

Countries that liberalize their telecommunications environment will also benefit. Although the PTOs would not benefit from increased competition

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[18] The four EU member states with the least developed telecommunication infrastructure -- Greece, Ireland, Portugal, and Spain -- have 5 extra years to comply with the directive. Trudy E. Bell, "Telecommunications," *IEEE Spectrum*, Jan. 1994, p. 22.

[19] Industry sources, interviews by USITC staff, Apr. 14, 1994 and May 9, 1994. For a more detailed discussion of telecommunication liberalization in these countries, see International Telecommunication Union, *Asia-Pacific Telecommunication Indicators* (Geneva: ITU, 1993), pp. 3-5.

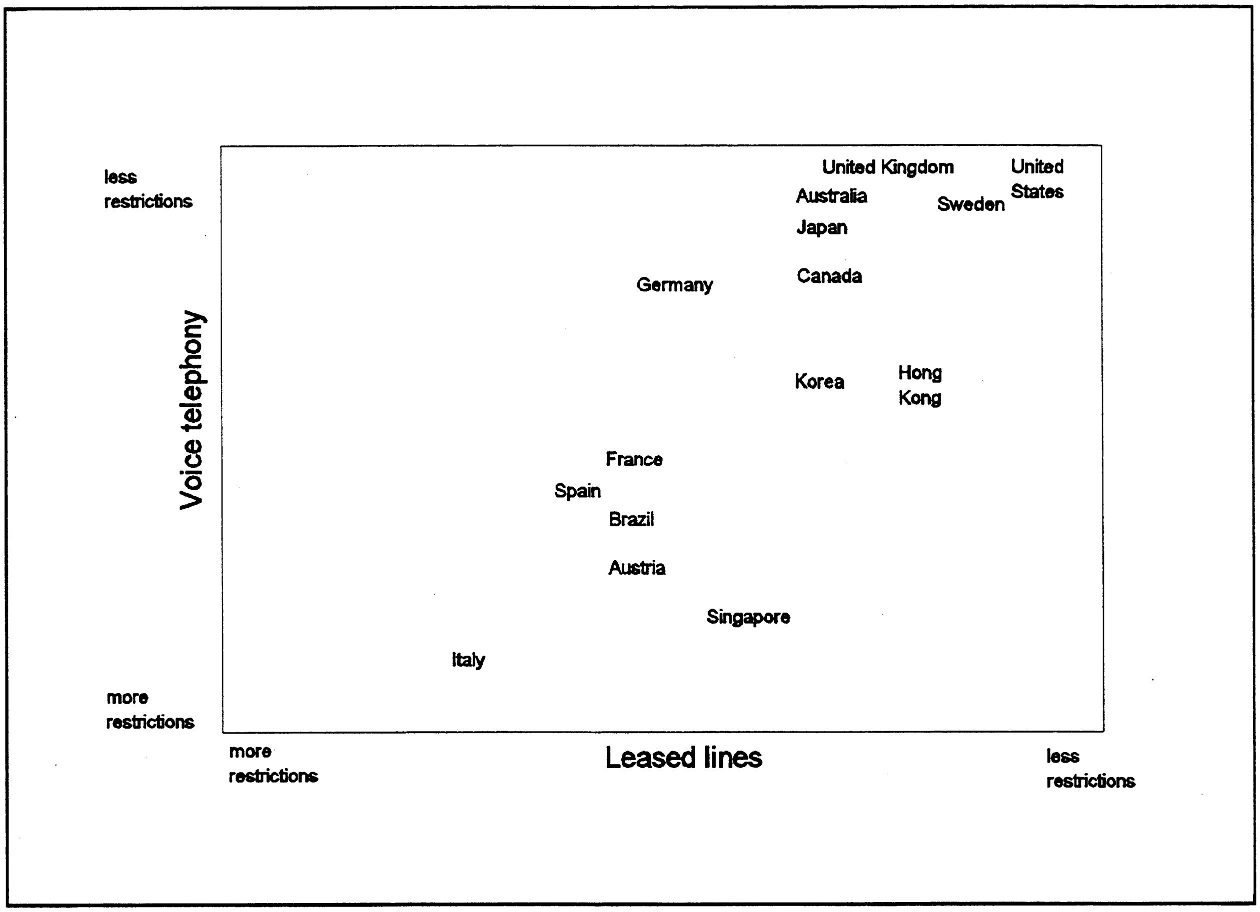
[20] The costs associated with providing leased lines are calculated by individual telecommunication firms, and many now base their rates on these calculations. However, the rates of comparable leased-line services vary too greatly to conclude that all telecommunication service providers use costs as a basis for prices.

[21] A problem with allowing any state-sanctioned monopoly to compete in new market segments is that these firms may potentially use excess monopoly profits to subsidize their price competitive markets.

[22] An example of such a step is the EU directive in which competition in voice services is to be allowed by 1998.

[23] Industry sources, interviews by USITC staff, Apr.-May 1994.

Figure 2
Relative competitive opportunities in major markets[1]




[1] Relative restrictions in voice telephony were assessed by examining the levels of competition allowed in basic telephony services, value added services, and the ability of individual customers to own telephony equipment. Relative restrictions in leased line were assessed by examining the regulations on connecting leased lines to a public network, the extent of competitive safeguards, independence of regulatory authorities from PTOs, availability of flat-rate fees, time required for acquiring leased lines, the availability of cost-based pricing, the ability to resell unused capacity, and the ability to switch calls through a third country.

Source: Data compiled by USITC staff.

deregulation, the PTOs must find a feasible way to restructure their organizations to enable quick responses to changes in customer demands and price competition from competitors. Outsourcing clients will receive better service at lower cost, enhancing their ability to compete in their respective end markets. This would be most important for clients with processing costs that account for a large share of total operating costs.[24] Ultimately, the benefits associated with liberalized telecommunication regulations are distributed among all firms in liberally regulated environments.□

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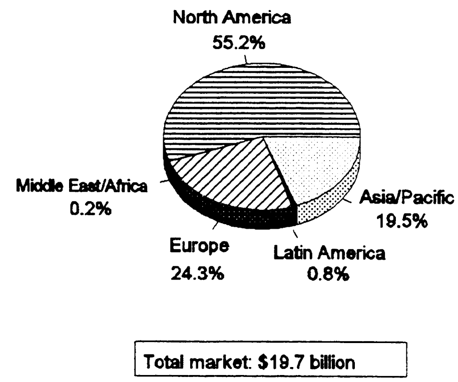
[24] For most firms, computer costs represent 3 to 5 percent of operating expenses. For service firms, this share is typically higher.

# SYSTEMS INTEGRATION SERVICES ENHANCE U.S. GLOBAL COMPETITIVENESS

The computer technology available for use in the business environment today is vast, complex, and constantly changing. In many cases, the expertise required to select appropriate and efficient computer systems for a company's needs exceeds that of in-house information system specialists. Increasingly, systems integration (SI) firms are filling the void created by this common mismatch. Systems integration combines hardware, software, and information systems into one efficient network, designed to achieve specific business strategies. The systems integrator generally coordinates the entire project, including the planning and system design, the purchase of appropriate equipment, the interconnection of varying technical standards or platforms, the selection or programming of required software, and the training necessary to operate the system once it is installed.

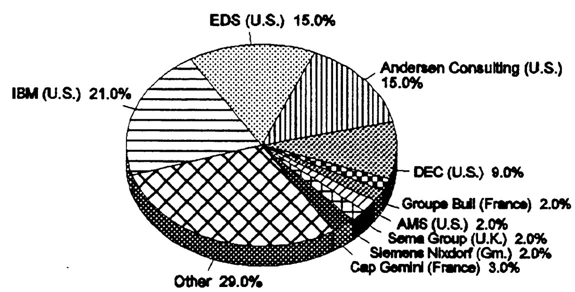
The worldwide market for systems integration services reached $19.7 billion in 1993 and is expected to expand at an annual rate of 16 percent during 1993-98. The North American market[1] remains over twice the size of the next largest regional contender primarily because of high computer hardware penetration levels[2] and an early recognition of the competitive advantages offered by integrated communication systems (figure 1). U.S. systems integration firms control over 60 percent of the global SI market (figure 2).

Figure 1
Worldwide systems integration market, 1993




Source: INPUT, Inc.

Figure 2
Global market share of key systems integrators




Source: Gartner Group, Inc., as presented in Datamation, July 1992.

This article examines the competitive environment in which the U.S. systems integration industry emerged, the types of customers served, and the competitive strengths that U.S. systems integrators have developed to respond to client demands. The findings of the article are twofold. First, by competing in a large and extremely demanding domestic market, the U.S. systems

[1] For the purposes of this article, North America includes the United States and Canada. Mexico is included under Latin America.

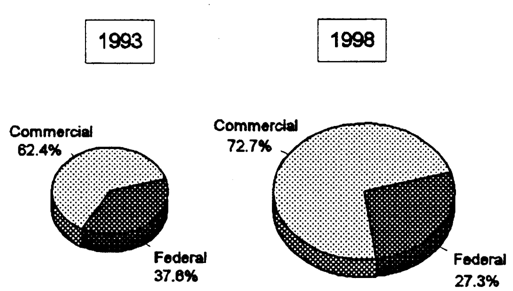
[2] Hardware and software penetration rates can be measured by levels of data processing spending per white collar worker. The United States reached and maintained a penetration level of $1,000 per worker in 1983, while Europe and Asia attained this rate only in the late 1980s. McKinsey & Company, Inc., *The 1992 Report on the Computer Industry*, p. 2-17.

integration industry has strengthened its ability to compete globally. Second, as companies across North America enhance their information infrastructures through the use of systems integrators, the competitiveness and overall productivity of multiple U.S. industries improves.

### Demand for Systems Integration Services

The U.S. market for SI services emerged in the 1960s as government agencies, such as the Department of Defense and the National Aeronautics and Space Administration (NASA), turned to outside support for construction of extensive communication infrastructures. Government contracts dominated the market for many years, but recently the share of the market accounted for by the private sector has grown rapidly. This trend is expected to continue, with the commercial market projected to expand at over twice the rate of the Federal market through 1998 (figure 3).[3]

**Figure 3**
**The commercial and Federal markets for systems integration**




**Total market was $10.1 billion in 1993 and is estimated to be $19.4 billion in 1998**

Source: INPUT, Inc.

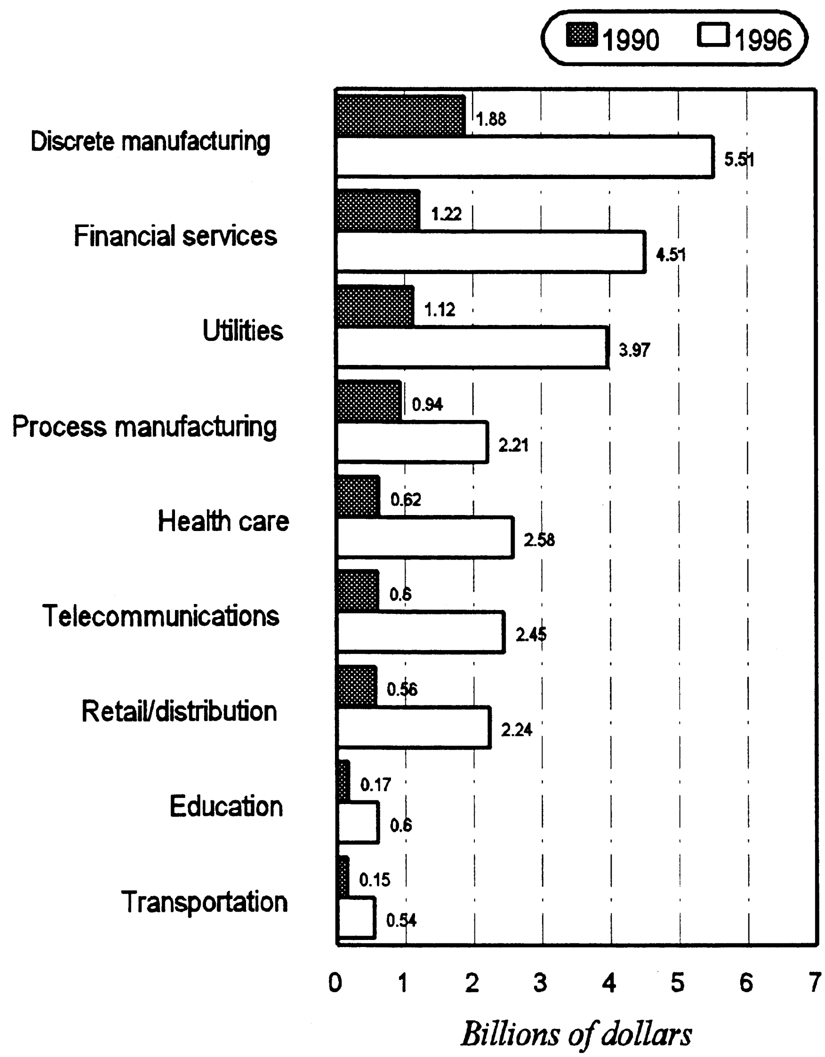
In addition to the increasing importance of private sector demand, the SI industry has experienced rigorous technological challenges in recent years. Systems integrators originally focused on basic project coordination and the resale of relatively standard hardware and software packages. Today, systems integrators handle increasingly complex projects requiring innovative design, development, and implementation. In many cases, SI firms are required to tailor technology to distinct business disciplines. For example, Computer Task Group (CTG) was called upon by KeyCorp banking group to update the bank's computing system and to use technology to improve its loan approval process. CTG created an electronic network using the latest software and hardware technologies available, integrated the direct-lending units of KeyCorp with its branch offices, and customized the company's loan approval software. As a result, KeyCorp reported increased speed and efficiency in its ability to process loans.[4]

Within the private sector, some of the fastest growing markets for SI services include the health care, telecommunication, retailing, and financial service industries (figure 4). Service industries have potentially the most to gain from the increased productivity offered by integrated computing systems because their competitive position in end markets is determined largely by their ability to generate and transport information rapidly and efficiently. Furthermore, unlike manufacturers who were forced to streamline data processing operations for cost-saving reasons as global competition in their end markets intensified during the 1980s, firms in the rapidly expanding service industries faced less intense competition and had limited incentive to streamline operations. Consequently, productivity growth in the service sector lagged far behind that in the manufacturing sector, despite the service sectors's expenditure of over $800 billion on computers, telecommunication products, and other types of

[3] The private sector market overtook the Federal market in terms of size during the early 1980s. Between 1993 and 1998, the Federal market for systems integration services is projected to expand at a compound annual growth rate of 7 percent. During the same period, the commercial market will expand at a compound annual rate of 17 percent. Based on data provided by INPUT, Inc.

[4] KeyCorp representative, telephone conversation with USITC staff, May 5, 1994; and Bob Francis, "Client/Server Integrators--Is Bigger Better?," *Datamation*, July 15, 1993, p. 24.

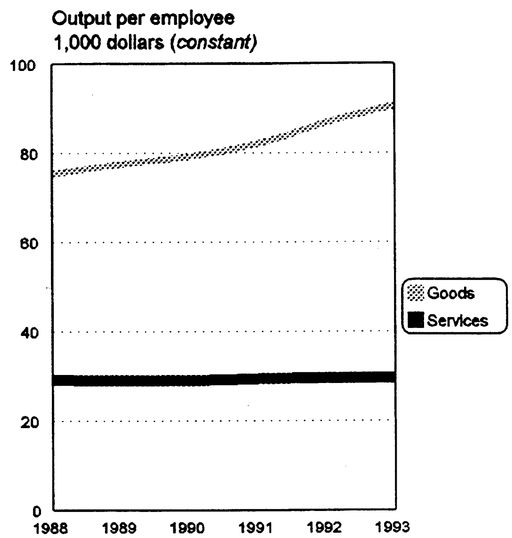
Figure 4
Vertical markets for systems integration[1]




[1] Spending by Fortune 1,000 companies by vertical markets.

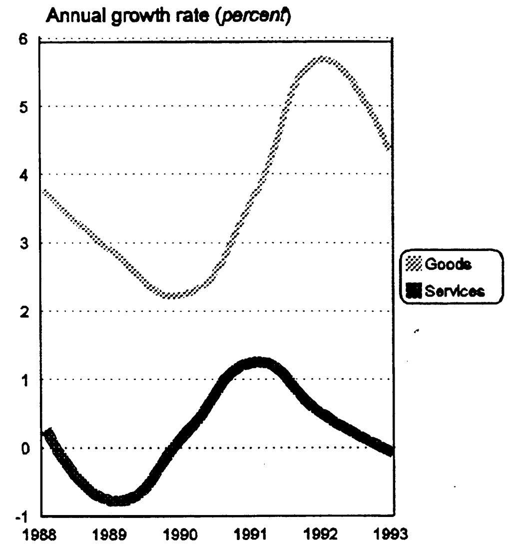
Source: G2 Research, as presented in *Electronic Business*, Apr.1992.

Figure 5
Productivity trends, 1988-1993, U.S. goods and services sectors




Source: USITC staff estimates.

Figure 6
Productivity growth rates, 1988-1993, U.S. goods and services sectors




Source: USITC staff estimates.

information technology (IT) equipment during the decade (figures 5 and 6).[5] Although the increased expenditures on IT products should have translated into the automation of traditionally labor-intensive functions (e.g. payroll), the ratio of administrative employees to professionals changed little during the 1980s. The lack of effective systems integration to capitalize on the labor-saving opportunities offered by IT products caused the services sector to simply increase its overall operating expenses, adversely affecting its ability to weather such economic downturns as that experienced during 1991-92.[6]

Heightened global competition in service industries today is forcing many companies to re-evaluate overall operating costs and strategies.[7] Deregulation, diminished barriers to entry, and maturation of global service competitors have been increasing the intensity of price competition in many service sectors, particularly the airline, telecommunication, and financial service industries.[8] In this intensely competitive environment, many service companies presently are asking outside systems integrators, rather than in-house staff, to design systems that will, finally, create productivity gains commensurate with expenditures.

[5] As shown in figure 5, the manufacturing sector has maintained a significantly higher level of productivity than the service sector in recent years. Output per employee in the service sector has remained stagnant, with productivity growth rates (figure 6) barely reaching 1 percent in 1991. Productivity growth rates in the manufacturing sector, however, have ranged between 2 and 6 percent.

[6] Computer Science and Technology Board, *Keeping the U.S. Computer Industry Competitive* (Washington, DC: National Academy Press, 1990), p. 43.

[7] Industry representative, telephone interview by USITC staff, May 10, 1994.

[8] The progress made in the General Agreement on Trade in Services (GATS) will further encourage international competition in services. For further explanation, see U.S. International Trade Commission (USITC), *Potential Impact on the U.S. Economy and Industries of the GATT Uruguay Round Agreements* (investigation No. 332-353), vol. I, USITC publication 2790, June 1994.

## Competitive Strengths Developed by U.S. Systems Integrators

In response to increasing demand from all sectors of the home market, U.S. systems integrators have developed or refined their ability to (1) interconnect previously incompatible hardware and software, often facilitating the transition to smaller but more powerful platforms[9] in the process, (2) offer a wide range of services compatible with the needs of preferred clients, and (3) furnish specialized services that enhance the competitiveness of clients in their respective end markets.

### *Interconnection Skills*

As businesses need to replace outdated and incompatible computer systems, their primary obstacle is the increasing complexity and diversity of hardware and software. Systems integrators counsel clients with respect to their alternatives and are particularly useful in configuring "downsized" computer systems. While most corporations traditionally have relied on mainframe computers to process large business applications (e.g., payroll), the same type of work can now be performed on a "downsized" network of machines,[10] linked together in a configuration referred to as client/server systems.[11] The cost and performance benefits associated with client/server platforms are luring many customers away from conventional mainframe systems, but most companies lack the in-house capabilities to effectively implement these powerful new systems.[12] By relying on the more comprehensive expertise of systems integrators that focus on client/server contracts (figure 7),[13] companies avoid the risk of installing hardware and/or software that are out of date or inappropriate for their needs.

Systems integrators are also using their interconnection skills to integrate "front-office"[14] applications that directly affect strategic business functions. Initially, most companies used IT budgets to improve conventional "back-office" business applications, such as standardized company payroll and accounting systems. However, the speed and processing efficiencies realized through integrated back-office applications presently are similar among companies and do not confer significant competitive advantages. Unlike payroll and accounting systems, front-office applications are handled differently by each corporation, and customized interconnection of these applications can significantly affect overall cost competitiveness.

### *Service Range*

Another strength of the U.S. systems integration industry is the wide range of service options (e.g., diversity in size and specialization of providers) available in the market to meet the potential scope of a project. For example, a local retail store may hire a small systems integration company to install a

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[9] Platforms refer to the size and type of computer on which a company's infrastructure is based. For example, many companies are shifting from mainframe-based platforms, to workstation- or personal computer (PC)-based systems.

[10] The development of advanced microprocessors has resulted in the creation of extremely powerful personal computers and workstations. Today's 486-based personal computers offer the same level of computing power as a 1960s-vintage mainframe. For more information on this trend, see USITC, *Global Competitiveness of U.S. Advanced-Technology Industries: Computers* (investigation No. 332-339), USITC publication 2705, Dec. 1993.

[11] Client/server networks link a number of "clients" (usually PCs or workstations) to a central "server" computer. The server is responsible for storing and supplying data and applications for the client computers.

[12] Many Fortune 500 corporations are in the process of migrating to client/server systems. The U.S. market leads in this downsizing trend, primarily because of the high hardware penetration levels in U.S. businesses. As traditional mainframe hardware becomes obsolete, many are replacing it with smaller systems.

[13] Damian Rinaldi, "BSG Consulting Creates Client/Server Culture," *Software Magazine*, Sept. 1993, p. 75.

[14] Front-office applications are those used for decision support and business-specific functions. Examples might include customized software for managing client accounts in a financial organization or programs to facilitate paperwork and recordkeeping in an insurance or health care company. An airline or travel agency may enhance efficiency by integrating customer databases with incoming reservations, thus eliminating the time required to repeat addresses and seat preferences.

Figure 7
Selected systems integration companies [1]

| Multiservice Firms | Management Consulting & Large Accounting Firms | Niche Firms | Computer Hardware & Software Vendors |
|---|---|---|---|
| * *American Management Systems, Inc.* | * *Arthur D. Little, Inc.* | * *BSG Corp.* | * *Digitial Equipment Corp. (DEC)* |
| * *Andersen Consulting* | * *Bain & Co.* | * *Fiserv, Inc.* | * *HP Professional Services Organization* |
| * *Computer Sciences Corp. (CSC Partners)* | * *Boston Consulting Group* | * *Innovative Information Systems Inc.* | * *IBM Integrated Systems Solutions Corp.* |
| * *Electronic Data Systems (EDS)* | * *Coopers & Lybrand* | * *Lante Corp.* | * *Lotus Consulting* |
| * *Logica NA* | * *Deloitte & Touche* | * *Trident Systems, Inc.* | * *Microsoft Consulting Services* |
| * *Perot Systems Corp.* | * *Ernst & Young* | | * *Oracle Consulting Services* |
| * *SHL Systemhouse, Inc.* | * *KPMG Peat Marwick* | | |
| * *Technology Solutions Corp.* | * *McKinsey & Co.* | | |
| | * *Monitor Co.* | | |
| | * *Price Waterhouse* | | |

[1] Systems integrations firms include traditional management consulting firms, large accounting firms, and hardware and software vendors. In addition, there are multiservice firms that provide everything from business re-engineering consulting to data processing. There are also "niche" firms that provide expertise in specific segments of the information technology industry.

Source: *Computer World*, Sep. 27, 1993.

specific type of network to handle inventory and ordering flows. A corporation may call on a larger systems integrator to design and implement a strategy to improve communications and operations among its international branch offices. Large multiservice firms offer the fullest spectrum of integration services[15] and are well-suited for large projects that require a variety of skills.[16] For example, when UCAR Carbon Co. in Tennessee wanted to re-engineer its production methods using advanced technology, it turned to systems integrator Andersen Consulting. Andersen designed an

[15] Many of the computer hardware companies that have entered the systems integration industry are trying to expand their service offerings to a level that is competitive with the multiservice firms. Hardware companies are also careful to note that their SI divisions do not maintain a hardware bias.

[16] In some cases, a systems integrator may subcontract elements of a project to smaller systems integrators in order to take advantage of specific areas of expertise. Occasionally, large systems integrators actually purchase small SI companies to acquire a certain skill or specialty. For example, Canadian-based SHL Systemhouse Inc. absorbed several smaller SI firms to take advantage of their skills in client/server conversion. *Datamation*, July 15, 1993.

information system that enabled UCAR to improve its manufacturing and order-processing methods and to eliminate entire assembly lines. As a result, UCAR halved its production cycles and reduced costs by 20 percent.[17]

For some projects, however, the narrower range of specialized and price-competitive services offered by small, niche-market systems integrators imparts an important competitive advantage. Typically, niche SI firms offer integration services that are highly focused on specific technologies or industries. For example, BSG Corp. and Innovative Information Systems Inc. concentrate on such emerging technologies as multimedia applications and object-oriented design.[18] Other small companies may focus on integrating and installing only one or two specific types of computer systems. For instance, the California-based Applications Group specializes almost exclusively in Oracle financial systems and PeopleSoft human resource systems.[19]

*Industry Specialization*

Many SI firms have responded to market demands by specializing in the needs of specific industries. For example, Electronic Data Systems (EDS) and Andersen Consulting target manufacturing industries, whereas IBM targets the financial services industry. Software customization for a manufacturing plant can vary dramatically from that required for a financial service firm. Further, specialization in individual vertical markets is cost effective, since systems integrators can re-use or customize certain basic techniques and programs that overlap among similar customers (e.g., banks). One company, Health Systems Integration of Minneapolis, offers software systems designed especially to reduce the extensive and costly paper flows in health care facilities.[20] Although the software may be customized to suit specific needs or strategies of a customer, the basic programs are similar. As competition intensifies in the service sector, the importance of systems that improve productivity and reduce costs will increase. The health care industry, in particular, must anticipate new types of competition in light of current efforts toward legislated reform.

### Implications and Outlook

The strengths of domestic SI companies have contributed to the increasing competitiveness of many U.S. industries. From retail and manufacturing companies to U.S. services firms, integrated computing networks are reducing costs and increasing productivity in companies across North America.

The worldwide market for systems integration services is forecast to expand at a compound annual growth rate of 16 percent over the next 5 years, reaching an estimated $41 billion by 1998 (figure 8). Although the United States will remain the largest market for SI services, it will experience one of the lowest overall growth rates as markets in other regions of the world begin to invest more heavily in SI services.[21]

In the short term, U.S. systems integrators are well-positioned to maintain a large share of the global SI market. The skills and strengths they have developed while competing in the demanding U.S. market are directly transferrable to competition

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[17] Lois Therrien, "Consultant, Reengineer Thyself," *Business Week*, Apr. 12, 1993, p. 86.

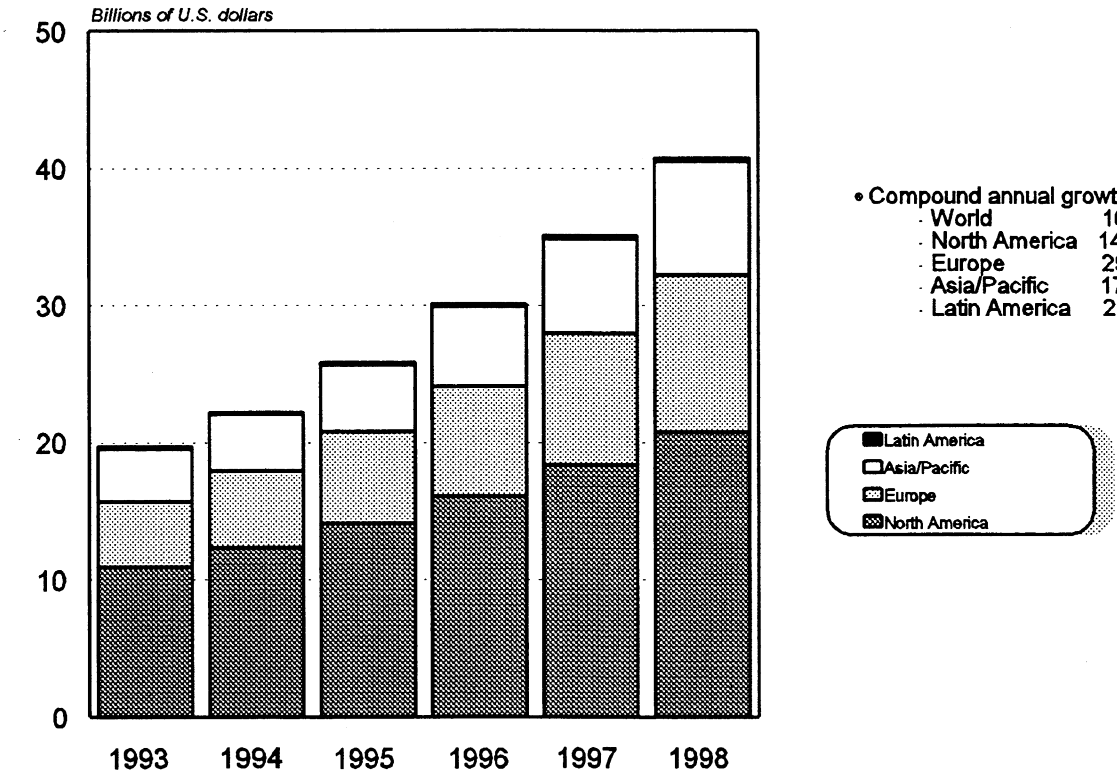
[18] Multimedia technologies incorporate voice, video, and data through a single transmission medium. Object-oriented software refers to reusable, self-defined software modules that can be strung together rapidly to create a program. The goal is to reduce expensive and redundant programming efforts. For a more detailed explanation, see USITC, *Global Competitiveness: Computers*.

[19] Industry representative, interview by USITC staff, San Francisco, CA, Mar. 16, 1994.

[20] The company's software includes member benefit programs and business management systems. Industry representative, telephone interview by USITC staff, May 10, 1994.

[21] Other regions have been slower to exploit the advantages of system integration services primarily because of lower hardware/software saturation rates and differing regional economic trends. Some analysts point out that the global economic slowdown affected the United States first, forcing U.S. companies to improve productivity through the use of technology and systems integration. As the economic downturn spread to other countries, so too have efforts to improve productivity through technology. Industry analyst, telephone interview by USITC staff, June 7, 1994.

Figure 8
Projected worldwide systems integration market, 1993-1998




Source: INPUT, Inc.

overseas. U.S. firms already enjoy substantial market share in other countries. EDS, with operations in over 30 countries, maintains regional market shares through contracts with multinational corporations and local businesses. In other regions, many of the large U.S. hardware firms have taken advantage of name recognition to develop a presence in the market for SI services. This is the case in Taiwan, where IBM, Digital Equipment, Sun, and Hewlett-Packard are all strong competitors. In some regions, U.S. firms have entered into joint ventures to expand market share. EDS, IBM, and Wang all have joint ventures offering SI services in Taiwan, while BSG Corp. (United States) recently formed a joint venture with Philips Communication and Processing Services (Netherlands) to offer services to multinationals migrating to client/server technology.

With respect to the global market, foreign competition principally comes from Groupe Bull, Sema Group, and Cap Gemini of Europe. Groupe Bull of France has maintained its international position by offering integration expertise to the growing number of companies shifting from proprietary to open systems.[22] Aside from these players, however, few European firms have the size and financial experience to compete with the U.S. giants on a global scale (figure 2). On the other

[22] Proprietary computer systems are not compatible with other types of hardware and software. Increasingly, however, consumers are demanding open systems that allow companies to more easily interconnect their hardware and to use the same software on a variety of machines. For more detailed information, see USITC, *Global Competitiveness: Computers*.

hand, a number of foreign companies are developing the skills necessary to compete with U.S. firms in their respective home markets. Europe boasts several successful SI firms that supply local markets. The same is true in Japan and Taiwan, where an increasing number of local companies have emerged in response to growing domestic demand for SI services. Among these are several Japanese hardware companies, whose expansion into SI services parallels the efforts of U.S. hardware firms. Mitsubishi, for example, is trying to offset declining mainframe sales by generating revenue through a newly created division that markets systems integration services.

Demand for SI services will continue to increase in international markets, following trends similar to those in the United States. There is already significant demand in the international service sector (particularly in financial services) for upgraded and integrated IT infrastructures. Although foreign competition is increasing in the systems integration industry, the experience gained by SI firms operating in the aggressive U.S. market will continue to enhance their ability to compete globally.☐

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# ECONOMICS AND INNOVATION SPUR SHIFT FROM MECHANICAL FASTENERS TO ADHESIVES AND SEALANTS IN CERTAIN AUTOMOTIVE APPLICATIONS

Although mechanical fasteners are expected to remain the principal method of securing metal operating and structural components to the basic metal frame in the final-assembly phase of automobile production, other traditional uses of mechanical fasteners are giving way to newer material developments and technologies that are likely to reduce their overall application in the automotive industry. During the last decade, as new and innovative uses for plastics, aluminum, and composite materials[1] gained popularity in the automotive industry, adhesives and sealants[2] were found to be more effective than mechanical fasteners[3] to secure these relatively lighter weight materials. As adhesives and sealants gained industrywide acceptance, the demand for mechanical fasteners declined, especially in new applications where metal components were replaced by lighter weight materials. Whereas the formability advantages of plastics and composite materials have reinforced their application for aerodynamic performance and styling concerns, adhesives have been favored over mechanical fasteners to minimize stress fractures.

Despite these material advantages, the growing use of plastics and adhesives has created various environmental concerns. As manufacturers address recycling problems and develop more environmentally safe products, the growth in demand for these newer materials is continuing. This article examines the substitution of adhesives and sealants for mechanical fasteners in automotive applications, the factors shaping competition in this market, evolving technologies gaining wider use, and the prospective growth of adhesives and mechanical fasteners in the automotive industry.

## Fastening Systems Reflect Adoption of New Materials

The automotive industry is the largest user of mechanical fasteners, consuming approximately 25 percent ($1.6 billion) of total U.S. consumption of these products in 1993, compared with 30 percent ($1.3 billion) of total consumption during 1985.[4] Before 1985, the U.S. automotive industry relied almost exclusively upon mechanical fasteners to secure automotive component parts. The final-assembly phase of automobile production (including the installation of transmissions, engines, hoods, doors, fenders, and trunk lids) accounted for the bulk of the mechanical fastener use. During this period the production of the average automobile required approximately 3,000 to 4,000 mechanical fasteners.

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[1] A combination of two or more materials (reinforcing elements and composite matrix binder), differing in form or composition. The materials retain their identities; that is, they do not dissolve or merge completely into one another. Normally, the components can be physically identified and exhibit an interface between one another. Examples are glass or carbon fibers, which provide load-bearing capabilities and polyester, and vinyl ester resins, which bind the fibers into a composite material. Based on ASM INTERNATIONAL's *Engineered Materials Handbook, Composites*, vol. 1.

[2] Distinctions between adhesives and sealants are covered in the article "U.S. Auto Industry Offers Opportunities for Formulators," *Adhesives Age*, Aug. 1992. An adhesive is largely used to bond one substrate to another. A sealant is used to fill a void and/or prevent the passage of a liquid or gas from one fastening joint to another. An example of adhesives and sealants being used together is the bonding of windshields to vehicles. In this application sealants prevent the penetration of moisture whereas adhesives (through bonding properties) allow the windshield to become a structural component of the vehicle.

[3] The principal mechanical fasteners are bolts, nuts, screws, studs, rivets, and washers of iron or steel. These fasteners are commonly used to hold, join, or assemble component products. Although copper, aluminum, and other metals are used to manufacture these fasteners, approximately 90 percent are manufactured from steel.

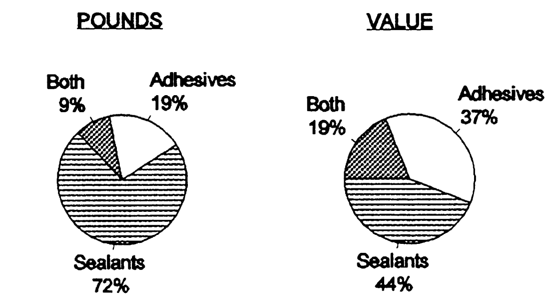
[4] Estimated from data published by the U.S. Department of Commerce, Bureau of the Census, *1987 Census of Manufactures* and from USITC staff contacts with industry sources.

The relatively small amount of adhesives and sealants that were consumed by the industry consisted of bonding agents used to attach brake linings, windshields, and vinyl coverings and trim to the automotive body.

Since 1985, however, the use of adhesives and sealants by the automotive industry has expanded significantly as manufacturers, seeking the advantage of lighter weight materials, increased the use of plastics, aluminum, and composite materials. Consequently, by 1993 an estimated 15- to 20-percent reduction in mechanical fastener use occurred, with the manufacture of the average automobile requiring between 2,300 to 2,500 mechanical fasteners.[5] Approximately one-half of these fasteners were characterized by the automotive industry as being "special fasteners;" the remainder were referred to as "standard" fasteners.[6]

In addition to relying upon mechanical fasteners, the automotive industry used approximately 10 percent ($910 million) of total U.S. consumption of adhesives and sealants in 1993,[7] compared with an estimated 5 percent ($300 million) of consumption in 1985. In automotive applications, sealants accounted for 72 percent (based on pounds) while adhesives accounted for 19 percent of consumption in 1991. Products that provide both adhesive and sealant properties accounted for 9 percent. When considering the value of these products, however, the percentages changed significantly: sealants accounted for 44 percent of consumption, adhesives for 37 percent, and products with both properties accounted for 19 percent. As indicated in figure 1, adhesives and those materials with both adhesives and sealant properties are higher value products.

Figure 1
Adhesive and sealant use by the U.S. auto industry, 1991




Source: ChemQuest Group, Inc., Cincinnati, Ohio.

The structural components of automobiles generally dictate the types of adhesives and sealants used during the manufacturing process. Although automotive manufacturers cite epoxies, PVCs, and urethanes as the most common materials used, a variety of such products as silicones, acrylic-solution caulks, hot melts, solvent-borne, and water-borne products are also used. There are two distinct classifications that encompass adhesives and sealants used by the automotive industry: (1) formulative technologies, which incorporate those products formulated from various chemical compositions and water versus organic chemicals as their solvents, and (2) resin types, which include adhesives derived from organic substances.[8]

## Factors Affecting Wider Use of Adhesives and Sealants

Sustained emphasis by automobile manufacturers on more fuel-efficient and corrosion resistant vehicles, greater styling flexibility, and reduced production costs has encouraged increased reliance on newer materials and production processes. In an increasing number of instances, these goals can be met through the use of plastics, composites, and other materials as substitutes for metals (primarily steel). One of the most significant factors influencing the switch from mechanical

[5] U.S. automotive officials, interviewed by USITC staff, Dec. 10, 1993 and Mar. 9 and 22, 1994.

[6] "Special" fasteners are produced to specific designs or customer specifications and are largely low-volume items, whereas "standard" fasteners (typically high-volume items) have multiple applications and can be manufactured and held in inventory in anticipation of orders from different purchasers.

[7] *Adhesives Age*, Apr. and Jun. 1993.

[8] Classifications provided by the ChemQuest Group, "U.S. Industry Offers Opportunities for Formulators," *Adhesives Age*, Aug. 1992.

fasteners to adhesives and sealants stems from the automotive industry's efforts to comply with Corporate Average Fuel Economy (CAFE) requirements (especially in full-size automobiles over 3,500 pounds).[9] The need to reduce size and weight of automobiles and improve the formability of structural material has forced the industry to be more cognizant of plastics, aluminum, and composite materials that bond effectively with adhesives.[10] Plastics, for example, are not only lighter in weight than most metals but allow the manufacturer greater latitude in aerodynamic design. The increasing use of plastics will enhance the demand for adhesives, since plastics generally do not bond well with mechanical fasteners because of possible stress cracking at the point of fastening.[11] In virtually every application, adhesives and sealants also add considerably less weight to a vehicle than mechanical fasteners.

The use of adhesives and sealants has also resulted in lowered production costs for automotive manufacturers by reducing the number of mechanical fasteners and by simplifying or streamlining the production process. For example, modular or one-piece construction using plastics and aluminum facilitates assembly and promotes recyclability since a minimum of different materials is involved.[12] Modular construction also improves body rigidity, which makes it easier to manufacture quieter automotive bodies. The formability of plastics and composites promotes modular construction, leading to increased use of adhesive fastening methods. An added benefit of using adhesives in steel-based construction is the elimination or reduction of corrosion, which often occurs after spot welding and traditional fastening methods.[13]

Design alterations and changes in structural materials have resulted in new opportunities for adhesives and sealants. For example, a relatively new technology involves attaching headliner material directly to the interior ceiling of vehicles, instead of incorporating the traditional mechanical fasteners to a metal frame or bow. The advantages of this system include weight savings, a simplification of the installation process, and reduction of production time.[14] Another important product development involves heat-resistant adhesives used to attach insulating pads to the underside of the hood, a function traditionally secured by mechanical fasteners. In addition, new uses for adhesives and sealants have been found in a variety of manufacturing operations, such as floor and door panels, under-the-hood applications, acoustics, and bumper assemblies. As a result of major shifts in automotive exterior materials, adhesive and sealant producers have found it necessary to adapt to subtle changes within the automotive industry. For example, polypropylene has gained increasing prominence as a substrate in automotive interior applications (dashboards and side door panels). This has resulted in new compatibility requirements and bonding challenges for widely used surface adhesive products.[15]

Although the use of plastics has gained popularity throughout the automotive industry, there is concern with respect to recycling plastic component parts. In addressing this concern, plastic producers are seeking ways to remove the thermoset bond line of the adhesive from the plastic substrate since it cannot be recycled in its current condition. Despite this inherent problem, however, demand for automotive plastics is expected to increase. The growth rate of plastic (based on pounds) for automotive demand in North America[16] is expected to increase at 5.3 percent annually during 1992-97.[17]

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[9] *Auto Chemicals, '91*, Feb. 18, 1991.

[10] "U.S. Auto Industry Offers Opportunities for Formulators," *Adhesives Age*, Aug. 1992.

[11] Adhesives and sealants are applied in such a way as to fasten surface areas considerably larger than those secured by mechanical fasteners.

[12] Director of Marketing and Sales, Thiem Automotive Division, National Starch and Chemical, *Adhesives '93, Getting Around*, Nov. 15, 1993.

[13] Automotive News Insight, *Stuck on Glue*, Oct. 25, 1993.

[14] *Adhesives '92, The Extra Mile*, July 27, 1992, p. SR 20.

[15] Don A. Pittenger, Senior Development Program Manager, DuPont Polymers, *Adhesives Age '92*, July 27, 1992.

[16] Includes the United States and Canada.

[17] The Freedonia Group, *Hydrocarbon Processing*, Nov. 1993.

Pollution control and worker safety are also major concerns for users of certain adhesives. The inherent environmental problems associated with solvent-based adhesives have driven the growth of hot melt and waterborne adhesives. But, although hot melt and waterborne adhesives do not present a serious environmental concern, additional technology is required to improve the fastening capabilities of these materials.

## Outlook

The use of adhesives and sealants in automobile production will continue to expand (as reflected in the projected growth rate of these products) as automotive manufacturers seek new and innovative uses for plastics, aluminum, and composite materials.[18] The use of all types of adhesives and sealants by the automobile industry is expected to increase between 7 and 8 percent annually during the next 5 years.[19]

Despite the significant advancements of adhesives and sealants in new automotive applications, mechanical fasteners are expected to remain the principal fasteners used in the assembly of automotive structural components manufactured from iron and steel. Maintenance and repair procedures that require removal or replacement of metal component parts tend to ensure the continued use of mechanical fasteners, due to the permanent fastening characteristics of adhesives and sealants. Therefore, mechanical fastener producers supplying the automotive industry do not appear to be significantly concerned with the advancements of adhesives and sealants in automotive production, given the sustained demand for mechanical fasteners in traditional and newly developed metal-to-metal applications. Total shipments of mechanical fasteners for all applications are expected to increase by 4 percent in 1993-94 and by an average annual rate of 2 to 3 percent through 1998, with demand from the automotive sector being the most important factor contributing to the expanded growth.[20]□

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[18] According to the ChemQuest Group (*Adhesives '92, The Extra Mile*, July 27, 1992), the annualized growth rate for urethane systems used in the assembly of plastic bumpers is 40 percent; 27 percent for epoxies, urethanes, and hybrids used for exterior body panels; and 23.4 percent for reactive hot melts used for head lamps and tail light assemblies.

[19] *Chemical Week*, Mar. 15, 1989, pp. 33-48.

[20] U.S. Department of Commerce, *U.S. Industrial Outlook 1994*.

# R&D CONSORTIA IN THE U.S. AND JAPANESE AUTOMOBILE INDUSTRY

The oil crises of the 1970s are widely viewed as significant turning points in the history of the U.S. automobile industry, as U.S. companies were forced to adopt more fuel efficient technologies and respond to the first substantial entrance of Japanese automobiles into the U.S. market.[1] The pressure for technological and organizational change that began with the oil crises and continued during the 1980s shows no sign of subsiding during the 1990s and beyond. In fact, innovation within the industry has accelerated as the technological sophistication of automobiles increases. The costs of meeting these requirements have also risen, and, in the United States, automakers are increasingly combining their research and development (R&D) efforts to make more efficient use of their respective R&D budgets. Beginning in 1988, but primarily since 1991, the U.S. automobile industry has formed 15 R&D consortia in a strategy of selected domestic cooperation.

This article reviews the factors associated with the emergence of R&D consortia in the U.S. automobile industry and evaluates the implications and challenges of these consortia for the industry. Because the consortia are formed largely as a response to competition from Japanese automakers,[2] an overview of Japanese automobile R&D consortia is also presented. Although there is a common perception among researchers in the United States that Japanese automobile R&D consortia are few in number and scope, information in this article suggests that this view may be inaccurate.

## Factors in the Formation of R&D Consortia in the U.S. Automobile Industry

The automobile industry traditionally has been considered to be a "mature" industry because it is characterized by high-volume production of a product that has ceased to undergo rapid and dramatic technological change.[3] Unlike many mature industries, however, the automobile industry is also characterized by relatively large investments in R&D to continually refine the product and the production process. Industry efforts to improve vehicle performance (acceleration, handling, and comfort), safety, fuel economy, engine emissions, quality, and styling, while at the same time trying to improve production efficiency, place substantial demands on the technical capabilities of automakers. Some of these product improvements are mandated by state or Federal laws, while others are demanded by consumers.

Making these improvements in automobiles often requires the use of technologies and production processes that rarely, if ever, have been used because of their high costs. For example, automakers have invested extensive R&D resources toward improvements in materials, engine and transmission design, computer-aided design (CAD), electronic/ electrical systems, and the use of alternative fuels. Some industry observers have concluded that since the late 1970s, the U.S. automobile industry has been reversing the historical trend of decreasing technological change in the industry and, instead, has reintroduced innovation as a major factor in competitiveness.[4]

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[1] David Halberstam, *The Reckoning* (New York: William Morrow and Co., 1986); Alan Altshuler, et al., *The Future of the Automobile* (Cambridge: MIT Press, 1984); Maryann Keller, *Rude Awakening* (New York: William Morrow and Co., 1989).

[2] This article does not address R&D consortia in the European automobile industry. Japanese automobile companies are by far the most significant competitive challenge to the U.S. automobile industry, and R&D consortia in the U.S. automobile industry have been formed largely as one means by which to meet that challenge.

[3] See William J. Abernathy, et. al., *Industrial Renaissance: Producing a Competitive Future for America* (New York: Basic Books, 1983), chs. 3-4, for a discussion of the concept of "mature" industrial sectors with specific reference to the U.S. automobile industry.

[4] William J. Abernathy, et al., pp. 27 and 115. The authors refer to this type of development within an industry as "de-maturity," and develop a methodology to show that the U.S. automobile industry began the process in the late 1970s.

Thus, as expected, R&D expenditures in the industry have been increasing rapidly. In 1986, R&D expenditures in the automotive industry (vehicles and parts) totaled $7.4 billion, equal to approximately 3.7 percent of total sales, or $5,076 per employee.[5] By 1992, R&D expenditures totaled $12.3 billion, the second highest of all U.S. industrial sectors, and equivalent to 4.0 percent of total sales, or $8,103 per employee. In 1992, General Motors and Ford had the first and third highest R&D expenditures, respectively, among all U.S. companies. The U.S. Big Three automakers--General Motors (GM), Ford, and Chrysler--account for about 90 percent of the automotive industry's total R&D expenditures.[6]

Automakers are not able to pursue the application of new technologies at a leisurely pace. In addition to the fact that competition, particularly in the North American market, is intense, Federal and state laws requiring improvements in fuel economy, engine emissions, and safety sometimes require automakers to meet new standards in relatively short time periods. A recent example of this relates to engine emissions. By 1998, California will require that 2 percent of all vehicles that automakers sell in the State be electric powered.[7] By 2003, that requirement will increase to 10 percent of all of a manufacturer's sales in the state. Most northeastern States are considering a mandate similar to that in California. The technological barriers that must be overcome to develop electric vehicles that have price, performance, safety, and convenience characteristics similar to gasoline-powered vehicles are considerable and, perhaps, impossible to overcome within the next 10 years.[8] Such electric vehicles probably will require fundamentally different drivetrains, bodies, electrical/electronic systems, and heating and cooling systems, most, if not all, of which will require the use of technologies rarely applied in automobile production.

[5] *Business Week*, "R&D Scoreboard", June 22, 1987, p. 141.

[6] Ibid., June 28, 1993, pp. 102-105.

[7] The vehicles do not necessarily have to be electric, but 2 percent of the vehicles sold in California must be zero-emissions vehicles (ZEVs), and, at this time, only electric vehicles qualify as ZEVs.

[8] There is widespread disagreement as to whether automakers can develop such an electric vehicle in time to meet the mandate.

While technological demands in the automobile industry require greater R&D expenditures than ever before, U.S. automakers are in a relatively weak financial position to fund adequately all research priorities. During the 1970s, the U.S. motor vehicle industry (including auto parts) earned pretax profits of $50.8 billion, and never experienced a combined sectoral loss. In the 1980s, profits totaled $34.8 billion, and the industry experienced losses in 2 years (1980 and 1982). The industry was unprofitable during 1990-91, but was profitable in 1992-93.[9] Much of the financial erosion of the U.S. industry is attributable to intense competition from Japanese automakers, which have captured approximately 30 percent of the U.S. automobile market. Although U.S. automakers have responded and continue to respond adequately to competitive pressures from Japanese automakers, which will likely help their financial condition in the future, competition is unlikely to diminish.

In an effort to utilize more efficiently corporate R&D resources, the U.S.-owned Big Three automakers began to engage in cooperative research efforts, or R&D consortia, in the late 1980s. The ability of all U.S. companies to pursue joint research projects was greatly facilitated with the passage of the National Cooperative Research Act (NCRA) of 1984, which reduced the possibility of antitrust violations resulting from cooperative R&D among competing firms.[10] With the acquisition of technology external to the firm, which some corporate leaders believe is of growing importance, cooperative research can increase the number of discoveries available to the firm and augment its internal technological know-how. Furthermore, the cost of meeting technological goals internally may be prohibitive, especially if relevant technologies are changing rapidly.[11]

[9] American Automobile Manufacturers Association, *Economic Indicators: 4th Quarter 1993*, Mar. 1, 1994, p. 14.

[10] *United States Statutes at Large*, vol. 98, pt. 2, 1984, pp. 98-462.

[11] F. Peter Boer, "Cooperative Research," *Managing R&D and Technology: Competition and Collaboration*, eds. Evelyn Samore and James K. Brown (New York: The Conference Board, 1988), p. 35.

## R&D Consortia in the U.S. Automobile Industry

In the face of growing R&D expenditures, lower profits, and sustained foreign competition, U.S.-owned automakers formed their first cooperative research agreement in September 1988 on automotive composites. Since then, U.S. automakers have formed an additional 14 consortia for a wide range of technologies (table 1), including: reformulated/alternative fuels, advanced batteries, environmental pollutants, serial data links, computer-aided design and manufacturing, vehicle recycling, low emissions technologies, low emissions paint technologies, supercomputer applications, electrical wiring components, and vehicle safety.[12] Of the 14 consortia, 12 were formed between 1991 and June 1994, illustrating the rapid pace of the formation of consortia in recent years. U.S. automobile parts firms, governmental agencies, and research labs are partners in some of the consortia.

The most ambitious of the U.S. R&D consortia is the Program for a New Generation of Vehicles (PNGV), established in September 1993. The project represents a unique industry-government effort to develop radical new vehicle technologies that will lead to an affordable, safe, practical, durable, low-emission, highly fuel efficient, passenger car. In addition to government funding, the project will have access to technology developed by key Federal agencies, such as the U.S. Department of Energy, U.S. Department of Defense, U.S. Department of Transportation, the U.S. Environmental Protection Agency, National Aeronautics and Space Administration, and the National Laboratories.[13]

Prospects for the formation of additional consortia are favorable. One U.S. automaker's vice president of engineering stated that as many as several dozen more consortia may be formed in the near future.[14] The two most recent consortia were formed in June 1994, and at least several more consortia are expected in 1994.[15]

## The Impact of R&D Consortia on the U.S. Automobile Industry

It is difficult to determine the effect and success of R&D consortia in the U.S. automobile industry. Most of the consortia in the automobile industry are relatively new and may yield only long-term results.[16] But, evidently, R&D consortia in the U.S. automobile industry are already proving to be of significant value, although no major technological breakthrough apparently exists. The first consortium formed in 1988 for composites has resulted in several patents for producing polymer-based composite[17] components. The president of General Motors has stated that such progress is inconceivable through separate research efforts.[18] The consortium also helped Ford to develop the front end of a heavy truck in 1991, and other members are expected to introduce consortium-related technologies in the near future.[19]

In May 1994, the Low Emission Paint Consortium (formed in February 1993) announced a plan to build a $20 million, 60,000 square-foot addition to a Ford assembly plant to develop powder paints that reduce hydrocarbon emissions. There is currently no suitable process for applying powdered clear-coat paint.[20] Also in May 1994, U.S. automakers announced the termination of the High

[12] Joseph Bohn, "Big 3 Catch Consortium Fever in Drive to Edge Past Japanese," *Automotive News*, Mar. 9, 1992, p. 16; information received from the United States Council for Automotive Research (USCAR), which is the umbrella organization for the other consortia.

[13] "Environment and Energy Study Institute Briefing on the Clean Car Initiative," Washington, DC, Mar. 24, 1994, information presented by Ms. Mary Good, Undersecretary of Technology, U.S. Department of Commerce, and Chairman of the PNGV.

[14] Joseph Bohn, "Consortium Fever," Mar. 9, 1992, p. 16.

[15] USCAR representative, telephone interview by USITC staff, June 1994.

[16] Eric von Hipple, *The Sources of Innovation* (New York: Oxford Univ. Press, 1988), p. 89.

[17] For further explanation of these composite materials, see USITC, *Advanced Polymer Composite Materials*, staff research study 18.

[18] Al Fleming, "Give and Take," *Automotive News*, June 22, 1992, p. 24 of insert section.

[19] Joseph Bohn, "Consortium Fever," Mar. 9, 1992, p. 1.

[20] Alan Adler, "Big Three Automakers Unite on Paint Research Project," *Knight-Ridder/Tribune Business News*, NewsEDGE, May 26, 1994.

Table 1
U.S. automotive R&D consortia

| Consortium | Formation date | Partners | Purpose |
|---|---|---|---|
| Automotive Composite Consortium | Sept. 1988 | GM, Ford, Chrysler | Research structural composites. |
| Auto/Oil Quality Improvement Research | Oct. 1989 | GM, Ford, Chrysler | Evaluate reformulated fuels and methanol. |
| United States Advanced Battery Consortium (USABC) | Jan. 1991 | GM, Ford, Chrysler, in participation with U.S. Department of Energy and the Electric Power Research Institute | Develop advanced energy systems for electric vehicles. |
| Environmental Research Consortium | Mar. 1991 | GM, Ford, Chrysler, Navistar International Transportation | Research the nature, reactivity, and transport of environmental pollutants. |
| High Speed Serial Data Communications Research and Development Consortium | May 1991 Ended May 1994 after research goals achieved | GM, Ford, Chrysler | Research on capabilities and requirements of serial data links (multiplexing) to support advanced vehicle systems (antilock brakes, traction control, all-wheel steering, etc.). |
| Vehicle Recycling Consortium | Nov. 1991 | GM, Ford, Chrysler, in expected participation with steel, plastics, and scrap industries | To develop ways to recycle automotive materials and components in an environmentally responsible way. |
| CAD/CAM Consortium | Feb. 1992 | GM, Ford, Chrysler | Computer-aided design/computer-aided manufacturing systems. |
| U.S. Council for Automotive Research (USCAR) | Feb. 1992 | GM, Ford, Chrysler, in participation with Society of Automotive Engineers and the American Automobile Manufacturers Association | Monitor current joint research and development activities and recommend new projects for cooperative research among GM, Ford, and Chrysler. USCAR is considered to be the umbrella organization for other R&D consortia. |
| Low Emissions Technologies R&D Partnership | June 1992 | GM, Ford, Chrysler. Will work with National Laboratories when appropriate. | R&D on emissions control technologies. |
| United States Automotive Manufacturers Occupant Safety Research Partnership | July 1992 | GM, Ford, Chrysler | R&D on crash-test dummies and related areas such as modeling, instrumentation, data management and reduction of subsystem safety test development. |

Table 1--Continued
U.S. automotive R&D consortia

| Consortium | Formation date | Partners | Purpose |
|---|---|---|---|
| Low Emission Paint Consortium | Feb. 1993 | GM, Ford, Chrysler | R&D programs on paint-related technologies to reduce or eliminate solvent emissions from automotive painting systems and to accelerate the availability of low emissions painting technology. |
| United States Automotive Materials Partnership | June 1993 | GM, Ford, Chrysler. Will work with National Laboratories, and Federal agencies. | Vehicle-oriented R&D in materials and materials processing. |
| Supercomputer Automotive Applications Partnership | Aug. 1993 | GM, Ford, Chrysler. Will work with Department of Energy, National Laboratories, and universities when appropriate. | R&D on high-performance computing and communications programs applied to vehicle design and development. |
| Electrical Wiring Component Applications Partnership | June 1994 | GM, Ford, Chrysler | Permit and encourage cooperative R&D including the joint sharing of technology and resources for a common electrical connection system. |
| Natural Gas Vehicle Partnership | June 1994 | GM, Ford, Chrysler, in participation with natural gas suppliers when appropriate. | Develop new materials and manufacturing techniques for natural gas vehicle storage tanks; reduce the cost (by 50 percent) that will increase the reliability, and set common requirements of storage tanks; and establish composite standards for natural gas that will reduce emissions and improve driveability and performance. |

Source: Public information published by USCAR; Representatives of USCAR, telephone interview by USITC, staff June 1994; Joseph Bohn, "Big 3 Catch Consortium Fever in Drive to Edge Past Japanese," *Automotive News*, Mar. 9, 1992, p. 16; "U.S. Auto Makers Form Natural Gas Consortium," *Comtex Scientific Corporation*, NewsEDGE, June 28, 1994.

Speed Serial Data Communications consortium (formed in May 1991), having met its goals as a research project. The consortium focused on "multiplexing" technology, which could allow automakers to connect a vehicle's computer controllers with, for example, fiber optics, to eliminate wiring harnesses. Although findings are proprietary, the consortium is known to have endorsed one protocol (communication standard) and two data transmission media as showing the greatest commercial viability. The chairman of the consortia stated that the project could not have met its goals more successfully.[21]

The R&D consortia have not enabled automakers to reduce their R&D budgets. In fact, R&D budgets have increased in recent years. Increasing R&D expenditures are not, however, an indication of ineffectiveness of the R&D consortia. The consortia allow the automakers to allocate their R&D spending more efficiently, enabling automakers

[21] William R. Diem, "Big 3 Ends Research into Multiplexing," *Automotive News*, May 23, 1994, p. 6.

to spend more money on other technologies. The president of Chrysler believes that without R&D consortia, automakers would have to cancel other internal research projects.[22] Data on current funding of the consortia are not available.[23] In 1992, when there were only 8 consortia, the executive director of USCAR estimated that R&D funding was over $200 million, with several hundred people working in the consortia.[24]

R&D consortia in the automobile industry have been described by some industry observers as the best chance U.S. industry has to better Japanese technology. Japanese automobile firms have expressed interest in joining the U.S. consortia, but U.S. firms have so far resisted Japanese participation. For now, the future of certain technologies appears to hinge upon the success of the consortia. For example, the chairman of the Automotive Composites Consortium contends that any failure of the consortium to make substantial advances in composites technology, to a large extent, will dictate the U.S. automobile industry's progress in general.[25]

The implications of consortia-related advances could be profound. The two most obvious consortia for such advances are the PNGV and the United States Advanced Battery Consortium (USABC). The PNGV holds the realistic, although so far elusive potential, to provide the U.S. automobile industry with a vehicle that has substantial fuel economy and emission advantages over current vehicles. Besides the obvious environmental benefits of such a vehicle, the U.S. automobile industry could ultimately possess a significant, although perhaps short-lived, competitive advantage over foreign rivals, particularly in market segments where sales of such vehicles are mandated by law.[26] In a related matter, the main barrier to the widespread production and sale of electric vehicles is the lack of a battery that is capable of providing motorists with an electric vehicle that is both as convenient and affordable as a gasoline-powered vehicle. The USABC is one of the automobile industry's best chances of discovering a suitable battery, an event that could finally make electric vehicles feasible in the mass market and provide U.S. firms with a technological lead over foreign companies.

### Challenges to U.S. Automobile R&D Consortia

Industry representatives are enthusiastic about their cooperative efforts, even though at this point U.S. automobile R&D consortia seem to primarily result in gradual technological progress despite their potential for more significant long-term accomplishments. Realizing that potential will be challenging. There is evidence that U.S. automobile R&D consortia have confronted difficulties in creating these collaborative efforts. The challenge of cooperating in areas where the automakers are direct competitors is evidenced by the fact that the first consortium formed by the automobile industry in 1988 required 18 months to develop an official agreement. The emissions-related consortium formed in 1992 required even greater time to negotiate because U.S. automakers have long viewed emissions technology as a competitive issue. The consortium was formed only after automakers agreed to narrow the original concept for the consortium to only four or five key emissions components.[27] In late 1992, the Big Three automakers agreed to cooperate on electric vehicle development to meet California's zero-emissions vehicle mandate,[28] but before a

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[22] Al Fleming, "Give and Take," June 22, 1992.

[23] Representative of USCAR, telephone interview by USITC staff, June 1994. The representative stated that the level of funding is not known to USCAR.

[24] Joseph Bohn, "Consortia Office Chief Hits the Ground Running," *Automotive News*, June 29, 1992, p. 6.

[25] Joseph Bohn, "Consortium Fever," Mar. 9, 1992, p. 1.

[26] The U.S. automobile industry would not retain sole possession of such vehicle technology if foreign automakers are allowed to be members of this government-industry effort. The U.S. Government is still considering whether to allow foreign-owned automakers to participate in the PNGV. The PNGV has been received with a significant amount of cynicism from many industry observers regarding the ability of the organization to meet its goals. The substantial resources (U.S. Government and industry finances, National Laboratories, and technology and research facilities of Federal agencies and universities) that will be devoted to the project, however, increase the potential for technological breakthroughs.

[27] Joseph Bohn, "Consortium Fever," Mar. 9, 1992, pp. 16-17.

formal agreement could be negotiated, the effort failed when Chrysler announced that it would not participate in the plan. The attempt to form an electric vehicle consortium was reportedly hindered by long-running rivalries and fundamental differences in philosophies.[29] In 1992, U.S. automakers also formed a joint venture to perform "teardowns" (disassembly) of foreign autos for competitive analysis,[30] but the effort failed after performing only one teardown. Reportedly, the difference in the way individual U.S. automakers conducted the teardowns was too great, and cooperation did not yield enough benefits to warrant a continuation of the project.[31]

Consortia tend to be more easily created and to have successful results when they involve technologies in which the automakers have not competed with each other. Such was the case when U.S. automakers were able to form the third consortium, the USABC for batteries, in only 4 months.

Ironically, one of the greatest challenges for the U.S. industry may be in managing any successes of the consortia. An important example of this occurred in March 1994, when GM announced that it would provide financial and technical help to Ovonic Battery Co. (Troy, MI) to manufacture a nickel-metal hydride battery for electric vehicles. The USABC had previously awarded Ovonic the consortium's first contract to develop the nickel-metal hydride battery, which the U.S. automobile industry has targeted as one of the most promising mid- and long-term electric vehicle battery technologies.[32] The GM-Ovonic agreement has reportedly raised concern among Ford executives, who indicated that it might constitute a cooperative agreement conflict. This event shows how difficulties can arise in R&D consortia when a worthwhile technology emerges.[33]

In general, U.S. automobile firms have overcome the difficulties associated with creating and managing R&D consortia. The fact that two new consortia were created in June 1994, with more reportedly to follow, indicates that automakers' experience in cooperative research is generally favorable and the problems manageable.

## R&D Consortia in the Japanese Automobile Industry

The effectiveness of R&D consortia in the U.S. automobile industry is best considered in the context of the effectiveness of Japanese automobile R&D consortia. Unfortunately, much less public information is available on Japanese R&D consortia. If Japanese automakers are not pursuing collaborative research efforts, then U.S. automobile consortia may provide a significant research advantage over the U.S. industry's most formidable foreign rivals. If Japanese automakers also participate in R&D consortia, U.S. cooperative research efforts are probably best viewed as one important means by which U.S. industry can keep pace with the technological capabilities of its foreign competitors. Many of the factors prompting the formation of R&D consortia in the U.S. automobile industry are also present in the Japanese automobile industry. For example, Japanese automakers view the United States as a critical market, and they must respond to new regulations and consumer preferences to maintain market share. Japanese firms are also subject to regulations and consumer preferences in the Japanese market that are similar to those in the U.S. market.[34]

There is a common perception among industry representatives and researchers in the United States

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[28] "Big 3 to Cooperate on Electric Vehicles," *Ward's Automotive Reports*, Dec. 14, 1992, p. 1.

[29] Douglas Lavin and Oscar Suris, "Chrysler Distances Itself from Project to Create Electric Car with Ford, GM," *Wall Street Journal*, Sept. 13, 1993, p. 4. To some extent the goals of this unsuccessful effort are encompassed in the broad goals of the PNGV.

[30] Mary Connelly, "Big 3 Plan Consortium for Emissions," *Automotive News*, June 1, 1992, p. 1.

[31] Representative of USCAR, telephone interview by USITC staff, June 1994.

[32] "GM Moves to Mass Produce Advanced Electric Car Battery," *The Los Angeles Times-Washington Post News Service*, NewsEDGE, Mar. 10, 1994.

[33] "GM and Ovonic Near Production Deal," *Ward's Engine and Vehicle Technology Update*, Apr. 1, 1994, p. 1.

[34] For example, the Japanese Government is actively promoting the introduction of electric vehicles. Japanese consumers may be even more demanding of performance and quality characteristics of their vehicles than U.S. consumers.

and Japan that Japanese automakers have formed few R&D consortia, but there are no supporting data.[35] However, the Japanese Ministry of International Trade and Industry (MITI) has encouraged cooperative research among Japanese firms in general,[36] and the automobile industry would seem to be an important sector to target, given the sector's economic significance in Japan.

There are several organizational forms of Japanese R&D consortia. The form that is considered to be most comparable to U.S. R&D consortia formed under the U.S. NCRA of 1984 is referred to as engineering and research associations (ERAs). ERAs, bringing together firms in the same industry to cooperate on research projects, can, and usually do, receive Japanese Government funding and loans.[37] There are currently 116 ERAs,[38] 7 of which have participation by 7 Japanese automobile firms. However, in only 3 of the 7 ERAs can more than one automaker be identified. The ERAs are for light metal composites (Toyota and Nissan), fuzzy logic[39] (Toyota, Nissan, Mazda, and Fuji Heavy Industries[40]), and electric cars (Mazda and Daihatsu[41]). Of the other 4 ERAs, Japanese automakers are conducting cooperative research with an unspecified number of firms that are not automakers. These remaining 4 automobile ERAs are for "creep" testing, computer-based traffic control systems, high-performance ceramics, and "medical and welfare apparatus."[42] The extent to which the nonautomobile firms participating in the other 4 ERAs are divisions, subsidiaries, or somehow related to a Japanese automobile firm can not be assessed from the available data. Given the complex corporate ties among Japanese firms, there may be, in an indirect way, greater cooperative R&D among the automobile firms than is immediately apparent.[43] Japanese automakers may benefit from the technological progress of ERAs in which they do not participate if the technological achievements of the ERAs flow back to the automakers via firms with which they are somehow affiliated. This possibility is more significant in light of the fact that some of the ERAs other than those noted above probably have automotive applications. For example, there are one or more ERAs for polymer materials, casting technology, shock absorbing material, super-computers, steel-making processes, gas turbines, robotics, and fuel cells, all of which are technologies with considerable relevance to the automobile industry. Other ERAs with less obvious potential for automotive applications might also be relevant to the automobile industry.

While ERAs may be the most comparable type of R&D consortia to those in the United States, they are not the only type. The Japan Automobile Research Institute (JARI) is a nonprofit corporation established in 1961 under the supervision of MITI to promote the development of Japan's automobile industry through R&D.[44] JARI has research

[35] U.S. industry representatives, Japanese industry representatives, and automobile industry researchers in the United States and Japan, telephone interviews and written correspondence with USITC staff.

[36] Howard E. Aldrich and Toshihiro Sasaki, "Governance Structure and Technology Transfer Management in R&D Consortia in the United States," paper presented at the Japan Technology Management Conference, Ann Arbor, MI, July 21-22, 1993, p. 5.

[37] Ibid., pp. 5 and 12.

[38] ERA data were received from Toshihiro Sasaki, Professor, Kyoto Sangyo University, Kyoto, Japan.

[39] "Fuzzy logic" refers to a mathematical theory to deal with approximations. In the automotive industry, fuzzy logic can be applied to sensors to make the vehicle perform in a more appropriate manner under different circumstances. For example, electronically-controlled transmissions that employ the logic can be made to avoid repeated up- or down-shifting that is annoying to drivers.

[40] Fuji Heavy Industries produces Subaru automobiles.

[41] Daihatsu has strong corporate ties to Toyota, which owns over 14 percent of Daihatsu. *How the World's Automakers are Related* (Detroit: Ward's Automotive International, 1993), p. 5.

[42] More descriptive information on these consortia could not be obtained.

[43] These corporate ties are often referred to as "keiretsu," an organizational form consisting of perhaps 20 or so companies, united by cross shareholding of stock and by a sense of reciprocal business loyalty. For example, Toyota is affiliated with the Mitsui keiretsu, Mazda with Sumitomo, and Mitsubishi Motor Co. with Mitsubishi. James P. Womack, et al., *The Machine that Changed the World* (New York: Rawson, 1990), p. 194. With respect to R&D consortia, less elaborate or extensive corporate ties may also be relevant.

priorities related to safety, pollution reduction, and fuels. The institute has extensive facilities and laboratories for engines, chemicals, biological science, dynamics, tires, safety, collision test grounds, a full-scale wind tunnel, acoustics, electromagnetic research, atmospheric-environmental testing, a variety of testing grounds, and other smaller facilities.[45] Not all of JARI's activities are consortia related; other projects involve surveys, forecasts, and symposiums. Information is limited, but JARI is known to have brought together automobile technicians and researchers from companies to research ceramic gas turbine technology and methanol vehicles and to prepare technical reports.[46] Not all JARI projects can be identified because, according to one Japanese automaker, the companies consider the projects to be confidential.[47]

Another form of R&D consortia in Japan has been created under the sponsorship of MITI in its own technical laboratory, known as the Agency of Industrial Science and Technology (AIST). AIST evaluates research ideas from Japanese firms and chooses those in which to participate. There appear to be only two automobile consortia (formed in 1992) under AIST: one for nitrogen oxide (NOx) catalyzers (involving Toyota, Nissan, Mitsubishi, Isuzu, Hino, and Nissan Diesel) and the other for diesel engine combustion (participants are unknown).[48] The NOx catalyst consortium is reportedly a significant development in that it represents the most ambitious R&D consortium in Japan's automobile industry and may signal a new interest in collaborative research among the country's automakers.[49] AIST also sponsors a battery project (formed in 1993) for, among other things, electric vehicles, in which Nissan and Isuzu are participants.[50] There is evidence that the consortium is primarily focused on lithium battery technology for use in electric vehicles. The effort is a 10-year project that will receive $134 million in funding from MITI. The consortium reportedly is close to reaching a technical breakthrough, which will be patented.[51]

In January 1993, Toyota and Nissan announced that they were starting a joint program to develop electric vehicles. The effort is reportedly in response to MITI's plan to place 200,000 electric vehicles on the road by the year 2000,[52] but it is likely that the project is also in response to California's electric vehicle mandate. Toyota and Nissan are Japan's first and second largest automakers, respectively, and both firms could devote considerable resources to the project.

## Outlook

All indications are that the U.S. automobile industry will maintain a strategy of cooperative research for the foreseeable future. Although there are no known major technological breakthroughs associated with the consortia, there is evidence that the consortia are yielding returns and that industry leaders are enthusiastic about their potential. The 1990s may mark the beginning of a significant avenue to innovation in the U.S. automobile industry, and automakers in other countries may follow the U.S. lead.□

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44 "Japan: Spotlight on Japan Automobile Research Institute," unpublished information, *Foreign Broadcast Information Service*, June 30, 1993, p. 1.

45 "Japan: Spotlight on Japan Automobile Research Institute," *Foreign Media Note*, Foreign Broadcast Information Service, June 29, 1993.

46 Roger Shreffler, "Japan's Hot R&D," *Automotive Industries*, July 1993, p. 10; "Japan: Spotlight on Japan Automobile Research Institute," *Foreign Media Note*, Foreign Broadcast Information Service, June 29, 1993.

47 Toyota Motor Sales, letter to USITC staff, Washington, DC, June 7, 1994.

48 Roger Schreffler, p. 10, *Japan Autotech Report*, Sept. 5, 1992, p. 26; Toyota Motor Sales, letter to USITC staff, Washington, DC, June 7, 1994; and representative of the Japan Automobile Manufacturers Association, telephone interview by USITC staff, Apr. 1994.

49 *Japan Autotech Report*, Dec. 5, 1992, p. 1.

50 "AIST to Develop Lithium Battery Power Storage Systems," *Comline News Service*, Apr. 5, 1993.

51 U.S. Department of State, "Japanese Research and Development in Advanced Lithium Battery Technology," telegram, prepared by U.S. Embassy, Tokyo, Japan, May 1994.

52 "New Product and Technologies," *JATI Courier*, Feb. 1993.

# INDIA AND PAKISTAN RESIST COMMITMENTS TO GREATER MARKET ACCESS IN THE TEXTILES AND APPAREL SECTOR

India and Pakistan have the potential to become large markets for global textile and apparel exports. Both countries have a large internal demand for producer goods and a large and growing middle class of consumers. Their programs to foster economic growth have led to average annual growth in gross domestic product of 4 percent in India and 5 percent in Pakistan during 1989-93, while world economic growth averaged just 1 percent a year. Increased demand for industrial goods spurred demand for merchandise imports, which rose at an average annual rate of 19 percent in India and 16 percent in Pakistan during 1989-93. Both countries, however, restrict virtually all imports of consumer goods, including most textiles and apparel.

U.S. textile and apparel industry officials have expressed concern about the lack of market access in India, Pakistan, and several other developing countries that are also significant suppliers of these products to the United States. They contend that these developing countries will gain much from concessions made by the United States in the Uruguay Round of multilateral trade negotiations to phase out its textile and apparel quotas. Under the General Agreement on Tariffs and Trade (GATT) Uruguay Round Agreement signed in Marrakesh, Morocco, on April 15, 1994, over 100 participating countries, including the United States, Pakistan, and India, agreed to a comprehensive set of regulations aimed at improving conditions for international trade in goods and services. While developing countries, such as Turkey, Egypt, Thailand, and the Philippines, have agreed to open their markets to textile and apparel imports, neither India nor Pakistan has offered comprehensive, substantive commitments to open its market.

The absence of comprehensive commitments by India and Pakistan in textiles and apparel has raised concern in the United States. This article examines the current U.S. textile and apparel trade situation with India and Pakistan and discusses the outlook for trade in this sector under the Agreement.

## Background

The Uruguay Round Agreement is expected to enter into force on January 1, 1995. The Uruguay Round Agreement on Textiles and Clothing (Agreement) provides for the liberalization of world trade in textiles and apparel through the phaseout of quotas currently in place under the Multifiber Arrangement (MFA) over a period of 10 years.[1] The Agreement also requires both developed and developing countries to reduce trade barriers to textiles and apparel in their home markets. Countries are called to reduce tariffs and bind rates in their respective tariff schedules, reduce or eliminate nontariff barriers, and facilitate customs, administrative, and licensing procedures. During the Uruguay Round negotiations, the United States and the European Union sought to have key countries bind their tariffs at rates no higher than 7.5 percent ad valorem for fibers, 15 percent for yarns, 30 percent for fabrics and home furnishings, and 35 percent for apparel. In addition, the United States requested that countries eliminate their nontariff barriers on textile and apparel products within 3 years after the entry into force of the Agreement and commit not to establish new nontariff barriers.

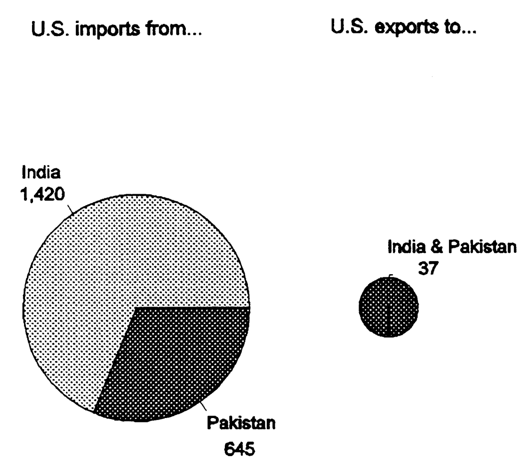
India and Pakistan have agreed to reduce tariff rates on cotton yarn to 40 percent ad valorem over 10 years, well above the 15-percent maximum rate sought by the United States for yarns. With the exceptions of cotton yarn and some industrial and specialty fabrics, neither country offered to reduce

[1] Under the GATT-sanctioned MFA established in 1974, importing developed countries negotiate bilateral textile and apparel agreements with exporting developing countries to set quotas and quota growth rates. The United States has quotas on MFA goods from some 40 countries that supply about 80 percent of these imports. For more detail on the Uruguay Round Agreement, see U.S. International Trade Commission (USITC), *Potential Impact on the U.S. Economy and Industries of the GATT Uruguay Round of Agreements* (investigation No. 332-353), USITC publication 2791, June 1994.

tariff rates for other textile and apparel products. Current tariff rates for textiles and apparel range from 40 to 175 percent ad valorem for India and 20 to 90 percent for Pakistan. The significance of these tariff rates is, however, negated by the fact that both India and Pakistan currently ban imports of most textiles and apparel under GATT balance-of-payments (BOP) measures.[2]

The textile and apparel sector is important to the economic growth of both India and Pakistan. In India, the sector accounts for about 25 percent of industrial production, 20 percent of the manufacturing workforce, and 30 percent of merchandise exports. A substantial portion of the Indian textile industry is a cottage industry, with generally old equipment and little modern technology. In Pakistan, textiles and apparel are the largest industrial sector and the major source of foreign exchange earnings, accounting for slightly more than 60 percent of merchandise exports and employing about one-third of the industrial labor force.

**Figure 1**
**U.S. textile and apparel trade with India and Pakistan, in millions of dollars, 1993**

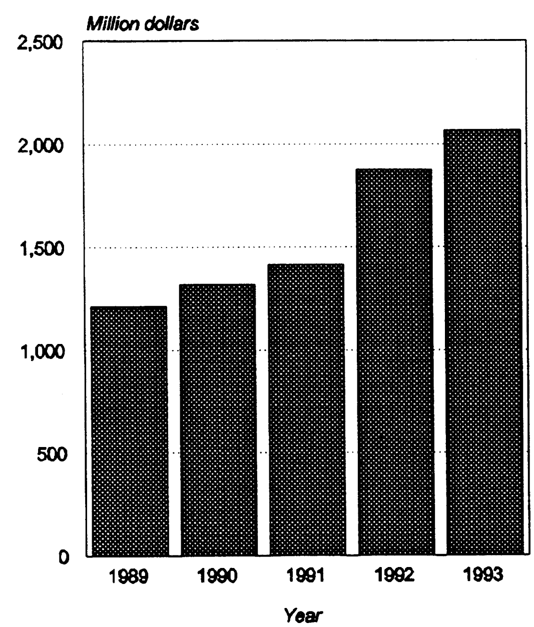



Source: Compiled from official statistics of the U.S. Department of Commerce.

## Trade Trends and Industry Overview

The U.S. textile and apparel trade deficit with India and Pakistan reached a combined total of $2 billion in 1993. U.S. exports of textiles and apparel to India and Pakistan that year totaled only $37 million, whereas U.S. imports of these products from the two countries totaled just over $2 billion (figure 1). U.S. textile and apparel imports from India and Pakistan expanded considerably between 1989 and 1993, rising by 70 percent (figure 2). U.S. textile and apparel exports to these countries ranged from $37 million to $43 million between 1989 and 1993. India and Pakistan together supplied slightly more than 5 percent of total U.S. textile and apparel imports in 1993.[3]

Figure 2
Growth of U.S. textile and apparel imports from India and Pakistan




Source: Compiled from official statistics of the U.S. Department of Commerce.

[2] Articles XII and XVIII of the GATT authorize member countries to impose import restrictions to forestall or stop a serious decline in monetary reserves and to achieve a reasonable rate of increase in its reserves in the case of low reserves, or for purposes of development in exception to normal GATT obligations.

[3] In cotton products, which account for most of their shipments, they supplied just over 8 percent of the imports.

To a large extent, the ability of India and Pakistan to increase textile and apparel exports has been based on their access to relatively low-cost cotton and labor. Both countries have government programs that generally keep domestic cotton prices below world market prices, giving their domestic yarn and fabric mills a cost advantage in raw materials.[4] Average hourly labor costs in the textile and apparel sectors of India and Pakistan are equivalent to less than 10 percent of comparable U.S. costs. These large disparities in labor costs more than offset any advantages that U.S. producers may have in labor productivity. Moreover, both India and Pakistan have been restructuring, modernizing, and expanding textile capacity. Significant investments in new textile equipment, largely by export-oriented entities, have resulted in increased efficiency and production of quality products in India and Pakistan.[5]

India and Pakistan are likely to be major beneficiaries of increased access to world markets under the Uruguay Round Agreement. A report submitted by the Federation of Indian Chambers of Commerce and Industry estimated that India's share of world textile trade would increase from 2.5 percent in the early 1990s to 7.2 percent by 2000. The report predicts export gains for India of $400 million in the first 3-year stage of the phaseout of the MFA and increases of $700 million annually by the end of the 10-year phaseout.[6] Other studies also indicate increases will occur in textile and apparel exports from India and Pakistan to the United States.[7]

## Outlook

U.S. industry sources believe that in the absence of import barriers, India and Pakistan would be significant growth markets for U.S. textile and apparel sales, particularly for brand-name apparel and home furnishings and industrial and specialty textiles. As industrial activity and employment opportunities increase in India and Pakistan, these markets are expected to increase considerably during the next 10 years. India, with a large and growing middle class estimated at 175 million to 200 million, the rough equivalent of three-fourths of the entire U.S. population, has the potential to be a particularly strong growth market for U.S. textile and apparel exports.[8] Pakistan's middle class is estimated at over 20 million and also is expected to show significant growth in the coming years.

If India and Pakistan were to reduce their trade barriers, they likely would increase their share of world textile and apparel imports and attract supplier countries that have concentrated on markets in the United States and other developed countries. Consumers in India and Pakistan likely would benefit from increased textile and apparel imports, as goods would be more widely available and more affordable. Some segments of the textile and apparel sectors in these countries, however, may have difficulty competing with large international firms with more sophisticated equipment and technology, greater economies of scale, and cheaper manmade fibers.

According to the Office of the United States Trade Representative, the United States has several options for dealing with countries that fail to provide

[4] The International Cotton Advisory Committee, which is an association of governments having an interest in cotton production, trade, and consumption, estimated that raw material costs for Pakistani spinners averaged 24 percent less than those for spinners in most other countries during the late 1980s. It also estimated that Pakistan's total cost advantage in the production of cotton yarn was about 12 percent. International Cotton Advisory Committee, "Background Information on the Production and Marketing Policies of Cotton Producing Countries," Washington, DC, May 26, 1993.

[5] During 1983-92, India and Pakistan were the largest purchasers of short-staple spindles, primarily for spinning cotton yarn, and major buyers of looms, mainly for weaving cotton fabrics. International Textile Manufacturers Federation (ITMF), *International Textile Machinery Shipment Statistics*, vol. 15 (Zurich: ITMF, Apr. 1993).

[6] "India Stands to Gain from GATT Accord," NewsEDGE/LAN, June 6, 1994.

[7] See, for example, USITC, *Potential Impact on the U.S. Economy...*, pt. IV; and *Report of the Industry Sector Advisory Committee on Textiles and Apparel for Trade Policy Matters (ISAC 15) on the Uruguay Round of Multilateral Trade Negotiations*, Jan. 14, 1994.

[8] India's population of 890 million is the second largest in the world after China and is expected to reach the 1-billion mark by the year 2000.

adequate access to their markets for U.S. textile and apparel products.[9] Such measures could include:

- o a decision by the Committee for the Implementation of Textile Agreements (CITA)[10] to direct the U.S. Customs Service to permanently deny entry to any shipments of products not yet integrated into the GATT if such shipments are in excess of the quotas for such products from any country;
- o use of appropriate dispute-settlement mechanisms under the Agreement to seek the denial of accelerated quota growth rates for countries that have failed to provide effective market access;
- o a review of the Generalized System of Preferences (GSP) status of any beneficiary country that has failed to provide effective market access for U.S. textile and apparel exports;[11]
- o consideration of initiating an investigation under section 301 of the Trade Act of 1974 of acts, policies, or practices that deny effective market access to U.S. exports of textile and apparel;[12] and
- o a decision by CITA not to integrate until the end of the 10-year transition period products that are a high priority for textile or apparel exports by countries that have failed to provide effective access to their markets for U.S. textile and apparel exports.

The U.S. Government has notified India and Pakistan that their GSP privileges would be reviewed in connection with their failure to commit to equitable and reasonable market access for U.S. textiles and apparel.[13] If the United States were to suspend the special duty-free benefits the two countries receive under the GSP, it could affect nearly $1 billion of trade.[14] Denial of GSP benefits, however, would have little effect on their textile and apparel shipments to the United States, because the great bulk of these imports are not eligible for GSP preferences.

The option of pursuing steps to deny accelerated quota growth rates cannot be exercised until after the third year of the Uruguay Round Agreement and must be approved by the GATT Dispute Settlement Body.[15] To illustrate the impact of adjusting the accelerated quota growth rates, if Pakistan has a 7-percent growth rate on cotton knit shirts, the quota level for that product would increase by at least 168 percent over the 10-year phaseout of the MFA.[16] However, if the accelerated quota growth were denied after the third year, total quota growth over the 10-year period may be reduced to 89 percent.

Despite the limited access provided to U.S. textiles and apparel, India and Pakistan are important markets for many other U.S. products. The United States is India's largest trading partner, supplying 11 percent of India's merchandise imports in 1993. Largely because of recent reforms undertaken by that country, total U.S. exports to India increased by

[9] Proposed "Statement of Administrative Action Language for the Agreement on Textiles and Clothing," July 1994.

[10] CITA is an interagency group made up of representatives of the Office of the United States Trade Representative, the U.S. Customs Service, and U.S. Departments of Commerce, Labor, State, and the Treasury. It maintains and oversees the U.S. textile and apparel trade agreements program.

[11] The GSP affords nonreciprocal tariff preferences to developing countries to aid their economic development and to diversify and expand their production and exports.

[12] Section 301 is the principal U.S. statute for addressing foreign unfair practices affecting U.S. exports of goods or services.

[13] Office of the United States Trade Representative, Textiles Office, facsimile of "Report on Market Access Conclusions from Marrakesh," June 3, 1994.

[14] India and Pakistan shipped $752 million and $102 million, respectively, of products into the United States under the GSP program in 1993.

[15] Agreement on Textiles and Clothing, art. 2, par. 14, Final Act Embodying the Results of the Uruguay Round of Multilateral Trade Negotiations.

[16] Under the MFA, quota levels and their annual growth rates are negotiated separately with each supplier country and, thus, may differ by country and by product. Under the Uruguay Round Agreement, annual quota growth must be increased by at least 16 percent at the beginning of stage 1. At the start of stage 2, this growth rate must be raised by at least another 25 percent, and, for stage 3, by at least an additional 27 percent.

46 percent in 1993, resulting in a narrowing of the U.S. trade deficit to $1.8 billion in 1993. The United States is also a principal supplier to Pakistan, accounting for roughly 10 percent of that country's total imports. In addition, both India and Pakistan have liberalized their trade regimes in recent years. India, for example, has reduced its overall tariff rates from a trade-weighted average of 87 percent in fiscal year 1991 to 47 percent in March 1993 and plans to lower its average tariff rate to 25 percent during the next 4 years. Nevertheless, the import tariff rates of India and of Pakistan remain among the highest in the world.

Although market access for U.S. textile and apparel exports is a primary concern to the domestic industry and has been identified as a concern by U.S. policy makers, these concerns exist in the overall context of improved trade with India and Pakistan. In the Uruguay Round Agreement, both India and Pakistan have agreed to further protect U.S. patents, copyrights, trademarks, and other intellectual property. In addition, India agreed during Uruguay Round negotiations to further open its markets to U.S. services, such as telecommunications and audio visuals. Even though India and Pakistan have not offered market access commitments meeting the U.S. goals for textiles and apparel, negotiations are continuing in an effort to secure comprehensive commitments in this sector. □

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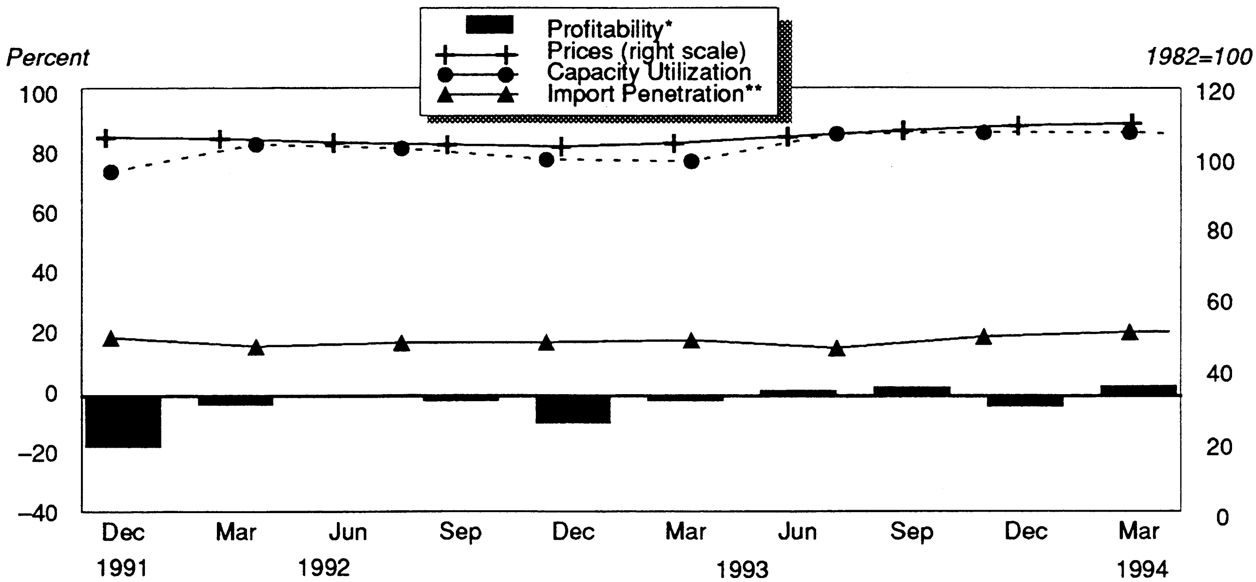
# APPENDIX A
# KEY PERFORMANCE INDICATORS OF SELECTED INDUSTRIES

- Steel
- Automobiles
- Aluminum
- Services

# STEEL

**Figure A-1**
**Steel mill products, all grades: Selected industry conditions**




* Operating income as a percent of sales for companies representing about 65 percent of production.

** Import share of apparent supply

Source: American Iron and Steel Institute, U.S. Bureau of Labor Statistics.

- Producers' shipments increased strongly between fourth quarter 1993 and first quarter 1994. Increased shipments reflected both continued strong demand and cyclical conditions. Prices continued to rise slowly, climbing an additional 0.9 percentage points, based primarily on increased demand.
- Strong market demand resulted in a substantial increase in imports. Increased demand was met primarily by domestic producers, resulting in only a small increase in import penetration. Imports in first quarter 1994 were 81.4 percent higher than those in first quarter 1993, reflecting the general economic recovery.
- Steelmakers returned to operating profitability in the first quarter of 1994.[1]

[1] Based on financial data reported to the American Iron and Steel Institute by producers accounting for approximately 65 percent of domestic shipments.

**Table A-1**
**Steel mill products, all grades**

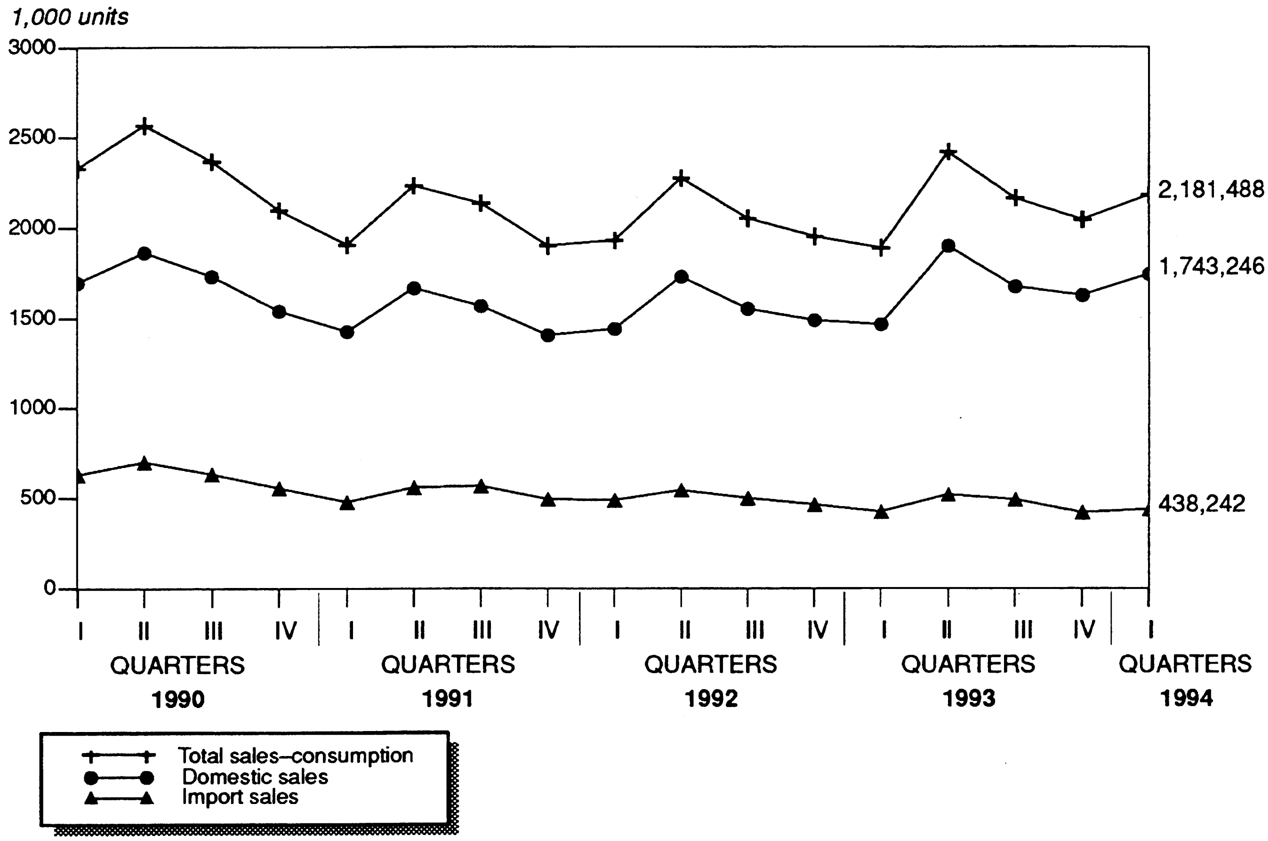
| *Item* | *March 1994* | *Percentage change, March 1994 from December 1993*[1] | *January-March 1994* | *Percentage change, Jan.-Mar. 1994 from Jan.-Mar. 1993*[1] |
|---|---|---|---|---|
| Producers' shipments *(1,000 short tons)* .... | 8,499 | 15.1 | 22,705 | 4.3 |
| Imports *(1,000 short tons)* ............... | 2,406 | 30.6 | 6,806 | 81.4 |
| Exports *(1,000 short tons)* ............... | 354 | 22.9 | 896 | -14.6 |
| Apparent supply *(1,000 short tons)* ...... | 10,551 | 18.1 | 28,615 | 16.9 |
| Ratio of imports to apparent supply *(percent)* ............................. | 22.8 | [2]2.2 | 23.8 | [2]8.3 |

[1] Based on unrounded numbers.
[2] Percentage point change.

Note.—Because of rounding, figures may not add to the totals shown.
Source: American Iron and Steel Institute.

# AUTOMOBILES

**Figure A-2**
**U.S. sales of new passenger automobiles**




Note:—Domestic sales include all automobiles assembled in Canada and imported into the United States under the United States–Canadian automotive agreement; these same units are not included in import sales.

Source: *Automotive News;* prepared by the Office of Industries.

**Table A-2**
**U.S. sales of new automobiles, domestic and imported, and share of U.S. market accounted for by sales of total imports and Japanese imports, by specified periods, Jan. 1993-Mar. 1994**

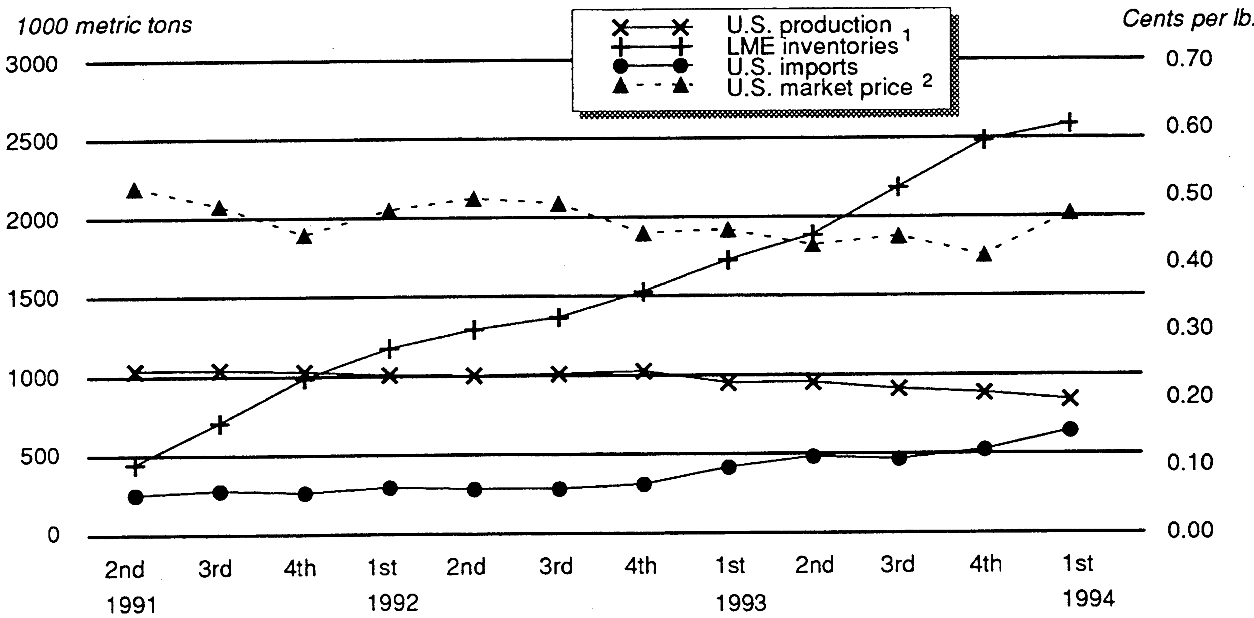
| *Item* | *Jan.-Mar. 1994* | *Percentage change— Jan.-Mar. 1994 from Oct.-Dec. 1993* | *Percentage change— Jan.-Mar. 1994 from Jan.-Mar. 1993* |
|---|---|---|---|
| U.S. sales of domestic autos *(1,000 units)*[1] | 1,739 | +7.0 | +18.6 |
| U.S. sales of imported autos *(1,000 units)*[2] | 442 | +5.5 | +4.2 |
| Total U.S. sales *(1,000 units)*[1,2] | 2,181 | +6.7 | +15.2 |
| Ratio of U.S. sales of imported autos to total U.S. sales *(percent)*[1,2] | 20.3 | -1.0 | -9.4 |
| U.S. sales of Japanese imports as a share of the total U.S. market *(percent)*[1,2] | 14.2 | -5.3 | -10.7 |

[1] Domestic automobile sales include U.S.-, Canadian-, and Mexican-built automobiles sold in the United States.
[2] Does not include automobiles imported from Canada and Mexico.

Source: Compiled from data obtained from *Automotive News.*

# ALUMINUM

**Figure A-3**
**Primary aluminum: Selected industry conditions**




[1] End of quarter inventories.

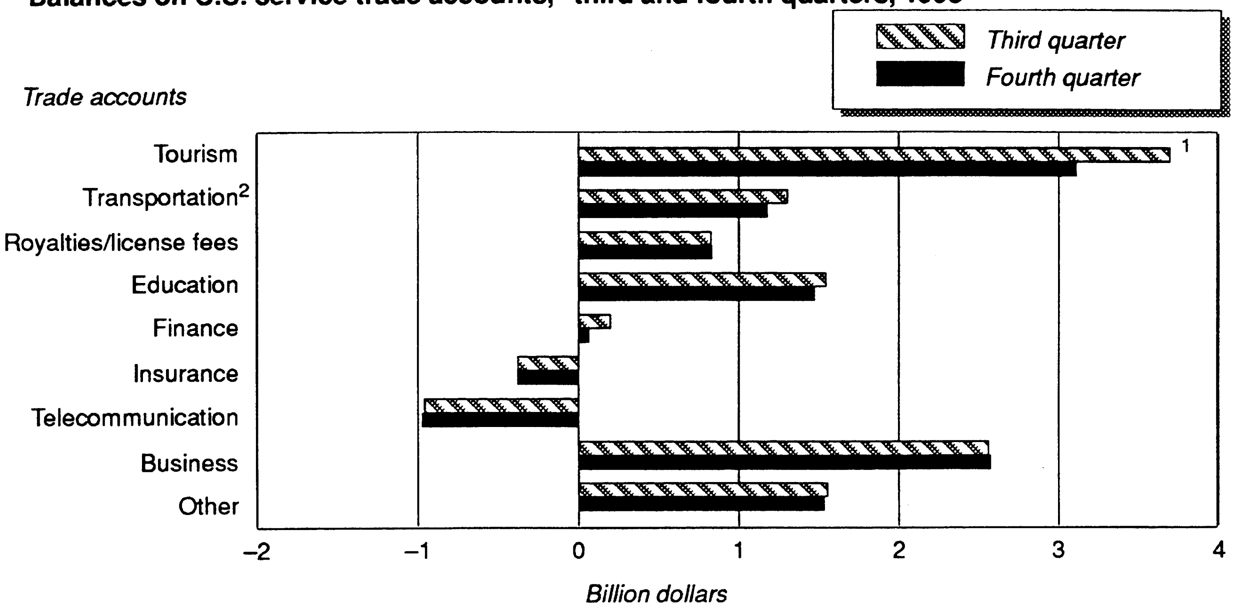
[2] In constant 1987 dollars.

Source: Bureau of Mines, World Bureau of Metal Statistics, Metals Week, and U.S. Department of Commerce.

- Despite higher LME inventories at the end of first quarter 1994, aluminum ingot prices have generally risen in part because of declining production and announced capacity cutbacks by major producers that have enhanced prospects for an improved global supply/demand balance. The average U.S. market price (in constant 1987 dollars) for primary aluminum during January–March 1994 was 47.2 cents per pound (the current market price is 59.4 cents per pound).
- Announced capacity cutbacks since November 1993 total more than 1.2 million tons, and annualized global aluminum production fell by 4 percent to 14.2 million tons in April 1994.
- The working party meeting in Canberra, Australia (July 19-21, 1994), attended by all signatories to the Memorandum of Understanding concerning the Aluminum Market (see *ITTR* May 1994), reviewed market conditions and cooperative measures undertaken by the participants. Technical assistance to Russia was delineated and members released initial statistical summaries and noted that refinements of production data would continue before the working party's next meeting scheduled in Norway before year-end.

# SERVICES

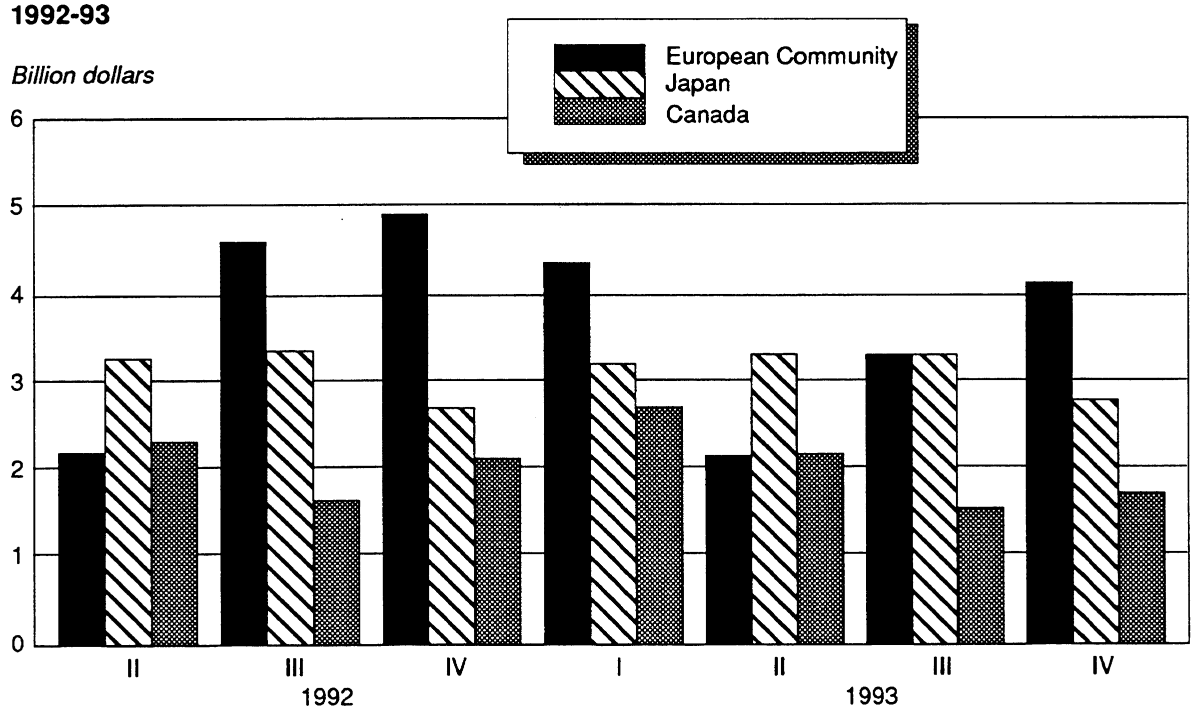
**Figure A-4**
**Balances on U.S. service trade accounts,[1] third and fourth quarters, 1993**




[1] Figures reflect trade among unaffiliated firms only.
[2] Includes passenger fares and port fees.

Source: Bureau of Economic Analysis, *Survey of Current Business.*

**Figure A-5**
**Surpluses on cross-border U.S. service transactions with select trading partners,[1] by quarters, 1992-93**




[1] Figures reflect private-sector transactions only; military shipments and other public-sector transactions have been excluded.

Source: Bureau of Economic Analysis, *Survey of Current Business.*