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Machine Vision: Vital Technology for Manufacturing Industries

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Machine vision is becoming an increasingly important technology that can be used to improve product performance and quality, increase productivity, reduce labor costs, and decrease liability in a wide variety of manufacturing industries. It is vital in semiconductor manufacturing equipment; and the latest technological advances in computer chips would probably not have been possible without machine vision. North America is both the largest producer and consumer of these products in the world. This article provides an overview of the technology and the industry structure, describes the application of machine vision in the semiconductor manufacturing industry, and examines future prospects for the technology. A glossary of technical terms appears at the end of the article.

Machine vision is a relatively new technology used in diverse manufacturing industries including the container, electronic, food, pharmaceutical, printing, semiconductor, wood products, and fastener industries (box 1).[2] Although machine vision dates back to the late 1950s when it was created in an academic setting,[3] companies did not begin to adopt the technology until the 1980s as increasing emphasis was placed on product quality and production efficiency, and improvements occurred in machine vision equipment.[4] The machine vision industry took advantage of the technological advances that led to significant improvements in computer hardware and software to develop faster, more-efficient, and lower-cost products.[5] Since the 1980s, sales of machine vision systems have steadily increased with the current worldwide market approaching $5 billion per year.[6]

[1] The views expressed in this article are those of the author. They are not the views of the International Trade Commission or any of the Commissioners.

[2] "Machine Vision Moves Off the Factory Floor," *Lasers & Optronics*, July 1998, p. 13.

[3] Teresko, John, "New Eyes in Manufacturing: Machine vision technology aids manufacturing," *Industry Week*, Apr. 19, 1999, p. 47.

[4] Myler, Harley R., *Fundamentals of Machine Vision*, SPIE, Bellingham, WA, 1999, p. 95.

[5] "Inspection systems: Planning a PC-Based Machine Vision System," *SMT Trends*, May 1, 1998.

[6] *Machine Vision Market: 1998 Results and Forecasts through 2003*, Automated Imaging Association, Ann Arbor, MI, 1999, p. 264.

Box 1
What is machine vision?

Machine vision in a nutshell is the automatic acquisition and analysis of an image. For example, ATM machines having this technology scan the retina, cornea, or facial characteristics to determine user access. This provides a highly secure ATM system and eliminates the need for PINs and passwords. As machine vision companies develop this technology into cost-effective applications, it has the potential to be more broadly employed in other entry/access tasks. Machine vision currently has industrial applications to--

- Properly align a specific part to ensure exact tolerances and precision manufacturing;
- Recognize defects[1] on a product during manufacturing (such as discoloration in paper products); and
- Read encoded identification information on manufactured parts used in specific products (e.g., electronic devices).

Its many applications enable machine vision to be used in virtually all types of manufacturing for production control, process control, quality control, machine control, as well as robot control.

[1] Machine vision may examine microscopic defects depending on the product and defect tolerances (e.g., semiconductor inspection).

Sources: "Machine Vision Moves Off the Factory Floor," *Lasers & Optronics*, July 1998, p. 13; and Batchelor, Bruce G., "Coming to Terms with Machine Vision and Computer Vision: They're Not the Same!" *Advanced Imaging*, Jan. 1999, pp. 22-24.

Machine Vision Applications and Systems[7]

Machine vision provides a more efficient and precise substitute for human vision in the manufacturing process.[8] It can function to control manufacturing processes by providing valuable data and feedback that enable continuous monitoring and systematic improvements. Applications also include directing and controlling robots or other machines to perform specific tasks, and serving as a quality-control mechanism to identify damaged products for removal or repair. For example, machine vision is used by--

- Metal fabrication firms to ensure compliance of parts with specifications or customer needs;[9]
- Pharmaceutical companies to measure the content of vials and ampules and to inspect these containers for damage;[10]

[7] System indicates both hardware and software.

[8] Machine vision is a specialized segment of the larger industry known as electronic imaging.

[9] Lawrence, John, "High-Volume Surface Inspection with a Human Touch," *Fabricating Equipment News*, Mar. 2000, p. 38.

[10] Guidoni, George, "Bigger visions in sight: providers of machine vision inspection systems

(continued...)

- Egg producers to detect flaws in hen eggs;[11]
- Automotive manufacturers to guide robots and test whether defrosters are properly functioning;[12]
- Wood products operations for clipping, grading, sorting, gauging surface roughness, resin-distribution analysis, and wood-failure evaluation;[13] and
- Cosmetics producers for the inspection of eyeliner pencils.[14]

Four main components make up a machine vision system: (1) a light-sensitive sensor such as a camera, (2) support electronics, (3) a light source to illuminate target objects, and (4) image-processing software. Machine vision consists of three main activities: image formation/acquisition, image processing, and image analysis/decision-making action. Machine vision first acquires an image using camera, x-ray, or laser technology, and then uses software programming to analyze the image and provide a "solution" or "decision" that can then be processed and executed by the machine.[15]

The two main types of machine vision systems are general purpose and application-specific. General purpose machine vision systems can be easily adapted to multiple uses but perform generic machine vision tasks such as gauging/measuring, flaw inspection, location analysis, and pattern recognition.[16] Application-specific machine vision systems address a unique application common to an industry, such as measurement of semiconductor line widths. In the past, proprietary hardware differentiated machine vision companies. Today, it is the software that differentiates machine vision companies because common sensor and lighting techniques are used throughout the industry.[17]

Machine vision provides advantages, such as increased quality, precision, and productivity, to manufacturers that incorporate the technology into their production process. In addition to significantly reducing the labor component in a cost-effective manner, machine vision can also address safety concerns by replacing workers in potentially hazardous work situations;

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[10] (...continued)
are eyeing new pharmaceutical markets," *Canadian Packaging*, Dec. 1998, pp. S1-3.

[11] Jiang, Bernard C., and Jiang, S.J., "Machine vision based inspection of oil seals," *Journal of Manufacturing*, 1998, pp. 159-166.

[12] Larson, Melissa, "Auto Industry Sees: Future of vision inspection," *Quality*, June 1998, pp. 53-55.

[13] Blackman, Ted, "Prospering won't be easy, but industry can compete," *Wood Technology*, Jan./Feb. 1998, pp. 42-49.

[14] Teresko, John, "New Eyes in Manufacturing. . .," *Industry Week*, Apr. 19, 1999, p. 47.

[15] Both the solution and feedback process distinguish machine vision from certain other electronic imaging processes that simply acquire an image, such as remote sensing from military satellites, TV monitoring techniques used in connection with medical diagnostics, and document scanning techniques such as page readers. Conversely, computer aided design (CAD) and animation systems are examples of electronic imaging that are used to create images, such as a car or a building, and animated motion pictures, respectively. *Machine Vision Market: 1997 Results and Forecasts through 2002*, p. 11.

[16] Nello, Zuech, "Robot vision or machine vision," *Robotics World*, Fall 1996, p. 68.

[17] The software application will vary according to the end-user problem that the machine vision is solving.

an issue becoming more prevalent in manufacturing industries. In certain industries, machine vision performs tasks that are not possible with human operators. For example, a human technician would most likely require one week to inspect a single semiconductor wafer because of the submicron size of chip components, whereas machine vision-aided machinery is capable of inspecting 30 to 40 wafers per hour.[18] In addition, increasingly stringent clean-room requirements, necessary to prevent contamination, further restrict semiconductor inspection by humans.

Although existing machine vision technology has limitations (see semiconductor case example and outlook sections), these tend to be eliminated as advances continue in the underlying technologies. As with other capital equipment using advanced technologies, machine vision is relatively expensive. In 1998, for example, the average price of a North American[19] system was $39,000,[20] however, this is 25 percent less than 10 years ago.[21] While prices continue to fall for the enabling technologies,[22] the total cost of machine vision systems has not declined commensurately due to the increased complexity of the machine vision solution and the accompanying engineering requirements needed to integrate the technology with existing systems. Despite its relatively high per-unit cost, the market for machine vision is expected to grow at an average annual rate of 11 percent through the year 2003,[23] indicating that price is not the most important factor in determining whether or not machine vision will be adopted by a particular manufacturer.

Machine Vision Systems Industry

Before the mid 1980s, machine vision systems were proprietary systems, expensive and virtually inoperable with system components of other machine vision companies because of inflexible designs and complicated setup programming.[24] With the development of "plug and play"[25] and other general purpose machine vision systems, the industry has been able to

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[18] USITC staff interviews with representatives of RVSI and Vision Systems International, Jan. 17, 2000.

[19] North America only includes the United States and Canada for the purpose of this article and in the data compiled by industry sources. No firms are known to operate in Mexico.

[20] In comparison, the average price of a North American machine vision system sold to the semiconductor industry was $57,514 in 1998. The average price of an application-specific system was $603,400. *The Machine Vision Market: 1998*, p. 5; and *Machine Vision in the Semiconductor Industry*, Automated Vision Systems, Inc., Campbell, CA, 1999, p. 127.

[21] Teresko, John, "New Eyes in Manufacturing," *Industry Week*, Apr. 19, 1999, p. 47.

[22] Camera and lighting technologies that improve machine vision capabilities and advance the technology are being developed. New camera technology, in particular, has led to lower prices with improved performance.

[23] *The Machine Vision Market: 1998*, p. 4.

[24] "Inspection systems: Planning a PC-Based Machine Vision System," *SMT Trends*, May 1, 1998.

[25] Plug-and-play systems are general-purpose machine vision systems that require little setup and maintenance and can be used in many applications. Kren, Lawrence, "A Fresh Look at Machine Vision: Technology Advances Continue to Drive Down the Cost of Automatic

(continued...)

integrate new technologies and produce lower-cost, PC-based systems that can quickly be reconfigured and require minimal training.

Through the 1990s, the immense growth in several manufacturing industries, especially the electronics and semiconductor industries, revealed the process-control limitations[26] of certain advanced manufacturing processes and automation. Companies in these industries were faced with increasing global competition in the sale of high-quality consumer goods; improved process control using machine vision helped to maintain their competitiveness through increased productivity, reduced material waste, and rapid payback on the capital investment.[27] Other industries that automated labor-intensive, hazardous, or repetitive tasks with machine vision achieved similar benefits. Many products currently on the market could not have been produced without machine vision technology, now an essential and integral part of many manufacturing processes.

Industry Structure

Although the technology was first developed in the United States, machine vision industries rapidly developed in North America, Japan, and the European Union, where the technical infrastructure existed to support growth of the technology. These regions combined have more than 550 machine vision companies.[28] North American companies make up almost half of these operations, including general business segments for multipurpose machine vision systems and application-specific machine vision (box 2 illustrates a small and a large U.S. machine vision company).[29] The total world market for machine vision systems reportedly reached almost $4.6 billion in 1998 (table 1) with North America accounting for the largest regional share (34 percent). In 1998, North American companies shipped an estimated $1.86 billion of these systems, representing about 40 percent of world shipment revenues (figure 1).[30] Of the North American total, the semiconductor industry accounted for $888 million, nearly half of the region's shipments.[31]

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[25] (...continued)
Inspection and Make Systems More Plug-and-Play," *Machine Design*, Mar. 11, 1999, p. 172.

[26] With increased automation, safety requirements and production speeds increased, requiring new technologies to control the production process and maintain product quality without jeopardizing the safety of production workers.

[27] Rapid capital payback is especially relevant for industries such as electronics and semiconductors. *World Machine Vision System, Component, and Software Markets: Innovative, Affordable, and Reliable Solutions Lead to Billion-Dollar Industry*, Market Intelligence, Mountain View, CA, 1992, p. I-1.

[28] *The Machine Vision Market: 1998*, p. 1.

[29] Multipurpose machine vision can also be adapted for specific applications. Application-specific machine vision is also known as machine vision for dedicated tasks. Machine vision can also be customized, typically built around a common technology base. *The Machine Vision Market: 1998*, p. 12.

[30] *Machine Vision in the Semiconductor Industry*, p. 5.

[31] *The Machine Vision Market: 1998*, pp. 23, 274.

Box 2
Illustration of two machine vision companies

According to industry representatives, *Cognex, Natick, MA*, is one of the largest and most recognized firms in the general machine vision segment of the industry although it also sells application-specific vision systems and inspection systems. It is a relatively large, publicly held firm with revenues of almost $122 million in 1998. The majority of its customers are original equipment manufacturers (OEMs) that incorporate Cognex vision systems into processing machinery for subsequent sale to end users, especially in the semiconductor and electronics industries. Principal products include modular vision systems and surface inspection systems. Cognex's modular vision systems locate, identify, measure, and inspect products such as automobile wheels, semiconductor chips, and cellular phones; and its inspection systems examine the surface of materials such as plastics, metals, and paper, during the manufacturing process. The principal portion of Cognex's sales (by value) are to customers in Japan and the United States, representing over 44 percent and 38 percent, respectively; another 14 percent of sales are for Europe. Cognex relies on a direct sales force in local offices to sell its products in North America, Japan, Europe, and Southeast Asia. One of Cognex's newest technologies, "PatMax," is an object location technology used in combination with other systems, especially inspection systems, in the automotive industry to enable robots to locate and grip specified parts regardless of their position or orientation on the assembly line.

Representative of a smaller company, *Adaptive Optics Associates (AOA), Cambridge, MA*, is in the Hamilton Standard division of United Technologies Corporation. AOA's core business is high-technology products and support services for the building systems, automotive, and aerospace industries. It provides its customers with high-speed digital imaging; real-time image data analysis, control software, and systems; and electro-optical systems integrations. A small division of a large conglomerate with limited resources and no internal sales force, AOA has two primary machine vision products: the Advisor Web Inspection system, customized for various web applications, and the Kine View High Speed Video system. AOA, in comparison with Cognex, develops more application-specific machine vision products for companies such as PPG, Chevron, Ford, and semiconductor manufacturers. AOA's Mass Scanning and Dimensioning System (MSDS), originally developed for Federal Express, captures images over a wide visual field (2 to 3 feet) and identifies and scans parcels regardless of their position. MSDS is now being applied to other processes such as the identification of small defects in auto paint finishes.

Sources: Company annual reports (1998) and literature; and USITC staff interviews with company representatives, Mar. 25, 1999.

Table 1
Machine vision industry world shipments and market, 1998

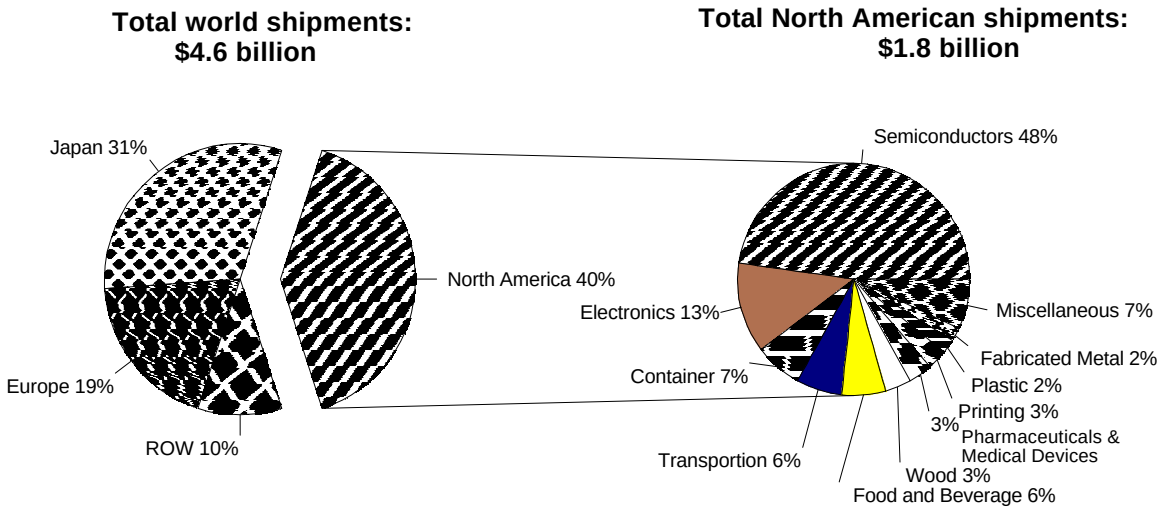
(*Million dollars*)

Region	Shipments	Market
North America	1,860	1,582
Japan	[1] 1,400	1,366
Europe	868	1,119
Rest-of-the-world	[2] 466	527
Totals	4,594	4,594

[1] Estimate based on USITC staff interview with representative of Vision Systems International, Jan. 28, 2000.
[2] Estimate derived by subtracting known regional shipments from known world market of $4.6 billion.

Source: Except as noted, data for world shipments and market derived from *The Machine Vision Market: 1998 Results and Forecasts through 2003*, Automated Imaging Association, Ann Arbor, MI, 1999, pp. 235, 247, 264, 266.

Figure 1
Share of world machine vision shipments and North American shipments by major end-use industries, 1998



Sources: USITC staff interview with representative of Vision Systems International , Jan. 28, 2000; and *The Machine Vision Market: 1998 Results and Forecasts through 2003*, Automated Imaging Association, Ann Arbor, MI, 1999, p. 264 and 274.

The majority of the machine vision companies in North America are independent, privately held U.S. companies;[32] only 10 to 12 North American companies and 30 companies worldwide (about 5 percent) are public.[33] The majority of the largest machine vision companies are U.S.-based (table 2), and at least half of those listed supply the semiconductor industry.

Table 2
Top machine vision companies,[1] 1998

Company	Total world revenues (*Million dollars*)[2]	Total world machine vision revenues (*Percent*)[3]	Primary end-user industry	Home country
KLA Tencor	1,166	75	Semiconductor	United States
Orbotech	232	85	Electronics	Israel
Cognex	122	100	Semiconductor	United States
Applied Materials	4,042	3	Semiconductor	United States
RVSI	169	70	Semiconductor	United States
Perceptron	50	100	Lumber/automotive	United States
ESI	259	15	Computers/ communications	United States
ICOS	35	100	Semiconductor	Belgium

[1] Listed in descending order by estimated machine vision revenue.
[2] Based on company annual reports and 10-K reports for 1998.
[3] Estimates of the percent of total world sales dedicated to machine vision business. USITC staff interview with representative of Vision Systems International, Jan. 17, 2000.

Sources: Various company reports; USITC staff interview with representative of Vision Systems International, Jan. 17, 2000; and *The Machine Vision Market: 1998 Results and Forecasts through 2003*, Automated Imaging Association, Ann Arbor, MI, 1999, pp. 93, 126, 133.

[32] Canadian companies make up a small percentage of the total number of machine vision companies in North America. Canadian market consumption comprised more than 9 percent of the total North American machine vision market in 1998. *The Machine Vision Market: 1998,* p. 32.

[33] Of the 30 companies, less than 10 percent of their business is comprised of sales of machine vision systems. USITC staff interview with representative of Vision Systems International, Jan. 17, 2000.

Market Trends

Typically, a machine vision company serves a niche market, with most of the larger producers focusing on specific end-user industries,[34] aiming to expand industrywide adoption of the technology and create new markets for machine vision. Many companies are developing more intimate ties with their customers enabling them to share the risk in developing new machine vision products.[35] However, with many companies located overseas (domestic or foreign producers) or using production sharing (cross-border manufacturing) to minimize their overall costs and improve competitiveness,[36] machine vision companies will need to expand further into these markets. This is especially true in the semiconductor industry where outsourcing of both wafer fabrication (using foundries),[37] as well as assembly, packaging, and testing facilities,[38] has led to the growth of the industry in Asia. As the outsourcing trend by semiconductor manufacturers continues, North American machine vision companies expect to expand globally to take advantage of international opportunities. In 1998, Taiwan alone had a 55 percent share of the worldwide semiconductor foundry market, indicative of the movement of semiconductor manufacturing abroad.[39]

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[34] "Frost & Sullivan: Opportunities for Machine Vision Systems Manufacturers Lie in Food and Pharmaceutical End-User," *PR Newswire*, Nov. 16, 1998, p. 3379.

[35] *Machine Vision in the Semiconductor Industry*, p. 22.

[36] Cross-border manufacturing allows rationalization of production processes at different global locations based on inherent efficiencies or reduced costs of production inputs. See, for example, "Production Sharing: Use of U.S. Components and Materials in Foreign Assembly Operations, 1995-1998," USITC Publication 3265, Dec. 1999, at the Commission's web site www.usitc.gov/reports.htm (search by publication number).

[37] Because of the existing high cost of building technologically advanced wafer fabs, many semiconductor companies (especially smaller firms) are contracting out the fabrication process to these foundries. This trend has given rise to what is known as the "fabless" semiconductor company that simply designs the products and contracts out all production and packaging operations. USITC interviews with representatives of Applied Materials and LAM Research, Aug.19 and 20, 1999; and *Machine Vision in the Semiconductor Industry*, p. 9.

[38] Some semiconductor companies (especially smaller firms) are contracting out the assembly/test stage to independent packaging and testing houses, the majority of which are Asian owned. Some companies are also engaging in production-sharing in Asia. For a more detailed discussion of the major East Asian countries engaged in semiconductor production-sharing arrangements with the United States see USITC, "Production Sharing: Use of U.S. Components and Materials in Foreign Assembly Operations, 1994-1997," USITC Publication 3146, December 1998, pp. 3-14 to 3-18, at the Commission's web site www.usitc.gov/reports.htm (search by publication number).

[39] Because of their smaller size, these Asian facilities, reportedly, will be more open to relationships with companies that offer a complete "system" in order to maximize equipment savings and to support expenditures for capital equipment. A semiconductor fab costs approximately $2 billion, half of which is spent on equipment. For this reason, machine vision companies may look to strategic alliances and mergers and acquisitions to offer a more complete line of equipment. USITC staff interviews with representatives of ICOS Vision Systems, Inc., and Applied Materials, Aug. 19, 1999; and "Foundries for Fab and Packaging Help Shape Industry of the Future," *Channel Magazine*, Nov.-Dec. 1999, p. 14.

A firm's reputation is, reportedly, one of the most important factors for machine vision companies' competitiveness in this global marketplace. Several companies indicate that reputation plays a significant role in purchasing decisions, with purchasers often choosing North American companies having prices as much as 10 percent higher than lesser-known competitors.[40] Other factors considered important in the purchasing decision include: ease of use, speed, accuracy, repeatability, traceability, flexibility, maintenance, and reliability.[41] For example, speed and accuracy have improved 10-fold during 1994-1999,[42] but opportunities remain for further improvements.

The North American industry exported an estimated 49 percent of its shipments in 1998,[43] reportedly down from over 51 percent in 1997, attributable to the effects of the Asian financial crisis;[44] the European industry exported an estimated 37 percent (more than half shipped to North America); and the Japanese industry exported approximately 8 percent.[45] The North American industry reportedly held almost 50 percent of the North American market, about 35 percent of the European market, and over 31 percent of the Japanese market in 1998; although these shares decreased somewhat from the previous year (see table 1 for an industry and market comparison).[46] Although limited comparative information is available among global competitors, industry sources indicate that the North American industry is very competitive overall, and particularly in providing sophisticated solutions to the semiconductor industry; the European industry is smaller than the North American but relatively competitive and innovative, especially in providing sophisticated solutions to the electronics industry; and the Japanese industry, also smaller than the North American, provides less-complex systems to end users and principally focuses on its domestic market.[47]

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[40] USITC staff interviews with representatives of DTS, Amkor Technology, and Multitech Design & Test, Aug. 23, 1999.

[41] Ibid; see glossary for technical terms.

[42] USITC staff interview with representative of DTS, Aug. 23, 1999.

[43] Trade figures are based on industry reports sponsored by the Automated Imaging Association and staff contacts with industry sources. Official trade statistics for machine vision systems are not available because they are not separately provided for in the Harmonized Tariff Schedule.

[44] *The Machine Vision Market: 1998*, p. 5.

[45] USITC staff interview with representative of Vision Systems International, Jan. 17 and 28, 2000.

[46] *The Machine Vision Market: 1998*, pp. 235, 247, 266.

[47] USITC staff interview with representative of Vision Systems International, January 17, 2000.

Case Example: Semiconductor Manufacturing

The semiconductor manufacturing industry has been the largest consumer (in sales revenue) of both application-specific and general-purpose machine vision systems since 1996, when it surpassed the electronics industry.[48] One semiconductor manufacturing representative emphasizes that "machine vision has made the semiconductor industry what it is today,"[49] by performing many tasks humans cannot do. In 1998, the North American semiconductor manufacturing industry generated 34 percent of all machine vision sales revenues in the North American market (figure 3), and comprised about 48 percent of North American industry shipments (see figure 2).[50] Almost 80 percent of the sales revenues were for application-specific machine vision systems (i.e., industry specific rather than general purpose) as compared to 74 percent in 1997.

The relatively recent increase in the use of machine vision in the semiconductor industry parallels the increased need for alignment systems, optical character recognition (OCR), and 2D symbol-ready systems, which are used in all production operations.[51] The principal applications of machine vision in the semiconductor industry (both front-end and back-end)[52] are: alignment, measurement, flaw detection, optical character verification (OCV), OCR, and verification.[53] Inspection, location analysis, and pattern recognition are the

[48] All application-specific machine vision is sold directly to the semiconductor industry. In 1998, due to a slowdown in semiconductor manufacturing, the revenue of North American general-purpose machine vision companies generated by this sector declined to about 20 percent. This compares with 30 percent in 1997; but it is expected to improve in 1999-2000 as the industry and Asian markets recover. *The Machine Vision Market: 1998*, pp. 23-25.

[49] USITC staff interview with representative of Amkor Technology, Aug. 23, 1999.

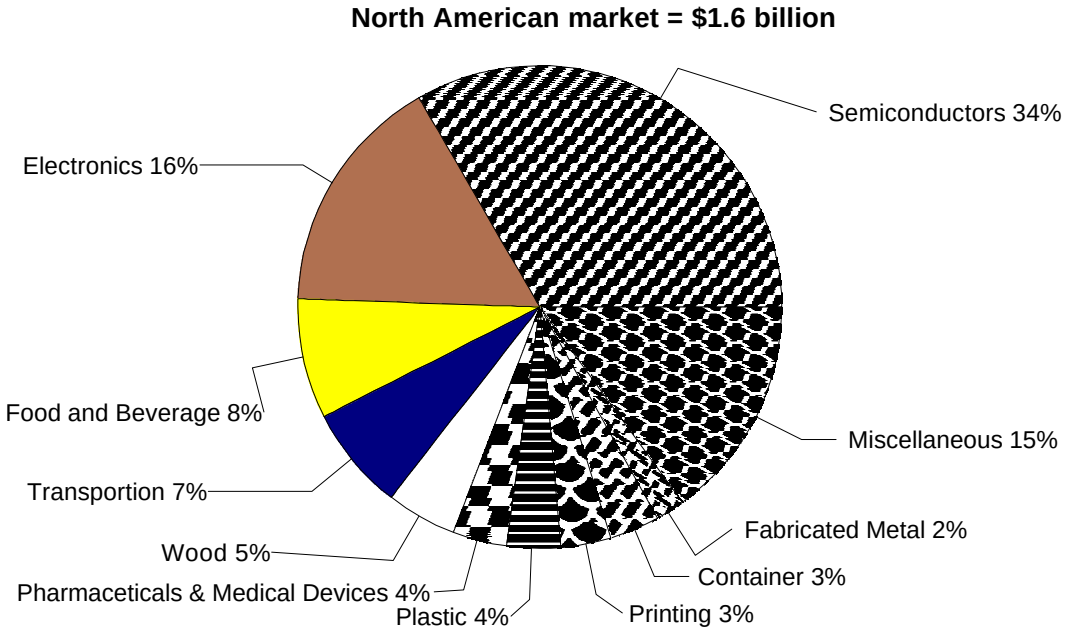
[50] In 1997, these same figures were 36 and 52 percent, respectively. The downturn in the semiconductor manufacturing industry due to overcapacity, and exacerbated by the Asian financial crisis, resulted in these declining shares. *The Machine Vision Market: 1998*, pp. 24-25, 274.

[51] *The Machine Vision Market: 1998*, p. 24.

[52] Three stages can be distinguished in the semiconductor manufacturing process. The first is the fabrication side or front-end, in which the wafer is put through various steps to build the different layers of the semiconductor chip. Once that is completed the chips must go through steps two and three, packaging and testing, or the back-end processes. Packaging involves cutting the wafer into die/chips which are then placed into differentiated packages based on end use. The die are then tested to make sure they function properly.

[53] Alignment is used to reorient the device in order to properly place specific features. Machine vision measurements commonly performed in the semiconductor manufacturing process are line width critical dimension (CD), registration of layers (overlay), wafer flatness, and lead position, among others. Flaw detection is used in both the front-end and back-end to check for defects throughout the process. OCV verifies the presence of markings and ensures proper labeling of wafers and packages. OCR is typically used to trace the wafer through the manufacturing process by the recognition of images and characters. Verification is used to check the presence of a specified characteristic. *Machine Vision in the Semiconductor Industry*, p. 33.

Figure 2
North American machine vision revenues generated by major end-use industries, 1998



Note:--Percentages based on rounded figures and do not sum to 100.

Source: *The Machine Vision Market: 1998 Results and Forecasts through 2003*, Automated Imaging Association, Ann Arbor, MI, 1999, p. 23.

generic equivalents, with inspection by far the most frequently used application.[54] Other factors fueling the expanded use of machine vision in the industry include those general manufacturing improvements and requirements already mentioned (e.g., improved performance over previously labor-intensive tasks, higher quality standards for consumer goods, improved system operation capabilities, and ease of use).[55]

The machine vision industry and the semiconductor manufacturing industry are closely linked. Technological advances in the semiconductor industry have required the use of machine vision during fabrication and packaging that would not have been possible with human vision (e.g., inspection of lead defects). Progress in machine vision technology, in such areas as speed, accuracy, throughput, higher definition, and color-based systems, have enabled semiconductor manufacturing firms to improve their manufacturing processes and develop products with

[54] In 1998, approximately 85 percent of North American machine vision industry revenue came from inspection applications, 11 percent from location analysis, and 4 percent from pattern recognition. In terms of units, the distribution is much different with 42 percent sold for inspection purposes, 45 percent for location analysis, and 13 percent for pattern recognition. *Machine Vision Market: 1998*, p. 27.

[55] USITC staff interviews with representatives of DTS, Amkor Technology, and Multitech Design & Test, Aug. 23, 1999.

improved capabilities.[56] Some of the changes in the semiconductor manufacturing industry that have required the use of machine vision are--

- Reduced size and increasing complexity of semiconductor chips,
- More demanding quality requirements of the customer,
- Faster processing speeds,
- More stringent clean-room requirements, and
- Increased packaging options and requirements.

For example, because human inspection is impossible during the front-end stage of semiconductor fabrication, industry officials point out that machine vision does not replace employees here.[57] In the back-end stage, machine vision can help packaging and testing companies improve their output, quality, and speed of processing.[58]

Changes in both front- and back-end processing in semiconductor manufacturing will be important to the machine vision industry. In the front-end, continued reduction in line widths and increase in wafer sizes will impact the machine vision industry by requiring the purchase of new production equipment. Line widths, which are critical to semiconductor manufacturing, are measured using machine vision. When advances in technology made it possible to produce line widths below 0.5 microns, conventional microscopy was unusable, creating the opportunity and necessity for machine vision.[59] This decrease in line widths has led to the need for adaptive process control and increased inspection. Additionally, increased cleanliness is required with smaller line widths because the amount of defect or dirt allowed decreases in proportion to the line width.[60] The increasing complexity and number of layers in the semiconductor wafer production process necessitate the improvement of process reliability and precision (provided by machine vision) due to increased handling and the potential for lower yield.[61]

Although price is not the primary criterion for the purchase of machine vision systems, it will certainly become an important concern for semiconductor manufacturers in the future, based on all the upgrades needed to keep up with technology changes. According to industry representatives, semiconductor equipment becomes obsolete every 2 to 4 years, making it

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[56] USITC staff interview with representative of IPAC, Aug. 19, 1999.

[57] USITC staff interview with representative of ICOS Vision Systems, Aug. 19, 1999.

[58] For example, Integrated Packaging Assembly Corporation (IPAC) has increased its product yield by 2.5 percent with the use of machine vision. USITC staff interview with representative of IPAC, Aug. 19, 1999.

[59] *Machine Vision in the Semiconductor Industry*, p. 13.

[60] The contamination, dirt particle or defect, may be no larger than one third the width of the line. *Machine Vision in the Semiconductor Industry*, p. 22.

[61] As the number of layers increases, the more the wafer must be handled and the greater the potential for individual components or die to be damaged. This requires that the process be more precise and reliable. It is estimated that a bare 200 mm wafer costs anywhere from $1,000 to $2,000 including overhead and direct costs; and a lot of finished 300 mm wafers (currently 25 wafers) can be sold for $1 to 2 million. Depending on type, the retail price of each chip can be anywhere from $3.00 to $1,000. USITC staff interviews with representatives of Applied Materials, Aug. 19, 1999; and *Machine Vision in the Semiconductor Industry*, p. 15.

necessary for manufacturers to purchase new equipment relatively often.[62] This includes machine vision equipment used in semiconductor manufacturing. For example, a stand-alone system,[63] most often used after the semiconductor chips are packaged and tested, costs $400,000 on average, whereas an integrated PC-based system costs $100,000 on average.[64] With the movement to open systems and the use of the PC platform, cost has decreased substantially but is still much higher for the complete system than for its component parts. Because machine vision is not currently considered cost effective in all stages of the semiconductor manufacturing process, especially during some of the packaging stages, industry sources believe opportunities exist for improved applications in this area.[65] The industry is striving to emulate human vision as closely as possible. Industry representatives point out that "smart" machine vision systems are needed, but that their goal is also to minimize the use of machine vision to minimize costs.[66] In the back-end in particular, machine vision is not part of the direct process, and therefore, is an additional cost. If the equipment is not cost effective or does not add to the process in some way, less incentive exists to maintain machine vision equipment. Process control and data collection reportedly are two areas in which machine vision can be very beneficial; huge cost savings are possible, especially in the wafer fabrication process.[67]

Because of the high cost of the equipment and the financial limitations of small semiconductor assembly, packaging, and testing firms, industry sources believe it would be beneficial for machine vision companies supplying equipment for these back-end processes to either form a partnership with complementary equipment companies or offer a more complete product line.[68] Such strategic alliances are expected to enable machine vision companies to achieve economies of scale and offer a fuller line of equipment at a more competitive price.

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[62] USITC staff interview with representative of Multitech Design & Test, Inc., Aug.23, 1999.

[63] A stand-alone system is a machine vision system that is not integrated with any other process equipment.

[64] USITC staff interview with representative of DTS, Aug. 23, 1999. Older equipment is usually kept operational for 5 to 8 years. Interview with representative of IPAC, Aug. 19, 1999.

[65] USITC staff interview with representative of IPAC, Aug.23, 1999.

[66] USITC staff interviews with representatives of DTS and Amkor Technology, Aug. 23, 1999.

[67] USITC staff interviews with representative of Applied Materials, Aug. 19, 1999.

[68] USITC staff interviews with representatives of ICOS Vision Systems, Applied Materials, and Vision Systems International, Aug. 19, 1999, and Jan. 17, 2000.

Outlook

By the year 2003, the North American machine vision market reportedly is expected to reach $2.2 billion[69] with North American industry shipments totaling about $2.6 billion.[70] According to industry sources, the current top ten end-use industries[71] will likely remain the principal business for machine vision suppliers, although continued emphasis on productivity and quality improvements are expected to provide the opportunity to further penetrate these markets as well as create new niche-market solutions.

Industries with rapid technology change are likely to offer the machine vision industry the greatest opportunities to develop new and innovative solutions to expand their business. For example, the potential shift in the semiconductor industry from production of a wafer size of 200 mm to a larger, 300 mm wafer is expected in 2001-2002.[72] This shift will necessitate the purchase of new manufacturing equipment to handle and process the larger wafers. The use of the larger wafers will require that robots do all the handling, as the increased weight makes it impractical for humans to handle. These changes will encourage the purchase of new machine vision systems to be integrated into new processing and handling equipment. Further, new semiconductor packaging technologies include new techniques, such as chip scale packaging using flip chips (see glossary) that require new machine vision equipment.[73]

Other industries may follow the pharmaceutical industry in increasing the use of machine vision to avoid the potential threat of costly legal action. Possible product contamination, and its legal consequences, was one of the key driving forces for initial adoption by the medical devices industry.[74] Industry observers believe that opportunities exist for the application of machine vision in the area of drug development to improve efficiency and meet stricter production specifications.[75] Product labeling is another application in which machine vision reportedly can provide innovative solutions for use in many industry sectors. According to market researchers at Frost & Sullivan, the automotive sector will be the next to expand the use of machine vision, and it is expected to be the largest user by 2004.[76]

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[69] *The Machine Vision Market: 1998*, p. 4.

[70] Ibid, p. 276.

[71] The ten industries are: semiconductors, electronics, container, transportation (e.g., automotive), plastic, food/beverage, wood, pharmaceuticals/medical devices, fabricated metals, and printing. In 1998, machine vision suppliers perceived that general-purpose machine vision products penetration of the textile industry was 10 percent, whereas in the container industry penetration was nearly 46 percent. *The Machine Vision Market: 1998*, p. 69.

[72] The movement to smaller line widths, which enables the production of more chips on a wafer and has the same effect as producing a larger wafer, may delay the shift from a 200 mm to a 300 mm wafer size. In 2000, about half the semiconductor wafers produced will be 200 mm size with the remainder being smaller. By 2005, it is expected that around 5 to 10 percent of the wafers produced will be 300 mm size. *The Machine Vision Market: 1998*, pp. 123-124.

[73] Flip chips reduce the size and improve the performance of the final product. "Market & Technological Trends," *SMT Trends*, Apr. 1, 1998.

[74] Guidoni, George, "Bigger visions in sight," *Canadian Packaging*, Dec. 1998, pp. S1-3.

[75] Ibid.

[76] Teresko, John, "New Eyes in Manufacturing," *Industry Week*, Apr. 19, 1999, p. 47.

According to industry officials, the further development of underlying technologies is likely to play a crucial role in the machine vision industry. For example, although in the past lighting limitations reportedly slowed adoption of machine vision,[77] promising new advances have been made in this technology.[78] Faster and more precise cameras with better granularity and pattern recognition have increased the capabilities of machine vision.[79] Other advances have led to the development of color-based and 3-D machine vision systems creating more cost-effective and accurate solutions.[80] The development of software is a key factor in the integration of the complete system. Machine vision has provided a competitive advantage in some industries and has become a necessity for others, and will likely continue to do so in the future. As the systems become more powerful and easier to implement and use, the opportunities will continue to grow for the further adoption of machine vision in manufacturing.**#**

[77] Issues with lighting, such as timing and illumination, limited the ability of machine vision to properly "see" the particular item being examined in the process, and, therefore, diminished repeatability and efficiency of the earlier systems.

[78] USITC staff interview with representative of RVSI, Jan. 17, 2000; and "RVSI Announces New Visionscape I-Pak, a Total Vision Solution for the Pharmaceutical Industry," *Business Wire*, Apr. 16, 1999, p. 1064.

[79] Hewlett Packard and IBM are companies that are working on new technologies in this area. USITC staff interview of Vision Systems International representative, Jan. 17, 2000.

[80] Color-based systems are most often used in the food industry to sort and grade fruits and vegetables. *The Machine Vision Market*, p. 291. 3-D systems are used to re-create the image in order to locate different depths or regions on an object. Corman, Bruce, "3D Inspection of Sheet Metal Cutting Tools," *Fabricating Equipment News*, Mar. 2000, pp. 42-43. For information on European companies that sell 3D machine vision see Braggins, Don, "What to Watch for in Euro Machine Vision, 1998," *Advanced Imaging*, Feb. 1998, p. 16.

Glossary

Machine Vision Terminology[1]

Alignment system	Machine vision system used in the positioning of a component with respect to some other specified part.
Application-specific vision system	Turnkey system addressing a single specific application used widely throughout the end-use industry.
Electronic imaging	Photographic system in which a sensor is placed behind a camera lens to convert an image into an electronic signal that can be stored for a later playback on a television screen.
Electro-optical system integration	Process of combining the major hardware elements of a machine vision system.
General-purpose machine vision	Machine vision products that can be configured or adapted to many different generic applications (e.g., flaw inspection, gauging, assembly verification, find/locate).
High-speed digital imaging	Process of rapidly capturing an image with a digital camera.
Machine vision	Study and implementation of systems that allow machines to recognize objects from acquired image data and perform useful tasks from that recognition. It employs any number of electro-optical or noncontact techniques to acquire the image data, process that data, and analyze it to draw conclusions with little or no operator intervention.
Modular machine vision system	Machine vision system with standardized components for flexible use.
OEM	Original equipment manufacturer usually is a firm that makes products practically from scratch.

[1] The machine vision terminology definitions were taken from the following sources: Van Zant, Peter, *Microchip Fabrication: A Practical Guide to Semiconductor Processing*; "The Many Faces of Machine Vision System Suppliers," *Control Engineering; Academic Press Dictionary of Science and Technology*; "The Many Faces of Machine Vision System Suppliers," *Control Engineering;* Myler, Harley R., *Fundamentals of Machine Vision*; "Machine Vision Market: 1998 Results and Forecasts through 2003," Automated Imaging Association; Newton, Harry, *Newton's Telecom Dictionary*; Kren, Lawrence, "A Fresh Look at Machine Vision: Technology Advances Continue to Drive Down the Cost of Automatic Inspection and Make Systems More Plug-and-Play," *Machine Design*; and USITC staff interviews with industry representatives.

Glossary–*Continued*

Machine Vision Terminology–Continued

Real-time image data analysis	Process of analyzing images as rapidly as they are being acquired by the camera.
Stand-alone machine vision system	Machine vision system not integrated into other production equipment. For example, stand-alone systems are used in the semiconductor back-end manufacturing process, especially after the test.
Surface inspection system	Machine vision system that inspect the surface of an object or part.
3D machine vision	System that offers 3-dimensional measurements based on the calculation of range by using triangulation measurement techniques.
2D symbol-ready system	Machine vision system that recognizes specified 2-dimensional symbols.

Semiconductor Industry Terminology[2]

Assembly	Portion of the semiconductor manufacturing process that is involved in mounting semiconductor die into packages. See also back-end semiconductor processing and packaging.
Back-end semiconductor processing	Portion of the semiconductor manufacturing process that is involved in mounting semiconductor die into packages. See also assembly and packaging.
Bond pad	Metalized area on a chip, usually square and located at its periphery, used to electrically connect the chip with the package.
Chip	A semiconductor device. A small part of a semiconductor wafer that contains a single complete circuit or device. Also called die.
Chip scale packaging	A semiconductor package that has an overall external dimension no more than 20 percent larger than the size of the die being packaged. For example, if the die size is 3 x 2 mm, the package would be considered chip scale packaging if its external dimensions are not more than 3.6 x 2.4 mm.

[2] The semiconductor industry terminology definitions were taken from the following sources: Van Zant, Peter, *Microchip Fabrication: A Practical Guide to Semiconductor Processing*; "Machine Vision in the Semiconductor Industry," Automated Vision Systems; and USITC staff interviews with industry representatives

Glossary–*Continued*

Semiconductor Industry Terminology–Continued

Die	A semiconductor device. A small part of a semiconductor wafer that contains a single complete circuit or device. Also called chip.
Fab	Identifies the facility used in the fabrication of semiconductors (also known as wafer fabs or semiconductor fab), often referred to as the front-end of the semiconductor manufacturing process.
Flip chip	A chip that has bumps of a connecting metal deposited or plated onto its surface and then is "flipped" over for soldering to the package.
Front-end semiconductor processing	Portion of the semiconductor manufacturing process that is involved in taking a raw wafer and creating the devices including the metal and bond pads.
Lead	Metal connection that extends from a semiconductor device package to make contact with the printed circuit board.
Line width critical dimension (CD)	Width of a feature on a semiconductor device. Usually the smallest width.
Mask	Glass or quartz substrate with a metal, usually chrome, pattern used to expose photoresist during lithography. The mask contains patterns (usually repetitive) for all devices on the wafer. When exposing a wafer through a mask, the wafer is exposed one device at a time. Compare with reticle.
Optical character recognition (OCR)	Process of reading a character string automatically.
Optical character verification (OCV)	Machine vision process that verifies a character string as correct and legible.
Packaging	Portion of the semiconductor manufacturing process that is involved in mounting semiconductor die into packages. See also assembly and back-end semiconductor processing.
Repeatability	A measure of the result of repeated measurements on the same part.
Reticle	Glass or quartz substrate with a metal, usually chrome, pattern used to expose photoresist during lithography. The reticle contains the pattern for one device on the wafer. When exposing a wafer through a mask, the wafer is exposed one device at a time. Compare with mask.

Glossary–*Continued*

Semiconductor Industry Terminology–Continued

Semiconductor An element such as silicon or germanium, intermediate in electrical conductivity between the conductors and the insulators, in which conduction takes place by means of holes and electrons.

Traceability The ability to keep track of the history of a part or system from its beginning steps in manufacturing to its use by the end customer.

Wafer A thin, usually round slice of a semiconductor material, from which chips are made.

Yield A percentage used in the semiconductor industry to indicate the amount of finished product leaving a process as compared to the amount of product entering that process.

Agriculture in the WTO: The Seattle Ministerial and Beyond

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In early December 1999, leaders from the 135-nation World Trade Organization (WTO) met in Seattle, Washington, for the third WTO Ministerial Conference.[2] Key among the objectives was to launch a new round of negotiations that would further reduce barriers to agricultural trade and tighten disciplines on trade-distorting domestic farm policies.[3] The outcome of the meeting was to have been contained in the Ministerial Declaration, outlining the areas for negotiation, targets for agricultural trade disciplines, and the timing for completion. The Conference was suspended without an agreement on key issues related to agriculture, labor, the environment, and developing-country concerns. As a result, agricultural negotiations, mandated by the Uruguay Round Agreement on Agriculture (URAA) to begin in January 2000, will be based solely on Article 20 of the URAA, which required continued negotiations aimed at further reductions in support and protection of the agricultural sector, but with no deadline for completion. This review examines the current status of multilateral trade negotiations for agriculture, identifies major policy differences among the major participants, describes why compromise in Seattle could not be reached, and discusses how the negotiations may proceed over the next few years.

Since the mid-1980s, U.S. agricultural exports have more than doubled, reaching a record high of almost $60 billion in 1996 (figure 1); and U.S. Department of Agriculture (USDA) forecasts indicate that exports will increase over the next decade, perhaps reaching $73 billion by 2008.[4] The contribution of export revenues to overall farm cash receipts (net of government payments) has also grown considerably, increasing from about 18 percent in 1986 to nearly 30 percent during 1995-96 (figure 2). The importance of export markets was

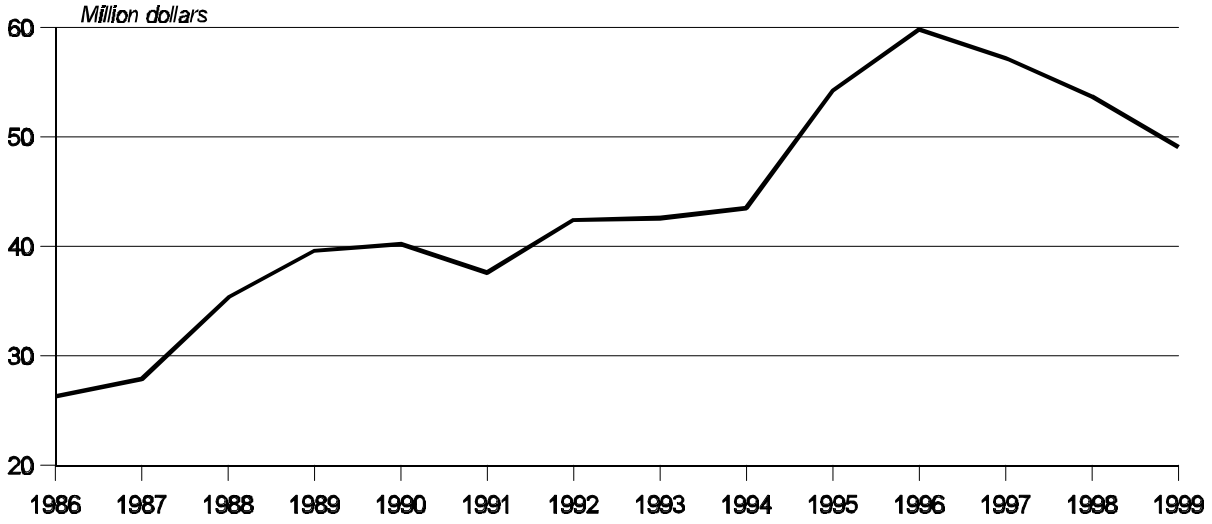
[1] The views expressed in this article are those of the author. They are not the views of the International Trade Commission or any of the Commissioners.

[2] As required by the WTO's founding charter, the Ministerial Conference meets at least once every 2 years. The two previous Ministerials took place in Singapore (December 1996) and Geneva (May 1998). The Ministerial Conference is the WTO's highest decision-making body.

[3] "The 3rd WTO Ministerial Conference. Background. The Seattle Ministerial," WTO - Official Ministerial website, found at Internet address http://www.wto.org/wto/seattle/english/about_e/03bgd_e.htm, retrieved Jan. 7, 2000.

[4] USDA, World Agricultural Outlook Board, "USDA Agricultural Baseline Projections to 2008," Staff Report WAOB-99-01, Feb. 1999.

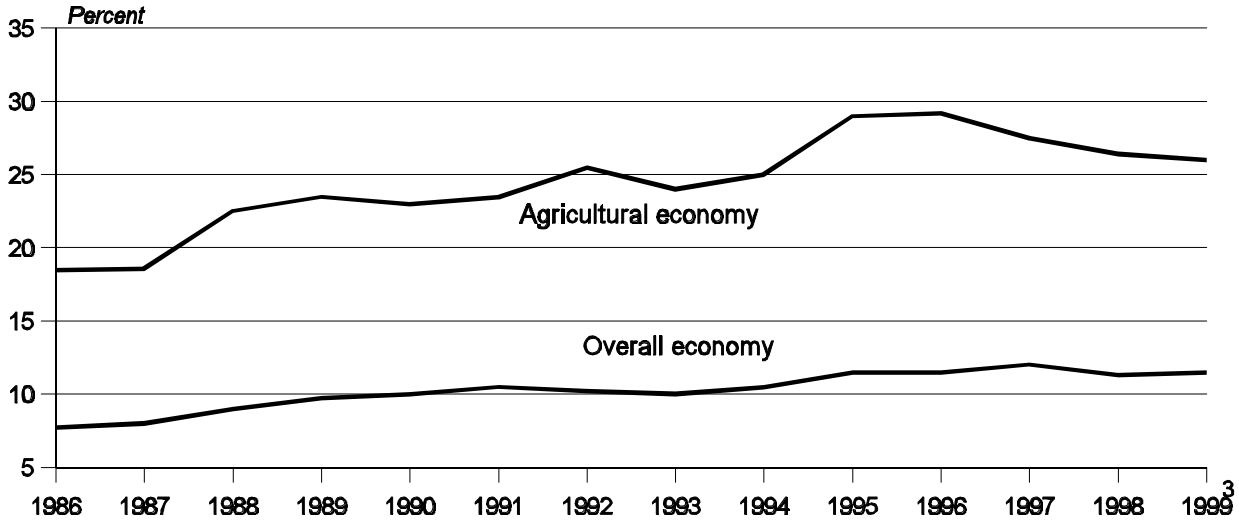
Figure 1
U.S. agricultural exports, 1986-99[1]



[1] Export values for fiscal year (Oct. 1 - Sept. 30).

Source: USDA, ERS, "Statistical indicators," *Agricultural Outlook*, issues covering 1986-99.

Figure 2
Export reliance: Agricultural[1] and overall[2] economy, 1986-99



[1] Agricultural export reliance=agricultural exports/cash receipts - government payments.
[2] Overall economy export reliance = total exports/gross domestic product.
[3] Projected.

Source: USDA, ERS, "Statistical indicators," *Agricultural Outlook*, issues covering 1986-2000.

highlighted recently when the economic crises in Asia (1997) and Russia (1998) negatively affected U.S. commodity prices and farm incomes.[5] Further, U.S. agricultural exports are estimated to support over 815,000 full-time jobs,[6] and are closely associated with improvements in farm equity and asset values over time.[7] Consequently, prosperity in the U.S. agricultural sector has become increasingly tied to the success of its exports.

More than 96 percent of the world's population live outside U.S. borders, and the United States will likely continue to produce considerably more food than it can consume.[8] Also, the potential growth in consumption for U.S. agricultural products (driven primarily by increases in income and population) is considerably greater in overseas markets, particularly in Latin America and Asia, than in the domestic market.

U.S. agricultural trade is significantly influenced by trade policies. Currently, the United States is participating in several regional, bilateral, and multilateral trade agreements that have facilitated trade by opening markets and reducing market distortions. The most important multilateral trade agreement affecting world agricultural markets is the WTO's Uruguay Round Agreement on Agriculture (URAA), which required WTO members to progressively reduce trade barriers for agricultural products during 1995-2000, and mandates that new agricultural negotiations begin this year.[9] A successful outcome of these negotiations is generally considered by most U.S. parties as important for the continued growth of agricultural trade and the future prosperity of farmers and ranchers, as well as the agricultural sectors of other countries.

Perspective: The Uruguay Round Agreement on Agriculture

The URAA, along with other accords in the Uruguay Round Agreements (URA), came into force in January 1995. The year 2000 marks the final year of the implementation of the URAA for developed economies.[10] Key provisions of the URAA include reductions in expenditures on export subsidies and in the quantities of exports receiving subsidies, conversion of nontariff border measures to tariffs (tariffication) coupled with tariff reductions, increases in minimum import access, and limits on trade-distorting domestic supports (box 1).

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[5] USDA, ERS, "Agricultural Trade and the 1997-99 International Financial Crises," *Agricultural Outlook*, Jan.-Feb. 2000.

[6] USDA, Office of Communications, "Sowing the Seeds for a New Millennium," Annual Report of the Secretary of Agriculture, FY 1999, p. 3, found at Internet address http://www.usda.gov/news/pubs/99arp/annualreport.pdf, retrieved Jan. 18, 2000.

[7] Comments of Debra Henke, Director of the Multilateral Trade Negotiation Division, USDA, FAS, at Cornell Program on Dairy Markets and Policy Workshop, Seattle, Oct. 18, 1999.

[8] Remarks by August Schumacher, Jr., Under Secretary for Farm and Foreign Agricultural Service, at Agricultural Outlook Forum, Feb. 22, 1999.

[9] Mandated by Article 20 of the Agreement on Agriculture. Negotiations on agriculture (as well as services) are the key elements of the so-called built-in agenda.

[10] Under the URA, developing countries are required to complete implementation by 2004.

Box 1
Major provisions of the Uruguay Round Agreement on agriculture

Export subsidies. Over a six-year implementation period (1995-2000), expenditures on export subsidies is being reduced by 36 percent, and volume by 21 percent, compared with the agreed 1986-90 base period average level. Products not receiving subsidy in the base period were made not eligible for future export subsidies.

Tariffication. Countries were required to convert nontariff barriers (such as quotas, embargoes and licensing) to tariffs. These tariffs, as well as pre-existing tariffs, are being reduced over six years by a minimum of 15 percent and on average 36 percent (simple, unweighted average).

Minimum access. Where imports into a country were already taking place, this level of access was preserved within the tariff quota. However, if import access was less than 3 percent of the market for each product (based on 1986-90 consumption), countries were required immediately to provide access of 3 percent. Minimum access is to be increased to 5 percent within six years.

Internal supports. Over six years, domestic support, as determined by the Aggregate Measure of Support (AMS) which provides an estimation of expenditure on trade-distorting programs, is being reduced by 20 percent compared to the agreed 1986-88 base period. Reductions are being made on support across all commodities, not on a commodity-by-commodity basis as in the case of market access and export subsidy provisions. Policies considered not to be trade-distorting and some forms of direct payments for production-limiting programs were excluded from the AMS calculation.

Safeguards. Special safeguard provisions enable countries to temporarily apply extra duties for products specified in their schedules of concessions if import prices fall below a certain level or if the quantity of imports rises too quickly in relation to an average over the previous three years.

Special concessions for developing countries. Developing countries are subject to only two-thirds of the cuts in tariffs, domestic support, and export subsidies. Cuts are required to be made over ten years. Least developed countries are exempt from all reduction commitments, although they must bind tariffs and domestic supports.

Article 13 (Due Restraint; commonly called the "Peace Clause"). Non-trade distorting policies, provided they do not directly contravene the provisions of the URAA, are not subject to GATT challenges for up to three years beyond the six-year duration of the URAA.

Article 20 **(Continuation of the Reform Process)**. Article 20 of the URAA requires that a new round of talks should be initiated by the final year of the implementation period (January 1, 2000).

Source: U.S. Uruguay Round Agreements Act, Statement of Administrative Action, pp. 709-741.
Also see USDA, FAS, "A Summary of the Final Act of the Uruguay Round, Agreement on Agriculture," found at Internet address http://www.fas.usda.gov/itp/Policy/Gatt/ag_text_html, retrieved Mar. 24, 2000.

Also affecting agriculture is the separate Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). This Agreement is aimed at preventing countries from using arbitrary and unjustifiable health and environmental regulations to block trade in agricultural products by establishing basic rules for trade-restricting measures to protect food safety and plant and animal health.[11] Other agreements affecting agricultural trade are the Agreement on Technical Barriers to Trade (TBT Agreement)[12] and the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement).[13]

Several USDA, independent, and private sector assessments have been made of the URAA which have identified both successes and shortcomings. On the plus side, the URAA was the first agreement to bring agriculture under the effective discipline of the General Agreement on Tariffs and Trade (GATT).[14, 15] It also established rules providing more favorable conditions for trade in agricultural products.[16] Tariffication brought increased transparency to existing nontariff barriers, while the minimum access and export subsidy provisions provided the basis for a more efficient flow of agricultural commodities worldwide.[17] Although separate from the agricultural agreement, improved dispute settlement procedures are considered by industry sources to be an important achievement of the Uruguay Round, and several disputes regarding agricultural products have already been taken to the WTO Dispute Settlement Body. Further, some observers consider that the most important accomplishment was that the URAA established rules that can be built upon in future international agreements.[18]

Regarding apparent shortcomings, the foregoing assessments could suggest a more favorable picture than may exist in terms of actual liberalization achieved in world agricultural markets since 1995. Concerning export subsidies, for example, while the outlay and quantity

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[11] U.S. Uruguay Round Agreements Act, Statement of Administrative Action, pp. 742-763. Also see USDA, FAS, "A Summary of the Final Act of the Uruguay Round, Agreement on Sanitary and Phytosanitary Measures," found at Internet address http://www.fas.usda.gov/itp/Policy/Gatt/sps_txt.html, retrieved Mar. 24, 2000.

[12] For details, see USDA, FAS, "Agreement on Technical Trade Barriers," found at Internet address http://www.fas.usda.gov/itp/Policy/Gatt/tbt_text.html, retrieved Mar. 24, 2000.

[13] For details, see USDA, FAS, "Agreement on Trade-Related Aspects of Intellectual Property Rights," found at Internet address http://www.fas.usda.gov/itp/Policy/Gatt/sum_fact.html#nAgreement, retrieved Mar. 24, 2000.

[14] USDA, ERS, "Agriculture and the WTO: The Road Ahead," *Agricultural Outlook*, Dec. 1996.

[15] In earlier rounds, agriculture had been granted special exemptions from GATT rules (under GATT 1947) and had not been subject to the disciplines applied to industrial and manufactured goods. USDA, ERS, "Uruguay Round Agreement on Agriculture: The Record to Date," *Agricultural Outlook*, Dec. 1998.

[16] International Policy Council on Agriculture Food and Trade, *Agenda Options for Agricultural Policy Reform in the Seattle Round*, IPC Position Paper No. 10, Washington, DC, 1999.

[17] Ingco, M.D., "Agricultural Liberalization in the Uruguay Round," *Finance and Development*, World Bank, Washington, DC, Sept. 1995.

[18] Martin, W., and L.A. Winters, *The Uruguay Round. Widening and Deepening the World Trade System*, World Bank, Washington, DC, Oct. 1995.

reductions may have strengthened world prices, permitted dairy subsidies under the URAA when fully implemented would represent an estimated 60 percent of world dairy trade; 40 percent in the case of wheat.[19] Market access provisions were probably affected by several factors. First, many countries allegedly engaged in so-called dirty tariffication when converting their nontariff barriers into tariffs, that is, setting tariff equivalents to provide more protection against imports than did the previous system of quantitative restrictions. Second, the base period (1986-88) in the URAA for gauging market access was one of high levels of protection (because commodity prices were generally low during 1986-88), such that tariff reductions from a high base level yield smaller actual cuts than if a more representative or normal base period had been chosen. Third, while tariffs were required to be reduced by 36 percent on average, only a 15 percent reduction was required for individual commodities, thus encouraging most countries to opt for placing the lowest allowable level of tariff cuts on their most import-sensitive commodities.[20] Fourth, the special safeguard provisions reduced the impact of tariff bindings by permitting countries to impose additional duties under certain market conditions. And finally, according to industry sources, the minimum market access requirement of 5 percent of domestic consumption has not presented major opportunities for exporters in world markets.

The URAA also achieved limited progress in reducing domestic support expenditures on trade-distorting programs, because the parties reportedly could only agree to reduce aggregate domestic support for agriculture and not for individual commodities. Further, not only were abnormally higher levels of support typical of the 1986-88 base period (translating into higher base AMS estimates than if a more representative period had been chosen), but also certain partly decoupled programs[21] were exempt from the agreement to reduce domestic supports.[22]

Overall, although the URAA is generally considered by most observers a promising start in the process of trade liberalization, many observers note that it is no more than a start. For example, even after full implementation many world agricultural markets will remain characterized by highly subsidized exports, limited market access, and heavy government intervention.

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[19] According to the USDA, the EU is the major user of subsidies, and will hold about 83 percent of global subsidies once the URAA is fully implemented, compared with the United States' share of only 2 percent. USDA, ERS, "Export subsidies," *ERS's WTO Briefing Round*, found at Internet address http://www.econ.ag.usda.gov/ briefing/wto/issues/export/htm, retrieved Sept. 24, 1999.

[20] For example, Canada's bound tariff rate for cheese is 289 percent; a commitment to reduce the tariff 15 percent by 2000 results in a final rate of 246 percent. This effectively closed the door on over-quota imports.

[21] Decoupled programs are those that do not link payments to production levels.

[22] As a result, the EU and the United States had fully met their URAA commitments on domestic supports even before the round came into force. For more information, see USDA, ERS, "U.S. Ag Policy—Well Below WTO Ceilings on Domestic Support," *Agricultural Outlook*, Oct. 1997.

The Next Round

Article 20 of the URAA called for a new round of negotiations to be initiated one year before the end of the implementation period and to be aimed at achieving the long-term objective of substantial, progressive reductions in agricultural support and protection (box 2). Thus, the new round is to focus mainly on tightening disciplines on export subsidies, increasing market access, and further limiting the use of trade-distorting domestic supports.[23] However, several countries requested that negotiations based on Article 20 also include disciplines in other areas, such as controls over state-trade enterprises. Other issues in the new round may include how to handle new technologies (particularly biotechnology), as well as the extent to which agricultural disciplines should reflect environmental, consumer, and social concerns (the so-called multifunctionality of agriculture).[24]

Box 2
Article 20 of the URAA - Continuation of the reform process

Recognizing that the long-term objective of substantial progressive reductions in support and protection resulting in fundamental reform is an ongoing process, Members agree that negotiations for continuing the process will be initiated one year before the end of the implementation period, taking into account--

- Experience to that date from implementing the reduction commitments;
- Effects of the reduction commitments on world trade in agriculture;
- Non-trade concerns, special and differential treatment to developing country Members, and the objective to establish a fair and market-oriented agricultural trading system, and the other objectives and concerns mentioned in the preamble to this Agreement; and
- What further commitments are necessary to achieve the above mentioned long-term objectives.

Source: Uruguay Round Agreement on Agriculture.

Negotiating Positions

The negotiating positions among the 135-member countries of the WTO have been characterized as falling into three major groups—reform, status quo, and developing countries.[25] The United States, Cairns Group countries,[26] and several market-oriented

[23] International Policy Council on Agriculture Food and Trade, *Agenda Options for Agricultural Policy Reform*, IPC Position Paper No. 10, Washington, DC, 1999.

[24] Ibid.

[25] "Stark differences remain in approach to Seattle meeting," *Feedstuffs*, Oct. 15, 1999.

[26] The Cairns Group consists of 18 medium-sized agricultural exporting countries with the shared goal of liberalizing global commodity markets. Members include Argentina, Australia, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Fiji, Guatemala, Indonesia, Malaysia, New Zealand, Paraguay, the Philippines, South Africa, Thailand, and Uruguay.

countries in Latin America have been identified in the reform group.[27] These countries hoped to see a specific negotiating agenda emerge from the Seattle meeting, with specific targets for export subsidies, market access, and trade-distorting domestic support disciplines.[28] The countries favoring the status quo were led by the European Union and Japan, and included other European countries such as Hungary, the Czech Republic, Switzerland, and Norway. This group reportedly favored a negotiating agenda based on the general scope of Article 20 without being more specific, and wanted to retain the right to use export subsidies, minimize further major increases in import access, and preserve the right to maintain producer subsidies.[29] The developing countries, which comprise the vast majority of WTO members, faced the new round with concerns that the URAA had done little that helped them. This group reportedly favored continued special and differential treatment in new negotiations, as well as additional concessions under the existing agreement.[30]

Agricultural Issues

During the period leading up to the Seattle Ministerial, several proposals were advanced by certain member countries regarding the framework for negotiations, and various options were submitted for the agenda. Differences over these proposals among the reform, status quo, and developing countries emerged, continued into the Ministerial, and reportedly were among the key reasons why the Seattle meeting ended without an agreement. The key issues affecting the negotiating positions, as reported by various sources, are summarized below and highlighted in table 1.

Export support

Several areas of disagreement have centered on how to tighten disciplines on export supports.[31] The pro-reform countries contend that export subsidies are the most distorting factor affecting world agricultural trade, and that the elimination of subsidies should be the number one objective in the coming round.[32] However, the status quo countries have put an equally high priority on continuing the use of subsidies.[33] Meanwhile, the developing countries favor elimination of subsidies provided they are given special and differential treatment.[34] Whatever decision is reached on export subsidies will depend on several questions that currently remain unanswered. If eliminated, over what period, and if reduced, by how much and over what period; and, what special treatment should be given to developing countries?

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[27] "Stark differences remain," *Feedstuffs*, Oct. 15, 1999.

[28] Ibid.

[29] "OECD meeting provides pointer to WTO talks," *Agra Europe*, Mar. 13, 1998.

[30] "Stark differences remain," *Feedstuffs*, Oct. 15, 1999.

[31] "Playing field on export subsidies needs to be leveled," *Feedstuffs*, Oct. 22, 1999.

[32] "The WTO and America's Agricultural Trade Agenda,"statement of Ambassador Peter Scher, Special Trade Negotiator, before the Senate Committee on Agriculture, Sept. 30, 1999; Also, communiqué following meeting of Cairns Group farm ministers, Sydney, Apr. 1998.

[33] "EU farm ministers agree outline goals for WTO," *Agra Europe*, Sept. 17, 1999.

[34] Proposal by Kenya, July 1999.

Export credits for agricultural products are identified as a form of subsidy by the WTO, but are not subject to WTO disciplines.[35] Exporters that can offer favorable credit terms to importers through government programs are at a considerable advantage in international markets.[36] Some observers have argued that as export subsidy disciplines become more restrictive, countries will resort to alternative mechanisms, such as export credits, that are not restricted.[37] Currently, agricultural export credit disciplines are being considered under the auspices of the OECD, and a recent U.S. proposal to the OECD would introduce disciplines on agricultural export credits similar to those on industrial export credits.[38] The EU strongly supports WTO disciplines on all forms of export support, in particular, export credits.[39] The EU already is significantly adversely affected by existing export subsidy disciplines since it reportedly accounts for more than 80 percent of world agricultural subsidies allowable under the URAA.[40]

Another issue concerns food aid.[41] While few question the need for humanitarian aid in cases of famine or disaster relief, food aid can act as a form of surplus removal and can crowd out commercial exports of competitive countries.[42] Finally, export restrictions[43] ar a concern of import-dependent countries such as Japan and several least-developed countries.[44] According to these countries, such restrictions contribute to unstable and unpredictable markets, providing justification for trade barriers and domestic support to

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[35] The subsidy component of export credits could be subject to disciplines. For discussion of methods to calculate the subsidy component of export credits, see Hyberg, B., D. Skully, and C. Davison, "Export credit guarantees: The Commodity Credit Corporation and U.S. agricultural policy," *Food Policy*, vol. 20, no. 1, 1995.

[36] An example is the USDA's GSM-102 program, which offers certain importers of U.S. products government guaranteed loans for up to 3 years. For further details of the program, see USDA, FAS, *Export Credit Guarantee Programs*, found at Internet address http://www.fas.usda.gov/excredits/exp-cred-guar.html, retrieved Mar. 24, 2000.

[37] Thompson, Y., P. Liapis, and P. Sckokai, "Alternative Trade Mechanisms in World Dairy Markets," *Canadian Journal of Agricultural Economics*, forthcoming, Mar. 2000.

[38] The proposal would limit the repayment period and link credit amounts to recipient country per capita GDP. For further details see USDA, FAS, "OECD Negotiations on Export Credits," found at Internet address http://www.fas.usda.gov/excredits/exp-cred-guar.html, retrieved Mar. 8, 2000.

[39] "Playing field on export subsidies," *Feedstuffs*, Oct. 22, 1999.

[40] USDA, FAS, Outreach offices, WTO Regional Domestic Outreach Presentation, found at Internet address: http://www.fas.usda.gov/itp/wto/presentation/demoutreach.html, retrieved Mar. 23, 2000.

[41] In FY1999, about 7 million tons of cereals were donated by the United States as aid, with Russia, Bangladesh, and Indonesia the major recipients. USDA, FAS, Planned US Food Aid for FY99, facsimile retrieved Feb. 28, 2000.

[42] "Playing field on export subsidies," *Feedstuffs*, Oct. 22, 1999.

[43] Examples are taxing or prohibiting exports of grains and oilseeds in order to assist domestic grain processing and livestock industries. Another is food embargoes due to sanctions.

[44] "Japan to lobby against export curbs," *Agra Europe*, Oct. 1, 1999.

Table 1
Overview of broad negotiating objectives of major participants in WTO agricultural negotiations, January 2000

	Reformers		Status quo supporters		
Issue	**United States**	**Cairns Group**	**European Union**	**Japan**	**Developing countries**
Export support:					
Classic export subsidies	Complete elimination	Complete elimination	Reductions	Reductions	Elimination with special treatment for LDCs
Export credits/ guarantees	Introduce limited disciplines within OECD	Introduce WTO disciplines	Introduce WTO disciplines	Position unstated	Position unstated
Food aid	Exempt from disciplines	Introduce disciplines	Introduce disciplines	Introduce disciplines	Position unstated
Export restrictions	Introduce disciplines	Introduce disciplines	Introduce disciplines	Introduce disciplines	Introduce disciplines
Market access:					
Tariffs	Bind and lower tariffs Reduce tariff disparities	Deep cuts, curtail tariff peaks and tariff escalation	Limit major reductions	Limit major reductions	Lower tariffs on agricultural products of interest to LDCs
TRQs	Increase TRQ quantities Reduce over-quota tariffs	Increase TRQ quantities Reduce over-quota tariffs	Limit major TRQ quantity increases	Limit major TRQ quantity increases	Increase TRQ quantities Reduce over-quota tariffs
TRQ administration	Reform and simplify	Reform and simplify	Reform and simplify	Reform and simplify	Reform and simplify
Special safeguards	Continue	Eliminate	Continue	Continue	Eliminate on agricultural products of interest to LDCs

Table 1—*continued*
Overview of broad negotiating objectives of major participants in WTO agricultural negotiations, January 2000

	Reformers		Status quo supporters		
Issue	**United States**	**Cairns Group**	**European Union**	**Japan**	**Developing countries**
Internal supports:					
Amber box	Substantially reduce trade-distorting supports	Eliminate trade-distorting supports	Modest reductions in trade-distorting supports	Modest reductions in trade-distorting supports	Reductions with special treatment for LDCs
Green box	Continue	Review definition of non-trade-distorting policies	Re-open to account for multifunctionality	Re-open to account for multifunctionality	Continue
Blue box	Position unstated	Eliminate	Continue	Continue	Position unstated
Peace clause	Position unstated	Eliminate	Continue	Continue	Position unstated
SPS Agreement	Do not re-open	Do not re-open	Re-open to account for precautionary principle	Re-open to account for precautionary principle	Position unstated
Biotechnology	Make rules transparent and predictable	Make rules transparent and predictable	Allow restrictions on GMOs based on precautionary principle	Allow restrictions on GMOs based on precautionary principle	Make rules transparent and predictable
State trading enterprises	Introduce disciplines on monopoly STEs Increase transparency	Disciplines, if introduced, should also apply to private firms	Introduce disciplines on monopoly STEs Increase transparency	Introduce disciplines on monopoly STEs Increase transparency	Introduce disciplines on monopoly STEs Increase transparency
Preferential treatment for developing countries	Continue and strengthen	Continue and strengthen	Continue and strengthen	Continue and strengthen	Continue and strengthen
Multifunctionality (non-trade concerns)	Should not be addressed in future negotiations	Should not be addressed in future negotiations	Should be addressed in future negotiations	Should be addressed in future negotiations	Position unstated

Source: Compiled from various government, industry, and trade sources by U.S. International Trade Commission.

protect their own industries. Such barriers are of particular concern to many of the export-dependent Cairns Group countries.[45]

Market access

Although it was generally accepted that a new round would widen market access by lowering tariffs and increasing tariff-rate quotas (TRQs), several issues relating to implementation of greater access were raised prior to the Ministerial.[46] For instance, to what extent should tariffs be reduced and over what period?[47] Several low-tariff countries contend that employing a straight line formula, as used in the Uruguay Round, is unfair,[48] and that other formulas, such as the Swiss formula, should be explored.[49] There has been discussion of establishing a maximum tariff (e.g., 25 percent) for all products, and then making future reductions from that level.[50] Also concern exists over tariff escalation (where higher tariffs are applied to higher-valued products), which tends to discourage trade in processed products.[51] Other issues are whether special safeguards (SSG) (see box 1) should be retained, and whether rules to protect domestic industries of import-dependent countries (such as continuation of the Special Treatment Clause in the URAA[52]) should be eliminated.[53] There are suggestions for tariffs to be simplified so that only ad valorem tariffs apply, instead of specific tariffs or compound tariffs.[54] Finally, although there is agreement among most WTO members on the need for special concessions for less-developed countries (LDCs), the issue of how far the concessions should go remains unanswered. For example, should the U.S. General System of Preferences

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[45] "Canada initial negotiating position on agriculture," *Public Statement*, Agriculture and Agri-Food Canada, Ottawa, Aug. 19, 1999.

[46] Konandreas, P. "Next Round of Negotiation in Agriculture with Special Reference to the Dairy Sector," presented at symposium on International Prospects for Dairying in the Next WTO Negotiating Round, Buenos Aires, June 3-4, 1999.

[47] International Policy Council on Agriculture Food and Trade, *Agenda Options for Agricultural Policy Reform*, IPC Position Paper No. 10, Washington, DC, 1999.

[48] For example, dropping a tariff 50 percent from 200 percent is very different from dropping a tariff 50 percent from 10 percent.

[49] Other formulas are available, such as the Swiss formula (used for industrial tariff reduction in the Tokyo Round) that reduced higher tariffs proportionally more than lower tariffs. Under the formula, the final tariff = (base tariff * technical factor) / (base tariff + technical factor). So, assuming a technical factor of 15, a base tariff of 10 percent would be reduced to 6 percent, while a base tariff of 60 percent would be reduced to 12 percent.

[50] "Opening of markets likely to require tariff reduction," *Feedstuffs*, Nov. 8, 1999.

[51] USDA, ERS, "Tariffication and Tariff Reductions," *ERS's WTO Briefing Room*, found at Internet address http://www.econ.ag.gov/briefing/wto/issues/tariffs.htm, retrieved Feb. 15, 2000.

[52] Japan and Korea were subject to the Special Treatment Clause during the Uruguay Round to protect their domestic rice industries. The Special Treatment Clause allowed them to avoid tariffication, but instead required an increase in their minimum access from 4 percent to 8 percent, rather than from 3 percent to 5 percent.

[53] "Opening of markets," *Feedstuffs*, Nov. 8, 1999.

[54] Thompson, Y, P. Liapis, and P. Sckokai, "Alternative Trade Mechanisms," *Canadian Journal of Agricultural Economics*, forthcoming, Mar. 2000.

(GSP)[55] be extended to all WTO members, or limited to just a few beneficiary developing countries, as it is now?

In addition to tariff reductions, greater market access could also be achieved by increasing TRQ levels. However, questions remain over how much to increase the TRQ levels and the implementation time frames.[56] Another issue is TRQ administration.[57] Since there are no WTO rules governing the process, countries use different methods to allocate TRQ volumes among importing firms. Some countries have proposed that TRQ administration rules be developed because they feel that administration methods used by some countries prohibit fair and open trade.[58]

Internal supports

One of the important achievements of the URAA was the acknowledgment among participants that disciplines governing domestic support programs (box 3) are crucial to facilitate agricultural trade liberalization.[59] However, WTO members disagree considerably over how to treat and tighten disciplines on trade-distorting domestic programs.[60] Discussions have centered on--

- Whether existing support categories should be maintained, and, if so, by how much should so-called amber box policies be cut, over what period, and using which base period;[61]
- Whether the concept of a straight percent reduction in the AMS (see box 1) should be continued;
- Whether the option of requiring reductions in a producer support estimate (PSE), as calculated by the OECD, should be used; and
- Whether domestic support reductions should be aggregated across commodities, as under the URAA, or changed to a commodity-by-commodity basis.[62]

[55] GSP is a U.S. program that gives preferential tariff treatment to beneficiary developing countries on imports of eligible products.

[56] Konandreas, P. "Next Round of Negotiation," presented at symposium on International Prospects for Dairying in the Next WTO Negotiating Round, Buenos Aires, June 3-4, 1999.

[57] Skully, D.W., "The Economics of TRQ Administration," International Agricultural Trade Research Consortium Working Paper #99-6, May 1999.

[58] "Opening of markets," *Feedstuffs*, Nov. 8, 1999.

[59] International Policy Council on Agriculture Food and Trade, *Agenda Options for Agricultural Policy Reform*, IPC Position Paper No. 10, Washington, DC, 1999.

[60] "Farm support payments to be key topic in negotiation," *Feedstuffs*, Nov. 1, 1999.

[61] Ibid.

[62] Konandreas, P. "Next Round of Negotiation," presented at symposium on International Prospects for Dairying in the Next WTO Negotiating Round, Buenos Aires, June 3-4, 1999.

Box 3
Domestic support categories under the URAA

Under the URAA, domestic supports were put into categories (often called "boxes"), using a traffic light analogy of "red" for stop, "green" for go, and "amber" for proceed cautiously. From this analogy negotiators have, on occasion, created additional "color" boxes to indicate other policy categories.

Red box policies are prohibited support payments that must be stopped. No domestic supports fell into this category.

Green box policies are permitted support payments that are not "actionable," meaning other members may not raise sanctions against them. These policies are considered not to be trade-distorting and not subject to limitations. They include conservation programs, research and extension, marketing and promotion programs, inspection and grading policies, domestic food aid, disaster relief, revenue insurance programs, and direct payments not linked to production.

Amber box policies are permitted support payments that are "actionable," meaning other members may raise sanctions against them if they can prove they have sustained injury as a result. These policies are considered to be trade-distorting and are subject to disciplines. They include commodity-specific market price supports, nonexempt direct payments to farmers, input subsidies, storage payments, interest subsidies, insurance price subsidies.

Blue box policies are permitted support payments not subject to reduction commitments because they are direct payments under production-limiting programs. A blue box designation, which typically benefits the United States and EU, indicates policies are excluded from the AMS reduction commitment during 1995-2000, but not from the 1986-88 base year AMS calculation. To be blue box policies, payments must be made on fixed area and yield; or 85 percent or less of the base level of production; or livestock payments made on a fixed number of head.

Source: USDA, FAS, "A Summary of the Final Act of the Uruguay Round, Agreement on Agriculture," found at Internet address http://www.fas.usda.gov/itp/Policy/Gatt/ag_text_html, retrieved Mar. 24, 2000.

Some countries (Australia, in particular) have expressed concern that many of the currently allowable green box policies are not trade neutral and have suggested that the scope of such policies be narrowed.[63] For example, although the United States recently used emergency payments to help farmers deal with low commodity prices, notification to the WTO as to whether this domestic support should be designated in the amber, blue, or green box category has yet to be determined.[64] Other green box categories have been viewed by ABARE officials as possibly having a distorting impact on trade, including risk management policies, revenue insurance programs, and rural development and environmental policies. In contrast, other countries reportedly are requesting a wider definition of green box policies, even to include

[63] Australian Bureau of Agricultural and Resource Economics (ABARE), "Multilateral agricultural policy reform," *Current Issues*, Sept. 1999.
[64] Information provided by USDA official.

payments to EU producers as compensation for compliance with higher animal welfare standards.[65]

Some countries, in particular the Cairns Group countries, reportedly are pressing for the blue box category of support to be eliminated, contending that it has significantly weakened the internal support disciplines in the URAA.[66] However, the EU recently made a proposal to reform its agricultural policy.[67] Called Agenda 2000, EU reform would increase the use of supports linked to production, which are permitted under the blue box, while reducing reliance on amber box policies.[68] Thus, observers indicate the EU is insisting that the blue box category support be continued in the next round.[69] The Japanese reportedly also favor[70] continuing the blue box.[71, 72] Finally, industry sources believe there is little agreement among the major parties over whether the Peace Clause (see box 1) should be extended beyond the December 31, 2003, deadline.[73]

New issues

In addition to questions associated with extending provisions covering export support, market access, and internal supports, several new issues have arisen--

(1) **Problems encountered in implementing certain URAA commitments** According to industry sources,[74] a key concern is whether (and how) disciplines should be imposed on State Trading Enterprises (STEs).[75] Although allowed under GATT rules, concern exists that STEs use their exclusive power to distort trade and

[65] "Farm support payments," *Feedstuffs*, Nov. 1, 1999.

[66] "A guide to the Seattle round of multilateral trade negotiations on agriculture," Canadian Agri-Food Trade Research Network, Nov. 20, 1999, found at Internet address http://www.eru.ulaval.ca/catrn/primer.htm#54, retrieved Jan. 19, 2000.

[67] USDA, ERS, "Examining the EU's Agenda 2000," *Agricultural Outlook*, Oct. 1999.

[68] USDA, ERS, "The European Union's Common Agricultural Policy: Pressures for Change," International Agriculture and Trade Report, SWRS-99-2, Feb. 1999.

[69] "Paradoxes in EU stance on Millennium round," *Agra Europe*, July, 16, 1999.

[70] "Japan's position on trade talks holds few surprises," *Feedstuff*, Sept. 6, 1999.

[71] Other countries using the blue box are Slovakia, Iceland, and Norway.

[72] The United States has not taken a public position on the blue box. Reforms under the 1996 FAIR Act means that the United States no longer uses blue-box supports. However, if the blue box were eliminated, and in the future the United States decided to reinstate farmer supports linked to production-limiting programs, such supports would likely count as amber-box policies and be subject to disciplines. Information provided by USDA official.

[73] "Farm support payments," *Feedstuffs*, Nov. 1, 1999.

[74] Industry sources as quoted in "Playing field on export subsidies," *Feedstuffs*, Oct. 22, 1999.

[75] State Trading Enterprises are used by both exporting and importing countries. Prominent export STEs include the New Zealand Dairy Board, Canadian Wheat Board, and Australian Wheat Board. Importing STEs include the Japanese Food Agency and Indonesia's BULOG. For further details on STEs, see USDA, ERS, "An Introduction to State Trading in Agriculture," Agricultural Economic Report No. 783, Oct. 1999.

engage in unfair trading practices.[76] A lack of transparency, often associated with such operations according to a GAO report, has also generated concern over whether some STEs are used to circumvent market access and export subsidy commitments made under the URAA (such as by providing hidden subsidies through the use of dual pricing systems or price discrimination).[77] Another reason for interest in STEs is that several countries requesting membership in the WTO implement domestic support programs through STEs (e.g., Russia, China, Taiwan, and Vietnam).[78] While increased transparency of STE operations has been advocated by several WTO members including the United States, details of how to achieve this goal are sketchy.[79] Reported possibilities include encouraging countries to remove the statutory rights of STEs, requiring STEs to publish price and sales information, and prohibiting tax revenues from being used to support the operations of STEs.

(2) **Development of new technologies**

Recent advances in biotechnology, such as genetically modified organisms (GMOs), have had an increasingly profound impact on world agriculture.[80] Although GMOs are widely accepted in the United States, their acceptance in other countries, especially the EU, has been slow. Specific rules governing trade in GMOs were not established in the URAA, and according to trade reports, several countries have called for discussions on biotechnology in the upcoming round of trade talks, focusing particular attention on approvals and labeling.[81] Several countries have proposed the establishment of a WTO working group on biotechnology that would determine whether existing rules are adequate and whether specific disciplines governing trade in GMOs are required.[82] The United States and Cairns Group countries contend that treatment of GMOs is adequately covered by the existing SPS and TBT Agreements, and that there is no need to open these agreements in the next round. However, the EU advocates the "precautionary principle," urging that when risks are uncertain or science is incomplete, countries should exercise caution in accepting genetically modified products.[83] Some countries have expressed concern that this position could provide the EU with justification to restrict imports of GMOs.[84]

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[76] "STEs overhauled in advance of trade talks," *Feedstuffs*, Aug. 10, 1998.

[77] General Accounting Office, *Review of state trading enterprises in Canada, Australia, and New Zealand*, GOA/NSIAD-96-94, June, 1996.

[78] USDA, ERS, "State trading enterprises: Their role in world markets," *Agricultural Outlook*, June, 1997.

[79] USDA, FAS, Outreach offices, WTO Regional Domestic Outreach Presentation, found at Internet address: http://www.fas.usda.gov/itp/wto/presentation/demoutreach.html, retrieved Mar. 23, 2000.

[80] "A guide to the Seattle round of multilateral trade negotiations on agriculture," Canadian Agri-Food Trade Research Network, Nov. 20, 1999, found at Internet address http://www.eru.ulaval.ca/catrn/primer.htm#54, retrieved Jan. 19, 2000.

[81] "Social questions to play influential role in talks," *Feedstuffs*, Nov. 22, 1999.

[82] Ibid.

[83] "EU farm ministers agree outline goals for WTO," *Agra Europe*, Sept. 17, 1999.

[84] "Precautionary principle is not protectionist, Brussels insists," *Financial Times*, Feb. 3, 2000.

(3) **Consumer and environmental interests**

Consumer groups and environmentalists are also concerned that discussion of biotechnology in the new round could result in increased trade in GMOs and a weakening of national labeling programs.[85] In addition, there has been considerable debate over whether a future agreement should address the "multifunctionality" of agriculture,[86] and whether governments should have the right to compensate producers for providing non-agricultural spillover goods and services. This view is strongly advocated by the status quo countries.[87] Many policies aimed at compensating farmers for these non-agricultural goods and services fall into the green box category of support (e.g., environmental payments). However, a key concern among EU farmers is that they are not compensated for compliance with animal welfare standards that are generally higher than those faced by their international competitors.[88] Opponents of multifunctionality reportedly are concerned that the concept is being used to circumvent domestic support disciplines, and contend that compensation, if given, should not be in any way linked to production levels but targeted specifically to the non-agricultural function that is being supplied.[89]

The Seattle Ministerial

Several reasons expressed in multiple sources appear to suggest why the Seattle meeting ended without agreement. Broadly these fall into two main areas—policy differences among members and WTO procedural issues. First, an impasse between the major participants over both agricultural and non-agricultural policies was perhaps a major reason for the unsuccessful talks. In agriculture, agreement could not be reached on the declaration text covering export subsidies, which called for a reduction in "the direction of progressive elimination." The EU, led by France and supported by Germany and Austria, reportedly insisted that the term "elimination" be removed, a demand opposed by the United States and the Cairns Group.[90] Disagreements within other working groups[91] were also significant.[92] For example, negotiators remained far apart on whether the new round should cover competition

[85] "Lamy wants Seattle resumed next year, holds to GMO stance," *Feedstuffs*, Dec. 20, 1999.

[86] The concept of agriculture's multifunctionality is that farmers contribute more than food and fiber production. They also provide spillover goods and ancillary services such as environmental benefits, food safety, rural employment and development, cultural values, and ethical treatment of animals for which they are not compensated for through agricultural markets. USDA, ERS, "The Use and Abuse of Multifunctionality," Nov. 1999.

[87] "EU farm ministers agree outline goals for WTO," *Agra Europe*, Sept. 17, 1999.

[88] Ibid.

[89] Australian Bureau of Agricultural and Resource Economics, "Multifunctionality. A pretext for protection?" *Current Issues*, Aug. 1999.

[90] "EU stance in Seattle points to future of CAP," *Agra Europe*, Dec. 10, 1999.

[91] The Ministerial was structured around five working groups concerning agriculture: issues from the 1996 WTO Ministerial in Singapore (investment, competition, government procurement), market access, rules and implementation, and WTO systemic issues (transparency and functioning of the WTO).

[92] General Accounting Office, *Seattle Ministerial*: *Outcomes and Lessons Learned*, GAO/T-NSIAD-00-86, Feb. 10, 2000.

policy,[93] and whether the working group on investment should continue or even whether investment should be on the agenda.[94] Other areas of reported disagreement involved which sectors should be included in the Accelerated Tariff Liberalization Initiative,[95] and disciplines on government procurement.[96] The developing countries were concerned over a number of non-agricultural issues, such as the implementing deadlines for the TRIPS, TRIMS, and Customs Valuation Agreements, as well as the perceived imbalance in other agreements regarding antidumping, subsidies, and textiles.[97] The inability of the United States and the EU to agree on increasing market access on textiles for the least-developed countries further increased developing countries' dissatisfaction in Seattle.[98] However, disagreement between the United States and developing countries over labor issues was also significant. The issue became a focus of attention following an interview in the *Seattle Post-Intelligencer* in which President Clinton reportedly stated that he would eventually support imposing sanctions against countries that violate labor standards established by the proposed WTO working group on trade and labor.[99] These comments, according to one observer, "opened up a deep, deep rift with the developing countries,"[100] and stiffened the resolve of LDCs not to allow the United States to put labor issues on the agenda.[101] Inclusion of labor standards in the WTO agreement was also one of the key demands of certain demonstrators in Seattle.

Second, several observers and officials have claimed that negotiations collapsed because of inadequate procedures and protocol within the WTO. They also noted that reaching a consensus[102] was impossible when negotiations covered numerous topics, and where active participation was required of all 135 members.[103] At the end of the Ministerial, WTO Director-General Mike Moore acknowledged "that the organization is running on an outdated

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[93] The United States also insisted on removing language from the draft text strongly supported by most members that would have opened the door to renegotiating dumping and subsidy rules. See WTO, "Ministers start negotiating Seattle Declaration," *WTO Briefing Note* for Dec. 1, 1999, found at Internet address http://www.wto.org/wto/minist/sum1-12.htm, retrieved Mar. 9, 2000.

[94] See WTO, "Ministers start negotiating," *WTO Briefing Note* for Dec. 1999, found at Internet address http://www.wto.org/wto/minist/sum1-12.htm, retrieved Mar. 9, 2000.

[95] See WTO, "Ministers consider new and revised texts," *WTO Briefing Note* for Dec. 2, 1999, found at Internet address http://www.wto.org/wto/minist/sum2-12.htm, retrieved Mar. 9, 2000.

[96] See WTO, "Ministers consider new and revised texts," *WTO Briefing Note* for Dec. 2, 1999, found at Internet address http://www.wto.org/wto/minist/sum2-12.htm, retrieved Mar. 9, 2000.

[97] See WTO, "Ministers start negotiating," *WTO Briefing Note* for December 1, 1999, found at Internet address http://www.wto.org/wto/minist/sum1-12.htm.

[98] "After Seattle. A global disaster," *The Economist*, Dec.17, 1999.

[99] "Delegates angered by U.S. agenda on labor," *Seattle Post-Intelligencer*, Dec. 3, 1999.

[100] Comment of Robert Litan, Director of Economic Programs, Brooking Institute, reported in the *Washington Post*, Dec. 3, 1999.

[101] "After Seattle," *The Economist*, Dec. 17, 1999.

[102] One of the central tenets of the WTO's way of doing business is that decision must be taken by consensus, so a minority of one is enough to block progress.

[103] "WTO to face urgent internal reform" *Agra Europe*, Dec. 10, 1999. General Accounting Office, *Seattle Ministerial*: *Outcomes and Lessons Learned*, GAO/T-NSIAD-00-86, Feb. 10, 2000.

culture of making decisions and with procedures suitable for a much smaller group."[104] Trade sources have expressed the view that future agreement will depend greatly on the success of the WTO General Council to make changes to WTO rules and procedures that enable future trade talks to be more open and better able to accommodate a larger and more diverse membership.[105]

Protesters also raised the pressure for greater democracy and transparency in the WTO.[106] For example, one procedure that received considerable criticism following the talks was the so-called Green Room process, which typically involves negotiations among about 20 to 30 key countries aimed at resolving issues of disagreement prior to wider discussion among all members. Several countries, in particular the developing countries, claimed that they had been marginalized and excluded from discussion on issues of vital importance to them.[107] On the final day of talks, the Organization for African Unity together with a group of Latin American and Caribbean countries announced that they would not join the consensus required to reach agreement in the WTO because they had been excluded from the process.[108]

Progress Made in Agriculture

Although no framework agreement was reached, and despite policy differences among the parties, several officials indicated that much was achieved in agriculture, and at least one indicated that an agreement had, in fact, been very close. For example, Canadian Agricultural Minister Lyle Vanclief said that negotiators got "down to millimeters away" from reaching agreement on an agricultural text.[109] WTO officials also indicated that an agreement on agriculture was closer than agreement in other working groups,[110] and contended that other areas of the negotiation ultimately led to the breakdown of overall talks.[111] However, EU Farm Commissioner, Franz Fischler, noted that while "substantial progress" was made on agriculture, "key questions remained unresolved."[112] By the end of the negotiation, what remained on the table was an agricultural text drafted by the chairman of the agriculture negotiating group (box 4), Singapore Trade Minister George Yeo. This text was characterized as a compromise package and described by Chairman Yeo as "walking a tightrope" between the demands of reform, status quo, and developing countries.[113]

The final document called for action in each of three areas—market access, export competition, and domestic supports—and goes far beyond Article 20 (see box 2), although it remains broad and sets no specific targets or timetables for completion of negotiations and

[104] Comments of WTO Director-General Mike Moore, at press conference, Dec. 3, 1999.
[105] "Making the WTO shape up to the 21st century." *Agra Europe*, Dec. 3, 1999.
[106] Ibid.
[107] "WTO negotiators push towards deal," *Agra Europe*, Dec. 3, 1999.
[108] "Making the WTO shape up," *Agra Europe*, Dec. 3, 1999.
[109] "Negotiators were close on agricultural deal," *Feedstuffs*, Dec. 13, 1999.
[110] "EU stance in Seattle points to future of CAP," *Agra Europe*, Dec. 10, 1999.
[111] "Negotiators were close," *Feedstuffs*, Dec. 13, 1999.
[112] "Farm reforms on hold after WTO breakdown," *Agra Europe*, Dec. 10, 1999.
[113] "Negotiators were close," *Feedstuffs*, Dec. 13, 1999.

implementation of an agreement.[114] The draft text called for "market access negotiations leading to the broadest possible liberalization" of import tariffs, and was very unspecific about minimum access requirements.[115] On domestic support, the text called for "substantial" reductions, but made no differentiation between "trade-distorting" domestic support and other types of support, and made no mention of blue box policies (although the text reportedly was nebulous enough to encompass an interpretation that would permit the EU to continue its blue box programs without penalty).[116] The draft text called for "substantial reductions in all forms of export subsidies . . . in the direction of progressive elimination of export subsidies." This language appears to soften an unconditional end to subsidies as originally demanded by the United States and Cairns Group countries. It also included "all forms" of export subsidy, something the United States reluctantly agreed to, since it would include, for example, U.S. export credits. However, the EU reportedly opposed the specific objective of prohibiting export subsidies,[117] although several officials indicated that this wording would likely have been accepted by the Europeans, if their demands over other parts of the negotiating agenda (such as agreement on a comprehensive round) had been met.[118]

The Yeo draft required that future negotiations should take non-trade issues into account (see box 4). These issues are described as "the need to protect the environment, food security, the economic viability and development of rural areas, and food safety, in full conformity with the SPS Agreement." However, no mention was made specifically to the word "multifunctionality" (although non-trade concerns can be considered to cover the same issues), which the EU reportedly agreed to drop, nor was there specific reference to animal welfare.[119] The EU wanted stronger language on export credits, against the wishes of the United States.[120] Also excluded from the draft was specific mention of an exemption on market access commitments for rice by Japan. Other initiatives dropped from the Yeo text included the establishment of a working group on biotechnology and introducing a WTO system for registering geographical indications for wines and spirits.[121] The Cairns Group dropped the requirement that agriculture be treated the same as manufactured goods under WTO rules.[122]

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[114] The agricultural text indicated that all elements on market access, export subsidies, and domestic supports should be submitted by July 1, 2000.

[115] "Making the WTO shape up," *Agra Europe*, Dec. 3, 1999.

[116] Ibid.

[117] "EU stance in Seattle points to future of CAP," *Agra Europe*, Dec. 10, 1999.

[118] "Negotiators were close," *Feedstuffs*, Dec. 13, 1999.

[119] Some observers note that the inclusion of non-trade concerns in the text provides the status quo countries with a so-called escape clause allowing them to continue to protect and support agriculture in the face of political pressure. "Making the WTO shape up," *Agra Europe*, Dec. 3, 1999.

[120] "WTO Ministerial Conference in Seattle," prepared by David King, Secretary General of the International Federation of Agricultural Producers, Paris, Dec. 1999. Reported in *WTO Watch*, Feb. 25, 2000.

[121] "Farm reforms on hold," *Agra Europe*, Dec. 10, 1999.

[122] "WTO Ministerial Conference in Seattle," prepared by David King, International Federation of Agricultural Producers, Paris, Dec. 1999. Reported in *WTO Watch*, Feb. 25, 2000.

Box 4
Final draft on agriculture

23. The negotiations shall continue the process of fundamental reform of trade in agriculture, through substantial progressive reductions in agricultural support and protection sustained over an agreed period of time, resulting in correcting and preventing restrictions and distortions in world agricultural markets, and the progressive establishment of a fair and market oriented agricultural trading system in conformity with WTO rules and disciplines. This shall be done based on Article 20 and the preamble to the Agreement on Agriculture.

24. Special and differential treatment for developing countries, as provided for in relevant WTO provisions, shall constitute an integral and effective part of the results of the negotiations. Special and differential treatment shall be embodied in the Schedules of concessions and commitments and, as appropriate, in the rules and disciplines to be negotiated, so as to be more operationally effective and so as to enable developing countries, while undertaking commitments and providing concessions in the areas covered in paragraph 25 below, to take account of their development needs, including food security and agricultural and rural development. Particular attention shall be paid to the situation of least-developed, net food-importing, and small island developing countries.

25. To achieve the objectives in paragraphs 23 and 24 above. The negotiations shall cover:
(i) Market Access: Comprehensive market access negotiations leading to the broadest possible liberalization, particularly with regard to products of export interest to developing country Members;
(ii) Export Competition: Substantial reductions in all forms of export subsidies, and equivalent action in respect of the subsidy component of other forms of export assistance, in the direction of progressive elimination of export subsidies;
(iii) Domestic Support: Substantial reductions to domestic support;
(iv) Rules and Disciplines: Improvements in the rules and disciplines consistent with the objective of fundamental reform.

Proposals for negotiations on all the above elements shall be submitted by 1 July 2000.

26. At the same time, as foreseen in Article 20, the negotiations shall take into account non-trade concerns. These include, in particular, the need to protect the environment. food security, the economic viability and development of rural areas, and food safety, without prejudice to the Agreement on the Application of Sanitary and Phytosanitary Measures. Non-trade concerns shall be addressed through targeted, transparent, and non-trade distorting measures. Other objectives and concerns mentioned in the Preamble to the Agreement on Agriculture, included making commitments in an equitable way among all Members.

27. Agreement on modalities shall be reached before 1 July 2001. Participants shall submit their comprehensive offer lists no later than 31 January 2002. The negotiations on commitments and legal texts shall be concluded before 15 December 2002.

Source: Unpublished Ministerial Conference document (excerpted paragraphs 23-27 pertaining to agriculture), Working Group on Agriculture (commonly known as the U.S.- EU Draft Agriculture Text), “Final Draft on Agriculture,” Agra Europe, Dec. 10, 1999.

Prospects for a New Round

At the WTO General Council meeting in early February, it was decided that agricultural negotiations, based on Article 20, would proceed.[123] It was agreed that talks will be held in special sessions of the WTO Agriculture Committee (reporting directly to the General Council),[124] and that a separate chairperson, yet to be chosen, will steer the sessions. Another procedural issue, also to be decided, is whether any timetable should be set, such as a deadline for completing the negotiations.[125] According to WTO officials, much work must be done to reform WTO procedures so that future decision-making processes are more transparent and inclusive.[126] Officials consider it a priority to ease the concerns of developing countries (who, according to many observers, were the big losers from the unsuccessful Seattle talks),[127] as well as implementing assistance for developing countries facing problems complying with existing Uruguay Round provisions.[128]

Based on statements by leading U.S. and EU officials subsequent to the Seattle Ministerial, industry sources report little change in positions.[129] For example, at the U.S./EU biannual summit on December 17, following the Seattle conference, the United States said that a new round would be impossible unless the EU modified its demands that new negotiations should encompass investment and competition, as well as soften its position on export competition in agriculture.[130] More recently, the Secretary of Agriculture indicated that the United States has not changed its stance on agriculture since Seattle, insisting on the elimination of export subsidies, expanding market access, tightening rules on trade-distorting domestic policies, introducing disciplines on the activities of STEs, and facilitating trade in new technologies, such as biotechnology.[131] Consistent with its Seattle position, the United States reportedly remains unwilling to negotiate disciplines on credits and food aid, and remains reluctant to make major market access concessions to developing countries on its import-sensitive commodities (such as sugar).[132]

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[123] "Trying to put Seattle behind: Governments agree to start talks in six weeks," *WTO Watch*, Feb. 14, 2000.

[124] Thus the WTO Agriculture Committee would be split into two parts, with a separate chairperson for each. One would specifically deal with trade negotiations. The other would work on other issues, in particular, monitoring and implementing the URA.

[125] "Governments agree to start ag talks soon," *Feedstuffs*, Feb. 14, 2000.

[126] "DG Moore embarks on consultations on future WTO work," WTO Press Release, Jan. 26, 2000.

[127] "The real losers in Seattle," *The Economist*, Dec. 17,1999; "An unjustified sense of victory," *Financial Times*, Dec. 21, 1999. Also, "WTO talks produce winners and losers," *Feedstuffs*, Dec. 13, 1999.

[128] "EU official calls for new round of trade talks," *Financial Times*, Jan. 26, 2000.

[129] "U.S., EU make little progress on trade," *Feedstuffs*, Dec. 27, 1999.

[130] Comments of Ambassador Charlene Barshefsky, at press conference following U.S./EU bilateral summit, Washington, DC, Dec. 17, 1999.

[131] Statement of Dan Glickman, Secretary of Agriculture, before the Senate Committee on Finance, Subcommittee on International Trade, Mar. 7, 2000.

[132] "Schumacher call for prompt start to WTO talks," *Feedstuffs*, Jan. 10, 2000.

Similarly, the EU is holding firm to its Seattle stance, sticking to its position that meaningful agricultural talks can only take place as part of a broad agenda.[133] EU officials have indicated, however, that they would accept the "frozen" Yeo text, including the elimination of export subsidies, as long as in return, other countries agree to the EU's demand for an ambitious comprehensive agenda for the new round (covering negotiations on investment, competition, implementation, and the environment).[134] This would allow concessions on agriculture to be traded off for gains in other sectors.[135]

Without a comprehensive round, industry sources expect negotiations on the built-in agenda to proceed very slowly.[136] However, two factors could prompt the EU to move ahead with a more limited agenda. First, an unofficial deadline for an agreement to be reached is December 31, 2003, which corresponds to the expiration date of the Peace Clause. This clause[137] requires countries to exercise restraint in challenging other countries' subsidies in the WTO or with national trade cases. Unless a new agreement on agriculture is reached by the deadline, countries with high levels of support and protection, could be challenged over several of their trade and agricultural domestic policies in the WTO or in domestic countervailing duty investigations.[138] However, it is not clear what types of WTO challenges would be possible if the Peace Clause were to expire. The Cairns Group countries, for example, assert that countries would be able to challenge certain internal supports, as well as the use of export subsidies. Other officials contend that without the Peace Clause, challenges would be limited to countervailing duty cases and nullification and impairment cases, and that challenges against export subsidies would not be possible.[139] In any event, given the time required to process challenges through the WTO dispute settlement procedures, the impact of an expired Peace Clause would probably not be felt until several years after the 2003 deadline.[140]

Second, the EU may decide to negotiate the reduction of agricultural trade barriers and support as part of Common Agricultural Policy (CAP) reforms.[141] According to some EU analysts, the prospect of EU eastward expansion, increasing budget pressures, and weak export markets (increasingly constrained by URAA export subsidy disciplines), will probably force further CAP reforms, perhaps as early as 2003-04. Such reforms might reduce price supports close to world levels, and could involve a complete decoupling of farm support from production, thereby abandoning the need to provide export subsidies. Under this scenario, the current objectives of the reform countries, to eliminate export subsidies and substantially

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[133] Statement of Pascal Lamy, European Commissioner for Trade, at a speech to the European Institute, Feb. 17, 2000.

[134] Comments of Romano Prodi, president of EU Commission, at press conference following U.S./EU bilateral summit, Washington, DC, Dec. 17, 1999.

[135] "Farm reforms on hold," *Agra Europe*, Dec. 10, 1999.

[136] "Disagreement exists on how agriculture talks are to proceed," *Feedstuffs*, Dec. 13, 1999.

[137] Article 13 of the Agreement on Agriculture.

[138] "Despite claims, progress made at WTO," *Feedstuffs*, Dec. 13, 1999.

[139] Information provided by USTR official.

[140] "No Geneva agriculture meeting as governments try to work out process," *Feedstuffs*, Jan. 24, 2000.

[141] Interview with EU official, Delegation of the European Commission, Washington, DC, Jan. 14, 2000.

reduce domestic supports, would fall in line with those of the EU and thereby make possible an agreement on agriculture in the WTO.[142] As a top EU official recently noted, crucial to the survival of EU agriculture is "to remain competitive at an international level and adapt to new market developments."[143]

Outlook and Challenges for the WTO

With the WTO member nations remaining far apart on several key issues, the prospects are not favorable for an early completion of a new round of multilateral trade talks. Nonetheless, the WTO General Council has initiated agricultural negotiations based on Article 20. Although talks are mandated to start, there is no requirement that the negotiations be substantive and no deadline is set for completion. Thus, little prevents the EU and other status quo countries from taking a go-slow approach to the talks until their demand for a comprehensive round is met, something that the United States and others countries are reluctant to agree to, at least in the near term. It is unclear at this stage the extent to which the expiration of the Peace Clause and the likelihood of further reforms beyond Agenda 2000 will encourage the EU into active bargaining.

While some WTO members (the Cairns Group, in particular) feel an urgency to move ahead with new trade talks in agriculture, forces are emerging within the United States and elsewhere in opposition to trade agreements that further open world markets. The Seattle talks were marked by the presence of demonstrators from consumer, environmental, labor, and church groups. These groups voiced concerns that the WTO, by enforcing multilateral trade rules, places a higher value on trade and economic prosperity than on environmental, social, and human values. The groups were also concerned that the WTO weakens the sovereignty of countries to impose trade restrictions. In particular, the protesters clearly highlighted the current public sentiment over concern for jobs and the environment.[144] While most officials agree that the protesters did not play a major role in the final outcome in Seattle,[145] some observers believe that the demonstrators had a major impact in redefining the global trade agenda by forcing consideration of the wider aspect of international commerce, such as international labor, consumer, environmental issues.[146, 147] This sentiment appeared to be noted in a recent speech by President Clinton, who commented on the need to support the WTO rules-based system even as efforts are made to reform and strengthen it: "Those who heard a wake-up call on the streets of Seattle got the right message. . . . Let me be clear: I do not agree with those who say we should halt the work of the WTO, or postpone a new trade

[142] "EU stance in Seattle points to future of CAP," *Agra Europe*, Dec. 10, 1999.

[143] Comments of EU Agriculture Commissioner Franz Fischler at opening ceremony for International Green Week, Berlin, Germany, Jan. 14, 2000.

[144] The Seattle fiasco," *The Journal of Commerce*, Dec. 7, 1999.

[145] At the end of the Ministerial, Ambassador Barshefsky said that no agreement was reached because of "the failure of governments, not the activities of demonstrators." Comments of Ambassador Charlene Barshefsky at closing plenary session of Seattle Ministerial, Dec. 3, 1999.

[146] "Seattle brings new voices into play in economic globalization," *Chicago Tribune*, Dec. 16, 1999.

[147] "Farm sector not prepared to confront new 'free trade' objectors," *The Webster Agricultural Letter*, Dec. 17, 1999.

round. But I do not agree with those who view with contempt the new forces seeking to be heard in the global dialogue."[148]

These new forces represent concerns that are likely to be addressed through international dialogue, and the WTO, as an institution, is increasingly being scrutinized as to whether it is able to meet this new role. For instance, several questions are likely to be considered as the WTO role is examined. Should the WTO handle international labor issues, or should agreements be pursued under other existing organizations, such as the International Labor Organization? Is the WTO able to negotiate international environmental protocols, or would such agreements be better addressed by the United Nations or by separate agreements such as the Convention on International Trade in Endangered Species? Should the WTO oversee agreements relating to food labeling and safety, or is the existing UN/FAO institution, the Codex Alimentarius, a more appropriate forum? These questions will probably be debated extensively in the coming months, especially in connection with the upcoming U.S. Congressional vote on whether the United States should continue its membership in the WTO.**#**

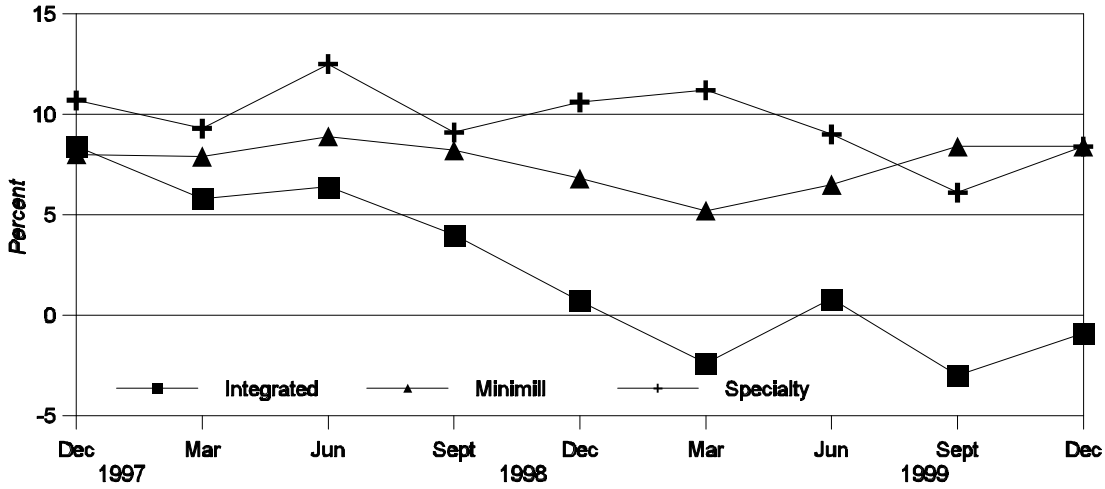
[148] Remarks by President Clinton at the World Economic Forum, Davos, Switzerland, The White House, Office of the Press Secretary, Jan. 29, 2000.

APPENDIX A
KEY PERFORMANCE INDICATORS OF SELECTED INDUSTRIES

- **STEEL** (Tracy Quilter, 202-205-3437/tquilter@usitc.gov)
- **AUTOMOBILES** (Laura A. Polly, 202-205-3408/polly@usitc.gov)
- **ALUMINUM** (Karl Tsuji, 202-205-3434/tsuji@usitc.gov)
- **FLAT GLASS** (James Lukes, 202-205-3426/lukes@usitc.gov)
- **SERVICES** (Tsedale Assefa, 202-205-2374/assefa@usitc.gov)

STEEL

Figure A-1
Steel industry: Profitability by strategic group[1]



[1] Operating profit as a percent of sales. Integrated group contains 8 firms. Minimill group contains 8 firms. Specialty group contains 4 firms.

Source: Individual company financial statements.

- Integrated steel producers cited lower average selling prices, import levels, and modernizations and planned outages as contributing to the sector's negative profitability for the fourth quarter of 1999. Market conditions continued to improve as minimill profitability held steady and specialty steelmakers experienced a 2.3 percentage-point increase in profitability despite higher raw material costs.
- In February 2000, the President announced tariff rate quotas (TRQ), pursuant to Section 201, for the steel wire rod and welded line pipe industries. The wire rod import quota was set at 1.58 million tons; imports exceeding this level will be subject to a 10-percent tariff in the first year. Line pipe imports will be capped at 9,000 tons for each exporting country, with a 19-percent tariff in the first year. Both TRQs become less restrictive over a 3-year period.

Table A-1
Steel mill products, all grades

Item	Q4 1999	Percentage change, Q4 1999 from Q4 1998[1]	1999	Percentage change, 1999 from 1998[1]
Producers' shipments *(1,000 short tons)*	27,432	19.3	103,912	1.4
Finished imports *(1,000 short tons)*	6,846	-28.3	27,151	-21.9
Ingots, blooms, billets, and slabs *(1,000 short tons)*	2,388	64.3	8,580	26.6
Exports *(1,000 short tons)*	1,613	31.7	5,426	-1.7
Apparent supply, finished *(1,000 short tons)*	32,665	4.3	125,636	-4.6
Ratio of finished imports to apparent supply *(percent)*	21.0	[2]-9.5	21.6	[2]-4.8

[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.

STEEL

Table A-2
Steel service centers

Item	Sept. 1999	Dec. 1999	Percentage change, Dec. 1999 from Sept. 1999[1]	Q4 1999	Q4 1998
Shipments *(1,000 net tons)*	2,525	2,254	-10.7	7,229	7,053
Ending inventories *(1,000 net tons)*	8,013	8,443	5.4	8,443	8,544
Inventories on hand *(months)*	3.2	3.8	([2])	3.8	4.0

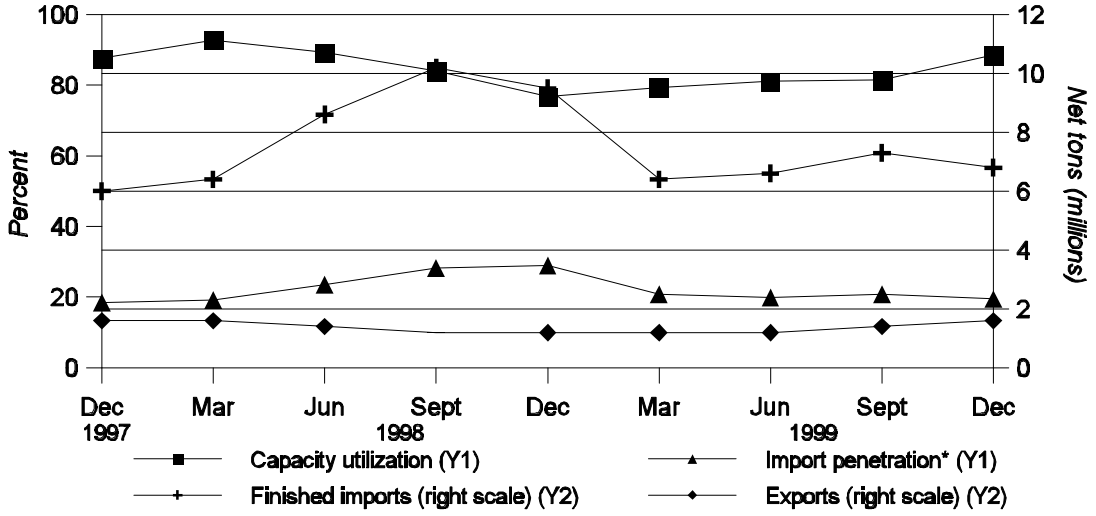
[1] Based on unrounded numbers.
[2] Not applicable.
Note.–Because of rounding, figures may not add to the totals shown.

Source: Steel Service Center Institute.

- The Steel Service Center Institute (SSCI) reported a slight increase (3 percent) in shipments for the fourth quarter 1999 compared with the fourth quarter 1998. However, December monthly shipments were down 11 percent compared to September levels, which was attributed to the typical holiday slowdown. In SSCI's most recent survey, 53 percent of responding members indicated that incoming orders are expected to increase during the next 3 months.[1]
- Total imports decreased 16 percent in the fourth quarter 1999 compared with the fourth quarter 1998, but finished imports were down 28 percent. Finished steel import penetration was at its lowest point (21 percent) since the first quarter of 1998. Semifinished imports were up 64 percent from the fourth quarter of 1998 and accounted for 26 percent of total imports.
- Capacity utilization continued to improve as steelmakers achieved an average of 88.6 percent for the fourth quarter 1999.

[1] SSCI, news release, "Steel Service Centers Start Strong in the New Millennium," Feb. 23, 2000 and Business Conditions Report, Part I-North America, Mar. 6, 2000.

Figure A-2
Steel mill products, all grades: Selected industry conditions



* Finished import share of apparent open market supply.

Source: American Iron and Steel Institute.

AUTOMOBILES

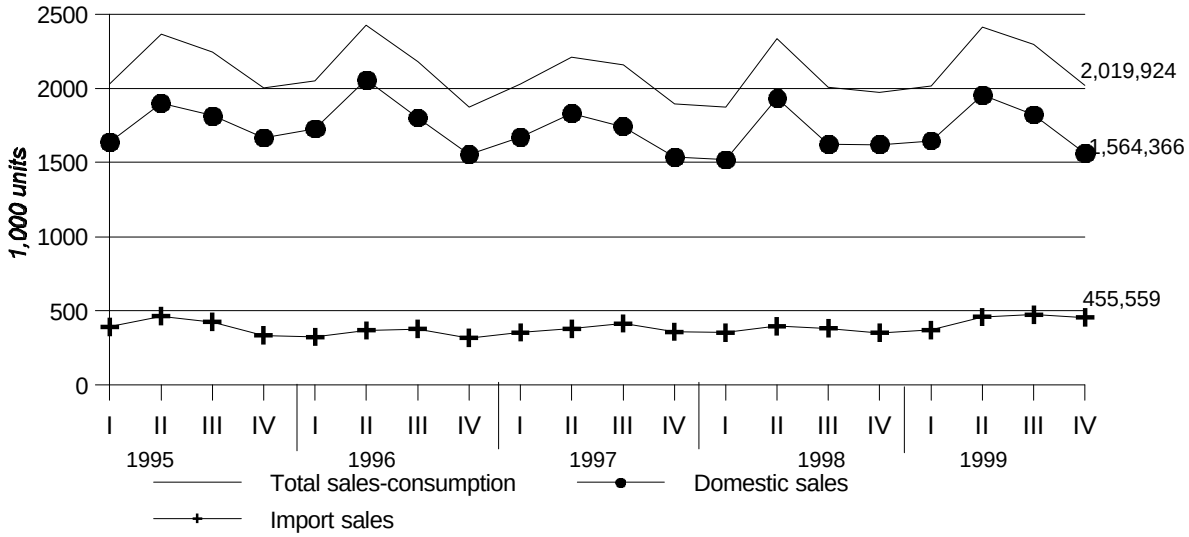
Table A-3
U.S. sales of new automobiles, domestic and imported, and share of U.S. market accounted for by sales of total imports and Japanese imports, by specified periods, January 1998-December 1999

Item	Oct.- Dec. 1999	Jan.-Dec. 1999	Percentage change: Oct.-Dec. 1999 from Jul.-Sep. 1999	Percentage change: Jan.-Dec. 1999 from Jan.-Dec. 1998
U.S. sales of domestic autos (*1,000 units*)[1]	1,564	6,986	-14.2	3.2
U.S. sales of imported autos (*1,000 units*)[2]	456	1,761	-4.1	23.8
Total U.S. sales (*1,000 units*)[1, 2]	2,020	8,747	-12.1	6.9
Ratio of U.S. sales of imported autos to total U.S. sales (*percent*)[1, 2]	22.6	20.1	9.1	15.8
U.S. sales of Japanese imports as a share of the total U.S. market (*percent*)[1, 2]	10.5	9.5	0.1	4.3

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

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

Figure A-3
U.S. sales of new passenger automobiles, by quarter

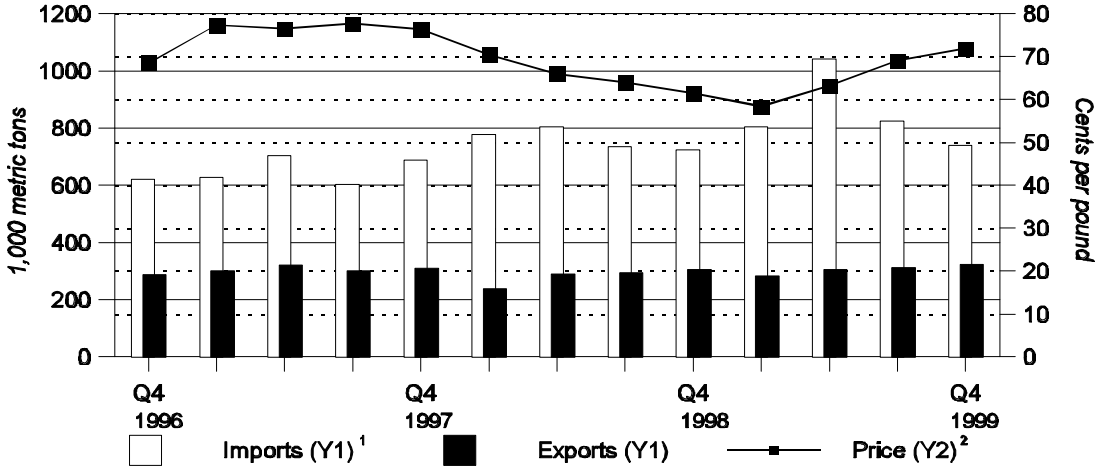


Note.–Domestic automobile sales include U.S.-, Canadian-, and Mexican-built automobiles sold in the United States; these same units are not included in import sales.

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

ALUMINUM

Figure A-4
Aluminum: U.S. imports, exports, and price



[1] Crude forms (metals and alloys) and mill products (e.g., plates, sheets, and bars) for consumption.
[2] Quarterly average of the monthly U.S. market price of primary aluminum ingots.

Source: U.S. Geological Survey.

- Overall aluminum consumption in the United States remained robust in fourth quarter 1999 as the U.S. economy continued to expand. Although domestic output declined slightly, significantly lower quarterly imports, especially of unwrought aluminum from Russia and Canada, resulted in the noticeable percentage-point decline in the level of import penetration.
- Despite somewhat higher global output in fourth quarter 1999, aluminum prices increased because of continued strong or strengthening regional demand, and reduced metal-exchange and commercial inventory levels. The price of primary aluminum ingot rose 2.9 cents per pound during the quarter, continuing the rising price trend observed since the beginning of the year.
- Alcan (Canada) received shareholder and Swiss regulatory approval for its merger with Pechiney (France) and Algroup (Switzerland). However, the Alcan-Pechiney component of the merger plan proposed to the EU was withdrawn; submission of a revised plan is intended in a month to address the EU Competition Commission's antitrust concerns, particularly in the container and packaging products markets. U.S.-based Alcoa and Reynolds also await EU, U.S., and Canadian regulatory approval, anticipating completion of their merger by mid-2000.

Table A-4
U.S. production, recovery, imports, import penetration, exports, average nominal price, and LME inventory level of aluminum, for fourth quarter 1998, third quarter 1999, and fourth quarter 1999

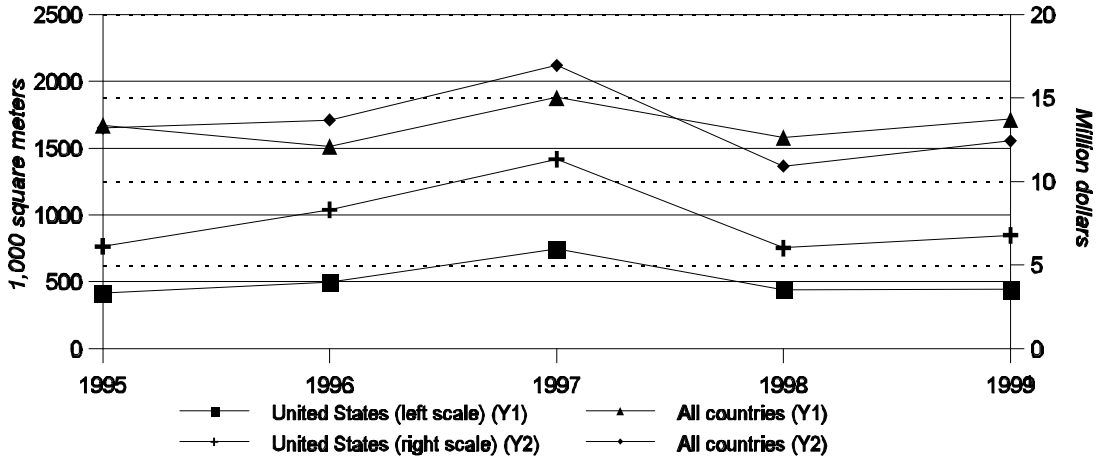
Item	Q4 1998	Q3 1999	Q4 1999	Percentage change: Q4 1999 from Q4 1998	Percentage change: Q4 1999 from Q3 1999
Primary production (*1,000 metric tons*)	939	953	967	3.0	1.5
Secondary recovery (*1,000 metric tons*)	844r	887	870	3.1	-1.9
Imports (*1,000 metric tons*)	724	825	739	2.1	-10.4
Import penetration (*percent*)[1]	34.0r	35.8	33.0	[2] -0.9	[2] -2.8
Exports (*1,000 metric tons*)	305	312	324	6.2	3.9
Average nominal price (*¢/lb*)	61.6	69.1	72.0	16.9	4.2
LME inventory level (*1,000 metric tons*)	636	797	775	21.9	-2.7

[1] Calculations based on unrounded data
[2] Percentage point change
Note: Revised data indicated by "r."

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

FLAT GLASS

Figure A-5
Average monthly Japanese imports of flat glass, by quantity and value, from the United States and all countries, 1995-99[1]



[1]Data for 1999 includes Jan.-Aug. (latest available data).
Source: Compiled from official statistics of the Ministry of Trade and Industry, Japan.

Background

- The U.S.-Japanese agreement on Japanese market access for imports of flat glass sought to increase access and sales of foreign flat glass in Japan through such means as increased adoption of nondiscriminatory standards and expanded promotion of safety and insulating glass. The agreement covered the 1995-99 period and expired on December 31, 1999.[1]

Current

- Japanese demand for imported glass has improved slightly, although the U.S. share of the market has declined. The average monthly quantity of Japanese imports from all countries increased by 9 percent for the first eight months of 1999 to 1.7 million square meters, while the average monthly value of such imports increased by 14 percent to $12.4 million as the average unit value of imports increased by 5 percent. Imports from the United States in Jan.-Aug. 1999 increased by less than 0.5 percent to 442,000 square meters, but increased in value by 13 percent to $6.8 million.

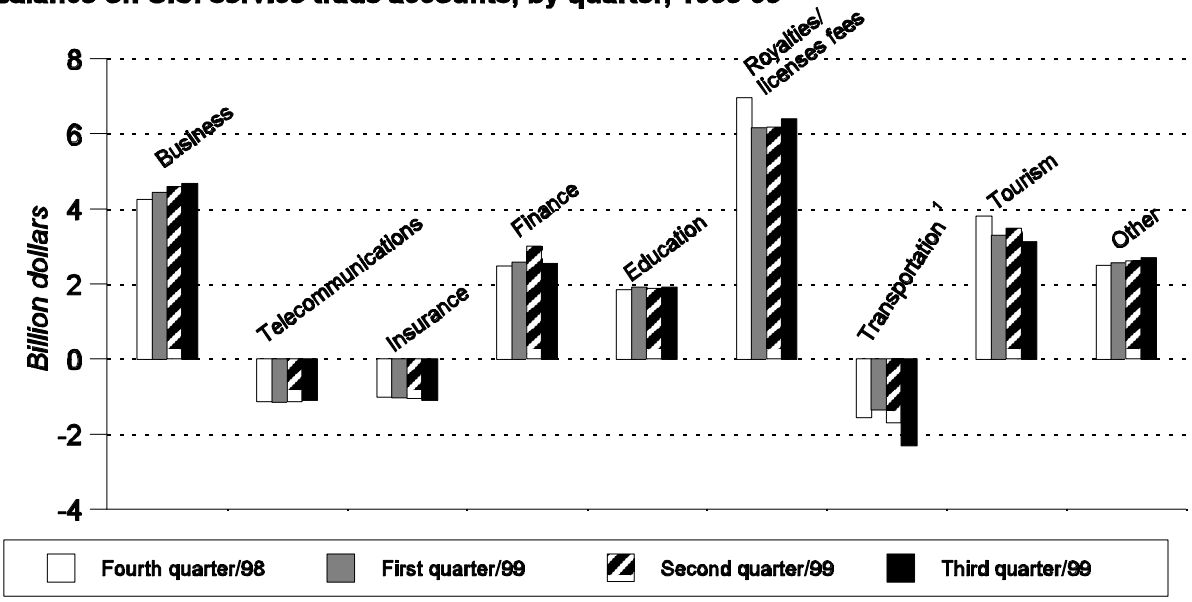
- The Government of Japan rebuffed efforts by the U.S. Government to negotiate a new bilateral agreement on flat glass, maintaining that a new agreement was not needed because Japan's flat glass market was already fully open to foreign glass products.[2] The agreement achieved some important successes in boosting demand for insulating glass and featuring American glass in public works projects, but important objectives remain unfulfilled.[3] U.S. and other foreign suppliers continue to have limited access to the distribution system controlled by the three major Japanese glass producers, and their share of the Japanese market remains small.[4] The U.S. and Japanese Governments plan to hold government-to-government discussions in March 2000 to address the remaining market access barriers and follow with a joint government/industry meeting later in the spring.

- Average monthly Japanese imports of flat glass will continue to be monitored in future issues of *Industry Trade and Technology Review*. Text will accompany figures only when developments warrant.

[1] Office of the U.S. Trade Representative (USTR), "The President's 1999 Annual Report on the Trade Agreements Program," p. 227, downloaded from http://www.ustr.gov/reports/tpa/2000/index.html on Mar. 3, 2000.
[2] U.S. State Department telegram, "Tokyo Press Reaction to Flat Glass Talks," message reference no. 09447, prepared by U.S. embassy, Tokyo, Nov. 16, 1999.
[3] USTR, "The President's 1999 Annual Report on the Trade Agreements Program," p. 227.
[4] Ibid.

SERVICES

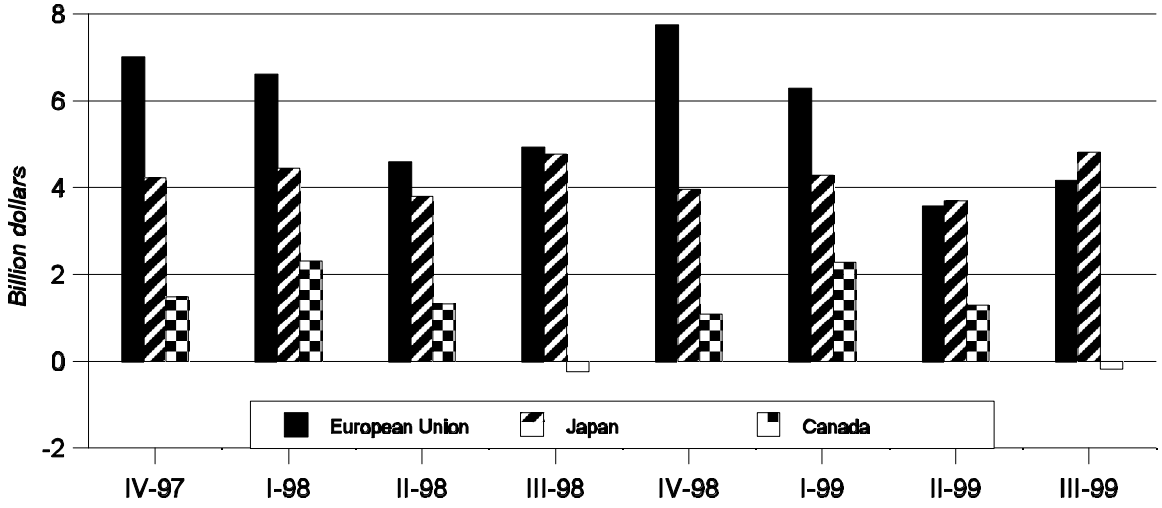
Figure A-6
Balance on U.S. service trade accounts, by quarter, 1998-99



[1] Includes port fees.

Source: Bureau of Economic Analysis, *Survey of Current Business*, Jan. 2000, p. 104.

Figure A-7
Surpluses on cross-border U.S. service transactions with selected trading partners, by selected quarters, 1997-99[1]



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

Source: Bureau of Economic Analysis, *Survey of Current Business,* table 10, Jan. 2000, pp. 112-115.