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PREFACE

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The Uruguay Round Elimination of Duties on Pharmaceuticals: Developments in the 2 Years Since Implementation

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The United States and most of its major trading partners agreed to eliminate duties on substantially all pharmaceuticals and on certain chemicals and semifinished goods during the Uruguay Round of multilateral trade negotiations. Duties were eliminated on January 1, 1995, when the Uruguay Round Agreements (URA) entered into force. Since the date of implementation, world trade in the covered products has continued to expand at a rate relative to the rate of expansion in the years just prior to implementation. The elimination of duties on pharmaceuticals is expected to encourage further consolidation among world producers and expansion of trade, and to sharpen world competition, particularly in generic pharmaceutical products. This article examines the trends in the U.S. pharmaceutical industry and pharmaceutical trade during 1995-96 as compared with 1993-94 before the elimination of duties went into effect.

During the Uruguay Round, the United States sought the reciprocal elimination of duties ("zero-for-zero") among major trading countries in a wide range of sectors of key interest to U.S. firms. The U.S. zero-for-zero initiative was achieved in only some sectors, and one of those was the pharmaceuticals sector. Under the URA, the United States and 16 other countries[1] agreed to eliminate their most-favored-nation duties on about 7,000 pharmaceuticals and chemical intermediates used primarily for the production of pharmaceuticals. These countries also agreed to conduct a review at least once every 3 years to identify products to be added to the list of covered products.[2] The pharmaceutical and intermediate products initially covered by the elimination of duties are highlighted in the text box.

[1] The EU-12, Switzerland, Norway, Japan, and Canada.

[2] Negotiators from several World Trade Organization (WTO) members, including the United States, engaged in the first review in early 1996 and reached agreement on the addition of 496 pharmaceutical products and chemical intermediates used for producing pharmaceuticals. Of these products, 262 are pharmaceutical products with International Nonproprietary Names (INNs) and 234 are chemical intermediates. Duties on these additional products and their derivatives were eliminated as of April 1, 1997.

Pharmaceutical Products Covered by Reciprocal Duty Elimination

The pharmaceuticals portion of the Uruguay Round Agreements covering reciprocal elimination of duties in the pharmaceuticals sector covers a list of goods in four annexes.[1] They are --

- Pharmaceutical active ingredients having an International Nonproprietary Name (INN) from the World Health Organization, and designated in annex I.
- Salts, esters, and hydrates of pharmaceutical products that are described by the combination of an INN active ingredient contained in annex I with a prefix or suffix as designated in annex II, as long as such salt, ester, or hydrate is classified in the same 6-digit HS subheading as the INN active ingredient.
- Salts, esters, and hydrates of INN active ingredients that are separately contained in annex III and that are not classified in the same 6-digit HS subheading as the INN active ingredient.
- Additional products used for the production and manufacture of finished pharmaceuticals, as well as certain finished pharmaceutical products, as designated in Annex IV.

In addition, most-favored-nation duties are eliminated on the following:

- Items included in chapter 30 of the Harmonized System (HS) -- formulated and/or packaged drugs.
- Items included in HS headings 2936, 2937, 2939, and 2941-- mainly bulk active ingredients for drugs in certain therapeutic classes.

[1] Exceptions to the product coverage include those items identified as agriculture products in the Agreement on Agriculture and specific products--Levomenthol, Monosodium glutamate, Paracetamol (also known as acetaminophen), Ibuprofen, and Dihydrostreptomycin (including its salts, esters, and hydrates).

The products accorded the reciprocal duty elimination are classified in several HS provisions and chapters. Those products classified in chapter 30 of the HS are the finished pharmaceuticals that have been packaged for retail sale, including dosage forms. Bulk products that are not in dosage form, but are used as active ingredients in pharmaceuticals, are generally classified in chapter 29 of the HS.[3] Within chapter 29, certain classes of bulk active ingredients classified as vitamins (HS 2936), hormones (HS 2937), glycosides and alkaloids (HS 2939), or antibiotics (HS 2941) enter free of duty under the reciprocal tariff treatment. U.S. imports of other bulk pharmaceuticals classified in chapter 29, as well as those

[3] Once bulk active ingredients are finished into dosage-form products such as tablets, capsules, ampules, ointments and powders--through the addition of fillers or diluents, binders, flavorings, ointment bases or stabilizers, or further processing such as microencapsulation--they are classified in chapter 30. INNs (text box) refer to specific chemical products, whether they are in bulk or dosage form.

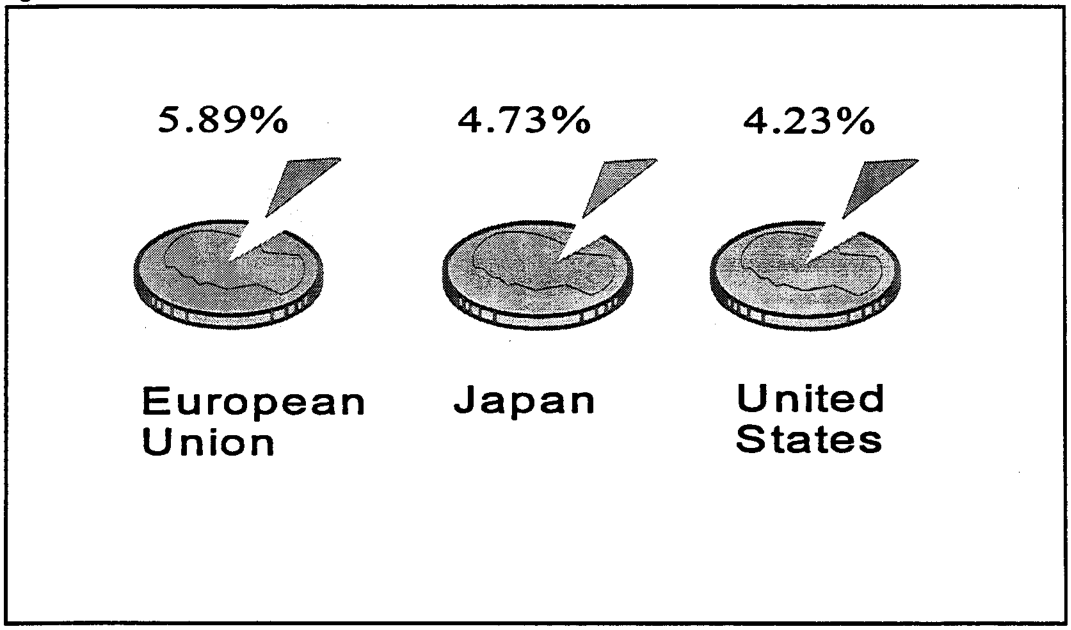
in other chapters,[4] that are provided for in the pharmaceuticals appendix and which enter under a subheading which has a letter "K" in the special rate of duty subcolumn of the Harmonized Tariff Schedule of the United States (HTS) are eligible for duty-free entry.

A summary of recent trade in the products covered by the initial agreement is provided in table 1. Along with other tables presented in this article, table 1 compares developments in the pharmaceutical industry in the pre-zero-for-zero period (from 1992-94) and the post-zero-for-zero period (from 1994-96).

Trade Shifts Associated with Tariff Elimination

The tariff eliminations that became effective January 1, 1995, pursuant to the "zero-for-zero" agreement amounted to a removal of the average 4.23 percent ad valorem U.S. duty rate for pharmaceutical products compared with the elimination of the somewhat higher average duty rates previously levied by the EU and Japan (figure 1).[5] The major export markets for

Figure 1
Average pre-URA duty rates for pharmaceutical products eliminated under the zero-for-zero agreement



Source: U.S. Department of Commerce, International Trade Administration.

[4] In addition to chapter 29 of the HTS, bulk INN products are classified in chapters 28, 31, 32, 34, 35, 38, and 39.
[5] U.S. Department of Commerce , International Trade Administration, *Uruguay Round Opportunities: Pharmaceuticals,* Sept. 22, 1995.

Table 1
U.S. Imports and exports of pharmaceutical products covered by the reciprocal duty eliminations, by Harmonized Tariff Schedule (*HTS*) product group, 1992-1996

HTS product group	1992	1993	1994	1995	1996	Average annual change, 1992-94	Average annual change, 1994-96
	1,000 dollars					*Percent*	
Imports:							
Bulk active ingredients:							
2936-Vitamins	343,692	426,414	505,358	558,548	627,081	21	11
2937-Hormones	94,832	101,979	134,296	177,075	271,258	19	42
2939-Alkaloids	173,480	174,883	184,155	198,497	481,323	3	62
2941-Antibiotics	454,310	512,477	582,795	753,051	828,647	13	19
30-Pharmaceutical products (finished dosage)	2,809,729	3,008,529	3,360,113	3,905,410	4,920,476	9	21
Subtotal	3,876,043	4,224,282	4,766,717	5,592,581	7,128,785	11	22
"Other bulk 'K' pharmaceuticals" and chemical intermediates covered in the Appendix of the *HTS*[1]	(2)	(2)	(2)	3,896,865	5,267,651	(2)	[3]35
Total, selected groups.	3,876,043	4,224,282	4,766,717	[4]5,592,581	[4]7,128,785	11	22
Exports:							
Bulk active ingredients:							
2936-Vitamins	123,398	135,163	187,359	318,316	318,746	23	30
2937-Hormones	360,354	427,953	376,131	374,860	321,794	2	-8
2939-Alkaloids	16,440	22,504	22,949	19,860	25,589	18	6
2941-Antibiotics	1,438,776	1,094,139	1,008,831	1,052,465	1,013,405	-16	0
30-Pharmaceutical products (finished dosage)	3,616,579	4,012,946	4,487,107	4,637,276	5,457,389	11	10
Subtotal	5,555,547	5,692,705	6,082,377	6,402,777	7,136,923	5	8
"Other bulk 'K' pharmaceuticals" and chemical intermediates covered in the Appendix of the *HTS*[1]	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Total, selected groups.	5,555,547	5,692,705	6,082,377	6,402,777	7,136,923	5	8

[1] Includes imported bulk products covered by the pharmaceuticals appendix that are classified in chapter 29 and in other chapters, and which enter under an *HTS* subheading that has a letter "K" in the special rate of duty column of the *HTS*. The categories of pharmaceuticals included are ethical, or prescription drugs, and over-the-counter (OTC) preparations. OTC preparations include many widely available cough, cold, and pain remedies, while prescription drugs are those dispensed at the direction of a licensed health care official.
[2] Not available.
[3] A measure of the change in import trade since implementation of the reciprocal duty elimination is shown by the annual change from 1995-96.
[4] For purposes of comparison, total does not include 1995 or 1996 imports of the group "Other bulk 'K' pharmaceuticals" and pharmaceutical chemical intermediates covered in the Appendix of the *HTS*" shown above.

Source: Official statistics of the U.S. Department of Commerce.

U.S. pharmaceuticals are Japan and the EU. Since the United States had the lowest average tariff rate on pharmaceuticals among its major trading partners prior to implementation of the URA, the average U.S. reduction in rates was the smallest. U.S. exporters, therefore, should potentially receive the largest benefit from the duty elimination.

Although certain categories of U.S. exports have shown significant gains (table 1), the greatest impact of the duty eliminations on the U.S. industry in 1995 and 1996 appears to be the increase in all categories of U.S. imports.[6] Imports of pharmaceuticals classified in HS headings 2936, 2937, 2939, 2941 and chapter 30 increased by $2.4 billion from 1994-96, compared with an increase of $890 million from 1992-94. Imports of antibiotics, the largest category of bulk active ingredients by trade value, increased by an average annual 13 percent from $454 million in 1992 to $583 million in 1994, and then by 19 percent to $829 million from 1994-96. Other products covered by chapter 30 increased by an average annual 9 percent from 1992 levels to a total of $3.4 billion in 1994, and then by 21 percent to $4.9 billion from 1994-96. The bulk "K" pharmaceuticals, including chemical intermediates, amounted to nearly $3.9 billion in 1995, and increased by 35 percent to $5.3 billion in 1996. Members of the EU and other WTO signatories that agreed to eliminate duties dominate the mix of these "K" pharmaceutical import sources. Industry sources indicate that company mergers and large-scale foreign plants principally have resulted in the more economical production of bulk active ingredients overseas whereas finishing and formulation typically occurs in the United States.

It is likely that the elimination of duties in key U.S. export markets contributed to increased exports by U.S. firms to those markets. Although total exports of pharmaceuticals [7] grew overall by an average annual 5 percent in the pre-zero-for-zero period (1992-94) and by 8 percent in the post-zero-for-zero period (1994-96), year-to-year growth in exports was the largest in 1995-96 (11 percent).[8] The export category with the largest absolute gain and average annual growth (30 percent) from 1994-96 was vitamins and provitamins (HS heading 2936).

The duty savings on imports for the industry, calculated for finished dosage form pharmaceuticals and bulk antibiotics, hormones, vitamins and alkaloids, amounted to an estimated $201 million in 1995 and approximately $318 million in 1996 (table 2).[9] Additionally, the duty savings for bulk, unfinished pharmaceutical products and intermediates

[6] Industry sources have indicated that in addition to the duty elimination, other factors that may account for the increase in imports include an increase in foreign production of "off-patent" or generic drugs, and production shifts resulting from recent merger and acquisition activity.

[7] Trade data for U.S. exports of the products denoted by the "K" special rate symbol are not available because the agreement concerns tariff treatment for imported products and has no provisions for requiring the reporting of exports.

[8] Additional factors influencing export growth are addressed in the next section relative to certain U.S. pharmaceutical sales abroad.

[9] The duty savings for this product group are calculated based on ad valorem equivalent (AVE) rates of duty for 1994 and comparable adjustments of import levels already accorded duty-free treatment under the Generalized System of Preferences, the United States-Israel Free Trade Agreement, the Caribbean Basin Economic Recovery Act, and the North American Free Trade Act.

Table 2
"Dutiable" imports, duty rate, and calculated duty savings, by Harmonized Tariff Schedule (*HTS*) product groups, 1995 and 1996 (projected)

HTS product group	1995 "dutiable" imports[1]	1996 imports	Estimated duty rate[2]	1995 calculated duty savings[3]	1996 estimated duty savings[4]
	— *1,000 dollars* —		*Percent*	— *1,000* dollars —	
Bulk active ingredients:					
2936 - Vitamins and provitamins	548,260	627,081	4.5	24,672	28,219
2937 - Hormones	168,938	271,258	3.9	6,589	10,579
2939 - Alkaloids	169,200	481,323	4.8	8,122	23,104
2941 - Antibiotics	684,305	828,647	4.8	32,847	39,775
30 - Pharmaceutical products (finished dosage)	2,933,635	4,920,476	4.4	129,080	216,501
Subtotal, bulk actives and dosage form pharmaceuticals	4,504,338	7,128,785	([5])	201,310	318,178
"Other bulk 'K' pharmaceuticals" and chemical intermediates covered in the Appendix of the *HTS*	3,896,865	5,267,651	6.4	249,399	337,130
Total, all groups	8,401,203	12,396,436	([5])	450,709	655,308

[1] The "dutiable" value of 1995 imports represents that portion of 1995 imports that would have been dutiable in the absence of the URA duty-free provisions.
[2] Estimated by the staff of the U.S. International Trade Commission based on 1994 ad valorem equivalent rates of duty.
[3] Calculated by multiplying estimated duty rate by 1995 "dutiable" imports except for the subtotal and total.
[4] Calculated by multiplying estimated duty rate by 1996 imports except for the subtotal and total.
[5] Not applicable.

Source: U.S. Department of Commerce and estimates by the staff of the U.S. International Trade Commission.

(the "K" imports covered by the pharmaceuticals appendix) amounted to an estimated $249 million in 1995, based on 1994 AVE rates of duty. The total revenue impact is a duty savings estimated at $451 million for 1995 on imports of $8.4 billion. Applying the same 1994 rates to 1996 imports would amount to a duty savings of approximately $655 million for 1996 on imports of $12.4 billion. However, factors such as rate staging from other agreements tend to increase the uncertainty of this 1996 estimate of duty savings.

Nevertheless, the duty savings are likely to have affected the level of imports of various pharmaceutical products. According to economic theory, the elimination of tariffs on bulk active ingredients and finished dosage form pharmaceutical products would be expected to result in increases in U.S. imports of these products and, possibly, decreases in domestic production, employment, and earnings, as well as reduced sales and profitability for certain companies.[10] Conversely, if imports of chemical intermediates increase as a result of the

[10] For companies using offshore facilities to produce patent-protected products, the local tax structure, labor and other input costs would be significantly different from those of producers entirely within the United States; thus, the overall impact of changes in imports on companies with (continued...)

elimination of duties, increases in domestic production and domestic exports of finished pharmaceutical products could be expected because the cost of producing finished pharmaceuticals would be lower. With the exception of the recently created categories for chemicals imported under the "K" provision, imports for each of these product categories have increased since 1994 as reflected in table 1.[11] The economic effects of duty elimination likely would be greater in regard to imports of generic or OTC pharmaceutical products, as they are more freely traded and have fewer restrictions than the patented pharmaceutical products. For chemical intermediates, various factors such as fungibility, uniqueness or product specifications, lower the overall elasticity of demand so that a reduction in tariffs likely would have less effect on import volume.

Economic Indicators Affected by Tariff Elimination

In addition to trade shifts that have occurred since the implementation of the zero-for-zero agreement, certain economic indicators for the U.S. pharmaceutical industry may also provide insights about the effects of duty elimination. These include changes in domestic and foreign sales levels, employment, producer costs, and research and development (R&D) expenditures. The pharmaceutical industry already had changed rapidly in recent years as a result of industry consolidation and the development of new products. The large companies in the industry have grown larger in size, principally through mergers and acquisitions, many of which have been international in scope. Some U.S. firms in the industry have proven superior in developing and marketing new and more effective products, and have gained market share at the expense of less successful firms. Other U.S. firms have experienced the expiration of patents on key products and now face more intense foreign and domestic competition in the highly competitive generic drug market.

Developments in sales of domestic ethical pharmaceuticals indicate growth of the industry in each of the 3 years prior to and the 2 years after implementation of the zero-for-zero agreement (table 3). However, the average annual growth rate of nearly 3 percent from 1992-94 increased to 11 percent from 1994-96. Sales abroad by U.S. pharmaceutical firms prior to the agreement grew at a similar average annual rate of 2 percent from 1992-94, whereas such sales increased after the agreement by 16 percent from 1994-96. In addition to the apparently improved access to foreign markets resulting from elimination of duties, it is important to note that this improved export growth also may have been affected by other agreements such as the NAFTA, which entered into force on January 1, 1994. Other factors that could have influenced export growth include the shipment of bulk ingredients for production overseas and efforts by companies to increase penetration in foreign markets.

[10] (...continued)
offshore facilities would be different as well.

[11] The degree to which the anticipated changes in domestic production of finished products offset each other, however, cannot be determined.

Table 3
Sales and pricing data on the ethical pharmaceuticals industry,[1] 1992-96

Item	Year					Absolute change		Average annual change	
	1992	1993	1994	1995	1996	1992-94	1994-96	1992-94	1994-96
	Million dollars							*Percent*	
Domestic ethical pharmaceutical sales	48,095	48,591	50,740	57,146	62,612	2,645	11,872	2.7	11.1
U.S. ethical pharmaceutical sales abroad	25,744	26,467	26,871	33,893	36,346	1,127	9,475	2.2	16.3
	Indices (*1984 = 100*)								
Producer price:									
Pharmaceuticals	165.72	172.43	174.81	178.70	181.20	9.09	6.39	2.7	1.8
All manufacturing	117.35	119.12	120.71	124.19	124.70	3.36	3.99	1.4	1.6
Consumer price:									
Pharmaceuticals	214.70	223.0	230.6	235.0	242.90	15.90	12.30	3.6	2.6
All manufacturing	140.32	144.46	148.23	152.38	154.10	7.91	5.87	2.8	2.0

[1] Ethical pharmaceuticals (available by prescription) include items covered by the reciprocal duty elimination for which PPI and CPI data are available, and comprise only a portion of the total trade of pharmaceutical products (table 1) covered by the reciprocal duty elimination.

Source: Bureau of Labor Statistics, and data from Pharmaceutical Research and Manufacturers Association (PhRMA).

Pricing is another indicator that can be examined with respect to possible changes in the pharmaceutical industry resulting from elimination of duties. The tariff eliminations would have been expected to lower input costs for finished pharmaceutical products. Moreover, according to economic theory, a reduction of tariffs on pharmaceutical imports and certain chemicals used in the production of finished pharmaceutical products should assert downward pressure on consumer prices, assuming the tariff saving is passed on to the consumer. Several factors such as shifts in exchange rates or product mix, however, may partially mask any pricing effects due to tariff changes. Adjustments in input costs for production ultimately will be reflected in the Producer Price Index (PPI) for the pharmaceutical industry. The PPI showed a steady increase from 1992-96 (table 3), although increasing at nearly double the rate in the pre-zero-for-zero period of 1992-94 compared with the PPI for all manufacturing industries (1.4 percent average annual growth). However, the pharmaceuticals PPI grew more slowly from 1994-96 than it did from 1992-94 (and nearly the same as the growth in PPI for all manufacturing from 1994-96), indicating that the pharmaceutical zero-for-zero agreement may be reflected in the index by the slower PPI growth. Although the average annual change in the PPI for pharmaceuticals slowed down to approximate recent growth in the PPI for all manufacturing, it is not certain to what degree the overall trend is an indicator of general manufacturing activity. Regardless of the reason, the reduction in the growth rate of the pharmaceuticals PPI, in turn, should have resulted in lowered consumer prices for pharmaceuticals.

The Consumer Price Index (CPI) for pharmaceuticals, after growing by an average annual rate of 3.6 percent from 1992-94, increased by only 2.6 percent from 1994-96 (table 3). In comparison, the CPI for all manufacturing showed an annual increase of 2.8 percent from 1992-94 and only 2.0 percent from 1994-96. Whether the duty savings are actually reflected in the CPI cannot be inferred from the available information due to several factors, such as the change of the import mix of pharmaceutical products from year to year, and the introduction of newer (generally higher priced) pharmaceutical products which take the place of older products each year. Also, imports account only for about 14 percent of domestic consumption of pharmaceutical products so that the elimination of duties is only one factor, along with the effects of industry rebate programs and the emergence of health maintenance organizations[12] (HMOs), that has probably contributed to a slower rate of growth in U.S. consumer prices for pharmaceuticals in recent years.

Employment levels also may be examined to assess whether the U.S. pharmaceutical industry has benefited from the zero-for-zero agreement. U.S. employment in the pharmaceutical industry has fluctuated during the past 5-year period (table 4). Employment for all pharmaceutical workers increased by an average annual rate of 1.2 percent from 1992-94, then decreased by 0.9 percent from 1994-96. The number of production workers increased by an annual average of 3.9 percent from 1992-94, then increased 0.8 percent from 1994-1996. Industry sources noted that mergers in the industry have led some of the major pharmaceutical firms to combine workforces while eliminating overlapping jobs. The result of industry restructuring may be reflected in the decline in the overall number of workers from 1994-96 whereas increased industry output has increased the number of production workers since 1994. Employees had higher average weekly and hourly earnings from 1994-96, as compared with 1992-94, whereas average weekly hours remained relatively unchanged during 1993-96 after declining in 1993.

Table 4
Employment data for the pharmaceuticals industry, 1992-96

	Year					Absolute change		Average annual change (*percent*)	
Employment factors	1992	1993	1994	1995	1996	1992-94	1994-96	1992-94	1994-96
All workers (*1,000*)	257.3	264.4	263.3	259.5	258.6	6.0	-4.7	1.2	-0.9
Production. workers (*1,000*)	112.1	117.1	121.0	126.7	123.0	8.9	2	3.9	0.8
Average weekly earnings (*dollars*)	599.68	607.34	610.41	635.36	654.95	10.73	44.54	0.9	3.6
Average weekly hours	42.5	41.4	41.3	41.8	41.4	-1.2	0.1	-1.4	0.1
Average hourly earnings (*dollars*)	14.11	14.87	14.78	15.20	15.82	0.67	1.04	2.3	3.5
Employees--all industries (*1,000*)	108,604	110,730	114,034	116,607	119,523	5,430	5,489	2.5	2.4
Pharmaceutical workers as a ratio of employees in all industries (percent)	0.2	0.2	0.2	0.2	0.2	([1])	([1])	([1])	([1])

[1] Not applicable.

Source: Bureau of Labor statistics and estimates by the staff of the U.S. International Trade Commission.

[12] Health maintenance organizations, or HMOs, are generally for-profit organizations that emphasize cost-cutting methods to maximize profits. With respect to pharmaceuticals, HMOs generally use generic substitution and bulk buying programs in order to obtain medicinals at the lowest price.

Historically, the pharmaceutical industry has been highly dependent on R&D of new products to ensure growth of the industry, and relatively large amounts have been invested. Thus, trends in R&D expenditures can be examined for possible increases, as R&D budgets could be expanded in light of savings from the elimination of duties. Domestic R&D percentage of U.S. sales has grown over the past 5-year period, reaching a high of nearly 22 percent of sales in 1994 and over 21 percent of sales in 1996 (table 5). Analysis of annual trends shows that absolute expenditures on domestic R&D have increased each year and the average annual growth rate has increased as well; in 1994-96, domestic R&D grew by 9.6 percent, compared with 9.2 percent during 1992-94.

Table 5
R&D expenditures and other economic factors in the pharmaceuticals industry, 1992-96

	Year					Absolute change		Average annual change (*percent*)	
Item	1992	1993	1994	1995	1996	1992-94	1994-96	1992-94	1994-96
Domestic R&D (*million dollars*)	9,312.1	10,477.1	11,101.6	11,874.0	13,378.5	1,789.5	2,276.9	9.2	9.6
R&D spending by U.S. firms overseas (*million dollars*)	2,155.8	2,262.9	2,347.8	3,333.5	3,539.6	192.0	1,191.8	4.4	22.8
Domestic R&D as a share of sales (*percent*)	19.4	21.6	21.9	20.8	21.4	2.5	-0.5	([1])	([1])

[1] Not applicable.

Source: Estimates by the staff of the U.S. International Trade Commission and data from PhRMA.

Although total profitability among selected pharmaceutical companies was about comparable in the respective pre- and post-zero-for-zero periods of 1994 and 1995 (table 6), total company sales grew by 15 percent from 1994 to 1995 and total company earnings grew by 9 percent in the year-to-year comparison, as reflected by information on trends in individual pharmaceutical company performance. It should be noted, however, that these trends may also be due to factors other than tariff elimination, such as changes in exchange rates, gains from consolidation and, for some companies, the development of and demand for new patent-protected products.

Findings

The duty elimination resulting from the zero-for-zero agreement in pharmaceuticals is difficult to link directly to the various industry changes that have occurred during 1995-96 because of the likely impact of other economic factors during the period. In light of this complexity, and the relatively short time the agreement has been in effect (2 years), findings are preliminary and inconclusive. The pharmaceutical industry, however, believes the agreement to be successful enough that negotiators have already begun to pursue the second update round.

Table 6
Sales, earnings, profitability and growth for selected pharmaceutical companies, 1994-95

Company[1]	Sales		Earnings		Profitability[2]		Increase 1994-95	
	1994	1995	1994	1995	1994	1995	Sales	Earnings
	Million dollars				*Percent*			
Glaxo-Wellcome	8,710	15,475	1,933	2,120	22	14	78	10
Merck	14,970	16,681	2,997	3,335	20	20	11	11
Bristol-Myers Squibb	11,984	13,767	2,331	2,600	19	19	15	12
Pfizer	8,281	10,021	1,298	1,554	16	16	21	20
SmithKline Beecham	9,532	10,800	928	1,000	10	9	13	8
Johnson & Johnson	5,158	6,274	1,669	2,039	32	32	22	22
Pharmacia-Upjohn	3,345	6,900	489	895	15	13	106	83
American Home Products	8,966	13,376	1,528	1,365	17	10	49	-11
Eli Lilly	5,712	6,764	1,286	2,291	23	34	18	78
Schering-Plough	3,880	4,472	1,204	1,381	31	31	15	15
Abbott Labs	4,951	5,629	1,385	1,586	28	28	14	15
Warner-Lambert	2,079	2,356	347	401	17	17	13	16
Novartis	([3])	10,940	([3])	([3])	([3])	([3])	([3])	([3])
Hoechst	11633	([3])	1,519	([3])	13	([3])	([3])	([3])
Hoffmann-LaRoche	8339	([3])	([3])	([3])	([3])	([3])	([3])	([3])
Rhone Poulenc Rorer	4,487	5,142	367	357	8	7	15	-3
Total, selected companies[4]	112,027	128,597	19,281	20,924	17	16	15	9

[1] Sales and earnings are shown for the pharmaceutical segment of the company if available; otherwise, full company figures are shown.
[2] Profitability shown as the percentage of sales represented by company earnings.
[3] Not available.
[4] Totals shown for comparison only.

Source: Standard & Poors, Securities and Exchange Commission, and estimates by the staff of the U.S. International Trade Commission.

As noted, the benefits of free or liberalized trade (e.g., reduced import duties) should result in a savings that may be passed on by the importer to a distributor or manufacturer, when further processing is required. In turn, the lower price of the imported good may accrue to multiple layers of consumers (e.g., the formulator, the pharmacist, and the person being treated).

For this sector, the most discernible immediate impact of duty elimination appears to have been on U.S. imports, specifically alkaloids and hormones (table 1). In addition, total U.S. imports of the products claimed for duty-free entry under the zero-for-zero agreement increased by almost $2.4 billion from 1994-96, excluding bulk "K" pharmaceutical and chemical intermediate products for pharmaceuticals.[13] The estimated duty savings related to all these products increased from $451 million in 1995 to approximately $655 million in 1996. The total amount of duty savings on imported goods is relatively small compared with total sales by the largest companies which approximated $129 billion in 1995. For high-

[13] Imports of bulk "K" pharmaceuticals and chemical intermediate products increased to $5.3 billion in 1996 (table 1). Comparable data did not exist in 1994.

valued products such as pharmaceuticals, the savings benefit would not be expected to be immediately realized by the average consumer.

It is equally likely that the savings resulting from the elimination of the average U.S. rate of duty of 4.23 percent ad valorem had no significant effect on the PPI and the CPI, other than possibly contributing to some slowing in the growth rate (table 3). It appears from PPI and CPI data that pharmaceutical prices increased in 1995 and 1996, and they did so at a faster rate compared to other products. Employment growth for production workers since 1994 may have been slightly affected by the elimination of duties, although industry rationalization is likely responsible for the addition of 5,700 production jobs to the U.S. workforce in 1995 and a loss of 3,700 production jobs in 1996.

Changes in other areas of the pharmaceutical industry include some fluctuation in the growth rate of R&D expenditures in 1995 and 1996, compared with that in prior years (table 5). Profitability among the larger pharmaceutical companies (e.g., Merck, Bristol-Myers Squibb) appears to have changed little between 1994 when duties were present and 1995, the first year of duty-free treatment; most companies have sustained double-digit growth in sales and earnings in year-to-year comparisons, 1994-95 (table 6).

No single measure of industry performance, other than increased imports, is likely to be attributable to the elimination of tariffs on pharmaceutical products; even trade shifts are difficult to isolate, given the short time during which the zero-for-zero agreement has been in effect and other factors including trade-related agreements such as NAFTA, exchange rate fluctuations, and the dynamic changes in production of pharmaceuticals. However, additions to the zero-for-zero roster may provide a clearer picture in the future.■

Alternative Materials in the U.S. Automotive Industry Promote Development of Joining and Bonding Technology

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The development and commercialization of processing technology is considered an important factor in improving industrial competitiveness. This article is the fifth in a series presenting ongoing USITC Office of Industries research on new manufacturing processes for materials (NMPM). NMPM are viewed as potentially cost-effective in ensuring greater productivity and efficiency.

Joining and bonding technologies have changed as industrial applications for nontraditional materials have expanded. For example, the auto industry has increased its consumption of lightweight materials over the past 20 years as fuel efficiency standards increased and as auto makers responded by producing lighter cars. As the polymer composite and aluminum content of automobiles increased, so did the need for specialized joining technologies. This article examines several joining technologies currently under development that may offer auto makers a competitive advantage as alternative materials make inroads into the auto industry.

The U.S. automobile industry, the world's single largest car and truck producer, accounted for approximately 21 percent of global production in 1996.[1] During that same year, the Big Three U.S. auto producers captured 35 percent of worldwide sales,[2] largely because of their effective response to market and regulatory demands. Consumer expectations of higher quality, increasingly stringent environmental standards, and heightened safety awareness have raised the intensity level of competition in the market. U.S. producers have responded by reducing costs and improving productivity (often through changes in manufacturing processes).[3]

Auto producers employ many strategies to maintain their competitive position. One strategy designed to meet environmental regulations is the substitution of lightweight materials for

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[1] *Automotive News, 1997 Market Data Book*, May 23, 1997, various pages.

[2] Derived from sales figures in *Ward's Automotive Yearbook, 1997*, p. 126; and *Automotive News*, p. 24.

[3] U.S. Department of Commerce, Motor Vehicle Division, "Drivers of the U.S. Automotive Industry," prepared by Albert T. Warner, director, Motor Vehicle Division, Feb. 27, 1996, found at http://www.ita.doc.gov/ industry/basic/hondsp.html, retrieved July 8, 1997.

steel and other metals.[4] The U.S. automotive industry has increased the polymeric materials[5] and aluminum content of a typical family vehicle (table 1), particularly in applications for nonload-bearing parts, e.g. plastic hoods, roofs, and side panels; and aluminum wheels, brakes, air conditioning compressors, heat exchanger, radiators and engine blocks.[6] Traditionally, these parts have been made of steel.

Table 1
A typical family vehicle, material content and total weight

Material/ year	1976		1986		1996		1976-1996 percent change
	Pounds	Percent of total	Pounds	Percent of total	Pounds	Percent of total	
Iron and steel	2,785.0	74.1	2,190.0	69.0	1,890.0	61.0	-32.0
Polymeric materials	325.0	8.6	433.0	13.7	642.0	21.0	97.5
Aluminum	85.5	2.3	139.5	4.4	257.0	8.3	200.0
All other	564.5	15.0	407.5	12.9	301.0	9.7	-47.0
Total vehicle weight	3,760.0	100.0	3,170.0	100.0	3,090.1	100.0	18.0

Source: *Recent trends in automobile recycling: an energy and economic assessment*, ORNL/TM/12628, March 1996.

As a means to limit emissions of carbon dioxide, and to meet corporate average fuel efficiency (CAFE) standards,[7] U.S. automobile manufacturers reduced the weight of the steel portion of the average passenger car by 21 percent between 1976 and 1986. The overall weight of the average car declined by 18 percent between 1976 and 1996. However, nearly all of the reduction was achieved by 1986, when auto makers were producing fleets in compliance with CAFE standards (table 1). Since then, the weight of the average car has remained stable, mainly because of the combined effect of unchanging CAFE standards and increased consumer demand for large accessory-laden vehicles.

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[4] For an analysis of the pros and cons of steel versus aluminum and plastic in automobile manufacturing , see Frank R. Field III, and Joel P. Clark, "A Practical Road to Lightweight Cars," *MIT Technology Review*, Jan. 1997, found at http://web.mit.edu/techreview/www/articles/jan97/clark.html, retrieved June 17, 1997.

[5] Polymeric materials include all plastics and polymer composites. Plastic is a nontechnical term for "resin system," and polymer composites are resin systems that are reinforced with a fibrous material in order to enhance mechanical and physical properties. Most auto parts that do not have a load-bearing function are made of resin systems although the load-bearing parts must be strong and are made with polymer composites. This article is concerned with the development of joining and bonding methods for polymer composite load-bearing structures for automobiles, such as frames. The term "plastic" will be used to refer to auto parts that are nonload-bearing (such as dashboards) and are made of nonreinforced resin systems.

[6] For details on the use of aluminum in the automobile industry see USITC, "Aluminum Product Development and the Automotive Industry," *Industry Trade and Technology Review*, USITC, May 1994, pp. 17-25.

[7] CAFE standards were established in 1975 by the Energy Policy and Conservation Act. According to these standards, automakers are required to meet fuel economy ratings for each fleet of passenger cars they produce. Since 1986, the fleet average has been 27.5 miles per gallon, although industry officials anticipate a higher standard during the next several years. See the data found at http://www.ita.doc.gov/industry/basic/cafe/html, after June 23, 1997.

Since a 25-percent decrease in vehicle weight could save 13 percent in gasoline consumption and reduce carbon dioxide emissions by 101 million tons per year,[8] manufacturers are experimenting with further weight reductions by using alternative materials for auto parts made of steel and other traditional metals. Alternative material candidates include polymer composites reinforced with glass (25-35 percent of the weight of steel), carbon fiber-reinforced polymer composites (50-65 percent of the weight of steel), and aluminum (one-half of the weight of steel).[9] Although CAFE standards have not changed in recent years, auto manufacturers are developing process technology for automobile production with lightweight materials.[10] Manufacturers are more likely to produce a vehicle with improved fuel economy once such technology becomes widely available. A higher CAFE standard would push the development of this process technology and lead manufacturers to increase their use of lightweight materials.

The adoption of alternative materials can also reduce manufacturing costs. Material properties (such as the temperature at which a material becomes malleable) are key determinants of the processing and assembly methods, which directly effect productivity rate and cost. For example, molded polymer composite auto parts cost less to manufacture than stamped steel parts because complex shapes can be formed in one large mold. The process requires less joining, bonding, and machining. Manufacturing costs are further reduced because less labor is required to complete the process. The material switch may also affect the speed of production because less time is needed to assemble consolidated parts.

Automakers are investing in research of joining and bonding technologies for alternative materials. The lack of fully developed joining technologies is considered a barrier to the utilization of advanced lightweight materials to form automotive structures.[11] Traditional means of joining steel parts--welding, brazing, and soldering--do not effectively bond polymer composites, and adjustments to welding and brazing must be made to successfully join aluminum. Mechanical fasteners continue to be a viable joining option, but they are typically used in conjunction with another method. For example, adhesively joined polymer composites may be mechanically fastened (either permanently or temporarily while the adhesive bond sets). The ideal joining methods would have the capacity to bond both similar and dissimilar materials, such as aluminum to steel, or polymer composite to aluminum. One well-known consortium conducting research on joining and bonding polymeric composites and aluminum auto parts is the Partnership for a New Generation of Vehicles (PNGV), highlighted in the text box.

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[8] "Transportation Technologies," found at http:/www.ornl.gov/ornl/energy_Efficiency/trans.html#ctp, retrieved Aug. 13, 1997.

[9] National Materials Advisory Board, *Materials Research Agenda for the Automotive and Aircraft Industries*, NMAB-468 (Washington, DC: National Academy Press, 1993), p. 34.

[10] Toni Marechaux, U.S. Department of Energy, Office of Transportation Technologies, USITC staff interview, June 1997.

[11] "Adhesive Bonding Technologies for Automotive Structural Components," found at http://www.ornl.gov/ orcmt/capabilities/dtin384.html, retrieved June 16, 1997.

Partnership for a New Generation on Vehicles (PNGV)

Research on joining technology for automobile manufacturing is sponsored by private and public collaboration, through the PNGV. The partnership was founded in 1993 between the U.S. Government and the Big Three U.S. car makers to develop the automobile of the future. Each PNGV activity contributes to one of the three goals that guide the program:

- improve U.S. competitiveness in automobile manufacturing
- develop and apply new innovations to conventional vehicles
- develop a vehicle with up to three times the fuel economy of conventional mid-sized sedans while maintaining current performance, safety standards, and cost of ownership

The PNGV strategy to reach the fuel economy goal is the reduction of vehicle weight. The goal is supported by a host of research projects on aluminum and polymer composites conducted in the national research facilities and Big Three laboratories. Materials research, including the development of joining technologies for alternative materials encourages progress toward this objective.

The 1996 PNGV report hailed several research projects on joining methods 'significant technical accomplishments.' A project on *adhesive bonding technologies for automotive structural components* was successful in creating standardized test methods to analyze the durability of bonded joints. Also, the bonding of aluminum to composites and a material surface treating method to improve a bond was addressed. The latter will soon be patented. A project on aluminum laser-welding led to the development of a computer controlled process monitor. No joining technology developed under the PNGV currently is used in the mass production of automobiles.

Ultra-light Steel Autobody (ULSAB) program

The steel industry has mobilized to maintain one of its largest markets. The ULSAB program is a international project initiated by the automotive industry (in this case European) and the steel industry to develop a lightweight steel autobody structure. Its members include 35 steel makers from 18 countries. The ULSAB has addressed the automobile industry's need to reduce the average vehicle weight by using a computer model to design a high-strength steel body and parts.

Auto/Steel Partnership and European Aluminum Association

The Auto/Steel Partnership is a consortium of the U.S. Big Three vehicle manufacturers and major U.S. and Canadian integrated steel mills. Twelve task forces conduct precompetitive research on standardization, cost-reduction, and design issues. Three of the task groups research welding technology and standards. The European Aluminum Association is also active in promoting the aluminum content in European-made automobiles.

Joining and Bonding

A portion of the research and development (R&D) on the future generation of vehicles is focused on surmounting the difficulties associated with bonding polymer composites, aluminum, and steel. More specifically, R&D is underway on less costly and quicker assembly and processing methods (relative to traditional materials) for joining alternative materials.[12] Research in this area is critical to support the application of alternative materials in the automotive industry.[13] The joining technologies described below show promise in facilitating the manufacture and adoption of structural auto parts composed of polymer composites and aluminum.

Although research on new joining technologies is underway, these methods are not yet commercialized. The ability to predict the behavior of a joint is stalled to a large extent by the lack of reliable nondestructive testing methods. Once reliable testing methods are developed and the technology produces satisfactory results, one less obstacle will exist for auto manufacturers who want to make composite and aluminum auto parts. The degree to which the joining and bonding methods described below are adopted can become known only as the auto industry gains greater experience with their application.

Adhesive Bonding

Adhesive bonding is the primary method for joining polymer composites, although metals will also bond with adhesives. The auto industry consumption of adhesives already has been increasing. Plastic has become the dominant material for interior auto parts. The change in bonding technology lowered production costs as the manufacturing process was streamlined and required fewer mechanical fasteners.[14] Adhesive bonds are stronger due to the wider distribution of load at the joint, unlike mechanical fasteners that are stressed at a single point. Auto manufacturers have greater design flexibility with adhesive bonds that have a smooth joint surface. No universal adhesive exists; an adhesive formula is chosen based on the properties of the substrate, the function of the joint, and the environmental conditions that the joint must endure. Three of the most common adhesives used to bond composites are epoxies, acrylics, and urethane.[15]

Aside from determining the best adhesive formula for a composite, a producer must have effective assembly and processing technologies to implement the bonding methods. The

[12] Research goals for the development of assembly and processing technologies such as joining and bonding are outlined in *Partnership for a New Generation of Vehicles, Report of Workshop on Composite Vehicle Structures,* Sept. 28, 1995, Detroit, MI.

[13] The joining techniques described in this report are intended to bond load-bearing structural auto parts made of aluminum or polymer composites. Joining techniques for load-bearing parts require greater strength than techniques for joining interior nonload-bearing auto parts, such as dashboards.

[14] USITC, "Economics and Innovation Spur Shift from Mechanical Fasteners to Adhesives and Sealants in Certain Automotive Applications," *Industry, Trade and Technology Review,* Aug. 1994.

[15] "Joining Composites," *Machine Design,* Sept. 14, 1995, p. 81.

joining technologies described below address two production challenges faced by the consumers of adhesives; lengthy curing time required to set each bond, and the need to treat the substrate surfaces before bonding. Although not technically joining technologies, microwave curing treatment and laser ablation perform functions that address these joining challenges. Technologies that meet these challenges will offer auto producers a greater choice of materials.[16]

Microwave Curing Treatment

The use of microwave radiation to hasten the curing process of polymer composites joined by an adhesive bond has proven to be successful.[17] Adhesives are conventionally cured with thermal heat, but the microwave process can create an adhesive bond of equal strength and performance in much less time.[18] Microwave radiation requires one-third to one-quarter of the time required to cure with thermal heat.[19] Joining by microwave radiation enables greater flexibility in the manufacturing process since, to a degree, a higher microwave power shortens the required curing time. Reduced processing time leads to energy and labor savings,[20] an effect that not only improves the manufacturing process but also facilitates wider adoption of composites and other alternative materials. Research and development of microwave curing is currently sponsored by the U.S. Department of Energy (DOE) at Oak Ridge and Los Alamos National Laboratories.

Diffusion-Enhanced Adhesion (DEA)

The DEA process was developed at the University of Delaware's Center for Composite Materials and was applied to the development of a composite armored tank vehicle capable of withstanding extreme battlefield conditions. The joining process was used to bond a composite gun projection platform to the body of the vehicle.[21] As a polymer composite layer is co-molded to the gun projection platform, a compatible epoxy adhesive is diffused into the composite layer and a bond is formed. A DEA bond is extremely strong and requires less equipment than traditional steel welding. DEA also requires low pressure, low temperature, and minimal assembly, which translates into lower manufacturing costs.[22] Another potentially

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[16] Adhesives have been used in the automotive industry for years as plastics became the materials of choice for nonload-bearing interior parts, in the 1970s and 1980s. For an analysis of the adoption of adhesives in the auto industry see "Economics and Innovation Spur Shift," USITC, *Industry, Trade and Technology Review*, Aug. 1994.

[17] C. David Warren, R. G. Boeman, and F. L. Paulauskas, "Adhesive Bonding of Polymeric Materials for Automotive Applications," prepared for the Proceedings of the 1994 Annual Automotive Technology Development Contractors Coordination Meeting, Dearborn, MI, Oct. 24-27, 1994, n.p.

[18] Thomas T. Meek, "Adhesive Bonding via Exposure to Microwave Radiation and Resulting Mechanical Evaluation," prepared for the Spring Materials Research Society (MRS) meeting, Apr. 1996.

[19] Warren, Boeman, and Paulauskas, n.p.

[20] Estimates of costs savings associated with microwave curing treatment are not available.

[21] Melissa Larson, "Quality Gets a Boost From Materials Science," *Quality*, Nov. 1996, p. 32.

[22] Ibid.

cost-reducing aspect of DEA is the elimination of the need to pretreat the composite surface.[23] One difficulty associated with DEA is the length of time required to make the bond. The auto industry is not likely to adopt a technology that slows production. The U.S. Department of Defense funded the project, and reportedly there are no commercialized applications of DEA in the auto industry.

Laser Ablation

Contaminants on a material surface often inhibit the chemical bond of an adhesive so most composite surfaces must be treated prior to bonding. Laser ablation is a surface treatment that removes the contaminants on the composite surface and also some of the resin. This creates a rough surface area as the fibers (carbon or graphite) characteristic of all reinforced polymer composites are exposed. The resin surrounding the exposed fibers interface with the adhesive, creating a joint that is resistant to cracks. The strength of the bond is attributable to the large surface area contact created as the fibers of one part extend across the joint and intermingle with the fibers of the other part. The production rate of structural auto parts treated with laser ablation would likely increase because of the time savings incurred by the elimination of surface treatment.[24] Glass-fibers of reinforced composites are inclined to split from the intensity of the laser beam, producing a weak bond. The technique appears to work better on composites reinforced with carbon-fiber rather than glass-fiber.[25] There is no commercialized technology of this type in the automobile industry, but extensive research sponsored by DOE is conducted at Oak Ridge National Laboratory.[26]

Welding

Welding is one of the low-cost methods for joining aluminum. Auto manufacturers have welded steel auto parts together for decades, but welding aluminum does require some process modifications. As the aluminum content in automobiles has increased, alternative welding techniques have become more important in the industry. Current research focuses on the development of modified welding methods, process monitoring, and noninvasive testing of welded joints.[27] Welding techniques that enhance productivity and maintain or improve product quality could lead to greater consumption of aluminum by auto producers; two techniques, laser and advanced welding, are undergoing further development.

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[23] Estimates of costs savings associated with DEA are not available.

[24] Estimates of costs savings associated with laser ablation are not available.

[25] C. David Warren, Felix L. Paulauskas, Ray G. Boeman, "Laser Ablation Assisted Adhesive Bonding of Automotive Structural Composites," project completion report, Oak Ridge National Laboratory, Feb. 4, 1997.

[26] Ibid.

[27] "Light-weight Materials, III. Findings and Recommendations," found at http://www.pmi.princeton.edu /conference /future vehicles/lightweight.html, retrieved June 12, 1997; and "Research aims at better laser welding for aluminum auto parts," press release, May 1996, found at http://www.anl.gov/opa/news96/news960509.html, retrieved Aug. 10, 1997.

Laser Welding

Laser welding is a promising method for joining aluminum, although the method works on other materials such as ceramics. Aluminum is difficult to weld with traditional electric-welding techniques because, unlike steel, it is a high conductor of electricity. It is also difficult to laser-weld because it is highly reflective and tends to scatter the laser beam. Compared to several other alternative welding techniques, however, laser welding is fast, precise, and requires less heat.[28] One drawback of laser-welding equipment is its sensitivity to contaminants commonly found in the automobile-manufacturing environment. Wider application of laser welding is dependent upon a resolution to this difficulty and the technology must be refined to so that joint strength, assembly times, and cost meet the standards and efficiencies already achieved for bonding steel components.[29] The development of process controls for laser welding to improve joint quality is conducted under the auspices of PNGV by private companies and several national laboratories. The progress of this research is marked by the development of an on-line weld monitor that can detect surface features and other measures, as the joint is formed. A patent for the technology is now pending.[30]

Advanced Welding

A manufacturing process designed to form and join preshaped aluminum and tubular steel is under development by Dana Corp., an automotive-component parts supplier (Reading, PA).[31] The project supports automakers' efforts to increase fuel efficiency by substituting lightweight materials to achieve weight reduction of the load-bearing frames of cars and light trucks. The process more precisely forms the load-bearing structures that reduces the need for filler material to join parts. Preshaped aluminum or tubular steel is formed by exposure to high pressure within very precise die cavities and then machined according to a computer-aided design (CAD) file. The method has several advantages: dissimilar metal substrates can be joined, the time required to cure the joint is minimal, and the process need not be fixed to one area of the factory floor.[32] The process makes the adoption of aluminum a viable option for U.S. auto makers and its flexibility allows manufacturers to readily respond to consumer demands. The manufacturing process is not yet commercialized, and Dana Corp. is supported by the National Institute for Standards and Technology (NIST), under Advanced Technology Program funding. [33]

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[28] Compared to arc welding (electrical-current method), *PNGV Technical Accomplishments*, July 1996, n.p.

[29] Estimates of costs savings associated with laser welding are not available.

[30] *PNGV Technical Accomplishments*, n.p.

[31] Larson, "Quality," *Quality*, p. 32.

[32] Estimates of costs savings associated with advanced welding are not available.

[33] ATP project brief, "Advanced Welding Technology for Structural Automotive Products," found at http://www.atp.nist.gov/www/comps/briefs/95020055.html, retrieved Sept. 30, 1997.

Other Bonding and Joining Technologies

Diffusion Bonding

This process was originally developed by an aircraft manufacturer and an aluminum producer. Diffusion bonding is a combination of two distinct processes; first, complex shapes are formed from a single piece of material, and second, materials are joined by diffusion.[34] The process relies on superplasticity, a property in which a material can become extremely elongated without breaking. For example, aluminum alloy can be treated to take on a superplastic property that facilitates the formation of complex auto parts. The number of parts to join is reduced; for example, Big Three collaborative work on a composite pickup truck bed of 20 pieces could replace a steel bed of 200 parts.[35] After the parts are formed, the metals are bonded by keeping the base-metal microstructure intact at the joint interface. The method works for dissimilar metals. Researchers claim that the combination of superplastic forming and diffusion bonding combines the benefits of each to form a joint of superior strength.[36] The method leads to greaterfreedom of design, a potential for energy-savings, and cost-effective manufacturing. However, the process takes time, which is a major drawback for its application in the auto industry. Research on diffusion bonding is underway at the Lawrence Livermore National Laboratory and is sponsored by the DOE.[37] The technology is not yet commercialized.

Microwave for Ceramics

Ceramic is an alternative material for some automobile engine components. Ceramics are lightweight and have the capacity to withstand very high temperatures; two qualities that can help auto manufacturers reduce fuel consumption. Ceramic engine parts such as piston heads and rotors allow the engine to run without a cooling system and with less fuel. Although ceramic engine parts facilitate fuel efficiency, reliable joining methods are needed. Microwave energy is one alternative to bonding ceramics by thermal heat, which requires extremely high temperatures to work successfully.[38]

Ceramics can be joined to composite materials by applying a microwave heating process. As a joining technology, the microwave process forms an interlayer of active braze alloy and successfully creates a bond between the ceramic engine parts and composite base material.[39] The heating characteristics of ceramics are favorable to the creation of a high-strength bond; the bond is formed from the inside out (the middle is heated from center and outward). The

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[34] Diffusion is a joining process whereby two flat surfaces are heat treated, causing the molecules to intermingle and bond.

[35] C. David Warren, program manager, Transportation Composite Materials Research, Oakridge National Laboratory, Oakridge TN, and advisor to the Automotive Composites Consortium, USITC staff interview, Sept. 1997.

[36] Larson, "Quality," *Quality,* p. 30.

[37] Ibid.

[38] Ahmad Iftikhar, et. al. "Microwave Joining of SiC Ceramics and Composites," proceedings of the First World Congress on Microwave Processing, Orlando, FL, Jan. 5-9, 1997.

[39] Ibid.

bond also forms quickly due to the fast-heating microwave.[40] Ceramics can also be joined to metals with soldering and adhesive bonding.[41] Microwave technology for joining ceramics is not yet commercialized, although continuing research on the technology is supported by the DOE and the Continuous Fiber Ceramic Composites Programs.[42] Research to expand the role of ceramics in automobiles is conducted through the Ceramic Technology Project at Oak Ridge National Laboratory.[43]

Outlook

As alternative materials continue to make inroads into the U.S. auto industry, demand will increase for new manufacturing technologies and associated joining and bonding technologies. Joining technologies for lightweight materials facilitate improved productivity, lower manufacturing costs, and a more flexible manufacturing setup. Adhesives and new welding techniques are a means to ensure greater design freedom for manufacturers. More significantly, the joining technologies profiled in this article are likely to contribute to the competitive advantage enjoyed by auto manufacturers of standard passenger vehicles made largely of lightweight polymer composites or aluminum.

Several circumstances challenge the widespread adoption of lightweight materials by the auto industry despite the need for continued improvements in processing technology. Some particular circumstances are as follows:

- Material cost is the most significant barrier to the use of polymer composites and aluminum in the auto industry.[44] Carbon steel has a clear cost advantage. On a per-pound basis, carbon steel is 4 times less costly than aluminum, 3 times less costly than of glass fiber-reinforced polymer composites, and 20 times less costly than carbon fiber-reinforced polymer composites.[45]

- While it may be possible to manufacture a polymer composite frame, the technology to mass-produce load-bearing composite parts currently does not exist.[46]

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[40] Craig Saltiel, et. al. "Materials Processing with Microwave Energy," *Mechanical Engineering*, Aug. 1995, p. 102.

[41] "Joining Metals and Ceramics," *Machine Design*, Sept. 14, 1995, p. 81.

[42] Ifikhar.

[43] Ceramics and Energy Efficiency, found at http://www.ornl/energy_eff/transp.html, retrieved Aug. 13, 1997.

[44] Thomas S. Moore, General Manager, Liberty and Technical Affairs, Chrysler Corp., "Making Composites Economically Competitive for High-volume Structural Automotive Applications," read at the Advanced Composite Conference and Exposition, Nov. 9, 1995.

[45] Since less alternative material is needed on a per-pound basis, the cost relative to steel is-- aluminum, 2 times; glass fiber-reinforced polymers, 1.5 times; and carbon reinforced polymers, 5 times. U.S. Congress, Office of Technology Assessment, *Advanced Automotive Technology: Visions of a Super-Efficient Family Car* (Washington, DC: GPO) OTA-ETI-638, Sept. 1995, p. 62.

[46] Ibid., p. 64.

- The automobile industry's lack of demand for polymer composites does not inspire suppliers to increase their production capacity.[47]

- The lack of understanding of the nature and behavior of composites and other advanced materials may delay the adoption of alternative materials in the U.S. auto industry. Detroit does not have the design experience and familiarity with advanced materials that exists in the aerospace industry.[48]

- Nondestructive testing methods are needed to test the quality and reliability of joints and bonds.

Finally, the steel industry is not relinquishing its role as a major supplier easily, and it is cooperating with the auto industry to develop better products and reduce costs. The auto/steel partnership poses competition for composite and aluminum suppliers who are vying for new business in the auto industry. Despite innovations such as ultralight steel, no type of steel is as lightweight as polymer composites or aluminum. These alternative materials are more likely than steel to be chosen for the production of a lightweight vehicle.

Despite some hindering circumstances, alternative materials potentially offer many competitive advantages to the auto industry, including--

- The tooling cost for polymer composites is less than steel.[49] A manufacturer must sell 300,000 to 500,000 cars to recover the cost of the die for a steel frame. For polymer composites, it is less than 50,000.

- The similarity of aluminum to steel reduces the cost of retooling because aluminum parts can be processed with some of the same equipment used to stamp steel. The design of aluminum parts is also similar to that for steel, which is important in an industry where consistency is valued highly.[50]

- The prospect of reducing emissions of carbon dioxide is perhaps the most valuable result of the widespread adoption of lightweight materials by auto producers.

Effective joining and bonding technology for alternative materials is a small but important part of reducing the weight of the average vehicle. Joining and bonding methods are "enabling technologies." These enabling technologies always provide a benefit: in this case,

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[47] Auto makers currently do not demand a high volume of composite parts, and suppliers lack capacity to produce a high volume. The rate of production of composite vehicle parts is slow, roughly 15 minutes per part for liquid-molded composites, compared with 17 seconds to stamp a steel part. Since these conditions have remained unchanged over the past several years, it is not cost-effective to mass-produce polymer composite parts. OTA, *Advanced Automotive Technology;* and USITC staff interviews with industry contacts.

[48] Warren, USITC staff interview, June 17, 1997.

[49] Marechaux, USITC staff interview, June 1997; and OTA, *Advanced Automotive Technology*, Sept. 1995, p. 63.

[50] Warren, USITC staff interview, June, 1997; and Field and Clark, "A Practical Road to Lightweight Cars."

new joining and bonding technologies allow for the wider use of lightweight materials in the manufacture of automobiles. Although not central to a material choice, without effective joining and bonding methods, material choice is limited. The benefit accrued to auto manufacturers who adopt new joining and bonding methods is not cost-related at this point, since reinforced composites and aluminum are currently more expensive than steel. However, according to one source, there is a measurable environmental benefit associated with the adoption of lightweight materials. By comparing the material content of a 1996 typical vehicle referred to in table 1 with a passenger vehicle made largely of composites, the latter would generate 400 to 500 pounds of scrap after a 15-year life span and would produce 3,000 to 4,000 pounds less of particulate matter, a source of air pollution. According to this source, buried composite scrap is stable and less harmful to humans and the environment than the particulate matter released by an average vehicle not reduced in weight.[51]

Many technologies profiled in this report are not yet commercialized. It is widely agreed among auto industry officials, however, that the next generation of vehicles will be made largely of aluminum and a subsequent generation will be made of polymer composites. As this material shift occurs, demand for reliable joining technologies that are adaptable to large scale auto production will increase. Continued research and development therefore, appears ensured for joining and other enabling technologies that support alternative materials in the automobile industry.■

[51] Warren, USITC staff interview, Sept. 1997.

Electronic Trade Transforms Delivery of Audiovisual Services

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This article discusses the potential for electronic trade of audiovisual works over the Internet. It explains the capabilities of the Internet with respect to audiovisual services, identifies factors motivating greater Internet use, describes the ongoing evolution of the audiovisual and other so-called "content" industries, and then examines formal and informal impediments to international, Internet-based trade in audiovisual services. This article follows previous work that examined the mergers and acquisitions undertaken to enhance distribution of motion pictures and other creative works.[1]

The advent of the Internet[2] has given a new stimulus to electronic trade by simplifying and accelerating the transfer of information. Internet access through personal computers is growing rapidly, and impending access through television sets will further hasten the growth of the electronic market. Trade in audiovisual services may change dramatically because of the new medium, which allows the electronic transfer of recorded products in many forms, and leads to the convergence of entertainment and information service industries into a new so-called "content" industry. Worldwide sales of content-related Internet services, estimated at less than $100 million in 1997, are expected to exceed $10 billion by the year 2000.[3] These developments create significant opportunities for U.S. firms, which are among the largest and most technologically advanced in the world, and which are the leading providers of Internet content. However, issues regarding piracy, transmission security, intellectual property protection, and restrictive government regulations must be resolved before the provision of content services over the Internet can attain its predicted potential.

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[1] See USITC, "U.S. film industry: How mergers and acquisitions are reshaping distribution patterns worldwide," *Industry, Trade, and Technology Review*, Jan. 1997.

[2] "Internet" refers to the global information system that (i) is logically linked together by a globally unique address space based on the Internet Protocol (IP) or its subsequent extensions/follow-ons; (ii) is able to support communications using the Transmission Control Protocol/Internet Protocol (TCP/IP) suite or its subsequent extensions/follow-ons, and/or other IP-compatible protocols; and (iii) provides, uses, or makes accessible, either publicly or privately, high-level services layered on the communications and related infrastructure. Barry M. Leiner et al., "A Brief History of the Internet," (Internet Society, Feb. 20, 1997) found at http://info.isoc.org/internet-history/, retrieved July 24, 1997.

[3] Dave Krupinski, "Computer Telephony and the Internet: A Stylus White Paper," Artisoft Inc., found at http://www.stylus.com/hvlm.htm, retrieved Aug. 18, 1997.

The Internet Medium

The Internet has the potential to revolutionize the delivery of audiovisual works. Although the transmission of electronic mail is the most common application of the Internet to date, the underlying digital technology can support high-quality multimedia transmission in audio, video, text and graphic formats, while packet-switching[4] ensures high-speed and reliable delivery (table 1). Further, the Internet is quickly becoming ubiquitous because of an open standard that is compatible with major computer operating systems.

Table 1
Internet attributes

Feature	Characteristics	Definition/Status
Availability	Global	The Internet is available worldwide and growing rapidly.
Standard	Open	Internet protocol (TCP/IP) is compatible with every major computer operating system.
Switching mechanism	Packet	Data are broken into packets that are sent via different routes on the circuit. The packets are reassembled and sorted at the destination.
Technology	Digital	Digital data signaling eliminates noise and distortion in transmission and reproduction.
Audio and video capability	Emerging	Transmission of audiovisual data requires high network capacity (see table 2).
Text and graphics capability	High	Fully developed.
Access through computers	High	Fully accessible.
Access through TV monitors	Emerging	Currently being developed.
Cost of entry	Low	Broadcasting requires investment in a computer and telephone line only.
User cost	Low	Low cost access through public networks.
Usage and content	Multifaceted	The Internet can support text, graphic, audio and video content for information, educational, entertainment, and other uses.
Location	Decentralized	Broadcasts can originate from any point on the network.

Source: Dave Krupinski, "Computer Telephony and the Internet: A Stylus White Paper," Artisoft Inc., found at http://www.stylus.com/hvlm.htm., retrieved Aug. 18, 1997, Mary Meeker and Chris DePuy, *The Internet Report*, (Morgan Stanley, 1996); and USITC staff.

[4] Packet-switching breaks digital messages into individual packets, enabling each packet to arrive at the same destination by different route. It provides for uninterrupted transmission when part of the circuit is down, and concurrent use of the same telecommunication lines to transmit many messages.

Table 2
Network capacity for multimedia applications

Connection line	Bandwidth	Application
POTS - Standard analog telecommunication lines	28.8 kbps	Audio (mono quality)
ISDN (Integrated Services Digital Network)	144 kbps - 1544 kbps	Audio (stereo to CD quality) Video (low to high quality)
T-1 - digital transmission links	1544 kbps	Audio (CD quality) Video
ATM - Asynchronous Transfer Mode	up to 622,000 kbps	Audio (CD quality) Video (broadcast quality) Virtual reality applications

Source: Dave Krupinski, "Computer Telephony and the Internet: A Stylus White Paper," Artisoft Inc., found at http://www.stylus.com/hvlm.htm, retrieved Aug. 18, 1997.

Low barriers to entry for on-line service providers and low access and usage costs for consumers also encourage rapid market growth. An individual equipped with a computer and a telephone line can initiate transmissions at any point on the Internet. After an initial investment in a computer, telephone connection, and access to an Internet service provider, the cost to the consumer is also low. According to industry representatives, the low capacity of existing telecommunication networks currently poses the main obstacle to the transmission of video programming over the Internet.[5] Audio and video transmissions require higher bandwidth, or transmission capacity, than the 28.8 kilobits-per-second (kbps) capacity of standard analog telecommunication lines. Thus, widespread commercial transmission of multimedia works depends on the upgrade of telecommunication infrastructures to higher bandwidth, such as integrated services digital networks (ISDN) and T-1 digital transmission links, and implementation of new technologies such as asynchronous transfer mode (ATM) transmission (table 2).

The Internet Market

Perhaps the most striking characteristic of the Internet is its rapid rate of growth, and potential to become widely available on a global basis in a short time. The number of users is estimated to have doubled every year in the past 5 years, and is projected to continue increasing by more than 50 percent per year until the end of the decade.[6] Although a precise assessment is difficult, estimates of the number of Internet users in 1997 range between 46 and 57 million people in 194 countries,[7] and could reach 157 million in the year 2000.[8] More than 3,000 new

[5] USITC staff interview, cable television industry representative, Washington, DC, July 10, 1997.

[6] Mary Meeker and Chris DePuy, *The Internet Report* (Morgan Stanley, 1996), pp. 2-3, 3-2.

[7] Ibid.; and Rodger Doyle, "Access to the Internet," *Scientific American*, July 1997, , http://www.sciam.com, retrieved July 24, 1997.

[8] Mary Meeker and Chris DePuy, *The Internet Retailing Report*, May 28, 1997 (Morgan (continued...)

commercial enterprises are believed to secure a presence on the Internet every day, adding close to 100,000 new sites to the network every month.[9] Internet use correlates strongly with the number of personal computers (PC). The near doubling of worldwide PC users between 1995 and 2000 is expected to generate a 17-fold growth in Internet use (table 3).[10] In addition, Internet access through television monitors, which is currently being developed, will put the network within reach of the world's 800 million households with television.[11]

Table 3
Estimates of PC and Internet use

Year	World		U.S.		U.S. share of world markets	
	PC	Internet	PC	Internet	PC	Internet
	Million persons				*Percentage*	
1995	140	9	69	6	49	67
1996	167	28	82	14	49	50
1997	191	46	96	25	50	54
1998	219	82	112	41	51	50
1999	246	134	130	58	53	43
2000	269	157	151	67	56	43
	Percent				*Percentage change*	
Annual growth 1995-2000	14	77	17	62	7	24

Source: Mary Meeker and Chris DePuy, *The Internet Report*, (Morgan Stanley, 1996), pp. 3-1, 3-16; and Mary Meeker and Chris DePuy, *The Internet Retailing Report*, May 28, 1997, (Morgan Stanley, 1997), found at http://www.ms.com, retrieved Aug. 28, 1997, p. 2-7.

With an estimated 25 million people on-line in 1997, the United States is by far the leading market for Internet-based services,[12] accounting for more than one-half of Internet connections,[13] and 58 percent of the 16.1 million[14] hosts[15] in the world. Although the U.S. share of the world market is likely to decline as Internet use increases at faster rates in regions of Europe and Asia, it is expected to remain the largest for the foreseeable future.

[8] (...continued)
Stanley, 1997), found at http://www.ms.com, retrieved Aug. 28, 1997, p. 2-6.

[9] Ibid, p. 2-3.

[10] Ibid, p. 3-5.

[11] Standard and Poor, "Movies and Home Entertainment," *Industry Surveys*, Feb. 27, 1997, p. 12.

[12] Meeker and DePuy, 1996, p. 3-5.

[13] Internet connections include hosts and users on the network.

[14] Doyle.

[15] A host is a computer that provides services to other computers on the Internet.

Convergence of Content-Related Services and Service Providers

Internet distribution of information, artistic and otherwise, will speed the convergence of once-distinct products (e.g., text and video), and display devices (e.g., televisions and computer monitors). At the same time, Internet distribution will place a premium on the creation of content. The so-called "content industry" creates entertainment and information products and services for on-line delivery. It comprises the existing recorded entertainment industries, such as the audiovisual and music industries, and new services especially created for the Internet. Many new operations exclusively dedicated to the production of on-line content are emerging every day. In addition, existing companies in the software, computer, audiovisual, telecommunications, and cable television industries are undertaking efforts to fully exploit the possibilities offered by the Internet. These efforts are two-pronged: securing content production capability and increasing access to distribution channels.

Recent actions undertaken by Microsoft Corp., a leader in the new information market, illustrate the developments in the content industry.[16] The company entered Internet-based service provision in 1996 by investing aggressively in both content production and Internet expansion. For example, it teamed with NBC to form MSNBC, a 24-hour cable TV news channel, with connections to the NBC network and a presence on the Internet. In direct competition with the print media, Microsoft launched many on-line publications such as *Sidewalk*, a travel and entertainment information service focused on U.S. cities, and *Slate*, a political magazine. Microsoft also endeavored to increase the accessibility of the Internet. In 1997, the company spent $1 billion on Comcast, a cable television company, reportedly to enable high-speed Internet access. Microsoft invested $425 million to acquire WebTV Networks, a maker of Internet adapters for television, to hasten the provision of Internet services through television monitors.[17]

Other U.S. cable television and direct-to-home satellite service firms also are preparing to distribute Internet content over their networks. The cable television industry expects to broadcast video programs using Internet technology in less than 2 years.[18] DirectPC, a satellite system developed by Hughes Network Systems, reportedly has the capacity to deliver Internet signals 15 times faster than standard modems.[19]

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[16] Steve Lohr, "Microsoft Looks Beyond Computer Nerds," *The New York Times*, June 10, 1997, found at http://www.nytimes.com, retrieved Sept. 24, 1997.

[17] Louise Kehoe, "Microsoft up 89% but sees slower growth," *Financial Times Limited*, July 18, 1997, found at NewsEdge/Web, retrieved July, 18, 1997.

[18] USITC staff interview, cable television industry representative, Washington, DC, July 10, 1997.

[19] David Elrich, "For Futuristic Home Gadgets, the Future Now Has a Due Date," *The New York Times*, Jan. 23, 1997, found at http://www.nytimes.com, retrieved Aug. 18, 1997.

Internet-related alliances between information technology and content provider firms are also taking place in Europe. Media and content service providers accounted for 13 percent of European merger deals in 1996, a 61-percent increase over the previous year.[20]

Issues in Electronic Trade of Content Services

To secure the benefits of Internet distribution, the international community must address problems related to piracy, transmission security, and intellectual property protection of content, which threaten to impede the growth of Internet-based trade. In addition, countries' policies pertaining to the Internet or to broadcasting may also constitute barriers to trade in content.

Piracy, Security and Intellectual Property

In 1996, U.S. audiovisual and sound recording companies lost an estimated $2.2 billion and $1 billion in worldwide revenue, respectively, due to piracy of copyrighted material.[21] U.S. industries' total losses due to piracy are estimated at $15 billion.[22] The entertainment sector is particularly vulnerable to piracy because digital technology permits successive reproduction of music and video products without any perceptible loss of quality. Counterfeits made from broadcasts and retail copies are indistinguishable from the original products. Consequently, the provision of a secure digital environment worldwide, protected against unauthorized access to and copying of proprietary services, is vital to the content industry. Therefore, the motion picture and sound-recording industries in the United States support the development of a voluntary, private licensing system that will incorporate an encrypted code embedded in authorized products.[23] The code will be used to identify authentic products and aid the enforcement of laws protecting intellectual property.

The protection of intellectual property also requires the adoption of copyright and antipiracy laws. To this end, the U.S. audiovisual industries endorse international treaties under the auspices of the World Intellectual Property Organization (WIPO). WIPO's Copyright Treaty updates existing copyright treaties to include digital technology, while the Performances and Phonograms Treaty extends to the recording industry the copyright protection standards enjoyed by other industries, such as publishing.[24] Both treaties raise the minimum

[20] Douglas Haywire, "Overseas Mergers Soaring Study Says," *Techwire*, July 30, 1997, found at http://techweb4.web.cerf.net, retrieved July 30, 1997.

[21] Motion Picture Association of America, "Congress should ratify the new World Intellectual Property Organization (WIPO) copyright treaties without concurrently considering the issue of OSP (online service provider) liability," press release, fax June 24, 1997; and Recording Industry Association of America, press release, found at http://www.riaa.com, retrieved Aug. 4, 1997.

[22] Motion Picture Association of America, Trade Barriers to Exports of U.S. Filmed Entertainment, Washington, DC, Nov. 1996, p. iii.

[23] Ibid.

[24] Ibid.

international standard for copyright protection, and extend the scope to electronic trade, network transmissions, and computer systems reproductions.[25]

Content Regulation on the Internet

Internet regulation in most countries is rudimentary or nonexistent.[26] Countries that have developed guidelines pertaining to the Internet have taken varying approaches. For example, the United States and Japan largely favor self-regulation by the industry. Some European and emerging countries, on the other hand, are developing new Internet laws that generally reflect their respective broadcast regulations. The status of regulations in developed and emerging markets, most of which focus on censoring or limiting the availability of material that is detrimental to minors and to public morals, is summarized below.

The United States and Japan

U.S. industry preference for a largely self-regulated Internet were facilitated by a recent court decision. In June 1997, the Supreme Court struck down provisions in the Communications Decency Act[27] which sought to criminalize the distribution of "obscene or indecent" material to minors over the Internet.[28] Soon after the Supreme Court decision, a group of companies that provide Internet services announced a plan to create a voluntary standard for Internet content. The companies proposed to develop filtering and rating systems associating labels with Internet content. The systems would also be assessed by independent reviewers.[29] The proposal was supported by the Clinton administration, which, in the Framework for Global Electronic Commerce released in July 1997, encouraged private industry to develop a system for self-regulation.[30]

In Japan, officials have chosen a path similar to that of the United States for developing the Internet service industry with minimal regulatory burden.[31] Japan's Telecommunications Business Law does not provide a definition of Internet services, and Internet broadcasting in Japan is currently dealt with as a data transmission service,[32] which is largely unregulated for content.

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[25] WIPO Copyright Treaty; and WIPO Performances and Phonographs Treaty, Dec. 23, 1996, found at http://www.wipo.org, retrieved Aug. 5, 1997.

[26] A. Michael Froomkin, "The Internet As a Source of Regulatory Arbitrage," found at http://www.law.miami.edu~froomkin, retrieved June 5, 1997.

[27] The Communications Decency Act is part of the Telecommunications Act of 1996.

[28] "Government's Effort to Keep 'Cybersmut' Away from Minors Deemed Unconstitutional," *Communications Today*, June 27, 1997, , found at http://www.commtoday.com, retrieved July 29, 1997.

[29] Digital Equipment Corp., "Leading Internet companies to create standards for self-regulation of content," July 18, 1997, found at http://www.dec.com, retrieved Sept. 15, 1997.

[30] "Clinton Report Focuses On Market-Driven Strategy To Internet," *Communications Today*, July 2, 1997, found at http://www.commtoday.com, retrieved July 29, 1997.

[31] U.S. Department of State telegram No. 006691, "Electronic Commerce: Special Press Report," prepared by U.S. Embassy, Tokyo, July 31, 1997.

[32] OECD, Communications Outlook 1997, vol. 2, (Paris: OECD, 1997), p. 189.

The European Union

European governments tend to regulate the Internet more actively, in part to safeguard the development of their Internet industry, which reportedly lags far behind that of the United States.[33] While the European Union (EU) has no Unionwide directive pertaining to Internet services,[34] some Member States are developing national regulations. For example, Germany's "Information and Communication Services Bill," which took effect in August 1997, extends existing consumer privacy protection laws into cyberspace.[35] The main provisions of the law prohibit propagating pornography, neo-Nazi material, racial hatred, violence, and prostitution on the Internet. These restrictions are also found in the country's broadcast regulations pertaining to audiovisual and information services (table 4). The law places the responsibility for content with the content supplier and not the Internet service provider, and requires that material unsuitable for minors be identified as such.

Table 4
EU member states: Specific restrictions on broadcast material

	Restrictions				
Country	Obscenity	Contrary to sound morality or decency	Detrimental to human dignity	Incitement to discrimination, hatred, and violence	Child sexual abuse and pornography
Austria	x			x	x
Belgium	x	x		x	x
Denmark				x	x
Finland	x			x	x
France				x	x
Germany			x	x	x
Greece	x	x			x
Ireland	x	x		x	x
Italy	x	x			x
Luxembourg	x			x	x
Netherlands					x
Portugal				x	x
Spain				x	x
Sweden				x	x
United Kingdom	x	x		x	x

Source: European Union, "Green Paper on the Protection of Minors and Human Dignity in Audiovisual and Information Services," Info2000, 1996, found at http://www.echo.lu/legal/en, retrieved June 5, 1997, and Bruno Guissany, "Why Europe Won't have a Decency Act," *The New York Times*, Nov. 12, 1996, found at http://www.nytimes.com, retrieved May 12, 1997.

[33] U.S. Department of State telegram No. 006691, "Electronic Commerce: Special Press Report," prepared by U.S. Embassy, Tokyo, July 31, 1997.

[34] European Union, "Green Paper on the Protection of Minors and Human Dignity in Audiovisual and Information Services," Info2000, 1996, found at http://www.echo.lu/legal/en, retrieved June 5, 199.

[35] Guido Guissani, "Proposed German statute would regulate content," *The New York Times*, Jan. 11, 1997, found at http://www.nytimes.com, retrieved June 6, 1997.

Every EU Member State except the United Kingdom has constitutional provisions for broadcast content, and all EU countries explicitly prohibit the broadcast of certain material for the purpose of protecting minors. With few exceptions, the broadcast laws of EU Member States cover all media, including print and broadcast (table 5). Those of Greece, Ireland, and Luxembourg are essentially limited to the press, including print and broadcast media. Control measures generally provide for legal recourse after the broadcast has taken place, although Ireland, Italy, and Spain do not specify the timing of control measures.

Table 5
EU member-states' constitutional provisions for content control

Country	Coverage	Control measures
Austria	Spoken, written, print or pictorial representation	*Ex post*[1] legal control
Belgium	All expression and media	*Ex post* legal control
Denmark	All media	*Ex post* legal control
Finland	All media	*Ex post* legal control; prior control allowed for the protection of children
France	All media	*Ex post* legal control
Germany	Speech, writing and pictures	*Ex post* legal control; laws protecting youth and personal dignity
Greece	The press	*Ex post* legal control on the basis of insults to Christianity or other religions and to the president, obscenity, or compromises to national security
Ireland	Expression of convictions and opinions	Restrictions are allowed to protect public order or morality (blasphemy, indecency) and the authority of the state
Italy	All media	Restrictions on public morality grounds
Luxembourg	Oral expression and the press	*Ex post* legal control
Netherlands	All media	*Ex post* legal control; non-press and non-broadcast media may be censored for persons under 16
Portugal	All expressions	*Ex post* legal control
Spain	Thoughts, ideas and opinions through any media	On the basis of rights of honor, privacy, self-image and protection of minors
Sweden	General	General control of "acceptability in a democratic society"
	Specific to the press, film, television, and possibly on-line media	*Ex post* legal control based on the protection of minors, violence, and racial hatred.
United Kingdom	None	None

[1] The measure is applied retroactively after distribution has taken place.

Source: European Union, "Green Paper on the Protection of Minors and Human Dignity in Audiovisual and Information Services," Info2000, 1996, found at http://www.echo.lu/legal/en, retrieved June 5, 1997.

The applicability of some European broadcast laws to the Internet is also being tested in court. For example, Georgia Tech Lorraine, the European campus of the Georgia Institute of Technology, was the target of a lawsuit in France because its Internet site did not offer a version in French. The lawsuit was based on the "Toubon" law, which requires that all commercial messages promoting services or products within France be made available in the French language.[36] The court dismissed the suit on procedural grounds without addressing the question of whether the "Toubon" law is applicable to the Internet.[37] Whether Internet transmission is considered a broadcast service for regulatory purposes, and whether the physical location of the server is material in the determination of the origin of a message, also remain unanswered questions. In the same vein, it is not clear that the broad restrictions on trade in audiovisual services, as specified in the EU schedule annexed to the General Agreement on Trade in Services,[38] are applicable to the Internet.[39]

On-line trade of content products may not enjoy significant growth in some emerging markets. Although telephone and personal computer penetration rates currently are low, emerging markets also have erected barriers restricting on-line trade and other Internet services in a variety of ways. Internet services are often provided by government telecommunication monopolies that limit user access to the network (table 6). For example, Saudi Arabia reserves the Internet for educational and other governmental uses whereas India's high access fees limit the service to a small segment of the potential market. In contrast to regulations in developed countries, which generally apply legal measures after the broadcast has taken place, emerging markets often impose censorship that requires that broadcast material be cleared before transmission. For example, Singapore regulates the Internet as a broadcast medium, i.e. it requires the vetting of content prior to broadcasting and censors as necessary. China also imposes censorship and requires users and Internet service providers (ISP) to register with government authorities.

Table 6
Internet restrictions in selected emerging countries

Country	Measures limiting Internet access	Access provider
China	Censorship; user registration	Government; registered private ISP
India	High access rates	State owned
Korea	Censorship	Government and private ISP
Saudi Arabia	Restricted use	State owned
Singapore	Censorship	Government-sponsored ISP

Source: Human Rights Watch, "Silencing the Net: The Threat to Freedom of Expression On-Line," *The New York Times*, May 1996, found at http://www.nytimes.com, retrieved June 6, 1997.

[36] Guido Guissani, "Georgia Tech is sued for Non-French Web site," *The New York Times*, Dec. 31, 1996, found at http://www.nytimes.com, retrieved May 12 , 1997.

[37] Guido Guissani, "French Court Dismisses Suit on Georgia Tech Site," *The New York Times*, June 10, 1997, found at http://www.nytimes.com, retrieved July 29, 1997.

[38] For in-depth discussion of these measures, see USITC, "U.S. film industry: How mergers and acquisitions are reshaping distribution patterns worldwide."

[39] *European Information Technology Observatory 97* (Frankfurt, 1997), p. 206.

Conclusion

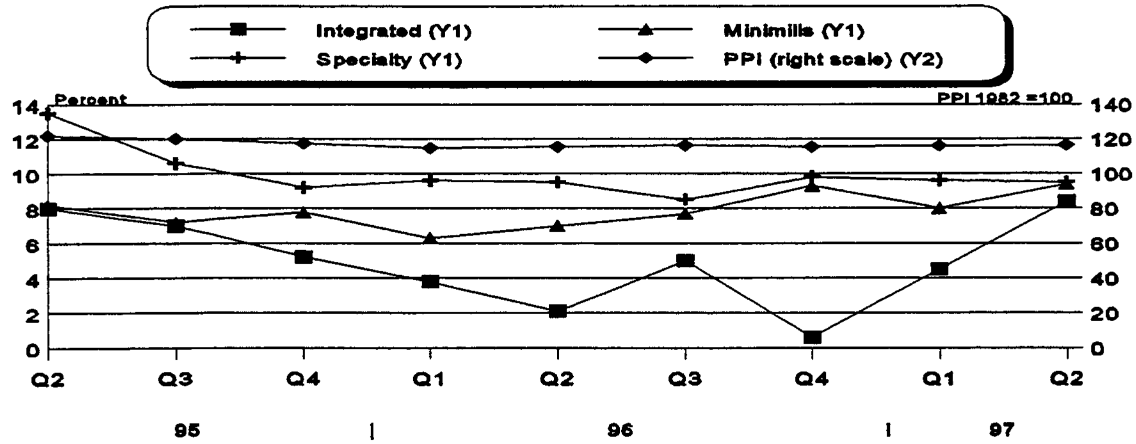
Internet technology provides for fast, reliable, and high-quality transmission of audio and video content, making it an attractive medium for distributing motion pictures and other audiovisual works. However, before the Internet can become a popular means of accessing audiovisual and other works, the international community must address a number of formal and informal impediments. Among formal impediments are restrictions on trade in audiovisual services and regulatory tendencies that, while they serve important social and economic objectives, may make use of the Internet more cumbersome and expensive. Informal impediments include increased potential for infringement of intellectual property rights and security breaches. Although new copyright and performance treaties developed by the WIPO are useful initial steps to safeguard intellectual property, it appears that there remains substantial room for government and industry to establish or negotiate policies that promote growth and welfare while preventing inappropriate or malicious use of the network. ■

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 S. Tsuji, 202-205-3434/tsuji@usitc.gov)
- ☐ **FLAT GLASS** (James Lukes, 202-205-3426/lukes@usitc.gov)
- ☐ **SERVICES** (Christopher Melly, 202-205-3461/melly@usitc.gov)

STEEL

Figure A-1
Steel industry: Profitability by strategic group,[1] producer price index for steel products



PPI = Producer Price Index
[1]Operating profit as a percent of sales. Integrated group contains 9 firms. Minimill group contains 7 firms. Specialty group contains 5 firms.

Source: Individual company financial statements and U.S. Bureau of Labor Statistics.

- Despite the relatively flat producer price index for steel products, the price increases announced in the first quarter 1997 have reportedly been accepted by downstream industries. Additionally, in July, beam producers announced price increases as demand from the construction sector remains strong and capacity was reduced via facility closures by Bethlehem and Northwestern.[1]
- Integrated steel producers experienced a further increase in profitability during the second quarter of 1997 as operating income rose while companies improved efficiency and implemented cost controls, in addition to growth in net sales. The resolution in August of a 10 month work stoppage at Wheeling-Pittsburgh should improve that company's profitability as production returns to normal levels.
- Minimills increased operating profitability to 9 percent for the quarter ending June 1997 from 8 percent for the quarter ending March 1997. This improvement was primarily led by an increase in operating income. Profitability of the specialty steel producers has fluctuated in a narrow range since the fourth quarter of 1995.

[1] Corinna C. Petry, "More Beam Prices Boosted," *American Metal Market*, Jul. 15, 1997, p. 1.

Table A-1
Steel mill products, all grades

Item	Q2 1997	Percentage change, Q2 1997 from Q1 1997	Jan.-June 1997	Percentage change, Q2 1997 from Q2 1996[1]
Producer's shipments (*1,000 short tons*)	26,645	5.5	51,895	2.6
Imports (*1,000 short tons*)	8,186	1.9	16,222	30.7
Exports (*1,000 short tons*)	1,462	5.1	2,853	3.7
Apparent supply (*1,000 short tons*)	33,370	4.6	65,264	8.4
Ratio of import to apparent supply (*percent*)	24.5	[2]-0.6	24.9	[2]2.8

[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	June 1997	Percentage change, June 1997 from Mar. 1997[1]	2nd Quarter 1996	2nd Quarter 1997
Shipments (*1,000 net tons*)	2,408	2.6	7,336	6,771
Ending inventories (*1,000 net tons*)	7,225	2.2	7,225	6,614
Inventories on hand (*months*)	3.0	(2)	3.0	2.9

[1] Based on unrounded numbers.
[2] Not applicable.

Note.--Because of rounding, figures may not add to the totals shown.

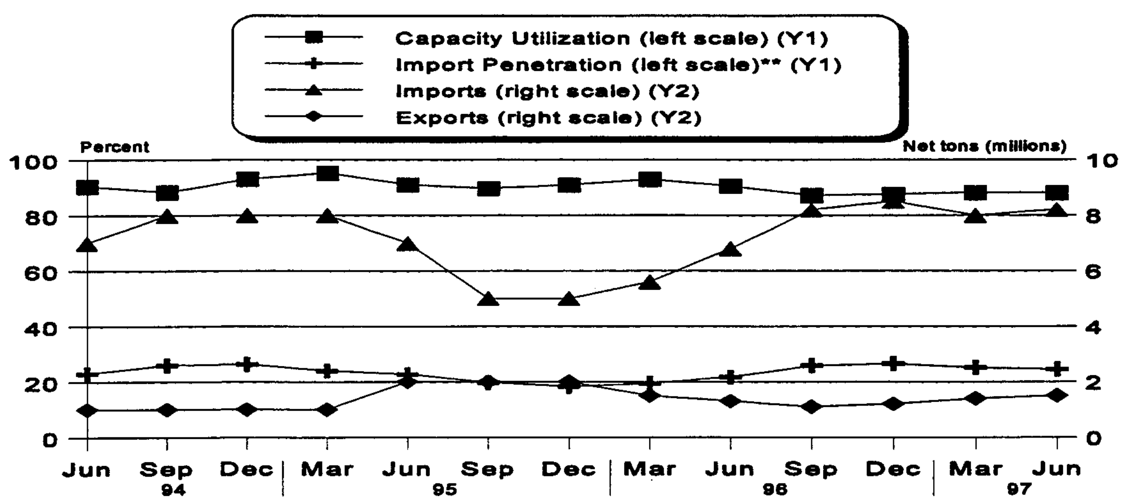
Source: Steel Service Center Institute.

- The Steel Service Center Institute reported that the average daily shipping rate for steel service centers remained above 110,000 tons for the first six months of 1997. This puts the shipping rate year to date ahead of 1995, which is the current record shipping year. Inventories on hand remained stable throughout the second quarter at 3 months, as ending inventory tonnage increased by only 2 percent from March 1997.[1]

- Exports have increased steadily since September 1996, including an overall increase of 4 percent for the first six months of 1997 over the first six months of 1996. Global prices continue to recover as world steel production approaches 96 percent of its effective capacity.[2] Domestic demand remains strong; therefore, imports through June increased 31 percent from 1996 levels. Domestic capacity utilization remains steady at 88 percent.[3]

[1] Steel Service Center Institute Business Conditions Report, Jul. 22, 1997.
[2] Peter F. Marcus and Karlis M. Kirsis, "New Game, New Rules," World Steel Dynamics, Jun. 17, 1997. p. 39.
[3] American Iron and Steel Institute, Jun. 1997.

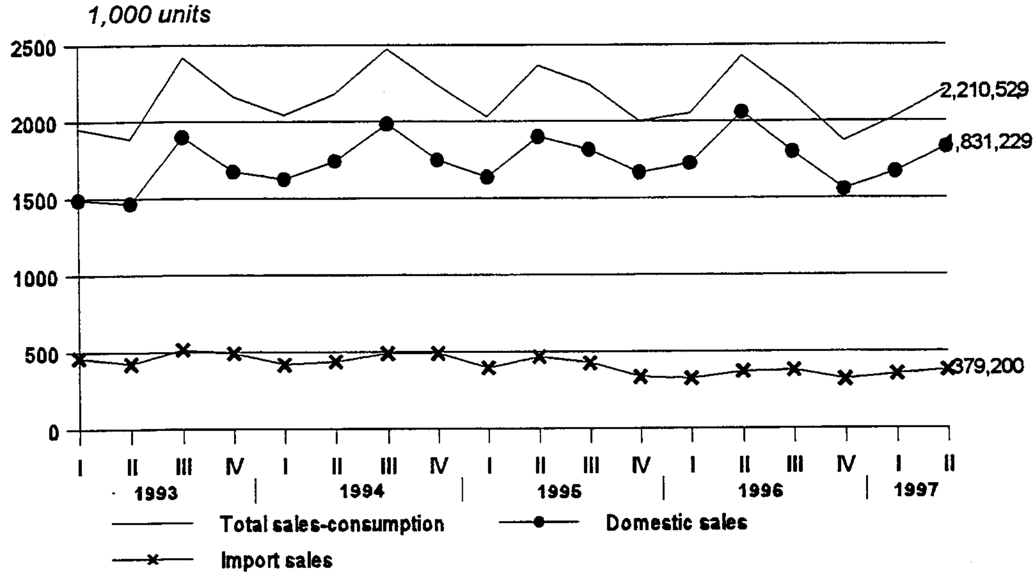
Figure A-2
Steel mill products, all grades: Selected industry conditions



**Import share of apparent open market supply.
Source: American Iron and Steel Institute.

AUTOMOBILES

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



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

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

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, Jan. 1996-June 1997

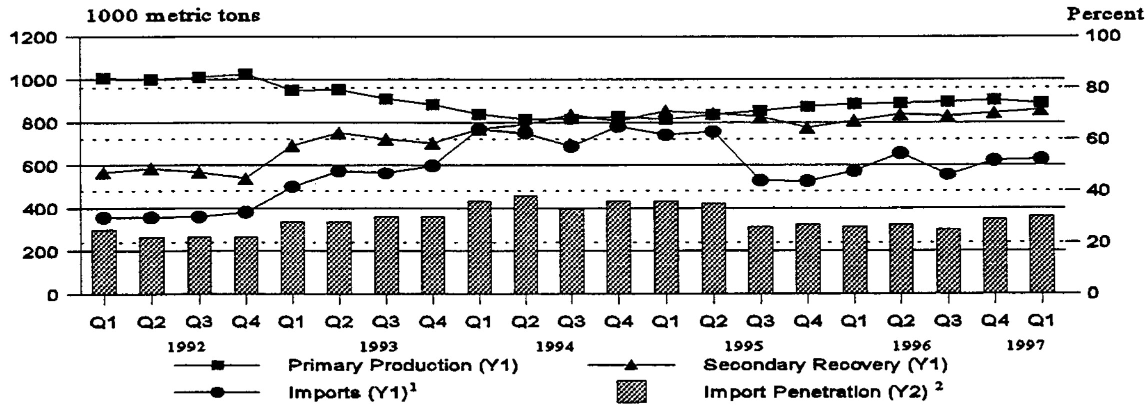
Item	Apr.-June 1997	Jan.-June 1997	Percentage change– Apr.-June 1997 from Jan.-Mar.1997	Percentage change– Jan.-June 1997 from Jan.-June 1996
U.S. sales of domestic autos (*1,000 units*)[1]	1,831	3,503	9.6	-7.4
U.S. sales of imported autos (*1,000 units*)[2]	379	734	6.8	5.9
Total U.S. sales (*1,000 units*)[1,2]	2,211	4,237	9.1	-5.3
Ratio of U.S. sales of imported autos to total U.S. sales (*percent*)[1,2]	17.2	17.3	-2.1	11.9
U.S. sales of Japanese imports as a share of the total U.S. market (*percent*)[1,2]	8.5	10.8	-36.0	6.5

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

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

ALUMINUM

Figure A-4
Aluminum: Selected U.S. industry conditions--



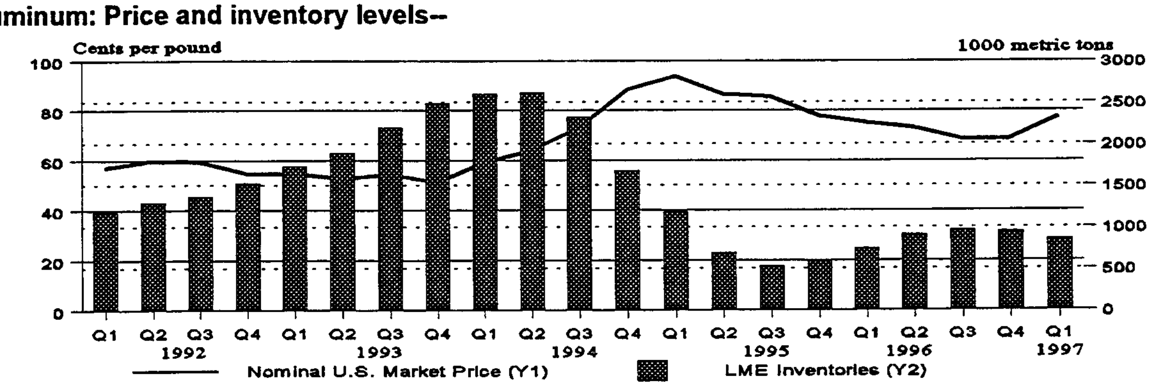
[1]Crude (metals and alloys) and primary (e.g. plates, sheets, and bars) forms for consumption.
[2]Percent share of imports to apparent domestic supply.

Source: U.S. Geological Survey.

- Globally, robust conditions continued through first quarter 1997 as orders remained strong throughout the major consuming regions. Primary-aluminum capacity utilization averaged over 90 percent. Price premiums for immediate delivery of ingot continued, indicating tight supply-demand balance. There was little apparent consumer restocking of inventories, largely due to anticipated restart of idled capacity and despite uncertainty about the level of inventories held outside the LME. The LME's inventories continued to decline for a second straight quarter, dropping 93,000 metric tons (10 percent) during first quarter 1997 to 853,000 metric tons.

- U.S. aluminum output held steady during the first quarter 1997 reflecting the order rates across end-use sectors. Ingot production remained relatively static at 1.7 million metric tons, with a decrease in primary production being offset by increased secondary recovery. Demand for can stock (the largest single product category) weakened, but was offset by stronger demand for other mill products, especially consumption of sheet and plate outside the beverage industry. With primary-production operating rates approaching 95 percent of capacity, the industry relied upon increased imports to meet demand. Import penetration rose one percentage point to 30 percent, up 6,000 metric tons to 628,000 metric tons. These conditions were reflected in dramatically higher prices from the previous quarter's level. The average U.S. price for primary ingot was up 8.8

Figure A-5
Aluminum: Price and inventory levels--

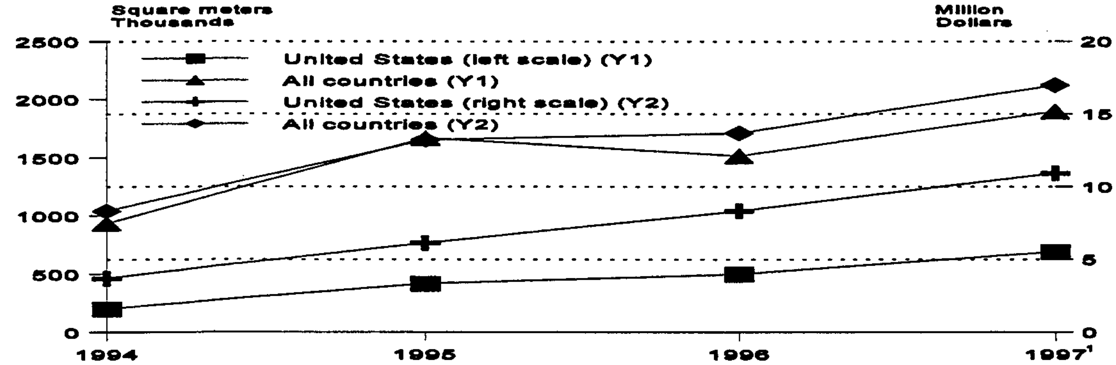


[1]Quarterly average of the monthly U.S. market price of primary aluminum ingots.
[2]End of quarter inventories.

Sources: U.S. Geological Survey, World Bureau of Metal Statistics, Metals Week, and U.S. Bureau of Economic

FLAT GLASS

Figure A-6
Average monthly Japanese imports of flat glass, by quantity, from the United States and all other countries, 1994-97



[1]January-July.
Source: Compiled from official statistics of the Ministry of Trade and Industry, Japan.

- In 1995, the United States and Japan reached agreement[1] on Japanese market access for imports of flat glass.[2] The agreement continues until the end of 1999 and seeks to increase access through such means as increased adoption of nondiscriminatory technical and performance standards for construction competition, and expanded promotion of safety and insulating glass. One goal of the agreement is to increase sales of foreign flat glass in Japan, although the agreement specifies no numerical targets.[3]
- The average monthly quantity of Japanese imports of flat glass from all countries increased by 79 percent in the first year of the agreement, before declining 9 percent from 1995-96. However, these imports posted a gain of 25 percent for the first seven months of 1997, reaching an average 1.9 million square meters ($17 million); during this same period, average monthly U.S. imports of flat glass from all countries (not shown) averaged 2.6 million square meters ($14 million). Average monthly Japanese imports from the United States grew steadily during 1995-97, more than tripling in volume to 700,000 square meters ($10.9 million).
- At the second annual review of the U.S.-Japan Glass Agreement in Washington on May 14, 1997, the United States rated the results over the past year as "poor,"[4] citing little progress in opening Japan's highly controlled glass distribution system, despite improved efforts by U.S. glass firms. As a result, the USTR warned that the United States was considering seeking another Japan Fair Trade Commission (JFTC) investigation[5] or citing this issue in USTR's super 301 report. In July 1997, twenty-six members of the United States Senate and fifty-three members of the House of Representatives requested the President to urge Japan to significantly improve its performance during the remainder of the five-year agreement.
- The USTR subsequently included this issue in its 301 report, issued on October 1, 1997,[6] citing the low volume of foreign glass in the Japanese distribution system, the lack of growth in overall use of insulated glass, and a decline in the use of safety glass. The USTR indicated that it will pursue U.S. concerns during consultations with the Japanese in late October.

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[1] "Measures by the Government of Japan and the Government of the United States of America Regarding Flat Glass." U.S. Trade Representative (USTR), facsimile of agreement, received Feb. 2, 1995.

[2] Flat glass is largely unworked; it may be surface ground or polished and have an absorbent, reflecting or non-reflecting coating, but it has not been tempered, laminated, bent, edge-worked, engraved, drilled, enameled, or otherwise worked. Safety glass (tempered or laminated) and insulating glass are also covered under the U.S.-Japanese agreement on flat glass.

[3] U.S. producers have participated in the global trend to establish production facilities (primarily joint ventures) in Asia; Guardian Industries Corp. has invested in plants in India and Thailand, and PPG Industries, Inc., has invested in plants in China. Such facilities give firms the option of servicing the Japanese market from relatively nearby countries.

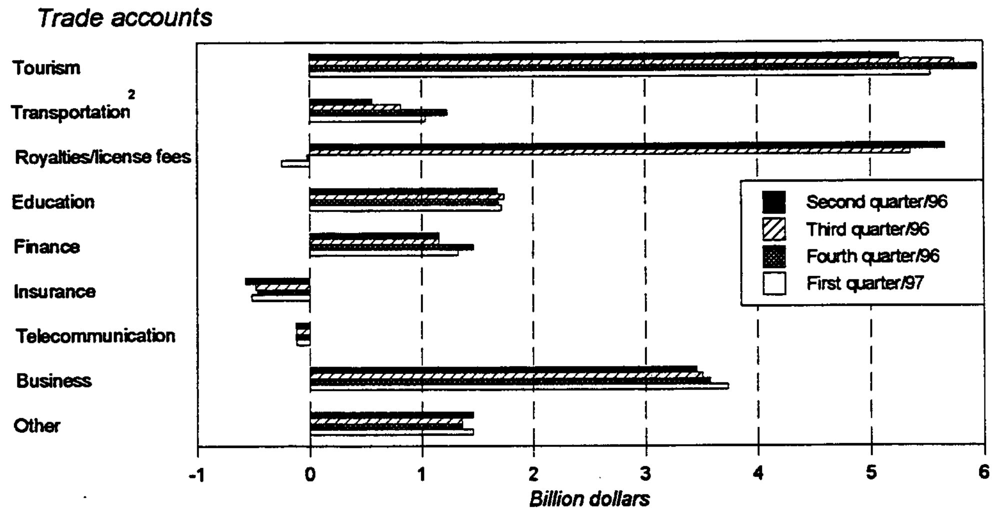
[4] U.S. Department of State (USDOS) telegram, "Glass: Second Annual Review of the Agreement," message reference no. 005113, prepared by U.S. embassy, Tokyo, June 12, 1997.

[5] Previous reviews of the glass industry by the JFTC have not revealed antitrust behavior. USDOS telegram, "Glass: Second Annual Review of the Agreement."

[6] USTR, "Identification of Trade Expansion Priorities Pursuant to Executive Order 12901," found at Internet address http://www.ustr.gov/reports/12901report97.pdf, retrieved Oct., 10, 1997.

SERVICES

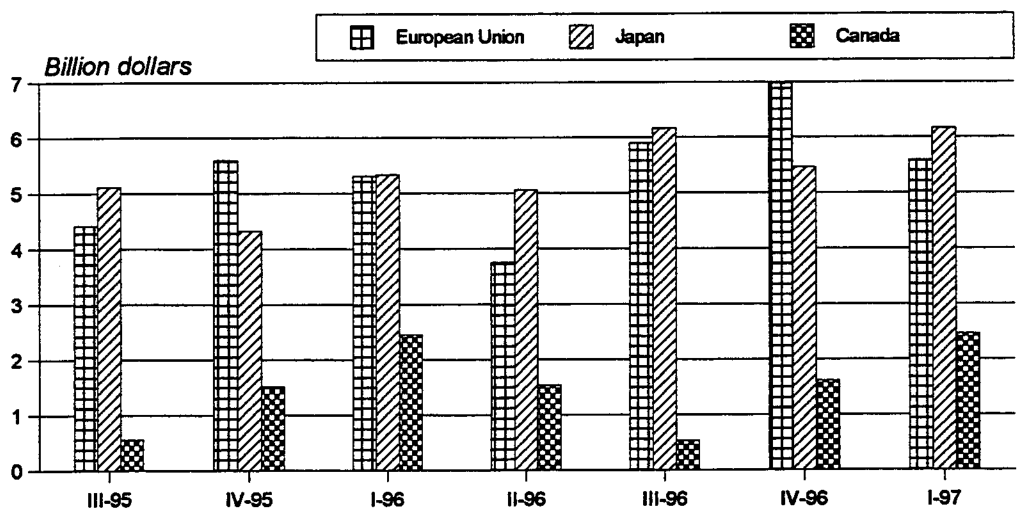
Figure A-7
Balance on U.S. service trade accounts, second quarter 1996 through first quarter 1997[1]



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

Source: Bureau of Economic Analysis, *Survey of Current Business*, July 1997 table 3, p. 83.

Figure A-8
Surpluses on cross-border U.S. service transactions with selected trading partners, by quarter, 1995-97[1]



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

Source: Bureau of Economic Analysis, *Survey of Current Business.*, table 10, July 1 997, pp . 92-95