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Logistic Services: Industry Overview and Issues for Negotiation

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Logistic services involve planning and managing the transport of goods throughout the delivery process. Demand for logistic services is largely driven by (1) manufacturers' needs to manage more efficiently the flow of goods across increasingly complex supply chains and (2) "just-in-time" (JIT) production techniques, which enable manufacturers to eliminate waste and to reduce inventory costs. Advances in information technologies (IT) and increased trade liberalization can also facilitate logistic services by more efficient document transmission and by lowering "barrier costs," such as tariffs. Lingering impediments to better logistic services still occur, however, especially in the transportation sector, where regulations may hinder market access and require use of domestic suppliers for some delivery routes. This leads to higher transportation costs and less service reliability, ultimately reducing consumer welfare. Trade agreements may reduce or eliminate such impediments. This article surveys logistic services, including major industry players and factors driving demand; examines impediments to the international provision of logistic services; and discusses the potential of reducing impediments through trade agreements.

Logistic services involve a complex web of activities designed to ensure the efficient movement of raw materials, intermediate inputs, and finished goods between suppliers, manufacturers, and consumers.[1] Logistic services professionals manage these factors and product flows by combining transportation services with storage and warehousing, assuring timely deliveries while sparing client firms the expense of storing and maintaining large inventories.[2] Although such services may be provided "in-house," often by internal shipping departments, companies are increasingly outsourcing logistic activities.[3] Reportedly, logistic specialists offer customers greater expertise in managing supply chains,[4] which are increasing in complexity due to the greater geographic scopes of factor and product markets.[5] Firms may choose to outsource discrete logistic functions, such as order fulfillment, freight forwarding, or warehouse management; or they may outsource the entire logistics management process. Firms that provide the full range of logistic services integrate their own resources and capabilities with those of other logistic service providers to create a comprehensive service.[6]

Industry Overview

Armstrong & Associates, Inc., a consulting and market research firm, estimates that the U.S. third-party logistics market is currently worth $77 billion.[7] In terms of total revenues, the top-five U.S.-based logistic services firms reportedly are UPS Supply Chain Solutions, C.H. Robinson Worldwide, Menlo Worldwide, Expeditors International of Washington Inc., and Penske Logistics (see tabulation):

* The views expressed in this article are those of the author. They are not the views of the U.S. International Trade Commission (USITC) as a whole or of any individual Commissioner. The author is an international trade analyst in the Services and Investment Division, Office of Industries.

Logistic services/firms	Million dollars
DHL Danzas Air & Ocean (Germany)	5,700
UPS Supply Chain Solutions (U.S.)	4,153
C.H. Robinson WorldWide (U.S.)	3,614
Exel plc–Americas (U.K.)	2,917
Menlo Worldwide (U.S.)	2,892
Expeditors International of Washington, Inc. (U.S.)	2,625
Penske Logistics (U.S.)	2,499
Ingram Micro Logistics (U.S.)	2,250
EGL, Inc. (Eagle) (U.S.)	2,171
Ryder Supply Chain Solutions (U.S.)	1,877
Total	30,698

Source: Armstrong & Associates.

Together these 5 firms generated 2002 revenue of about $19.3 billion, representing approximately 25 percent of U.S. third-party logistic service revenues in that year.

The third-party logistic services market includes nonasset- and asset-based firms that provide domestic and international transportation management services, value-added warehousing, distribution services, and IT services. Nonasset-based firms arrange for the transportation and storage of freight, in effect acting as intermediaries between their clients and asset-based transportation companies. For example, Minneapolis-based C.H. Robinson arranges freight transportation for their clients, contracting with approximately 30,000 asset-based carriers.[8] Similarly, Caterpillar Logistics arranges freight transportation for its parent company, Caterpillar Inc., and for approximately 50 other client companies.[9] Some nonasset-based distributors are also starting to offer logistic services, by contracting with trucking and other asset-based transportation companies to ensure that products get to market on time.[10]

As global supply chains become more complex, customers are increasingly relying on single providers to manage their entire logistics and transportation processes. Such suppliers are better able to integrate raw material supply with finished product delivery, providing a complete door-to-door logistics service. This level of integration improves service reliability thereby appealing to many manufacturers, especially those that use the JIT production process. Asset-based transportation firms that provide truck-load (TL), less-than-truckload (LTL), air freight, or sea freight as a core service often provide logistics as a key value-added service.[11] For example, the Penske Corp. truck leasing division relies on a fleet of over 200,000 vehicles to offer logistic services, such as transportation management and warehousing services.[12] In the last several years, asset-based suppliers of integrated express delivery services also have expanded their service offerings to include logistic services.[13] After a series of logistic-related acquisitions, in February 2002, United Parcel Service (UPS) announced the creation of its Supply Chain Solutions division, which combined the resources of various related subsidiaries.[14] Similarly, in 2001 FedEx Corp. (FedEx) announced the realignment of its logistic services unit to provide transportation management and logistic services through the company's FedEx Services division. Both UPS and FedEx consider logistics a key component to their respective growth strategies.[15]

Demand Drivers and Outsourcing Trends

Globalization, JIT manufacturing, and electronic commerce (e-commerce) are driving demand for third-party contract logistic services. Globalization has extended product distribution channels and increased the geographic scope of sourcing networks for component parts. At the same time, manufacturers are making efforts to centralize production processes.[16] Although this enables companies to maximize production scale economies, it increases transportation costs and lengthens the time it takes for products to get to markets.[17] Global manufacturers are therefore increasingly looking for ways to reduce transportation-related costs and improve supply chain efficiencies.

One such cost-saving mechanism is JIT manufacturing, which enables firms to "produce to order," thereby reducing the need to maintain costly inventories. An example can be found in the automotive industry, where TNT Logistics, a subsidiary of Netherlands-based TPG, manages the inbound supply of parts for a BMW manufacturing facility located in the United States. As such, TNT monitors both the movement of physical goods into the facility as well as the flow of shipping information to plant managers.[18] By outsourcing logistic services to third parties, manufacturers can realize significant cost savings. For example, when Lucent Technologies overhauled its supply chain in 2001 by outsourcing key logistics functions, the company reduced its total number of warehouses from over 300 to 54, scaled back its inventory from $8 billion to $806 million, and streamlined its purchasing processes.[19]

Logistic services also play an important role in electronic commerce, where some firms function as the distribution arm of online companies,[20] thereby allowing these companies to reduce delivery costs.[21] For example, UPS manages a large warehouse for Nike in Europe, and both UPS and FedEx have become default shippers[22] for thousands of e-commerce sites. In addition to such business-to-consumer electronic commerce, many logistic service providers manage electronic transactions between businesses. As noted, TNT Logistics handles distribution of spare automotive parts to dealers. Their process is linked together by a proprietary software program called Matrix, which put the order and fulfillment processes online, thereby increasing visibility in the supply process.[23] The company also manages the distribution of tires to retailers for Michelin, resulting in increased efficiency for Michelin's retail distribution processes.[24] Such transactions are facilitated by the Internet, which enables near real-time management of factor and product flows, thereby reducing the time necessary for products to get to market.[25] The market for business-to-business e-commerce is expected to reach $2.4 trillion by the end of 2004,[26] up from $830 billion in 2002.[27]

Logistic Services Impediments and Liberalization Initiatives

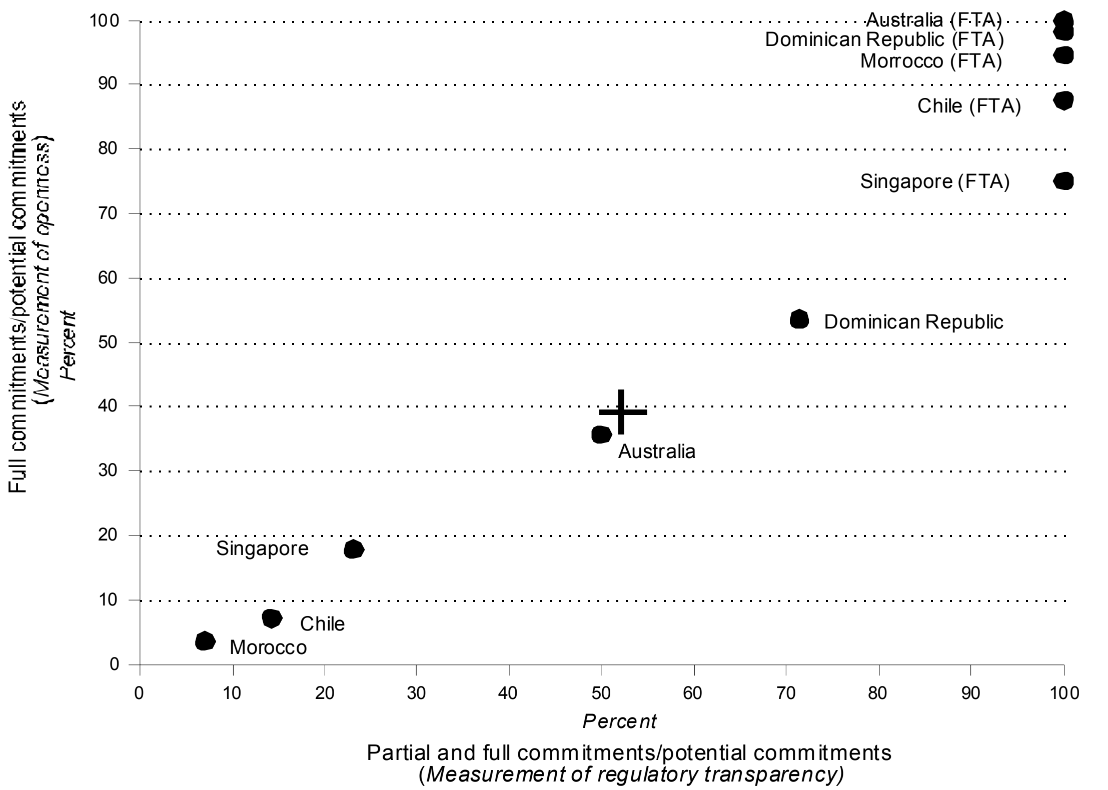
Logistics is a management service that is affected by a broad range of impediments. Although market access for the core management service may sometimes be hindered through such measures as establishment limitations or nationality requirements, restricted access to transportation networks is the most commonly reported trade impediment. For example, in Mexico, transportation regulations prevent foreign operators from using trucks that weigh over 4 tons. As a result, foreign delivery firms, including providers of logistic services, must bear the greater expense of using smaller vans or trucks to transport inter-city deliveries, or contract out operations to domestic firms.[28] In China, trucking licenses are divided into five different categories, effectively limiting the flexibility of logistic services firms that seek to operate in that market.[29] In Indonesia, foreign investment in local trucking or ground transportation joint ventures, which is the only form of establishment, is limited to a 49-percent ownership share.[30]

Customs procedures may also impede the efficient provision of logistic services. Customs impediments include restrictions on the weight and value of shipments; documentation requirements, which may stem in part from the lack of electronic data interchange (EDI) systems;[31] and inspection requirements. All of these impediments reduce efficiency and raise costs for foreign logistic service firms that depend on open access to transportation infrastructure to ensure timely delivery for their customers.

To date, logistics-related trade impediments have not been significantly addressed in trade agreements. In the World Trade Organization (WTO), sectors related to logistic services, such as courier, cargo handling, road freight transport, storage and warehousing, and freight agency services, garner relatively few full-General Agreement on Trade in Services (GATS) commitments from members.[32] This appears to be largely due to the high degree of domestic regulation imposed on the transportation industry in many countries because of economic, social, and safety concerns. Article XIV of the GATS states that signatories remain free to adopt or enforce measures intended to promote health, safety, and overall welfare. Other transportation sectors necessary for the provision of logistic services remain largely outside of GATS disciplines. For example, international aviation is governed by a web of bilateral aviation agreements; current GATS aviation disciplines apply only to aircraft repair and maintenance, selling and marketing services, and computer reservation services. Similarly, international maritime transport is governed by shipping conferences, which meet regularly to set rates and monitor developments that affect the industry.[33] During the Uruguay Round, GATS negotiations on maritime services proved problematic, according to many observers, largely as a result of domestic cabotage restrictions and national preference schemes, and post-Uruguay Round maritime negotiations were suspended without agreement.[34] In the area of customs administration, WTO negotiations on trade facilitation have recently stalled in the face of strong opposition from developing countries, which often lack the resources to invest in modern customs processing technology.[35]

Although air and maritime transportation remain subject to significant restrictions, recent U.S. free trade agreements (FTAs) guarantee market access and national treatment for a broad range of other logistic services. This may be due, in part, to the structure of the agreements, wherein all sectors are considered open unless the subject of a specific reservation. This contrasts with the "positive list" structure of the GATS, in which countries must schedule commitments to specific sectors in order to guarantee market access and national treatment.[36] Figure 1 illustrates the GATS commitments related to logistic services for countries with which the United States has recently completed FTA negotiations.[37] In the figure, the ratio of full commitments to potential commitments spanning the range of logistic services is expressed along the vertical axis, showing the current degree of openness in these sectors. The ratio of full and partial commitments to potential commitments across the range of logistic services is expressed along the horizontal axis, reflecting the extent to which selected countries have established benchmarks and enhanced regulatory transparency. The "+" symbol in figure 1 represents the average score for the countries, reflecting that, on average, these countries scheduled full GATS commitments in about 40 percent of all instances, and scheduled full or partial commitments about 52 percent of the time. In terms of GATS commitments, the Dominican Republic exceeded the average in terms of binding unfettered market access and national treatment, establishing benchmarks, and enhancing regulatory transparency. Countries below and to the left of the "+" symbol trail the average. In terms of FTA commitments, all partner countries exceed the average as a result of the few reservations listed by each country and the greater transparency of the agreements.

Figure 1
Logistics-related GATS and FTA commitments[1] for selected U.S. FTA partner countries[2]



[1] FTA commitments include measures where countries reserve the right to adopt or maintain restrictions.
[2] Service industries included are: road freight transportation, cargo handling, storage and warehousing, freight transport agency services, courier, management consulting, and production management consulting. Bahrain, Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua scheduled no GATS commitments in these service industries, and are therefore not included in this figure.

Note.—The "+" symbol indicates an average of 40 percent for full commitments and 52 percent for partial and full commitments.

Source: Compiled by the Commission.

Outlook–The Current GATS Negotiating Round

In the WTO, service negotiations under the GATS recommenced in January 2000. The current negotiating round, known as the Doha Round, is anticipated by WTO members to elicit more meaningful commitments, both in terms of the number and quality of commitments.[38] To achieve such commitments, there are advantages of addressing the entire range of sectors encompassed by logistic services. This range is referred to as a "checklist."[39] Use of the checklist approach facilitates the scheduling of meaningful commitments without requiring significant changes to the Services Sectoral Classification List,[40] assists WTO members in developing a common agreement about the full range of applicable services, and serves as an effective mechanism by which to assess the value of market access and national treatment offers.[41]

In 2001, Hong Kong proposed using such an approach to negotiate logistic and related services in the WTO.[42] Hong Kong defines logistic services as "the procedure to optimize all activities to ensure the delivery of products through a transport chain from one end to the other."[43] Further, Hong Kong demonstrates that, although the WTO Services Sectoral Classification List (W/120)[44] does not identify logistic services as a distinct service, many sectors integral to logistic services are captured under the subheadings "transport services" and "business services."[45] Hong Kong encourages WTO members to consider the development of a "checklist" for logistic services that would consolidate the logistic-related W/120 categories and indicate the scope of logistic services.[46] Countries that prefer not to liberalize certain sectors within the logistics checklist could choose the categories where they are willing to make commitments. This may appeal to countries that maintain strict regulations over certain transportation services, such as aviation or maritime industries.

Despite the lack of consensus at the Cancun Ministerial meeting in September 2003, the chairman of the WTO services negotiating group began in April 2004 a series of informal meetings with members designed to increase the number of negotiating offers and discuss future work. Leaders of the Group of Eight (G-8) industrialized nations recently voiced their determination to rejuvenate the WTO talks.[47] At the same time, informal discussions on logistic services have been opened to participation by all WTO members after several years of closed-door discussions.[48] The informal discussion group, led by Hong Kong and Australia, seeks to develop a better understanding of logistic services and to generate support for negotiations on the subject.[49] ■

ENDNOTES

1. The Council of Logistics Management (CLM), an industry association, defines logistics management as "that part of Supply Chain Management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements." CLM, "Definitions," found at *http://www.clm1.org/Website/AboutCLM/Definitions/Definitions.asp*, retrieved Mar. 23, 2004.
2. British Department of Trade and Industry, "Logistics and Supply Chain Management," found at *http://www.dti.gov.uk/mbp/bpgt/m9gb00001/m9gb000011.html*, retrieved Apr. 8, 2004.
3. In a recent survey, 83 percent of respondents reported outsourcing at least some logistic activities to specialized firms. Robert Lieb and Brooks A. Bentz, "The Use of Third Party Logistics Services by Large American Manufacturers, the 2003 Survey," Northeastern University and Accenture Consulting, Oct. 1, 2003, p. 3.
4. The term "supply chain" refers to the network of interrelated activities involved in producing, moving, and storing goods. "Supply chain management" involves the management of all activities across the supply network. The goal of managing supply chains is to integrate various discrete business operations in order to coordinate all activities within an organization, including manufacturing, logistics, sales, marketing, product design, finance, and information technology. CLM, *definitions*.
5. The Organization for Economic Cooperation and Development (OECD), *Transport Logistics, Shared Solutions to Common Challenges* (Paris: OECD: 2002), p. 15.
6. These firms are sometimes called "fourth-party" logistics providers. This term was coined by Andersen Consulting in response to the evolution of logistic services beyond transportation and storage. These firms typically manage the entire supply chain. Where they lack particular expertise, they contract other firms for discrete logistic activities. Outsourcing Center, "What is the difference between a 3rd party logistics provider and a 4th party logistics provider?," found at *http://logistics.about.com/gi/dynamic/offsite.htm?site=http%3A%2F%2Fwww.outsourcing-faq.com%2F20.html*; and OECD, *Transport Logistics*, p. 16.
7. Armstrong & Associates, Inc., "3PL/Contract Logistics Market," found at *http://www.3plogistics.com/*, retrieved Apr. 8, 2004.
8. Hoovers Online, "C.H. Robinson Worldwide, Inc.," fact sheet, found at *http://www.hoovers.com/c.h.-robinson-worldwide/--ID__54320--/free-co-factsheet.xhtml*, retrieved Apr. 8, 2004.
9. Hoovers Online, "Caterpillar Logistics," fact sheet, found at *http://www.hoovers.com/caterpillar-logistics-services/--ID__128854--/free-co-factsheet.xhtml*, retrieved Apr. 8, 2004.
10. Rob Spiegel, "Third-party Logistics: Competitor or Partner? Are Distributors Moving Toward the Logistics Business?," 2001 Cahners Business Information, Nov. 19, 2001, found at *http://www.looksmart.com,* retrieved June 8, 2004.
11. TL services involve the carriage of goods from one customer on a single truck. Less-than-truckload services involve consolidating shipments from various customers on a single truck or van.
12. Hoovers Online, "Penske Truck Leasing," fact sheet, found at *http://www.hoovers.com,* retrieved Apr. 8, 2004.
13. These firms integrate ground and air networks to provide a broad range of door-to-door delivery services on a global basis, and include firms such as FedEx Corp. (FedEx), United Parcel Service (UPS), and Deutsche Post's DHL WorldNet (DPWN).
14. UPS, "New UPS Supply Chain Solutions Links Logistics, Freight and Financial Services," press release, Feb. 20, 2002.
15. Recently, both FedEx and UPS indicated that logistics-related services are important parts of their respective growth strategies. FedEx and UPS, 2002 annual reports.
16. OECD, *Transport Logistics*, p. 11.
17. Ibid.
18. Kristin S. Krause, "Whatever It Takes," *Traffic World*, June 17, 2002, p. 29.
19. Erik Sherman, "Heavy Lifting: Overhauling Your Supply Chain can be a Herculean Task. Here's How Some Companies Have Met the Challenge - Supply Chain," 2004 Chief Executive Publishing, found at *http://www.looksmart.com,* retrieved June 8, 2004.
20. AOL Time Warner, Statement to the USITC, hearing transcript for USITC investigation No. 332-456, Nov. 5, 2003, pp. 51-52.
21. *Standard & Poor's Industry Surveys*, "Transportation: Commercial," 2003, p. 10.
22. The term "default shipper" refers to the organization that is preselected to deliver a product when an electronic commerce customer purchases a product on-line.

23. TNT Logistics, "Spare Parts Delivery for a North American Car Manufacturer," case study, found at *http://www.tntlogistics.com/sectors/case_studies/honda_shared_channel_solution.asp*, retrieved Apr. 12, 2004.
24. TNT Logistics, "Michelin - Improved Efficiency in Distribution to Retail Outlet," case study, found at *http://www.tntlogistics.com/sectors/case_studies/na_michelin_distribution.asp*, retrieved Apr. 12, 2004.
25. OECD, *Transport Logistics*, p. 22.
26. *Standard & Poor's Industry Surveys*, "Transportation: Commercial," p. 10.
27. Ibid.
28. Industry representative, interview with USITC staff in connection with investigation No. 332-456, Washington, DC, July 31, 2003; and UPS, statement to the USITC, hearing transcript, Nov. 5, 2003, p. 22.
29. DHL Worldwide Express, written submission in connection with USITC investigation 332-456, Oct. 24, 2003.
30. Statement by FedEx Corp. regarding significant barriers to U.S. exports of services for inclusion in the Office of the U.S. Trade Representative (USTR) *National Trade Estimate* report, Dec. 13, 2002.
31. EDI enables firms to improve efficiency and reduce costs through a reduction of steps necessary to exchange information.
32. See USITC, *Express Delivery Services: Competitive Conditions Facing U.S.-based Firms in Foreign Markets*, investigation No. 332-456, USITC Publication 3678, Apr. 2004, p. 4-22; WTO, "Land Transport Services, Part I—Generalities and Road Transport," *Background Note by the Secretariate*, S/C/W/60, Oct. 28, 1998; and WTO, CTS, "Postal and Courier Services," *Background Note by the Secretariate*, S/C/W/39, June 6, 1998, p. 6.
33. Joseph Francois and Ian Wooton, "Trade in International Transport Services," *Tinbergen Institute Discussion Paper*, No. TI 2000-057/2, June 2000.
34. Ibid; Martime-WTO, Council for Trade in Services, Maritime Transport Services: *Background Note by the Secretariat*, S/C/W/62, Nov. 16, 1998, p. 10; Jong-Soon Kang and Christopher Findlay, "Regulatory Reform in the Maritime Industry," in *Impediments to Trade in Services: Measurement and Policy Implications* (London: Routledge, 2000), p. 152; and Renato Ruggiero, Address to Danish Shipowners' Association, Copenhagen, Mar. 25, 1998, found at *http://www.wto.org*, retrieved Aug. 11, 2004.
35. Global Trade Negotiations Homepage, Center for International Development at Harvard University, *Trade Facilitation Summary,* found at *http://www.cid.harvard.edu/cidtrade/issues/tradefac.html*, retrieved, Aug. 6, 2004.
36. Under the GATS, market access and national treatment commitments are specified in national schedules, which indicate the degree of permissible activity for specific industries. In national schedules, "none" indicates that there are no limitations on market access and national treatment; "unbound" indicates the absence of a commitment.
37. With the exception of Costa Rica, El Salvadore, Guatemala, Honduras, Nicaragua, and Bahrain, which did not schedule GATS commitments, these countries include Singapore, Chile, Australia, Morocco, and the Dominican Republic. To date, the United States has implemented FTAs with Israel, Canada, Mexico, Jordan, Singapore, and Chile.
38. See WTO, "An Introduction to the GATS," *WTO Secretariat*, Oct. 1999. The Uruguay Round of trade negotiations, which concluded in 1994 with the establishment of the WTO and the GATS, was generally seen as the first step toward services liberalization. Successive negotiating rounds, as prescribed by GATS Article XIX, are intended to further open services markets worldwide. Article XIX states that "Members shall enter into successive rounds of negotiations, beginning not later than five years from the date of entry into force of the WTO Agreement, and periodically thereafter, with a view to achieving a progressively higher level of liberalization."
39. WTO, CTS, *Communication from Australia; Hong Kong, China; Liechtenstein; Mauritius; New Zealand; Nicaragua; Switzerland; and the Separate Customs Territory of Taiwan, Penghu, Kinmen and Matsu: Logistics Services*, TN/S/W/20, June 25, 2004, p. 1.
40. For a full discussion of the benefits of this approach, see OECD, "Assessing Barriers to Trade in Services, Using 'Cluster' Approaches to Specific Commitments for Interdependent Services," *Working Party of the Trade Committee*, Document No. TD/TC/WP(2000)9/FINAL, Nov. 7, 2000.
41. Ibid.
42. Communication from Hong Kong, "Logistics and Related Services," *WTO, Council for Trade in Services*, No. S/CSS/W/68, Mar. 28 2001.
43. Ibid.
44. The list identifies specific services over which GATS negotiations are held.
45. Communication from Hong Kong, "Logistics and Related Services."
46. Ibid.

47. Tim Kelly and Warren Giles, "G8 Seeks to Light Fire Under World Trade Talks," *The Montreal Gazette*, June 6, 2004.
48. USTR representative, telephone interview with USITC staff, Washington, DC, June 15, 2004.
49. Ibid.

Powder Metallurgy and Advanced Aluminum Sheet Processing: Applications of Advanced Technology in the Automotive Industry

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Market competition and government regulation have compelled U.S. automobile producers to improve fuel efficiency, safety, and affordability of their products. Advanced material technology bears strongly on (1) how well the automobile producers can substitute new materials for traditional materials and adopt advances in conventional fabrication methods. Material substitution is extremely important because automakers must lower automobile weight in order to lower the cost of the final product and to meet fuel economy guidelines. Advanced materials technology also bears strongly on (2) how widely the automotive industry can use the materials and in what volumes since, development and cost-effective application of advanced materials technology is often difficult in this cost-sensitive industry. Barriers to development include research and development costs and the establishment of a supply infrastructure. This article discusses powder metallurgy and advanced aluminum sheet processing: two materials technologies that are at different stages of commercialization. To assess their further potential in automotive applications,[1] this article examines the (1) potential technical and economic advantages and disadvantages of each technology; (2) supply infrastructure; (3) current uses in the North American, European, and Japanese automotive industries; and (4) joint industry/government efforts to advance these materials technologies.

Powder Metallurgy Automotive Components

Substitution of powder metallurgy (P/M) components for steel began in North America during the 1980s. At that time, process advances in P/M technology permitted the manufacture of certain complex automotive components that could meet the strength requirements found in steel, but meet them at a fraction of the cost, because of the superior near-net-shape properties of the P/M production process and the elimination of certain machining stages.

The largest consumer of P/M components both worldwide and in North America is the automotive industry, which accounts for 60 percent of total North American consumption and 70 percent of North American ferrous consumption.[2] Major P/M automotive applications include engines (e.g., connecting rods, main bearing caps, and camshafts) and transmissions. The amount of P/M components in automobiles has more than doubled during the past 20 years, from an average of 17.0 pounds in 1980

* The views expressed in this article are those of the author. They are not the views of the U.S. International Trade Commission (USITC) as a whole or of any individual Commissioner. The author is an international Trade Analyst in the Minerals, Metals, Machinery, and Miscellaneous Manufactures Division, Office of Industries.

to 40.5 pounds in 2003,[3] an increase of 4 percent from 2002,[4] and is expected to rise to 50.0 pounds during the next 10 years.[5] P/M components fall into two principal groups:

- Components of certain metals that are difficult to produce by methods other than P/M processes due to their high melting point, for example, tungsten, molybdenum, or tungsten carbide. Porous bearings, filters, and many types of hard and soft magnetic components of these metals are produced exclusively by P/M processes.

- Components for which P/M processes are cost-effective alternatives to machined components, castings, and forgings due to the superior near-net-shape capabilities of the P/M process and the elimination of costly machining steps. Examples include connecting rods, planetary gear carriers, clutch plates, and camshafts.

There are three principal P/M processes for producing automotive components. The particular process selected will depend largely on the desired properties and geometries, with an individual process being more suited to certain components. A discussion of the principal processes is included in box 1.

Advantages and Disadvantages[6]

The principal advantages of P/M processing and components are as follows:

- P/M processes create components with very good surface finishes.

- P/M is suitable for a large number of alloy combinations, permitting variations in properties such as high temperature, performance, toughness, and hardness.

- The near-net shape of P/M parts having close dimensional tolerances reduces, or in some cases, eliminates the need for cutting, machining, and other costly secondary operations. Near-net-shape parts also reflect less scrap loss as the P/M process normally yields a metal part that retains 95 percent of the raw powder material.

- P/M also allows small, intricate, metal parts to be produced faster than with traditional methods.

In contrast, the principal disadvantages of P/M processing and components include the following:

- High material costs are such that on a unit weight-basis, P/M parts are considerably more expensive than wrought or cast parts.

- Due to their higher porosity, P/M parts tend to have lower resistance to corrosion than do those produced by traditional forging methods.

- P/M components have lower plasticity properties in terms of impact strength, ductility, and elongation than do traditional forged steel components.

Box 1
Principal processes used to produce powder metallurgy components

Press and Sinter

This process consists of mixing metal powders with a lubricant, *pressing* them together in a die under high pressure, and *sintering* (heating) the component that emerges from the die at a temperature below the melting point of the primary components. Press and sinter is common for creating conventional P/M components such as automotive transmission components (planetary gear carriers) and engine components (oil pump gears, and crankshaft and camshaft sprockets), as well as specialty components such as superalloy parts, friction materials, high-strength permanent magnets, tungsten carbide cutting tools and wear components, and tool steels.

Powder Forging

Powder forging is used to produce components essentially free of internal porosity, making the process ideal for manufacturing structural components. The process begins with the creation of a powder blank or pre-form that is pressed to a near-net shape, close to the dimensions of the finished component. After sintering, the pre-form is pressed and hot forged in a closed die to achieve the finished size and shape. Connecting rods for engines and other high-strength parts are manufactured with this process.

Powder Injection Molding (PIM)

PIM is designed to produce relatively small, high-strength, precision components with complex shapes. PIM enables parts to be fabricated with more complex geometries, in higher volumes, and at lower costs than possible with other P/M techniques. In this process, fine powder is injected into molds along with a thermoplastic binder which is later removed by heating in an oven prior to sintering. New applications for PIM components are being developed in the automotive, chemical, aerospace, business equipment, biomedical, and armaments industries.

Source: U.S. Department of Energy, Office of Industrial Technologies, *PM^2 Industry, Vision and Technology Roadmap: Powder Metallurgy and Particulate Materials*, Sept. 2001; and *Powder Metals* (Princeton, NJ: Metal Powder Industries Federation, 2001), p. 4.

Supply Infrastructure

The P/M industry is essentially comprised of powder producers and component and product producers. In 2002, North American ferrous metal powder shipments increased by 12 percent to 434,000 short tons,[7] representing nearly $2 billion in sales.[8] Worldwide ferrous metal powder production exceeded 1 million short tons in that year. The largest producer of ferrous metal powders worldwide is Höganäs AB (Sweden).[9] Höganäs AB is the largest supplier of ferrous metal powders to the European and Asian markets, where its main competitors include Québec Metal Powders Ltd. (QMP) (Canada) and Kobe Steel Co. Ltd. (Japan). In North America, Höganäs supplies metal powder through its production facility, North American Höganäs, in Hollsopple, PA.[10] However, the largest manufacturer of ferrous metal powder in North America is reported to be Hoeganaes Corp. in Cinnaminson, NJ.[11] Other firms with a significant presence in North America include QMP; Kobelco Metal Powder of America, in Seymour, IN, a subsidiary of Kobe Steel (Japan); and Domfer Metal Powders Ltd. (Canada).

North American P/M component shipments[12] increased by 13 percent in 2002, to 408,000 short tons, and were valued at nearly $5 billion.[13] Because of the specialized nature of the P/M process, component production in the United States is largely performed by custom fabricators who serve as job shops for original equipment manufacturers (OEMs). GKN Sinter Metals, Inc.,[14] with 38 production facilities throughout the United States, is the leading producer, followed by Metaldyne Inc.[15] (Plymouth, MI), Federal-Mogul Corp. (Southfield, MI), Stackpole Ltd. (Ontario, Canada), and BorgWarner Inc. (Chicago, IL). Virtually all of the metal powder consumed by GKN Sinter Metals is supplied by its sister company, Hoeganaes Corp. In contrast, Toyota Motor Corp. and DaimlerChrysler meet their P/M components needs through in-house production facilities.[16]

Present Automotive Applications in North America

Engine applications

Connecting rods[17] account for the single-largest P/M end use, representing 50,000 short tons, or nearly 12 percent, of steel powder consumed annually.[18] P/M connecting rods were first introduced into U.S. automobile manufacture in 1986 and have steadily gained market share, due largely to economic factors; their price has dropped below that of conventional precision-forged steel rods once the cost of including the in-line machining operation to finish conventional connecting rods is factored into the overall cost of production. At the same time, advances in P/M-forging technology have increased the strength attributes of the connecting rods sufficiently to make them competitive with conventional connecting rods.[19]

P/M processes have increasingly gained acceptance since the 1990s in the production of main bearing caps and camshaft lobes. Casting of main bearing caps tends to be an expensive process due the amount of machining required to obtain close tolerances and the consequent loss of scrap metal. Because P/M processes tend to produce a near-net-shape part that fits the bearing cap to the connecting rod, there is less material waste and less capital investment in expensive machining operations. Near-net forming of camshaft lobes also results in reduced machining and lower production costs relative to a traditional camshaft. According to industry representatives, the application of P/M to both main bearing caps and camshafts will likely follow the same course as P/M in connecting rods, resulting in the majority of these items being produced from powder metals within the next 10 to 20 years.[20]

Transmission applications

The fastest-growing P/M application in automobiles is for transmission components. Automatic transmissions contain P/M planetary gear carriers and pinion gears; manual transmissions contain P/M clutch pressure plates, shift levers, and detent plates; and transfer cases contain P/M sprockets, planetary gear carriers, and pinion gears. P/M components in transmissions compete principally with welded stampings, steel castings, and grey iron castings. Advances in compacting and sintering technology have lowered the cost of P/M components below that cost of conventionally stamped and cast components. Because P/M enables fabricators to produce more complex components than conventional forming methods, P/M processes permit the reduction of subsequent machining steps, leading to lower costs. A typical planetary gear carrier, for example, contains a number of finely detailed lubrication channels, pinion pockets, cored pin holes, and face grooves that have become too expensive to machine after conventional stamping or casting. In contrast, the degree of complexity of P/M components is essentially limited only by the design skills of the die maker.

Automotive Applications in Europe and Japan

Although the content of P/M components in European and Japanese automobiles has more than doubled during the past 20 years,[21] their use still lags far behind that in U.S. automobiles. Although European and Japanese automakers also use P/M components in engines, in the form of connecting rods and bearing caps, the fewer cylinders in the typical engine of these two regions accounts for a smaller volume of material in each automobile. In addition, the far greater production of manual transmission automobiles in Europe and Japan compared to the United States also results in less use of P/M components since lower volumes of these components are contained in manual transmissions than automatic transmissions.[22] Finally, conversations with officials of firms producing P/M products reveal that P/M production capacity, infrastructure, technology, and product range is much more extensive in the United States, as U.S. firms also have been more effective in marketing P/M components to the automotive industry.[23]

Government/Industry Technology Advancement Efforts

Although the P/M industry had considered that progress was impressive in terms of global sales during the previous 10 years, future success reportedly can only be guaranteed if the industry committed major new research and development investments to improve the performance of its products. These investments would enable the P/M industry to compete with traditional metal industries which are vigorously seeking to recapture lost market share by developing new process technologies to improve product quality and lower cost. In 2001, the P/M industry, under the coordination of the Metal Powder Industries Federation (MPIF) with assistance of the U.S. Department of Energy's (USDOE) Office of Industrial Technologies, launched a major initiative to provide high-quality P/M components and services to customers by enhancing material properties and performance; improving manufacturing and processing capability; and incorporating advances in sensor, process-control, information, and modeling technologies into P/M processes.[24] Specific automotive-related goals of the P/M industry, as part of the roadmap, include--[25]

- Increasing automotive market sales by 12 percent through 2020;
- Increasing productivity by 5 percent annually through 2010, and by 8 percent by 2020;
- Reducing overall energy consumption involved in metal powder production by 50 percent by 2010 and 80 percent by 2020; and
- Reducing total time required to bring components to market from 2 years to 6 months.

Advanced Aluminum Sheet in Auto Bodies

U.S. interest in aluminum[26] for auto body applications dates back to the mid-1970s when sudden rises in petroleum prices forced automakers to lower the weight of automobiles. Light-weight aluminum was viewed as an ideal substitute for steel because it enabled automakers to control the weight of the vehicle while adding required safety-related features such as air bags and extra padding.[27] Although the use of aluminum in automobiles has been growing since the 1970s, application has been largely confined to die castings, extrusions, and forgings in the engine block, transmission, and wheels.[28] Substitution of aluminum for steel has been largely influenced by regulatory requirements for automakers to meet fuel efficiency standards through reductions in vehicle weight and to meet certain standards for recycling of material.[29] In order to displace large amounts of steel, aluminum would need to become a primary metal in the body of the automobile. Currently nearly 27 percent of the weight of an average automobile is accounted for by the auto body. Use of aluminum sheet has been limited to a small number of closure panels (comprised largely of lift gates, hoods, and deck lids) that are comparatively easy to form.[30] The quantity of aluminum sheet contained in the average automobile produced in the United States was 29 pounds in 2002, up from 27 pounds in 1999.[31] Aluminum sheet applications account for only 11 percent of the total amount of aluminum in automobiles.

Advantages and Disadvantages

The principal advantages of aluminum sheet applications in the automotive industry are as follows:

- Aluminum has one-third the density of steel and satisfies the torsion and stiffness requirements of an automotive material. The strength-to-weight ratio of aluminum is often double that of steel. As a result of its light weight, aluminum enables automakers to better meet fuel economy standards without sacrificing many of the performance characteristics of steel.

- Aluminum body parts are typically stamped on the same tooling used to stamp steel parts. As a result, no significant capital investment would be need to transition from steel to aluminum body parts.

However, there are also four principal obstacles to the increased use of aluminum sheet in such applications:

- Under present manufacturing methods, aluminum sheet[32] is five times more expensive than steel by unit weight. The higher cost of aluminum panels is related both to its higher price and its more difficult forming attributes for complex body components.[33] Also adding to the cost disparity with steel is that approximately 50 percent of a sheet, whether of steel or higher-cost aluminum, is largely wasted in the form of scrap when stamping the final component.

- Complex body components, including door panels and inner trunk components which contain sharp creases or deep recesses to accommodate various safety features, are more difficult to form because aluminum tears more readily when subject to relatively low rates of strain, leading to splitting and wrinkling of the metal in tight corners. For this reason, steel sheet tends to be preferred in complex body components. Unlike steel, the metal has a tendency to "spring back" when the aluminum part is removed from the die, making it more difficult for aluminum to retain its dimensional tolerances.[34]

- The high thermal and electrical conductivities of aluminum (three times that of high-strength steel) pose problems in resistance spot welding; because aluminum quickly dissipates heat, its welding requires more energy to be applied, often resulting in distortion of the aluminum panel.[35]

As a result of these obstacles, an auto body part of aluminum sheet is often subject to additional stamping stages or may be divided into two parts and joined together rather than stamped as a single part.[36] Both alternatives involve added costs, making the aluminum part more expensive than a comparable steel part. Hence, the use of aluminum sheet has largely been confined to specific segments of the auto body market, such as closure panels, which are easier to form. Aluminum has been able to gain some market share in closure panel applications[37] because automakers are increasingly substituting lower-weight, high-strength, low-alloy (HSLA) steels for traditional carbon steels in body panels; and many of these HSLA steels face similar formability and cost problems as does aluminum.

At the same time, the aluminum and automotive industries have sought to adopt new process technologies to deal with formability problems. Although such processes are not yet capable of producing significant commercial quantities of aluminum body panels at a price competitive with steel, research is continuing at a rapid pace. Two prominent examples of these technologies are *superplastic forming* and *electromagnetic forming* (box 2).

Supply Infrastructure

Alcoa Inc, with headquarters in Pittsburgh, PA, and Alcan Aluminum Corp. (Canada) are the major producers of aluminum sheet certified for use in automotive applications. Most aluminum auto body parts in North America are stamped in-house by automakers largely because the stamping of body parts has been a core business for OEMs since the inception of the automotive industry in the United States.[38] The OEMs still possess sufficient press capacity to stamp the majority of their body components internally and when in-house capacity is insufficient to meet their production needs, they rely on Tier 1 suppliers to fill their remaining needs on a contract basis.

Present Automotive Applications in North America

Although the North American automotive industry currently uses various amounts of aluminum to form hoods, lift gates, and deck lids[39] in 20 to 30 automobile models, significant aluminum use has been largely confined to the following models:

- Ford Motor Co. uses aluminum sheet for the hoods of its redesigned F-series trucks. This use is considered the largest single application of aluminum sheet in the North American automobile industry, consuming more rolled aluminum annually than any other single automotive component application.[40]

- General Motors' (GM's) family of full-sized sport-utility vehicles (GMC Yukon, Chevy Tahoe and Suburban, and Cadillac Escalade) incorporate an aluminum lift gate; and the Oldsmobile Aurora V-8 model (production discontinued during 2003), which boasted the highest aluminum content of any automobile sold in the United States that has sales volumes greater than 10,000 automobiles per year, featured an aluminum hood and trunk lid.[41]

- The 2004 Chevy Malibu Maxx features an aluminum lift gate and the 2004 Cadillac SRX has an aluminum hood.[42]

In addition to these automotive components produced using conventional stamping techniques, GM has implemented a variation of superplastic forming (SPF) technology that it refers to as quick plastic forming, to produce the trunk on its now-discontinued Oldsmobile Aurora and the lift gate on its Malibu Maxx. According to GM, its quick plastic forming process is considerably faster than conventional SPF, allowing the company to produce components at the rate of one every 1 to 2 minutes.[43]

Box 2
New aluminum sheet processing technologies

Superplastic Forming (SPF)

Superplasticity is the ability of certain materials to undergo significant elongation at a particular temperature and strain rate. For metals such as aluminum, superplasticity refers to very high tensile elongations, ranging from 200 to several 1,000 percent.[1] During the SPF process, the material is heated within a sealed die. Inert gas is then applied under pressure at a controlled rate causing the material to take the shape of the die pattern. Superplastic alloys can be stretched at higher temperature by several times their initial lengths without breaking, allowing the production of parts that are otherwise impossible to form by conventional stamping techniques.[2] Benefits of SPF include:

- Increased metal formability and part complexity,
- improved structural performance, and
- near-net-shape forming of complex shapes that avoids scrap losses.

The SPF process is widely used in the aerospace industry to manufacture very complex geometries. At least one automotive part, the trunk lid on the now-discontinued General Motors Oldsmobile Aurora V-8, is produced through SPF.

Electromagnetic Forming (EMF)

EMF of aluminum shapes involves passing an electrical current pulse through a coil placed in proximity to the aluminum sheet.[3] The process is designed to produce more complex deep-draw aluminum panels such as doors and interior trunk components. Benefits of EMF include:

- Increased formability, as aluminum alloys formed under this method attain greater ductility and higher strains when stretched;
- reduced wrinkling, as imparting of a magnetic pressure upon the aluminum sheet appears to resist the tendency for each part of the sheet to change direction and fold over each other; and
- significant reduction of "springback" through application of tensile stress to reduce differential elastic strains throughout the thickness of the sheet, an advantage in achieving close dimensional tolerances of the final product.

According to researchers involved with the development of this technology, when fully developed, electromagnetic forming will be able to be easily scaled to produce large volumes of aluminum body components.[4]

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[1] Amit Joshi, "Introduction to Superplastic Forming Process," Nov. 2001, found at *http://www.metalwebnews.com/howto/superplastic-forming/superplastic-forming.html*, retrieved Dec. 3, 2003.

[2] Ibid.

[3] The electric pulse generates a high magnetic field around the coil that induces an eddy current in the aluminum sheet and an associated secondary magnetic field. The two fields are repulsive and the force of magnetic repulsion causes a deformation of the aluminum sheet that is not possible using conventional aluminum forming techniques. A die can then be used to further form the aluminum sheet.

[4] Officials of the Department of Materials Science and Engineering, The Ohio State University, Columbus, OH, telephone interview by USITC staff, Dec. 11, 2003.

Automotive Applications in Europe

Although U.S. automakers have made more extensive use of aluminum sheet, due to the larger weight of U.S. vehicles and the incentive to meet fuel economy standards through weight reduction, European automakers also have made major efforts to incorporate aluminum sheet.[44] These efforts began seriously during the mid-1980s and were driven by both the higher price of fuel in Europe and by desire of automakers to reduce weight in the front part of the vehicle by reducing the weight of major components, such as the hood. Audi probably has the most experience with incorporating aluminum in body applications. A major effort to incorporate aluminum sheet into auto bodies was the introduction of the all-aluminum Audi A2 during the mid-1980s. According to Audi, the aluminum body, which is attached to an aluminum space frame design, is 43-percent lighter than a comparable steel body.[45] The Audi A8, introduced in 1984, also has aluminum panels attached to an aluminum space frame through a series of laser-welded seams and riveting. The weight of the A8 body is estimated to be nearly 50-percent lighter than a comparable steel body.[46] The latest European aluminum-intensive vehicle, the Jaguar seventh-generation XJ sedan appeared on the market in late 2003. The redesigned Jaguar contains aluminum doors, fenders, deck lids, and hoods. The weight of the XJ's auto body is 440-pounds lighter than its predecessor, 110-pounds lighter than the Audi A8's super-light aluminum body, and 40-percent lighter than an equivalent conventional steel body.[47]

Automotive Applications by Japanese Transplants

Among Japanese automakers, both Nissan Motor Corp. and Mazda Motor Corp. feature aluminum in auto body applications. Nissan began to use aluminum sheet for the first time in the hoods and deck lids of the 2002 Altima models.[48] Nissan also plans to install aluminum hoods and deck lids in its Maxima sedans, expected to be launched onto the market by the 2005 model year.[49] In addition, Mazda has announced the introduction of a specially designed shock-absorbing aluminum hood[50] in its new RX-8 supercar for 2004. Decisions by Nissan and Mazda represent somewhat of a trend reversal for the Japanese transplant automakers, since transplants tend to use less aluminum sheet in car or truck applications, on average, than U.S. automakers. Japanese transplant automakers have instead concentrated on developing cast aluminum for engine applications.

Government/Industry Technology Advancement Efforts

Most of the government research effort to promote the automotive use of aluminum sheet has centered on the various FreedomCAR (Cooperative Automotive Research) partnerships between the USDOE and the U.S. Council for Automotive Research.[51] FreedomCAR focuses government support on fundamental research projects to find new technologies and approaches to apply to automobiles.[52]

There have been at least two major FreedomCAR-sponsored projects related to automotive-grade aluminum sheet. The *Superplastic Forming of Aluminum Sheet Metal for Automotive Applications* was a partnership completed in 1997 with GM, Kaiser Aluminum, and the Pacific Northwest National Laboratory (PNNL) (Richland, WA) to develop forming technologies to reduce the forming time of conventional SPF technology and increase product output rates. Research generated from this project has enabled GM to use its quick plastic forming technology to produce the lift gate for the current Malibu Maxx.

The *Electromagnetic Forming of Aluminum Sheet* project is a partnership established in 2002 among Ford, GM, DaimlerChrysler, and the PNNL to develop electromagnetic forming (EMF) technology to enable the economical manufacture of automotive parts from aluminum sheet.[53] The project has three major goals: (1) establish analytical methods for designing forming systems based on knowledge developed on the forming limits and relations between electrical system characteristics and specific aluminum alloy deformation responses, (2) reduce process costs through the development of more durable coil designs, and (3) develop hybrid forming systems that would integrate EMF with conventional sheet metal stamping for the economical production of automotive sheet.

Outlook

Use of P/M and aluminum sheet components likely will increase in the future as automakers continue to seek components that are both less expensive to produce and lighter weight. The rate of this advance will depend largely on the continuation of processing improvements that will permit both reductions in the cost of P/M and aluminum sheet components, and expansion of product use beyond the narrow range currently being produced from these materials. At the same time, manufacturers of components with traditional materials and manufacturing methods can be expected to resist further penetration by P/M and aluminum sheet by improving their own products. These competitive forces will likely lead to the production of future automobiles that are more fuel efficient, safer to drive, and affordable to consumers. ■

ENDNOTES

1. For more information on application of advanced materials to automobiles, see Vincent DeSapio, "Aluminum Metal Matrix Composites Gaining Greater Market Acceptance," *Industry Trade and Technology Review*, USITC, publication 3501, Mar. 2002, pp. 40-41.
2. Major nonautomotive P/M uses include cutting tools (carbon carbide insets), recreation equipment, hardware, hand tools, household appliances, industrial motors and controls (in the form of cams, gears, and links), jet engines (high-strength metal parts), and business machines.
3. David L. Schaefer and C. James Trombino, "State of the North American P/M Industry–2003," p. 4.
4. *Powder Metallurgy 2002 Facts* (Princeton, NJ: Metal Powder Industries Federation, 2002), p. 3.
5. Al Wrigley, "Powder Metals Seen Growing on Industry Gains," *American Metal Market*, Mar. 6, 2003, found at *http://www.amm.com/subscrib/2003/mar/week1/0306in01.htm*, retrieved Nov. 3, 2003.
6. *Powder Metallurgy 2002 Facts*, p. 3.
7. Ferrous powder accounted for nearly 80 percent of all metal powder shipments followed by aluminum metal powder, accounting for 10 percent of total shipments. Schaefer and Trombino, "State of the North American P/M Industry–2003," p. 4.
8. According to the U.S. Department of Energy (USDOE), the number of U.S. companies involved in the manufacture of metal powder totals 400 with total employment of 6,000. USDOE, Office of Industrial Technologies (OIT), *PM^2 Industry, Vision and Technology Roadmap: Powder Metallurgy and Particulate Materials*, Sept. 2001, p. 2.
9. Höganäs' annual production capacity ranges from 400,000-440,000 short tons, but is in the process of expanding production capacity to nearly 600,000 short tons.
10. North America Höganäs has recently completed an expansion of its capacity from 100,000 short tons to 330,000 short tons, establishing the firm as a major player in the North American market for powder metals.
11. Hoeganaes Corp. (U.S.) was spun off from Höganäs AB (Sweden) in 1969 and is now owned by GKN plc (United Kingdom).
12. According to the USDOE, the number of U.S. companies involved in the manufacture of P/M components totals 700 with total employment of 30,300. USDOE, OIT, *PM^2 Industry, Vision and Technology Roadmap: Powder Metallurgy and Particulate Materials*, p. 2.
13. North America accounts for an estimated 40 percent of worldwide shipments of P/M components. Schaefer and Trombino, "State of the North American P/M Industry–2003," p. 4.
14. A division of GKN plc. GKN Sinter accounts for approximately 16 percent of the total U.S. market for P/M components.
15. Metaldyne has signed an agreement with Mazda Motor Corp. (Japan), allowing the automaker to use its P/M forged connecting rod technology in its Atenza/Mazda 6 and other future vehicles.
16. General Motors (GM) no longer produces P/M components through in-house production facilities since the company spun off into an independent firm, Delphi Inc., which had been responsible for producing GM's P/M components.
17. The five major North American automobile manufacturers, GM, Ford, DaimlerChrysler, Toyota, and Honda all use P/M connecting rods. Industry sources estimate that P/M connecting rods account for nearly 90 percent of all connecting rods produced in North America.
18. Wrigley, "Powder Metals Seen Growing on Industry Gains."
19. P/M connecting rods are often considered superior to steel connecting rods in terms of performance because the P/M process eliminates the parting line, a possible weak point, that results when a conventional steel connecting rod is forged using a die.
20. Representatives of the three major U.S. automakers, telephone interviews by USITC staff, Dec. 18-22, 2003.
21. The growth of P/M parts in the typical European automobile rose from 5.5 pounds in 1980 to 18.3 pounds in 2002, whereas the amount of P/M parts in a typical Japanese automobile rose from 6.7 pounds in 1980 to 16.0 pounds in 2002. This compares with 39.0 pounds in the typical North American-produced automobile. Schaefer and Trombino, "State of the North American P/M Industry–2003," p. 4.
22. In North America, only an estimated 1-2 percent of automobiles sold are equipped with manual transmissions compared with an estimated 70-75 percent of automobiles in Europe and Japan.
23. Representatives of Cloyes Europe GmbH (Germany) and Federal Mogul Sintered Products (United Kingdom), telephone interviews by USITC staff, Jan. 7 and 13, 2004.
24. USDOE, OIT, *PM^2 Industry, Vision and Technology Roadmap: Powder Metallurgy and Particulate Materials*, p. iv.
25. Ibid., p. v.

26. Main aluminum alloy grades used in auto body applications include 6xxx Series alloys (e.g., 6009, 6010, 6016, and 6022), which are heat-treatable and used principally in body panels; and 5xxx Series alloys (e.g., 5005, 5052, 5182, and 5252), which are non-heat-treatable and used principally in interior panels and components and trim.
27. "Aluminum," *Automotive Industries*, Apr. 2003, p. 37.
28. According to the Aluminum Association of America, the amount of aluminum contained in the average automobile has increased from 86 pounds (3 percent) in 1976 to 274 pounds (11 percent) in 2002.
29. Anish Kelkar, Richard Roth, and Joel Clark, "Automobile Bodies: Can Aluminum be an Economical Alternative to Steel?" 2001, found at *http://www.tms.org/pubs/ journals/JOM/0108/Kelkar-0108.html*, retrieved Nov. 18, 2003.
30. Ibid.
31. Compiled from statistics of The Aluminum Association, Washington, DC.
32. Based on price of $1.40 per pound for aluminum sheet quoted by a representative of a major U.S. automaker.
33. In contrast, forming limitations for aluminum are far fewer than for steel in relatively simple closure panel components, such as hoods and lift gates, which can be stamped using mechanical presses to form aluminum into the final shape.
34. "The Battle of the Metals: New Aluminum Processes," *Automotive Engineering International* Online, found at *http://www.sae.org/automag/metals/11.htm*, retrieved Nov. 18, 2003.
35. To minimize welding of stamped aluminum components, the panels tend to use self-piercing rivets and adhesives to attach most of the components.
36. "The Battle of the Metals: New Aluminum Processes,"*Automotive Engineering International Online*.
37. According to Ducker Worldwide, a market research firm headquartered in Detroit, MI, the percentage of automobile hoods manufactured from aluminum should double over the next 10 years from 12 percent of total North American automobiles in 2003. Representative of Ducker Worldwide, telephone interview by USITC staff, Dec. 20, 2003.
38. Interviews with automotive industry representatives indicate that 60-70 percent of all North American body parts are stamped by the automakers at in-house stamping facilities.
39. There is presently no use of aluminum in the doors of any automobile model manufactured in the United States.
40. Al Wrigley, "Alcoa Wins Big Contract for Aluminum Truck Hoods," *American Metal Market*, May 23, 2003, found at *http://www.amm.com/*, retrieved Nov. 3. 2003.
41. The Aluminum Association, Inc., "Automotive Applications of Aluminum," found at *http://www.canadiandriver.com/articles/jk/030528.htm*, retrieved Dec. 10, 2003.
42. Brian Corbett, "04 Breakthrough Year," *Ward's Auto World*, Sept. 1, 2003, found at *http://waw.wardsauto.com/ar/auto_breakthrough_year/index.htm*, retrieved Dec. 11, 2003.
43. Paul Krajewski, GM, telephone interview by USITC staff, Mar. 1, 2004.
44. Automobiles in Europe tend to be heavier in the front due to the greater preponderance of front-wheel drive (FWD) vehicles and the inclusion of more safety-related components, such as anti-lock braking systems (ABS), in the front of the vehicle. European automakers found that by substituting aluminum for steel in automotive hoods, they could reduce the front weight of the vehicle by 10-18 pounds. Karl-Heinz von Zengen, European Aluminum Assn., telephone interview by USITC staff, June 17, 2004.
45. Jim Kerr, "More Aluminum Being Used in Cars," *www.CanadianDriver.com*, 2003, found at *http://www.canadiandriver.com/articles/jk/030528.htm*, retrieved Nov. 28, 2003.
46. Gary S. Vasilash, "Aluminum Studies," *Automotive Design & Production*, found at *http://autofieldguide.com/articles/article_print1.cfm*, retrieved Dec. 8, 2003.
47. Corbett, "04 Breakthrough Year," *Ward's Auto World*.
48. Nissan began production of the 2002 Altima in its Smyrna, TN, facility with an original production volume of 190,000 units.
49. Nissan plans to produce the Maxima in Tennessee with annual production volumes of 100,000-150,000 units.
50. Known as the "Shock Cone Aluminum Hood," and designed by Alcoa Inc., this item is designed to limit injuries to pedestrians who may be hit by the automobile.
51. For more information about the FreedomCAR Programs, see: *http://www.eere.energy.gov/vehiclesandfuels/index.shtml*; and *http://www.eere.energy.gov/vehiclesandfuels/program_areas/freedomcar*.
52. USDOE, Office of Energy Efficiency and Renewable Energy (OEERE), FreedomCar & Vehicle Technologies Program, found at *http://www.eere.energy.gov/vehiclesandfuels*, retrieved Mar. 30, 2004.
53. USDOE, OEERE, Automotive Lightweighting Materials," pp. 28-29.

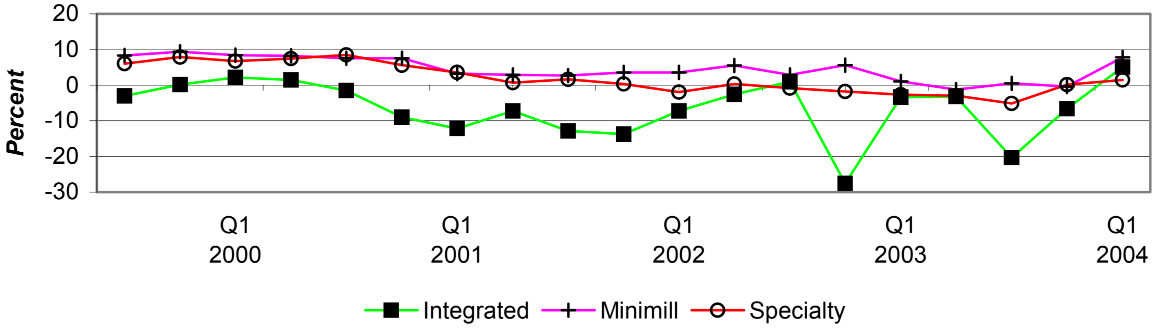
APPENDIX A
Key Performance Indicators of Selected Industries and Regions[1]

Title	**Author**[1]	**Page**
Steel	Harry Lenchitz (202) 205-2737 *harry.lenchitz@usitc.gov*	A-2 A-3
Automobiles	Laura A. Polly (202) 205-3408 *laura.polly@usitc.gov*	A-4
Unwrought Aluminum	Judith-Anne Webster (202) 205-3489 *judith-anne.webster@usitc.gov*	A-5
Flat Glass	Vincent DeSapio (202) 205-3435 *vincent.desapio@usitc.gov*	A-6
Services	Cynthia Payne (202) 205-3410 *cynthia.payne@usitc.gov*	A-7
North American Trade	Michael Jones Ruben Mata (202) 205-3403 *ruben.mata@usitc.gov*	A-8 A-9

[1] The data and views presented for the following indicators are compiled from the industry sources noted and are those of the authors. They are not the views of the United States International Trade Commission as a whole or of any individual Commissioner. Nothing contained in this information based on published sources should be construed to indicate how the Commission would find in an investigation conducted under any statutory authority.

STEEL

Figure A-1
Operating income[1] swings positive for all sectors during first quarter 2004



[1] Operating income (loss) as a percent of sales. Integrated group comprises 4 firms. Minimill group comprises 7 firms. Specialty group comprises 4 firms.
Note.--First quarter 2004 integrated group includes l previously untracked firm, and no longer includes l previously tracked firm, reflecting ownership changes in the industry.

Source: Individual company financial statements.

- Allegheny Technologies Incorporated completed the acquisition of certain assets of J&L Specialty Steel from Arcelor of Luxembourg on June 1, 2004. The acquisition followed ratification of a labor agreement between the United Steelworkers of America and employees at Allegheny Ludlum and at the former J&L facilities in Midland, PA and Louisville, OH. The facilities covered by the new labor agreement have an estimated capacity of 700,000 tons per year of flat-rolled products.
  See *http://www.alleghenytechnologies.com* and *http://www.uswa.org*
- International Steel Group Incorporated completed the acquisition of the idled assets of the bankrupt Georgetown Steel Company on June 21, 2004. The Georgetown, SC facility has an estimated steelmaking capacity of 1 million tons per year, a rolling capacity of 800,000 tons per year, and the capacity to produce 500,000 tons per year of Direct Reduced Iron. See *http://www.intlsteel.com*
- Wheeling Pittsburgh Steel Corporation plans to recover steel scrap worth $1.1 million by demolishing buildings and idled mill and railroad equipment at all six of the company's steelmaking and finishing plants. Scrap from the demolition program, expected to be completed during third quarter 2004, has already been used in the company's steelmaking operations. See *http://www.wpsc.com*
- An alliance between the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) and three major trade associations representing basic and specialty steel producers was announced on July 7, 2004. The American Iron and Steel Institute, the Steel Manufacturers Association, and the Specialty Steel Industry of North America, intend to work cooperatively with OSHA on a series of goals aimed at improving workplace safety and health in the steel industry. See *http://www.osha.gov*

Table A–1
Finished and semifinished imports, along with exports, increase significantly during first quarter 2004 compared to fourth quarter 2003

Item	Q4 2003	Percentage change, Q1 2004 from Q4 2003	YTD 2004[1]	Percentage change, Q1 2004 From Q1 2003
Producers' shipments *(1,000 short tons)*	25,727	9.9	28,265	8.6
Finished imports *(1,000 short tons)*	4,372	18.9	5,197	1.6
Semifinished imports *(1,000 short tons)*	1,227	27.1	1,559	17.1
Exports *(1,000 short tons)*	1,832	14.9	2,105	6.0
Apparent supply, finished *(1,000 short tons)*	28,267	10.9	31,357	7.5
Ratio of finished imports to apparent supply *(percent)*	14.5	[2]2.1	16.6	[2]-0.9

[1] Preliminary.
[2] Percentage point change.
Note.–Because of rounding, figures may not add to the totals shown.

Source: American Iron and Steel Institute.

STEEL

Table A–2
Steel service centers: First quarter 2004 shipments exceed year-ago period by 25 percent

Item	Dec. 2003	Mar. 2004	Percentage change, Mar. 2004 from Dec. 2003	Q1 2003	Q1 2004	Percentage change, Q1 2004 from Q1 2003
Shipments *(1,000 short tons)*	4,043	5,441	34.6	11,811	14,781	25.1
Ending inventories *(1,000 short tons)*......	13,588	12,890	-5.1	14,181	12,890	-9.1
Inventories on hand *(months)*.................	3.4	2.4	([1])	3.4	2.4	([1])

[1] Not applicable.

Note.–Metals Service Center Institute data collection and presentation methods have been updated. Data presented for first quarter 2003 have been updated and differ from previously published data.

Source: Metals Service Center Institute.

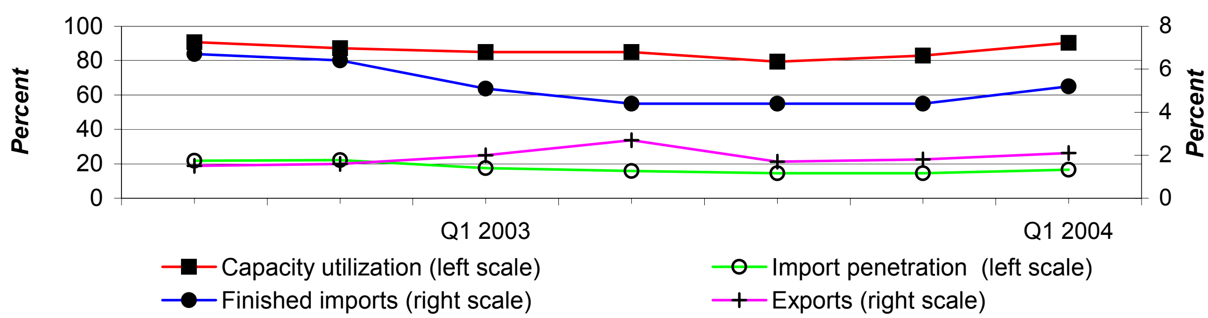
- Increased shipments drove inventories down more than 9 percent at U.S. steel service centers during first quarter 2004 compared to first quarter 2003 (table A-2). Inventories on hand declined by 1 full month compared to the year earlier period according to the Metals Service Center Institute.
  See *http://www.msci.org*

- The American Institute for International Steel import market survey (May 2004) predicts decreased imports of semifinished and structurals during the next 3 to 5 months. The survey predicts no significant changes in imports of corrosion resistant, merchant bar, and pipe and tube, while imports of wire rod are predicted to increase. There was no consensus on import trends for other steel products in the survey.
  See *http://www.aiis.org*

- World crude steel production through the end of May 2004 exceeded 460 million tons, an increase of more than 8 percent, compared with the first 5 months of 2003, according to the International Iron and Steel Institute. China's production increased by almost 23 percent through the end of May 2004 compared to the year-earlier period. See *http://www.worldsteel.org*

- Domestic steel mill capability utilization increased by 7.5 percentage points during first quarter 2004 compared to fourth quarter 2003 (figure A-2). Driven by increasing demand, finished imports and exports both showed double-digit percentage increases compared to the previous quarter. See *http://www.steel.org*

Figure A-2
Steel mill products, all grades: First quarter 2004 capability utilization exceeds 90 percent for the first time in almost 2 years



Note.--Capability utilization is the raw steel tonnage produced divided by the tonnage capability to produce raw steel for a sustained full order book

Source: American Iron and Steel Institute.

AUTOMOBILES

Table A-3
U.S. sales of new passenger vehicles (cars and light trucks), domestic and imported, and share of U.S. market accounted for by sales of total imports and Japanese imports, by specified periods, January 2003-March 2004

Item	Jan.-Mar. 2004	Percentage change Jan.-Mar 2004 from Oct.-Dec. 2003	Percentage change Jan.-Mar. 2004 from Jan.-Mar. 2003
U.S. sales of domestic passenger vehicles (*1,000 units*)	3,149	-2.4	5.4
U.S. sales of imported passenger vehicles (*1,000 units*)	762	-1.5	-1.9
Total U.S. sales (*1,000 units*)	3,911	-2.2	3.9
Ratio of U.S. sales of imported passenger vehicles to total U.S. sales (*percent*)	19.5	0.7	-5.6
U.S. sales of Japanese imports as a share of the total U.S. market (*percent*)	10.1	0.0	-9.7

Note.—Domestic passenger vehicles include U.S.-, Canadian-, and Mexican-built cars and light trucks sold in the United States. Imported passenger vehicles do not include cars and light trucks supplied by Canada and Mexico.

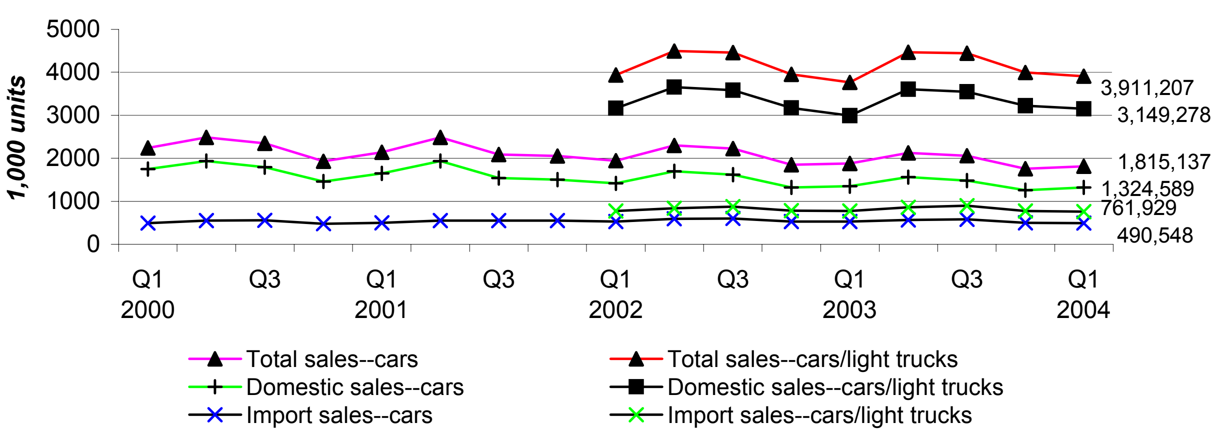
- The strengthening economy led to a considerably stronger first quarter in 2004 as compared to first quarter 2003. Sales of domestic vehicles in particular showed strong year-over-year performance for the first quarter.

- Income growth and incentives on new vehicle purchases combined to put passenger vehicles at their most affordable level in 25 years during the first quarter 2004. The average purchase price, including finance charges, totaled $26,676, accounting for 20.5 weeks of median family income.

- Automakers and dealers continue to offer generous incentives. Consumer incentives are increasingly used to pay off trade-ins; about 30 percent of vehicles traded in are in a negative equity situation, where the consumer owes more on the vehicle than it is worth. The average vehicle loan length is now at 63 months, and the average down payment is at a record low of less than 5 percent.

- Automakers are cautiously watching fuel prices in the United States. Despite the fact that light truck sales declined in first quarter 2004, GM and Ford do not believe that U.S. consumers will turn away from larger pickup trucks and SUVs in the near future. Expenditures on fuel are a smaller portion of household spending now than they were 20 years ago, and purchasers of larger pickups and SUVs tend to be in higher income brackets and therefore potentially less concerned about fuel prices.

Figure A-3
U.S. sales of new passenger vehicles (cars and light trucks) decreased in the first quarter 2004, owing to a decline in sales of light trucks

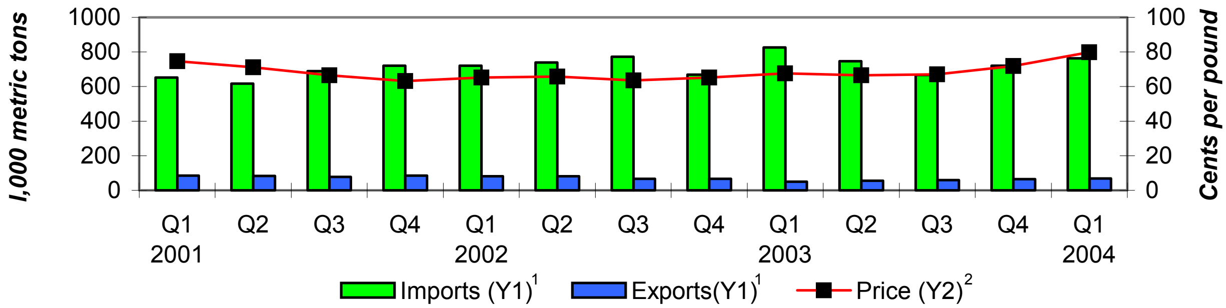


Note.—Domestic sales include U.S.-, and Mexican-built vehicles sold in the United States; these same units are not included in import sales.

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

UNWROUGHT ALUMINUM[1]

Figure A-4
Exports of primary aluminum increased by 38 percent since first quarter of 2003 as exports to Mexico reflected growing demand for aluminum by the motor vehicle industry



[1] Unwrought aluminum and aluminum alloys.
[2] Quarterly average of the monthly U.S. market price of primary aluminum ingots.

Source: Compiled by USITC staff based on data obtained from the U.S. Geological Survey.

- As China implements reforms aimed at slowing the growth of its aluminum industry, investment growth in the Chinese industry declined considerably in 2004 as compared to 2003, and no new aluminum smelter capacity has been proposed. Development of similar facilities underway also slowed in 2004 and some new projects have been cancelled. The reforms are intended to prevent the industry from overcapacity which may lead to a decline in price.

- The lowest recycling rate in the United States in 25 years (44 percent, down from a high of 70 percent in 1992) and strong demand for scrap by Europe and China, pushed aluminum scrap prices up by 10 percent in the first quarter of 2004 from the preceding quarter.

Table A-4
The price of aluminum increased by 12 cents per pound since first quarter 2003 due to the high cost of both alumina and energy, and growing demand by domestic consumers and China

				Percentage change	
Item	**Q1 2003**	**Q4 2003**	**Q1 2004**	**Q1 2004 from Q1 2003**	**Q1 2004 from Q4 2003**
Primary production (*1,000 metric tons*)	700	660	635	-9.3	-3.8
Secondary recovery (*1,000 metric tons*)	721	731	736	2.1	0.7
Imports (*1,000 metric tons*)	826	720	763	-7.6	6.0
Import penetration (*percent*)	37.6	35.2	36.9	[1]-0.7	[1]1.7
Exports (*1,000 metric tons*)	50	65	69	38.0	6.2
Average nominal price (*cents/lb*)	67.6	71.8	79.9	18.3	11.2
LME inventory level (*1,000 metric tons*)	([2])	1,423	1,227	([2])	-13.8

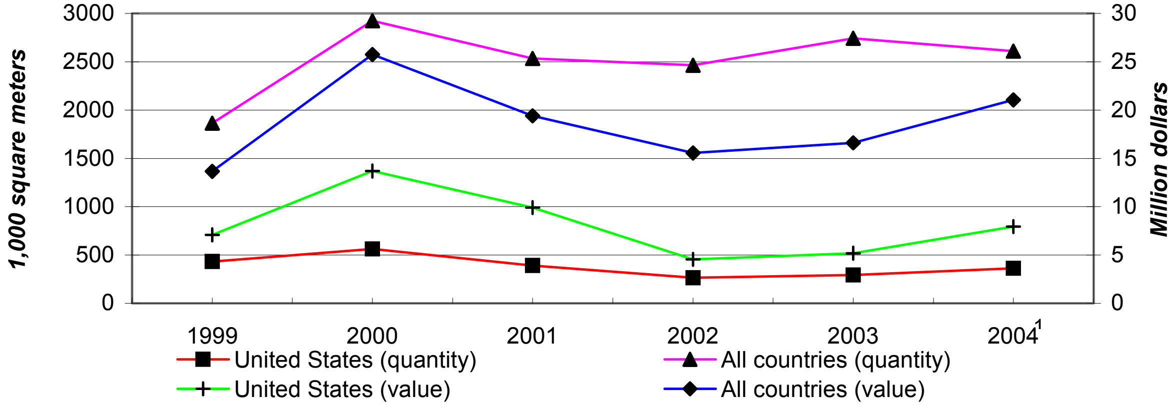
[1] Percentage point change.
[2] Not applicable.
Note.–Revised data indicated by "r."

Sources: Compiled from data obtained from U.S. Geological Survey and World Bureau of Metal Statistics.

[1]Product coverage includes only unwrought aluminum and certain aluminum alloys for improved data comparability.

FLAT GLASS

Figure A-5
Japanese monthly average imports from U.S. increased during first 4 months of 2004



[1] Data for Jan-April (Latest available data).

Source: Compiled from "World Trade Atlas: Japan" at http://www.globaltradeatlas.com, using official statistics provided by the Government of Japan.

Background

- Although the U.S.-Japanese agreement on Japanese market access for imports of flat glass, which sought to increase access and sales of foreign flat glass in Japan, expired on December 31, 1999,[1] the U.S. Government continues to engage the Japanese Government in discussions over access to the Japanese market. In the 2003 Trade Forum discussion held in July 2003 under the U.S.-Japan Partnership for Economic Growth, the U.S. Government "highlighted the continuing problems that prevent market entry, including the need for tighter enforcement of rules against anticompetitive behavior."[2] The U.S. Government also urged Japan to modify regulations to facilitate use of energy-efficient glass in Japan.

- U.S. and Japanese negotiators have agreed that Japan's Ministry of Trade and Industry (MITI), in conjunction with the Japan Fair Trade Commission (JFTC), should monitor Japanese flat-glass manufacturers and the glass distribution system in Japan to promote competition in the sector.[3]

- **Current**
- Despite increased growth in the Japanese economy in 2004, Japanese average monthly consumption of imported flat glass from all countries declined 7 percent for the first 4 months of 2004, to 2.6 million square meters, compared with the same period in 2003. The average monthly value of total Japanese flat glass imports for the first 4 months of 2004 increased 20 percent, to $21.1 million, compared with the same period in 2003. In full-year 2003, the quantity of average monthly Japanese imports increased 8 percent compared with the same imports in 2002, and increased 7 percent in value during the same period.

- Average monthly Japanese imports from the United States increased by quantity and value during the first four months of 2004 compared with the same period in 2003 (up 18 percent to 362,000 square meters and up 27 percent to $7.9 million, respectively) due largely to increased demand in Japan for higher-value, architectural-grade coated and ultra-clear flat glass products from the United States, for use in construction-related, applications. In full-year 2003, average monthly imports from the United States increased 10 percent in quantity and 16 percent in value compared with the same imports for 2002.

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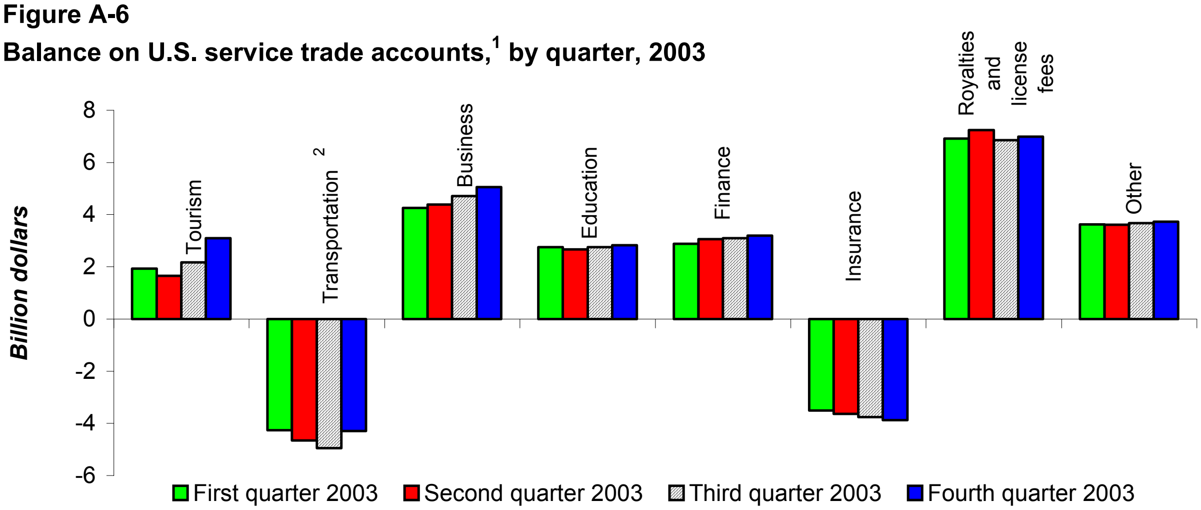
[1]Office of the United States Trade Representative (USTR), *The President's 1999 Annual Report on the Trade Agreements Program*, p. 227, found at *http://www.ustr.gov/reports/tpa/2000index*.html, retrieved Mar. 3, 2004.

[2]USTR, *2004 Trade Policy Agenda and 2003 Annual Report of the President of the United States on the Trade Agreements Program* (final draft), 2003, pp. 21-22.

[3]USTR, *Fourth Annual Submission by the Government of the United States to the Government of Japan on Deregulation and Competition Policy*, Oct. 12, 2000, p. 32.

SERVICES

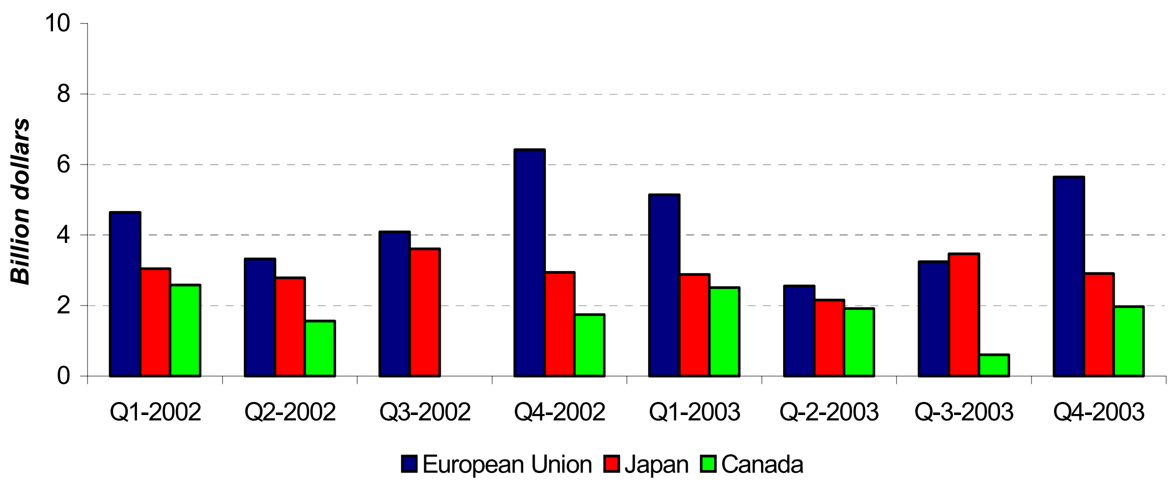
Figure A-6
Balance on U.S. service trade accounts,[1] by quarter, 2003



[1] Data for telecommunication services are to small to be revealed graphically.
[2] Includes passenger fares, freight and port services.

Source: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business,* Apr. 2004, p. 86.

Figure A-7
Surpluses on cross-border U.S. services transactions with selected trading partners, by quarter, 2002-2003[1]



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

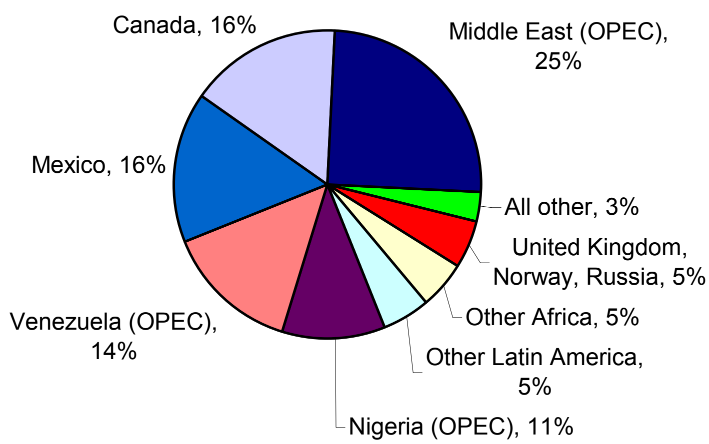
Source: U.S. Department of Commerce, Bueau of Economic Analysis, *Survey of Current Business*, Apr. 2004, pp. 96-99.

NORTH AMERICAN TRADE HIGHLIGHTS

U.S. trade with its North American neighbors is highlighted in table A-5. The following is a summary of key developments during the first quarter of 2004.

- Strong U.S. growth and record high prices in the energy sector were the main factors contributing to the 8-percent ($7.5-billion) rise in U.S. imports from its NAFTA partners in the first quarter of 2004 compared with the first quarter of 2003 (quarter-to-quarter). Average prices for U.S. crude petroleum imports from all sources increased 13 percent from January 1 to March 31, 2004 due to supply uncertainty in the global market.[1] The United States receives 32 percent of its crude petroleum imports from Mexico and Canada, and another 19 percent from other Latin American sources (figure A-8).

Figure A-8
U.S. Crude Petroleum Imports (by volume), January-March 2004



Source: Energy Information Administration (EIA), Form EIA-814, "Monthly Import Reports," Mar., Apr., and May 2004

Total U.S. exports to Canada rose by 7 percent ($2.7 billion), underscoring the 5.5-percent quarter-to-quarter increase in Canadian consumer spending.[2] In addition, a solid 6.5-percent quarter-to-quarter growth in business investment continued to fuel demand for U.S. industrial machinery, transportation, and telecommunication equipment.

- U.S. imports from Canada grew by 8 percent ($4.6 billion) as the Canadian economy benefited from exchange rate stability and renewed U.S. demand. Higher values for imports of petroleum accounted for 15 percent of the total growth in imports from Canada in the quarter.[3] Growth in U.S.-Canada trade in the quarter was characterized by a faster increase in U.S imports than U.S. exports. This was evident from the 10-percent ($1.9-billion) rise in the U.S. merchandise trade deficit with Canada, as compared with the first quarter of 2003.

- U.S. exports to Mexico expanded 11 percent ($2.1 billion) sparked by demand for intermediate inputs and consumer goods.[4] Consumer spending is expected to generate strong U.S. exports with the emergence of the Mexican housing and credit markets.

- U.S. imports from Mexico increased 9 percent ($2.9 billion) as Mexican manufacturing recovered with a 2.8-percent annualized increase, compared with the fourth quarter of 2003. Increased petroleum prices accounted for 9 percent of the total rise in imports from Mexico in the quarter. The volume of crude petroleum rose by 11 percent, while the value increased by 7 percent.

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[1] Calculated by the U.S. International Trade Commission from monthly indices published by the U.S. Bureau of Labor Statistics, found at *http://www.bls.gov/news.release/ximpim.nr0.htm*, retrieved July 14, 2004.
[2] Zoltan Pozsar, "GDP Analysis-Canada," *The Dismal Scientist* from Economy.com*,* found at *http://www.economy.com/dismal/pro/release*, retrieved June 30, 2004.
[3] Compiled from official statistics of the U.S. Department of Commerce (USDOC).
[4] "Mexico," *Latin America Monitor*, June 2004, pp. 4-5.

NORTH AMERICAN TRADE HIGHLIGHTS

Table A-5
North American trade, 1999-2003, January-March 2003, and January-March 2004

Item	1999	2000	2001	2002	2003	January-March 2003	January-March 2004	Percent change 2003/04
	Value *(million dollars)*							
U.S.-Mexico trade:								
Total imports from Mexico	109,018	134,734	130,509	134,121	137,199	33,489	36,398	9
U.S. imports under NAFTA:								
Total value	71,317	83,995	81,162	84,747	87,750	21,627	22,910	6
Percent of total imports	65	62	62	63	64	65	63	[1]-2
Total exports to Mexico	81,381	100,442	90,537	86,076	83,108	19,593	21,683	11
U.S. merchandise trade balance with Mexico[2]	-27,637	-34,292	-39,971	-48,045	-54,091	-13,896	-14,715	-6
U.S. -Canada trade:								
Total imports from Canada	198,242	229,060	216,836	210,518	224,016	55,636	60,239	8
U.S. imports under NAFTA:								
Total value	115,715	123,052	113,179	115,807	119,416	28,651	30,865	8
Percent of total imports	58	54	52	55	53	51	51	([3])
Total exports to Canada	145,731	155,601	144,621	142,543	148,749	36,412	39,106	7
U.S. merchandise trade balance with Canada[4]	-52,511	-73,459	-72,215	-67,975	-75,267	-19,225	-21,133	-10

[1] Percentage-point change.
[2] The negative (-) symbol indicates a loss or trade deficit. The $48.0-billion deficit in U.S. merchandise trade with Mexico in 2002 was partially offset by a $4.7-billion U.S. surplus in bilateral services trade (the most recent year for which data are available).
[3] Less than -0.5 percent.
[4] The $68.0-billion deficit in U.S. merchandise trade with Canada in 2002 was partially offset by a $5.8-billion U.S. surplus in bilateral services trade. During the first 3 quarters of 2003 the U.S. surplus in bilateral services trade totaled approximately $7 billion, not seasonally adjusted.

Source: Compiled by USITC staff from official statistics of the U.S. Department of Commerce. Statistics on U.S. services trade with Canada and Mexico are based on preliminary data provided in U.S. Department of Commerce, Bureau of Economic Analysis, "U.S. International Transactions Accounts Data," tables 10 and 10a, found at *http://www.BEA.DOC.GOV/BEA/International/BP_web/list.CFM?ANON=92.*

- Tight global energy markets persisted in the first quarter with natural gas, electricity, and petroleum products experiencing price increases. Prices of natural gas and electricity in Mexico grew by 11 and 6 percent, respectively, since the beginning of the year, increasing costs for the manufacturing sector and offsetting the benefit to state-owned PEMEX.[5] Canada also was affected, mainly through imports of natural gas from the United States which increased by more than 100 percent from the first quarter of 2003 to the first quarter of 2004 and reached $0.5 billion.[6]

- Low interest rates, coupled with strengthened consumer confidence, accelerated housing construction across the United States in the first quarter of 2004. U.S. imports of forest products from Canada increased by 42-percent ($0.9-billion) quarter-to-quarter, largely due to this construction upturn. The strong housing market also led to higher U.S. sales and increased imports from Canada of furniture, lamps, and bedding.

- In terms of manufactured goods supplied by Mexico, the strongest quarter-to-quarter increases in U.S. imports were television receivers ($0.6 billion); auto parts ($0.3 billion); trucks ($0.2 billion); motor vehicle seats ($0.1 billion); and engine parts ($0.1 billion). These trends reflect "just-in-time" production sharing practices with the United States. Labor-intensive sectors, such as apparel, experienced a 6-percent quarter-to-quarter decline in U.S. imports from Mexico.[7]

[5] *Mexico Watch,* "Economic Summary," June 1, 2004, pp. 1-4.
[6] Compiled from official statistics of the USDOC.
[7] Ibid.