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PREFACE

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Listing of Published Articles

(December 1998 - April 2003)

Listing of Published Articles—*Continued*

CONTENTS

Page

CONTENTS—*Continued*

Page

Catalysts: An innovative industry responds to technological and competitive challenges—*Continued*

Appendix A: Key performance indicators of selected industries and regions A-1

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WTO Agricultural Trade Negotiations: A Third Update[1]

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Major policy differences among World Trade Organization (WTO) members have affected the status of multilateral trade negotiations for agriculture. This article examines developments in the agricultural negotiations during the months between the Doha Ministerial in November 2001 and the March 31, 2003 deadline date for agreement on the trade rules or what are called modalities. These trade rules would govern how far and how fast countries can reduce export subsidies and trade-distorting domestic supports, and how fast countries can open markets to foreign competition. Specifically, this article highlights (1) the negotiating positions of the major country groups on the key topics of the market access, export competition, and domestic support; (2) the proposal of Hong Kong Ambassador Stuart Harbinson, who chairs the special negotiating sessions of the WTO Committee on Agriculture; (3) the WTO-member reactions; and (4) the outlook for the negotiations scheduled for Cancun in September 2003.

Recapping the Doha Ministerial

Despite concerns about security and the ability of countries to focus on trade issues following the events of September 11, the Fourth WTO Ministerial began in Doha, Qatar, on November 9, 2001, as scheduled. As with the Seattle Ministerial, the main purpose of the Doha Ministerial was to launch a new comprehensive round of trade negotiations, covering a wide range of topics including agriculture, industrial products, services, environmental issues, investment, government procurement, antidumping/ subsidies, and intellectual property.[3] Agriculture interests considered agreement on a broad agenda for future trade talks as necessary for any progress because concessions gained in agriculture offset concessions granted in other areas. A successful outcome of the Doha meeting, according to WTO officials, would involve unanimous agreement on a Ministerial declaration—a document outlining the scope and timing of a new round of trade negotiations. Following the events of Seattle, the stakes were very high because there was great concern that a second unsuccessful launch of a new round could deliver a severe blow to the institutional credibility of the WTO and to the feasibility of reaching agreements through multilateral trade negotiations. So many issues remained unresolved and the participating countries were so many.[4]

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[1] Earlier articles about multilateral trade negotiations for agriculture, are Jonathan R. Coleman, "Agriculture in the WTO: The Seattle Ministerial and Beyond," *Industry Trade and Technology Review (ITTR),* U.S. International Trade Commission (USITC) publication 3293, Mar. 2000, pp. 21-45; Jonathan R. Coleman, "WTO Agricultural Negotiations: An Update," *ITTR*, USITC publication 3363, Oct. 2000, pp. 1-6; and Joanna Bonarriva and Jonathan R. Coleman, "WTO Agricultural Negotiations: A Second Update," *ITTR*, USITC publication 3501, Mar., 2002, pp. 7-36. All articles are posted on the USITC Internet site at *www.usitc.gov/webpubs.htm*.

[2] The views expressed in this article are the authors'. They are not the views of the USITC as whole or of any individual Commissioner.

[3] WTO, "Agricultural Negotiations: Backgrounder," Oct. 10, 2002, found at *http://www.wto.org/english/tratop_e/agric_e/negs_bkgrnd00_contents_e.htm*, retrieved Mar. 15, 2003.

[4] Comments of Director General Mike Moore, in speech entitled, "Agriculture's Stake in the WTO Trade Negotiations," presented at the U.S. Department of Agriculture (USDA) Outlook Forum, Feb. 22, 2001, found at *http://www.wto.org/english/news_e/spmm_e/spmm53_e.htm*, retrieved Apr. 2, 2001.

After 6 days of intensive talks, the 143 members (at that time) unanimously adopted a Ministerial declaration, the Doha Development Agenda (DDA), that launched a new comprehensive round of trade negotiations. The Doha Ministerial was universally viewed as a success by member countries, not only in terms of paving the way for opening world trade in goods and services, but also in salvaging the credibility of the WTO as an institution. Part of the success was attributed to the structure of negotiation sessions, which differed from the structure in Seattle, where negotiating procedures were viewed as nontransparent and exclusionary.[5] Specifically, the DDA for agriculture (box 1) was structured for comprehensive negotiations aimed at substantial improvements in market access; reduction of, with a view to phasing out, all forms of export subsidies; and substantial reductions in trade-distorting domestic support. In Doha, it was also agreed that special and differential treatment for developing countries should be an integral part of all elements of the negotiations, and that non-trade concerns reflected in the negotiating proposals be taken into account in the negotiations.[6] The final Ministerial declaration establishes an ambitious timetable for completing the agricultural negotiations. It was agreed that modalities[7] for further commitments be established no later than March 31, 2003, and that the final negotiations be completed by January 1, 2005.

The DDA timetable ambitiously provided countries about 15 months (January 2002 to March 2003) to agree on the modalities for further trade liberalization (box 2). Negotiations commenced in March 2002 in Geneva under the direction of Hong Kong Ambassador Stuart Harbinson, who led the agricultural negotiations at Doha. At the March 2002 session of the WTO Committee on Agriculture, a negotiation schedule was established for the next 12 months.[8] According to the schedule, six special sessions of the WTO Committee on Agriculture would take place between June and November 2002, to present and review proposals regarding the three key topics of the negotiation—market access, export competition, and domestic support—as well as non-trade concerns. Then, based on these discussions and specific proposals by WTO members, Chairman Harbinson would release a first draft of the modalities document in December 2002. This document would then be reviewed and fine tuned during the period January to March 2003. By the March 31, 2003 deadline, a consensus modalities and commitment package would be finalized.

When negotiations opened, much of the euphoria of the successful Doha outcome had diminished.[9] The modality discussions at the special sessions did very little to bring opposing sides together. The fundamental problem was that WTO members were unable to seek common ground and they remained far apart in most negotiating areas.[10] Negotiating positions among the 144 member countries of the WTO

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[5] For example, one procedure that received considerable criticism following the talks was the so-called Green Room process, that typically involved negotiations among roughly the same 25 major trading countries aimed at resolving issues of disagreement prior to wider discussion among all members. Developing countries, in particular, claimed that this process marginalized and excluded them from discussing issues of vital importance to them. "WTO Negotiators Push Towards Deal," *Agra Europe Weekly*, Dec. 3, 1999.

[6] USDA, Foreign Agricultural Service (FAS), "Doha Ministerial Provides New Impetus for Multilateral Negotiations on Agriculture," *AgExporter*, Feb. 2003, pp. 4-6.

[7] The term "modalities" refers to trade rules governing how far and how fast (1) countries reduce export subsidies and trade-distorting domestic supports, and (2) they open markets to foreign competition.

[8] WTO, "Agricultural Negotiations: Work Programme for the 'Modalities' Stage, March 2002 to March 31, 2003," found at *http://www.wto.org/english/tratop_e/agric_e/agneg_mod1_e.htm*, retrieved Apr. 2, 2003.

[9] In particular, many countries questioned the U.S. commitment to agricultural trade liberalization following the 2002 Farm Bill that was estimated to add $73.5 billion in farm subsidies. Also, several countries were disappointed by the U.S. Administration's decision to introduce safeguards on imports of steel. The European Union (EU) also was contemplating how the new round would mesh with proposals to reform the Common Agricultural Policy and to open EU membership to an additional 10 countries.

[10] Sally Razeen, "Whither the WTO? A Progress Report on the Doha Round," Trade Policy Analysis No. 23, Center for Trade Policy Analysis, Cato Institute, Mar. 3, 2003, found at *http://www.freetrade.org/pubs/pas/tpa-023es.html*, retrieved Apr. 16, 2003.

Box 1
Final Declaration from the Doha Ministerial Conference, Doha, Qatar, November 9-14, 2001
Agriculture

13. We recognize the work already undertaken in the negotiations initiated in early 2000 under Article 20 of the Agreement on Agriculture, including the large number of negotiating proposals submitted on behalf of a total of 121 Members. We recall the long-term objective referred to in the Agreement to establish a fair and market-oriented trading system through a programme of fundamental reform encompassing strengthened rules and specific commitments on support and protection in order to correct and prevent restrictions and distortions in world agricultural markets. We reconfirm our commitment to this programme. Building on the work carried out to date and without prejudging the outcome of the negotiations we commit ourselves to comprehensive negotiations aimed at: substantial improvements in market access; reductions of, with a view to phasing out, all forms of export subsidies; and substantial reductions in trade-distorting domestic support. We agree that special and differential treatment for developing countries shall be an integral part of all elements of the negotiations and shall be embodied in the Schedules of concessions and commitments and as appropriate in the rules and disciplines to be negotiated, so as to be operationally effective and to enable developing countries to effectively take account of their development needs, including food security and rural development. We take note of the non-trade concerns reflected in the negotiating proposals submitted by Members and confirm that non-trade concerns will be taken into account in the negotiations as provided for in the Agreement on Agriculture.

14. Modalities for the further commitments, including provisions for special and differential treatment, shall be established no later than 31 March 2003. Participants shall submit their comprehensive draft Schedules based on these modalities no later than the date of the Fifth Session of the Ministerial Conference. The negotiations, including with respect to rules and disciplines and related legal texts, shall be concluded as part and at the date of conclusion of the negotiating agenda as a whole.

Source: World Trade Organization, Final Declaration from Doha Ministerial Conference, found at *http://www.wto.org/english/ tratop_e/dda_e/dohaexplained_e.htm#agriculture*.

continued to be split into three major groups: reform, status-quo, and developing countries.[11] Little movement in positions took place. In July 2002, the United States released a comprehensive proposal covering all key topics as well as special and differential treatment for developing countries.[12] This was followed by Cairns Group,[13] separate proposals in September 2002, covering market access and domestic support.[14] The U.S. and Cairns Group proposals were similar in that they both called for tariff reductions based on a Swiss-25 Formula,[15] domestic support based on a percentage of a country's value of agricultural

[11] For detailed discussion of negotiating groups, see Coleman, "Agriculture in the WTO: The Seattle Ministerial and Beyond."

[12] USDA, FAS, "U.S. Proposal for Global Agricultural Trade Reform," July 25, 2002, found at *http://www.fas.usda.gov/itp/wto/proposal.htm*, retrieved Mar. 25, 2003.

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

[14] Cairns Group, "Market Access Proposal" found at *http://www.cairnsgroup.org/proposals/job02_112.pdf*; retrieved Mar. 15, 2003; and "Domestic Support Proposal" found at *http://www.cairnsgroup.org/proposals/7623.pdf*, retrieved Mar 15, 2003.

[15] The Swiss Formula for industrial tariff reduction in the Tokyo Round reduced higher tariffs proportionally more than lower tariffs. Under the formula, the final tariff = (base tariff * technical factor) / (base tariff + technical factor). Assuming a technical factor (which is also the tariff ceiling) of 15, a base tariff of 10 percent would be reduced to 6 percent, whereas a base tariff of 60 percent would be reduced to 12 percent.

Box 2
Timeline of key dates and events in World Trade Organization agricultural negotiations, November 2001-January 2006

Date	Event
November 2001	Fourth Ministerial Conference, Doha
March, 2002	Stuart Harbinson selected as chairman and negotiating schedule established.
3-5 June, 2002	Special session on export subsidies and restrictions.
17-19 June, 2002	Special session on export subsidies and restrictions.
29-31 July, 2002	Special session on market access.
2-3 September, 2002	Special session on market access and domestic support.
23-25 September, 2002	Special session on domestic support.
18-20 November, 2002	Special session on matters that require follow-up.
18 December, 2002	Circulation completed on overview paper drafted by Harbinson, based on discussions to date.
22-24 January, 2003	Comprehensive review based on overview paper, followed by drafting of first draft of modalities document.
17 February 2003	Chairman released first modalities draft
24-28 February, 2003	Special session to comment on first modalities draft
18 March, 2003	Chairman released of revised modalities draft.
31 March 2003	Special session to consideration of final text of modalities document
September 2003	Formulas and other "modalities" for countries' commitments are finalized.
	Fifth Ministerial Conference, Mexico. Countries' comprehensive draft commitments and stock taking.
1 January 2005	Deadline for concluding negotiations, part of single undertaking.
1 January 2006	Implementation of tariff and subsidy cuts agreed to in the negotiations.

Source: USDA, FAS, "U.S. Proposal for Global Agricultural Trade Reform Negotiating Timeline," found at *http://www.fas.usda.gov/itp/wto/timeline.htm*, retrieved Mar. 3, 2003.

production, and the elimination of export-subsidies. The main difference between the U.S. and Cairns Group proposals was in modalities dealing with special and differential treatment of developing countries,[16] with the Cairns Group proposing more favorable terms than the United States.[17] The European Union (EU) finally put forward a proposal in late January 2003 that future modalities be a continuation of the Uruguay Round Agreement on Agriculture (URAA).[18] The EU proposal included provisions for special and differential treatment for developing countries, as well as for non-trade concerns.

The widely divergent proposals made the overview paper, which was to be a first attempt at a modalities document, into a list of the major ideas and negotiating positions of members.[19] In March 2003, Chairman Harbinson released a new modalities document "under his own responsibility," meaning that the report contained modalities devised by the Chairman aimed at a balance between the highly diverse opinions, and was not, as originally conceived, a consensus document developed by WTO members.[20] With only the Chairman's controversial proposal for guidance, a round of informal meetings was held March 24-28 in an

[16] Under the Uruguay Round Agreement on Agriculture provisions, developing countries were subject to only two-thirds of the cuts in tariffs, domestic support, and export subsidies that developed countries are committed to over a 10-year period. Least-developed countries were exempt from all reduction commitments, although they must bind tariffs and domestic supports.

[17] "Cairns Group Tables Proposal on Market Access," *Feedstuffs*, Sept. 23, 2002.

[18] "The EC's Proposal for Modalities in the WTO Agriculture Negotiations," Jan. 29, 2003, found at *http://europa.eu.int/comm/agriculture/external/wto/officdoc/mod.pdf,* retrieved Mar. 3, 2003.

[19] "WTO: Harbinson Circulates "Overview Paper," *BRIDGES Weekly Trade News Digest*, vol. 6, No. 43, Dec. 20, 2002.

[20] WTO, "Negotiations on Agriculture: First Draft of Modalities for Further Commitments, Revised," Mar. 18, found at *http://www.wto.org/english/tratop_e/agric_e/mod_tnagw1r1_e.pdf*, retrieved Mar. 20, 2003.

attempt to bridge the gaps in member positions. The informal meetings were to have culminated in the adoption of the modalities with specific targets and time lines. Owing to the intransigence of country positions, no consensus seemed apparent by the March 31 deadline.[21] The informal talks broke up with the Chairman unable to issue a second draft on negotiating modalities. Instead, he reported the failure to bridge what he described as "significant gaps" in member positions with respect to agriculture.[22]

In a joint statement, U.S. Trade Representative (USTR) Robert Zoellick and Secretary of Agriculture Ann Veneman stated that " [the] United States is disappointed... that resistance to change and reform... stymied agreement on modalities."[23] The United States chided the EU and Japan for "holding back" and called on them to show more flexibility to meet the serious reform engendered in the DDA.[24] Australian Trade Minister Mark Vaile singled-out the EU for its opposition to genuine reform of agricultural trade.[25] The EU spokespersons downplayed the failure of the missed deadline and insisted that they were making compromises whereas others were not. The EU views its modalities proposal as a middle-way between extreme positions offered at the talks.[26] The major negotiating positions of the key country groups, including the compromise position taken by Chairman Harbinson in his modalities document,[27] are summarized in the following shaded text.

[21] "Little Progress as WTO Deadline Looms," *Feedstuffs*, Mar. 31, 2003.

[22] "Gloomy Harbinson Says WTO Deadline on Agriculture Modalities to Be Missed," *International Trade Daily*, Bureau of National Affairs, No. 61, Mar. 31, 2003.

[23] Joint statement by Ann M. Veneman, Secretary of Agriculture, and Robert B. Zoellick, USTR, on the Doha Development Agenda Negotiations, Mar. 31, 2003, found at *http://www.usda.gov/news/releases/2003/03/0104.htm*, retrieved Apr. 2, 2003.

[24] Veneman and Zoellick, "Statement on the Doha Development Agenda Negotiations," USDA Release No. 0104.03, Mar. 31, 2003.

[25] "Agriculture Modalities: Deadline Missed, Eyes Now on Cancun," *BRIDGES Weekly Trade News Digest*, vol. 7, No. 12, Apr. 2, 2003.

[26] European Commission (EC), " 'We Will Plough On,' Says Fischler," press release, Mar. 31, 2003, found at *http://europa.eu.int/rapid/start/cgi/guesten.ksh?p_action.gettxt=gt&doc=IP/03/457|0|RAPID&lg=EN&display=*, retrieved Apr. 2, 2003.

[27] "Agriculture Modalities: Deadline Missed, Eyes Now on Cancun."

Comparison of Negotiating Positions of Major WTO Members and the Harbinson Modalities[28]

Market Access

Tariffs[29]

United States:

Tariffs (out-of-quota duties and tariff-only items) to be reduced using a Swiss Formula with a coefficient of 25, in equal annual installments over 5 years.

Tariffs to be reduced from applied rates on January 1, 2000, or final bound levels, whichever is lower.

Tariffs to be simplified to either single ad valorem or specific tariffs (i.e., eliminate compound tariffs).

WTO members to agree on a specific date for the eventual elimination of all agricultural tariffs.

Cairns Group:

Developed country tariffs to be reduced based on a Swiss-25 Formula over 5 years.

Developed countries to make one-half the cuts to the final bound level in the first year (i.e., downpayment) and the remaining cuts to be made in equal installments over the remaining 4 years.

For developing countries, tariff reductions over a 5-year period to be based on the following:

Bound tariff range (*percent*)	**Reduction**
0-50	Swiss-50
51-250	50% reduction
250+	Reduced to 125 percent

European Union:

Tariffs to be cut on average by 36 percent with a minimum of 15 percent cut per tariff line over 6 years for developed countries and 10 years for developing countries.

Developed and high-income developing countries to provide duty-free and quota-free access to their markets for all imports from least-developed countries.

Developed countries to provide duty-free access to at least 50 percent of their imports from developing countries.

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[28] For more information, see U.S. Comprehensive Proposal found at *http://www.fas.usda.gov/itp/wto/actual.htm*; Cairns Group Market Access Proposal found at *http://www.cairnsgroup.org/proposals/job02_112.pdf*; Cairns Group Domestic Support Proposal found at *http://www.cairnsgroup.org/proposals/7623.pdf*; and Harbinson's Revised Draft found at *http://www.wto.org/english/tratop_e/agric_e/mod_tnagw1r1_e.pdf*.

[29] Tariffs applied to imports can be either specific ($/unit), ad valorem (percentage), or a combination of the two. In order to compare tariffs across commodities and countries, specific tariffs can be converted to their "ad valorem equivalents" by dividing the specific tariff by the unit value of the imported product. Bound tariffs specify the maximum tariff a country can impose on imports, but the tariff actually applied is often lower than the bound tariff. Under WTO rules, bound tariffs cannot be increased without providing compensation to exporting nations.

Tariffs—*Continued*

Japan:

Tariffs to be reduced from final bound rates on a simple average basis by an unspecified percent with a minimum of an unspecified percent for each tariff line in equal installments.

No specific modalities proposed.

Provide flexibility for developing countries in terms of implementation period and reduction rates.

Least developed countries to be exempt from tariff reductions.

Developing Countries:

Tariffs to be reduced substantially for developed countries.

Tariff peaks and tariff escalation by developed countries should be substantially reduced.

Developing countries to be given flexibility in terms of low tariff reductions and longer implementation periods.

Duty-free and quota-free access to developed country market for least-developed countries.

Developing countries to have longer implementation period and lower tariff reductions compared with developed countries.

Harbinson Proposal:

Tariff reductions to be based on tariff ranges, minimum reductions, and average reductions according to table 1 below.[30]

Table 1
Tariff reductions for developed and developing countries under the Harbinson Proposal

Percent

Country group	Bound tariff range	Reduction	
		Minimum	Average
Developed countries.	0-15	25	40
	15-90	35	50
	Greater than 90	45	60
Developing countries	0-20	15	25
	21-60	20	30
	61-120	25	35
	Greater than 120	30	40

Source: Harbinson's Revised Draft found at *http://www.wto.org/english/tratop_e/agric_e/mod_tnagw1r1_e.pdf.*

Strategic product category created. Strategic products are those considered important to a country's food security, rural development, and livelihood security. Countries negotiate for strategic products that will be subject to minimal tariff cuts.

Developed countries to provide duty- and quota-free access to imports of all products from least-developed countries (i.e., internationalize the EU's "Everything But Arms" initiative).

[30] All specific tariffs must be converted to ad valorem tariffs under this approach.

Tariff Rate Quotas[31]

United States:

Tariff-rate-quota (TRQ) quantities to be increased by 20 percent over 5 years, increasing a minimum of 4 percent annually for 5 years.

In-quota tariffs to be reduced (from applied rates as of January 1, 2000, or final bound levels, whichever is lower) to zero through equal annual reductions over 5 years.

A share of TRQ increases to be reserved for non-traditional developing country suppliers.

Cairns Group:

Developed countries to increase TRQ quantities to 20 percent of domestic consumption over 5 years, with 50 percent of the quota expansion to be made in the first year of implementation and remainder of expansion in equal increments over the remaining 4 years.

Developing countries to increase TRQ quantities to 14 percent of domestic consumption over 9 years in equal annual increments.

In-quota tariffs to be eliminated in 5 years for developed countries and eliminated or reduced for developing countries.

European Union:

No specific modalities proposed.

Japan:

No increase in current access TRQs.

Minimum access TRQs to be based on an updated base period of domestic consumption.

Developing Countries:

Developing countries to receive preferential access to developed-country TRQs.

Harbinson Proposal:

Two options: (1) increase all TRQ volumes to 10 percent of current consumption, (2) increase some (up to one-quarter of TRQ products) TRQ volumes by 8 percent of current consumption but balance with other (the same number that increased only 8 percent) TRQ volume increases of 12 percent of current consumption.

Current consumption to refer to the 1999-2001 period. Quota expansion to take place over 5 years.

In-quota tariffs not to be reduced (except for tariffs on imports of tropical products, whether processed or primary).

Tariff Rate Quota Administration[32]

United States:

Notification on TRQ administration methods to include specific information to ensure transparency (e.g., quota allocation dates, license validity periods, establishing clear criteria for awarding licenses to importers, and license application processing periods).

[31] A tariff-rate quota is a two-tiered tariff in which a low (in-quota) tariff is applied to imports up to a quota level. Once the quota level is reached, additional imports are assessed at a higher (over-quota) tariff.

[32] The method by which quotas are allocated to importers, including licensing; first-come, first-served; and auctioning.

Tariff Rate Quota Administration—*Continued*

United States:—Continued

Certain TRQ administration practices to be prohibited (e.g., limiting product types eligible for import, limiting TRQ allocations to state-controlled importers or domestic producer groups, conditioning imports on re-export requirements, distributing TRQs in non-commercially viable quantities, and limiting duration of licenses to excessively short periods).

After 8 months into the TRQ year, TRQs to be reallocated to other importers if existing TRQ holders have not contracted for delivery by the end of the year.

Cairns Group:

Certain practices in TRQ administration to be prohibited, including end-use requirements, sub-allocation of quota, setting unfavorable commercial terms (e.g., product specification, pricing, or packaging), limiting the period for which the quota is open, prohibiting TRQ allocation to non-WTO members.

Rules to be established to reallocate unused quotas.

European Union:

Rules to be established that increase transparency and ensure high quota fill rates (e.g., TRQ allocations to be in economically viable sizes, licenses that are issued must be used to the greatest extent possible, mechanism for redistributing unused quota to be established, period of license duration should be reasonable, rules of license application and application procedures to be transparent).

Japan:

Guidelines be established to increase fill rates through transparency and predictability (e.g., reduce TRQs to holders in subsequent years that do not fill quota, establish methods to re-issue unused quota, clarify allocation procedures including conditions to be met by licence applicants).

Developing Countries:

Transparency to be increased.

Harbinson Proposal:

Specific TRQ administration practices that discourage TRQ fill to be prohibited.

Importing State Trading Enterprises (STEs)[33]

United States:

Share of imports under TRQ through entities other than import STEs to be increased either 30 percent upon implementation increasing to 50 percent over 5 years in equal annual installments, or 20 percent from the levels in effect at implementation over 5 years in equal annual installments (depending on which results in a greater share of direct imports under TRQs through entities other than import STEs).

Members not to restrict the right of any interested entity to import, or to purchase for import, agricultural products.

Importing STEs to provide information for transparency (e.g., specific information on a transaction-basis, including quantity, sources of imports, and contract specifications identified by end users).

[33] An STE is granted rights by a government to influence the level of the country's trade in a particular sector.

Importing State Trading Enterprises (STEs)—*Continued*

Cairns Group:
No specific modalities proposed.

European Union:
No specific modalities proposed.

Japan:
Transparency to be increased through notification requirements in relation to import volume and price from each trading partner, domestic prices, and import-related business plan.

Developing Countries:
Developing countries to be allowed to continue using STEs.
No specific modalities proposed.

Harbinson Proposal:
No new disciplines to be introduced.
Single-desk sellers to be allowed, although transparency must be increased.

Special Safeguards (SSG)[34]

United States:
Special agricultural safeguards to be eliminated upon implementation.

Cairns Group:
Special agricultural safeguards to be eliminated upon implementation for developed countries.
Special agricultural safeguards to be established for developing countries.

European Union:
Special agricultural safeguards to be maintained as stated under URAA.
Introduce a new special agricultural safeguards for developing countries for agricultural products that are sensitive from a food security perspective.

Japan:
Special agricultural safeguards to be expanded to cover:
(i) tariffied products in the URAA,
(ii) seasonal and perishable products, and
(iii) products with tariff reductions commitments of more than an unspecified percent.
Where products whose bound tariffs are less than an unspecified percent are concerned, minimum additional duty of an unspecified percent to be applied when the volume based special agricultural safeguard is to be triggered.

[34] Special safeguard provisions under the URAA enabled countries to temporarily apply extra duties for products specified in their schedules of concessions if import prices should fall below a certain level or if the quantity of imports rises too quickly in relation to an average over the previous 3 years.

Special Safeguards (SSG)—*Continued*

Developing Countries:

Both price- and volume-based special agricultural safeguards to be introduced for all agricultural product imports into developing countries.

Harbinson Proposal:

Special agricultural safeguards to be phased out for developed countries.
Special agricultural safeguards to be created for developing countries and to be applied to "strategic products."
Developing countries to determine which products they desire to designate as "strategic."
Tariffs on strategic products to be cut a minimum of 10 percent.

Export Competition

Export Subsidies[35]

United States:

Export subsidies to be eliminated, with reductions phased in over 5 years in equal annual increments.

Cairns Group:

Export subsidies to be eliminated for developed countries in 3 years, with 50-percent reduction immediately and remaining reduction in 3 equal installments over the remaining implementation period.
Export subsidies to be eliminated for developing countries in 6 years, with 50-percent reduction immediately and remaining reduction in 6 equal installments over the remaining implementation period.

European Union:

Export subsidy budgetary outlays to be cut by 45 percent over 6 years for developed countries and 10 years for developing countries.

Japan:

Export subsidies to be reduced from the final commitment level by an unspecified percent for budgetary outlays, an unspecified percent for quantity, and an unspecified percent for unit value.
Disciplines to be imposed on other export-enhancing mechanisms such as export credits, as well as to other export-enhancing domestic supports with similar impacts as export subsidies (e.g., price compensating deficiency payments, but excluding de minimis provisions).
Developing countries to be allowed flexibility in terms of implementation period, reduction rates, and scope of measures exempt from reduction commitments.
Least-developed countries to be exempt from all reduction commitments.

[35] Under the URAA, budget outlays for export subsidies were reduced by 36 percent and volume by 21 percent, compared with a 1986-90 base period average level, over a 6-year implementation period (1995-2000). Products not receiving a subsidy in the base period were made ineligible for future export subsidies.

Export Subsidies—*Continued*

Developing Countries:

Export subsidies to be eliminated.

Harbinson Proposal:

Export subsidies to be eliminated over 9 years, with most cuts enacted early in the implementation period (i.e., subsidy reductions are front loaded). At least one-half of export subsidies to be phased out in 5 years (subsidies based on the value of budgetary outlay) according to the following schedule (70 percent of the preceding years subsidy value):

Year	1	2	3	4	5	6+
Percent of bound URA level	70.0	49.0	34.3	24.0	16.8	0.0

For all remaining products, subsidies to be phased out over 10 years (75 percent of the preceding years subsidy value):

Year	1	2	3	4	5	6	7	8	9	10
Percent of bound URA level	75.0	56.3	42.2	31.6	23.7	17.8	13.4	10.1	7.6	0.0

Export Credits and Guarantees[36]

United States:[37]

Disciplines to be developed for officially supported export credit, credit guarantee, and loan and insurance programs; and to apply to all institutions and programs involved with official support for agricultural products.

Export financing programs to have a maximum repayment term of 180 days for developed, and 30 months for developing countries.

The interest rate offered shall not to be less than the cost of borrowing for the fund, plus a risk-premium reflecting current market conditions.

Premiums under export credit programs to be: (i) adequate to cover long-term operating costs and losses; (ii) expressed in terms of the principal value of the credit; and (iii) paid in full when the credit is issued.

Details of all programs to be notified to the WTO.

Cairns Group:

Export credits to be subject to strict WTO rules.

Repayment terms of principal and interest to be no more than 180 days.

European Union:

Export credits to be subject to strict WTO rules.

Government-supported export credits to be bound and reduced according to the same percentage reductions in other export subsidies.

[36] Credit with generous repayment schedules extended to a foreign buyer for the purchase of agricultural products. Guarantees are provided by the exporter, its bank, or by a government-funded export credit program.

[37] As outlined in U.S. submission at special session, Nov. 20, 2002.

Export Credits and Guarantees—*Continued*

Japan:

Reduce export credits and guarantees from the base level by an unspecified percent for budgetary outlays, and unspecified percent for quantity in equal installments.

Developing Countries:

Definition of an export credit to be clarified.
Export credits to be subject to strict WTO rules.
Notification of officially supported export credit transactions to be required within specific time frame.

***Harbinson Proposal*:**

Export credits to be subject to a maximum tenor (repayment period). No specific tenor for developing countries proposed.
Importer to pay at least 15 percent of value to exporter up front.
Minimum interest rates subject to specific rules.

Exporting STEs

United States:

Any entity desiring to export, or to purchase for export, agricultural products is not to be restricted from doing so.
STEs that export a large share of the country's total exports of an agricultural product must not receive special financing privileges, including government grants, loans, loan guarantees, or underwriting of operational costs.
Exporting STEs must be transparent by providing to the WTO Committee on Agriculture cost and price information of products exported or sold for export by the STE on a transaction-specific basis.
Any WTO member to be allowed to request any country with an STE to provide specific information concerning all operations relevant to the export of agricultural products.

Cairns Group:

No specific modalities proposed.

European Union:

Disciplines to be introduced to prevent cross subsidization, price pooling, and other unfair practices.
No exports at a price less than the price paid by the STE to the producers of the product.
Detailed information on commercial operations, including acquisition costs and export pricing, to be notified to the WTO.

Japan:

Stringent notification requirements to be established on export STEs, including quarterly notification of volume and price of exports to each trade partner, procurement price, and elements of business plans that are related to their exports.

Developing Countries:

Developing countries to be allowed to continue using STEs.

Harbinson Proposal:

Restrictions to be established including: (i) prohibiting exports at a price lower than the STE paid to the domestic producer, (ii) prohibiting STEs from having a monopoly over exports, (iii) prohibiting STEs from obtaining special financing or other financial concessions from the government.

Food Aid

United States:

Reporting requirements to be expanded in the WTO to increase transparency of food aid activities and to strengthen the market displacement analysis in international organizations charged with reviewing food aid activity.

Cairns Group:

Establish rules to ensure that food aid is not provided to circumvent export subsidy disciplines.

Establish rules to ensure the provision of food only to meet humanitarian needs that should not impact normal domestic production or consumption patterns.

WTO members to coordinate with the Food and Agriculture Organization's Consultative Subcommittee on Surplus Disposal to lessen the trade-distorting impact of surplus disposal.

European Union:

Food aid to be provided to vulnerable groups in response to an emergency and humanitarian crisis or following appeals from the United Nations (UN), such as the World Food Program.

Food aid not to be used as a surplus disposal mechanism.

All food aid to be in fully grant form and not tied in any way to commercial exports of agricultural products or other products and services to the recipient country.

Japan:

Non-grant food aid (other than those implemented in response to appeals from such international organizations as the UN World Food Program) to be replaced progressively with grant food aid.

Developing Countries:

Food aid to be fully grant form only.

Guidelines to be introduced to ensure disbursement of food aid is demand driven.

Harbinson Proposal:

Food aid to be administered through the UN World Food Program, with government-to-government food aid prohibited except in emergency situations. NGOs involved in food aid also required to operate through the World Food Organization.

Food aid to be provided in fully grant form and made in response to appeals from UN-sponsored agencies. These grants must not be tied to any commercial exports.

Export Taxes and Restrictions[38]

United States:

Only developing countries to be allowed to impose export taxes, so long as the export tax applies to all agricultural products and applies at a uniform rate across all agricultural products.

[38] Restrictions on how much of a product can be exported from a country can be imposed to protect a domestic industry or for national security. Restricting the export of a primary commodity assists the domestic processing industry for that commodity. Advanced technologies are also targets for export restrictions to prohibit rogue states from using the technology to create weapons of mass destruction. Food embargoes due to sanctions are also another type of export restriction. Export taxes are imposed on products exported, mostly as a means of raising government revenue or to discourage exports as a means of assisting domestic users of the exported product.

Export Taxes and Restrictions—*Continued*

Cairns Groups:
No specific modalities proposed.

European Union:
No specific modalities proposed.

Japan:
All export prohibitions and restrictions to be replaced by export taxes (tariffication), with export taxes to be reduced by 36 percent immediately plus and unspecified percent during implementation.
Export restrictions to be allowed on short-term basis by exporting countries facing an emergency in order to ensure the food security of the country.

Developing Countries:
Developing countries to be exempt from any disciplines on export restrictions and taxes.

Harbinson Proposal:
All existing export restrictions allowed to be continued, although no new export restrictions can be introduced.

Domestic Support[39]

Amber Box Programs[40]

United States:
Amber Box programs (i.e., non-exempt support) to be defined by the Aggregate Measure of Support (AMS)[41] and production-limiting support (i.e., Blue Box under URAA)[42] as defined in Article 6.5 of the Agreement on Agriculture.
Level of non-exempt support to be reduced from the member's final bound AMS ceiling to 5 percent of its average value of total agricultural production in the base period of 1996-1998, through equal annual reduction commitments over 5 years.
Members whose final bound AMS is less than 5 percent of the 1996-98 value of agricultural production to maintain their ceiling for non-exempt support at the final bound AMS level.
In the calculation of non-exempt support, countries are not to include domestic support that is consistent with the provisions of Article 6.4 of the URAA.

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[39] Domestic support, determined by the Aggregate Measure of Support (AMS) which provides an estimation of expenditure on trade distorting programs, is being reduced over a period of 6 years by 20 percent compared to the 1986-88 base period. Reductions are being made on support across all commodities, in contrast to a commodity-by-commodity basis in market access and export subsidy provisions. Policies considered not to be trade distorting and some forms of direct payments for production-limiting programs were excluded from the AMS calculation.

[40] In WTO terminology, Amber Box programs are domestic policies considered to be trade distorting and subject to careful review and reductions over time under the URAA (e.g., commodity-specific market price supports, non-exempt direct payments to farmers, input subsidies, storage payments, interest subsidies, and insurance subsidies).

[41] The AMS calculates the value of support, aggregated across all commodities, that includes government payments and producer transfers from consumers. The measure was established under the URAA and is the maximum countries can spend on Amber Box trade-distorting support.

[42] See explanation of term later under discussion of Blue Box programs.

Amber Box Programs—*Continued*

United States:—Continued

All non-exempt domestic support to be eliminated by a date to be established in these negotiations.

Current rules for excluding low levels of support (de minimis) to be maintained as under the URAA.

Developing countries to be given special consideration for creating additional criteria to exempt support measures which are essential to development and food security goals, especially the exemption of programs oriented toward subsistence, resource-poor, and low-income farmers.

Cairns Groups:

Final bound AMS commitment to be reduced on a product-specific disaggregated basis to zero in 5 years (9 years for developing countries).

Countries to make 50 percent of total AMS reduction in the first year, and the remaining 50 percent over 4 years on a straight-line basis.

Rules to avoid product-specific support from being classified as nonproduct-specific support to be strengthened.

URAA Article 6.2 exemption[43] to be retained for developing countries.

Retain access to existing domestic support arrangements for least-developed countries.

European Union:

AMS to be reduced 55 percent from final URA bound level, over 6 years for developed countries and 10 years for developing countries.

Introduction of a food security box providing exemptions for domestic support measures for agricultural products considered essential for food security and for the diversification of agricultural production.

Japan:

AMS on an aggregate basis to be reduced from the final commitment level by an unspecified percent in equal installments.

Provide flexibility for developing countries in terms of implementation period, reduction rates, and the scope of measures to be exempt from reduction commitments.

Least-developed countries to be exempt from reduction commitments.

Developing Countries:

Developed countries to substantially reduce or eliminate Amber Box supports.

Longer implementation and greater flexibility in support reductions.

Introduce a "Development Box." Countries would have broad flexibility in a new round to design farm programs to help low-income farmers and boost food security. Development box countries would be exempt from commitments to cut subsidies and open borders for basic food products.

[43] Article 6.2 exempts investment and agricultural input subsidies by developing countries from being subject to domestic support commitments, and such subsides were not included in the AMS calculation of developing countries.

Amber Box Programs—*Continued*

Harbinson Proposal:

AMS to be bound and reduced 60 percent over 5 years.
Product-specific AMS for any single product to be capped at average support during 1999-2001.
Retention of Article 6.2 of URAA exempting developing countries from some trading-distorting (Amber Box) policies.
Article 6.2 to be extended.
Use of some trade-distorting practices, such as transportation and marketing subsidies, by developing countries to be exempt from disciplines.
For developing countries, payments to be exempt for maintaining domestic production capacity of staple crops for food security purposes, and to small-scale family farms for the purpose of maintaining rural viability and cultural heritage.

Green Box Programs[44]

United States:

Green Box support to be defined by criteria-based measures that have no, or at most, minimal trade-distorting effects or effects on production.

Cairns Groups:

Green Box support criteria to be revised and clarified so that such support does not distort production or trade.
Decoupled payments to individual producers to be available for no more than 3 years and not to be renewed.

European Union:

Green Box exemption criteria to be maintained as under URAA, but expanded to include non-trade concerns, such as animal welfare.

Japan:

Green Box exemption criteria to be maintained as under URAA, except to improve policy-specific criteria for income insurance, income safety-net, and natural disaster programs.

Developing Countries:

Green Box exemption criteria to be tightened.
Green Box payments by developed countries to be bound and subject to reduction.
Programs that aid food security and development to be considered in the Green Box.

Harbinson Proposal:

No limits on Green Box payments.
Green Box criteria to be modified somewhat relating mostly to circumstances in which farmers can receive Green Box emergency payments, such as in the cases of drought and animal disease.

[44] In WTO terminology, Green Box programs are domestic support policies considered not to be trade distorting and not subject to limitations (e.g., conservation programs, research and extension, marketing and promotion programs, inspection and grading policies, domestic food aid, disaster relief, revenue insurance programs, and direct payments not linked to production).

Blue Box Programs[45]

United States:
Blue Box support to be eliminated and rolled into the Amber Box.

Cairns Groups:
Blue Box support to be eliminated and rolled into the Amber Box.

European Union:
Blue Box to be maintained as in the URAA.

Japan:
Blue Box to be maintained as in the URAA.

Developing Countries:
Blue Box support to be eliminated and rolled into the Amber Box.

Harbinson Proposal:
Two options: (i) Blue Box support to be capped at 1999-2001 level with 50-percent reduction over 5 years (for developing countries, 33 percent over 10 years), (ii) Blue Box support to be eliminated (i.e., all Blue Box support to be rolled into the Amber Box).

De Minimis[46]

United States:
De minimis to be maintained at 5 percent as in the URAA.

Cairns Groups:
De minimis support provision for developed countries to be reduced and phased out over an agreed period.
Retain de minimis for developing countries.

European Union:
Eliminate de minimis for developed countries.
De minimis to be maintained at 5 percent as in the URAA for developing countries.

Japan:
De minimis to be maintained at 5 percent as in the URAA for developing countries.

[45] In WTO terminology, Blue Box programs are domestic policies that include direct payments under production-limiting programs and that are not subject to reduction commitments. A Blue Box designation, which typically benefits the United States and EU, indicates policies are excluded from the AMS reduction commitment during 1995-2000, but not from the 1986-88 base year AMS calculation. To be Blue Box policies, payments must be made on a fixed area and yields on 85 percent or less of the base level of production, or on a fixed number of head (of livestock).

[46] Under URAA, this exempts from reduction commitments any aid for an individual product which amounts to less than 5 percent of the value of production of that product. Non product specific de minimis is 5 percent the total value of agricultural production.

De Minimis:—*Continued*

Developing Countries:
De minimis level to be increased for developing countries and eliminated for developed countries.

Harbinson Proposal:
5 percent de minimis to be reduced by 0.5 percent annually over 5 years (i.e., from 5 percent to 2.5 percent over 5 years) for developed countries.
De minimis to remain at 10 percent as in the URAA for developing countries.

Peace Clause[47]

United States:
No specific modalities proposed.

Cairns Groups:
No specific modalities proposed.

European Union:
Peace Clause to be maintained as in the URAA.

Japan:
No specific modalities proposed.

Developing Countries:
No specific modalities proposed.

Harbinson Proposal:
No specific modalities proposed.

Non-Trade Concerns[48]

Food Labeling

United States:
Food labeling to be addressed under the Agreement on Technical Barriers to Trade (TBT Agreement), rather than under the Agreement on Agriculture.

[47] The text of the URAA states that nontrade-distorting policies, provided they do not directly contravene the provisions of the URAA, are not subject to GATT challenges for up to 3 years beyond the 6-year duration of the URAA. This restricts the use of countervailing duties to counteract domestic support measures deemed to conform to the Agreement on Agriculture for the period that the Peace Clause is in effect. The clause is due to expire on January 1, 2004, and if it is not extended, some currently existing domestic support measures and export subsidies could be deemed countervailable.

[48] Examples include issues related to agriculture's "multifunctionality" brought up in the negotiations that are tangentially related to international trade in goods and services, traditionally including food security, food safety, environmental concerns, resource conservation, and rural development. Some newer non-trade concerns proposed by WTO members are animal welfare, biotechnology, species preservation, safeguarding the landscape, poverty reduction, and preservation of rural culture.

Food Labeling—*Continued*

Cairns Groups:

Food labeling to be addressed under the TBT Agreement, rather than the Agreement on Agriculture.

European Union:

Criteria and guidelines to be established for the implementation of mandatory labeling requirements for food and agricultural products.

Members to have the right to choose the level they deem appropriate for consumer information and protection regarding the characteristics and the production and processing methods of agricultural products.

Members to have the right to provide information to consumers on the characteristics of a product, its process and production methods, including the manner in which animals or plants are raised or grown, the organic or non-organic nature of the production process, and the modified properties of agricultural products.

Japan:

No specific modalities proposed.

Developing Countries:

No specific modalities proposed.

Harbinson Proposal:

No specific modalities proposed.

Food Safety[49]

United States:

No specific modalities proposed.

Cairns Group:

No specific modalities proposed.

European Union:

Precautionary principle to be the basis for establishing trade barriers in certain circumstances.[50]

Need to clarify the use of precaution and establish criteria for its application in accordance with Article 5.7 of the SPS Agreement.[51]

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[49] Food safety is cited in negotiations to justify quarantine and inspection measures for agricultural products. The concept of food safety can involve mandatory labeling of products and the traceability of their ingredients and manufacturing processes.

[50] A principle advocated mainly by the EU that when risks are uncertain or science is incomplete, countries should exercise caution in accepting products developed by new technologies. Some countries have expressed concern that this position could provide the EU with justification to restrict imports of genetically modified organisms (GMOs).

[51] The WTO Sanitary/Phytosanitary (SPS) agreement, which entered into force after the Uruguay Round in 1995 with the establishment of the WTO, limits technical barriers to trade for human health protection or animal and plant disease control. According to the Agreement, countries are permitted to set their own food safety and animal and plant health standards, but they must be based on science. Article 5.7 of the SPS Agreement allows trade barriers to be established under certain conditions. The measures may be maintained as long as a more complete risk

(continued...)

Food Safety—*Continued*

Japan:
No specific modalities proposed.

Developing Countries:
No specific modalities proposed.

Harbinson Proposal:
No specific modalities proposed.

Geographical Indications[52]

United States:
Geographical indications to be addressed under the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement[53]), rather than under the Agreement on Agriculture.

Cairns Group:
Geographical indications to be addressed under the TRIPS Agreement, rather than the Agreement on Agriculture.

European Union:
Geographical indications to be protected under the Agreement on Agriculture by establishing a list of names currently misused by producers other than the right holders in the country of origin and misuse of such names to be prohibited.
Protected names to be exclusively reserved to the agricultural products originating in the place indicated by the geographical indication in question, and not to be used after a phase-out period.

Japan:
No specific modalities proposed.

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[51] (...continued)
assessment cannot be conducted because the scientific data remains incomplete, imprecise, or inconclusive; and as long as the risk is considered to be too high relative to the chosen level of protection. However, maintenance of the measures shall depend on the development of scientific knowledge. Therefore, the regulatory authorities shall re-evaluate the data and the measure once new scientific information is obtained. Measures shall be based on scientific evidence, from qualified and respected sources, but not necessarily that of the majority of the scientific community.

[52] Geographical indications identify an agricultural good as originating in the territory of a member, or a region or locality in the territory, where a given quality, reputation, or other characteristic of the good is essentially attributable to its geographical origin and which is protected in the laws and regulations of the member. Nomenclature in the description of foods and beverages which indicates the region of origin, include Indian "Basmati" rice, Greek "Kalamata" olives, Italian "Parmigiano" cheese, and French "Champagne." Protection extended to such products would prohibit the use of the descriptive term for similar products produced outside of the particular region.

[53] The purpose of the TRIPS Agreement, which entered into force after the Uruguay Round in 1995 with the establishment of the WTO, was to provide adequate, harmonized protection and enforcement for intellectual property rights.

Geographical Indications—*Continued*

Developing Countries:
No specific modalities proposed.

Harbinson Proposal:
No specific modalities proposed.

Animal Welfare

United States:
No specific modalities proposed.

Cairns Group:
No specific modalities proposed.

European Union:
Compensation of additional costs to meet animal welfare standards to be exempt from AMS calculation where it can be clearly shown that these costs stem directly from the adoption from high standards and that compensation is not trade-distorting.

Japan:
No specific modalities proposed.

Developing Countries:
No specific modalities proposed.

Harbinson Proposal:
Producer compensation payments for compliance with animal welfare standards to be included in the Green Box, but with restrictions. For example, payments for animal welfare must be less than the cost of compliance with animal welfare standards.

Reaction to the Harbinson Proposal

Reactions to Chairman Harbinson's proposal were uniform in their opposition. The reform group countries critiqued its lack of ambition and the status-quo countries labeled it unrealistic and unfair. The reactions reveal the philosophical issues dividing the negotiators. Although most countries want to "level the playing field" in international trade, they are divided over harmonizing or entirely eliminating levels of protection. There is general consensus that export competition needs to be disciplined, but no agreement on which forms are least trade-distorting or the need to completely eliminate them. Issues such as whether to explicitly address non-trade concerns and how to provide special and differential treatment to least developed countries have been met with a range of approaches based on deeply held philosophical viewpoints.

The United States, whose proposal contained substantial cuts in subsidies and trade barriers, labeled the proposal "not completely satisfactory."[54] U.S. officials raised concerns about the lack of harmonization of domestic support levels, noting that the proposals would leave the EU level of domestic support at three times that of the United States.[55] In addition, U.S. officials emphasized that the reduction of tariffs on a simple average basis proposed in the draft would not provide the type of market access that the United States

[54] Veneman and Zoellick, "Statement on the Doha Development Agenda Negotiations," USDA media release no. 0104.03, Mar. 31, 2003.

[55] David Hegwood, Special Counsel to the U.S. Secretary of Agriculture, "A Fair Path to Free Trade: The WTO Agriculture Negotiations," media release, Feb. 21, 2003.

is expecting as a result of the Doha Round.[56] Australia and other Cairns group countries were equally unhappy with the Chairman's proposal, noting the failure to achieve substantial market-access improvements and the ambitious mandate for reform set out in Doha.[57]

In contrast, the EU asserted the text was too extreme in its liberalization objectives. Officials declared that the document reflected excessive focus on market access supported by the United States and the Cairns Group but ignored issues such as the protection of geographical indications for foods, food security, and other non-trade concerns. Franz Fischler, EU Agriculture Commissioner, characterized the Harbinson proposal as containing "serious imbalances" such as elimination of export subsidies with only disciplines placed on export credits, and the cutting of the less trade-distorting Blue Box.[58] Japan, Korea, Bulgaria, and France made clear that the proposal was not acceptable as a basis for further negotiations.[59]

Looking Ahead

According to the original schedule, the Harbinson modalities draft was intended for member governments to prepare their country-specific offers, which under the Doha timetable are due by the September 2003 meeting of trade ministers in Cancun, Mexico (see box 2). Now the Cancun Ministerial is perceived by observers as the most likely point at which members would be able to agree to the modalities.[60] Up to this point negotiators have been unable to offer any fresh ideas on the main pillars of the agriculture talks. These officials have indicated that without political guidance from ministers, which is not likely forthcoming before September, the negotiations would continue to stall.[61]

If left for Cancun, the modalities framework discussion could crowd out the already full agenda for the September Ministerial, just 16 months before the entire Doha Round is scheduled to be completed. From the start of the Doha Round, the 3-year time frame for completing the talks was seen by observers as particularly ambitious given the negotiating agenda, which includes agriculture, services, tariffs on industrial goods, antidumping/countervailing rules, and trade and the environment, among other issues.[62] The agenda is heavy laden because the agreement to launch the Round was subject to a number of compromises, including insistence by developed countries on the inclusion of new talks on investment, competition policy, trade facilitation, and transparency in government procurement. Because agriculture is viewed by many countries as the key to a successful Doha Round, any delay in the farm trade talks is anticipated to impact the Round as a whole.[63]

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[56] "Sense of the Senate Regarding WTO Agriculture Negotiations," S.671, Miscellaneous Trade and Technical Corrections Act of 2003, Sec. 2006.

[57] Australian Department of Foreign Affairs and Trade, "WTO Agriculture Reform Proposals Don't Go Far Enough," media release, Feb. 13, 2003.

[58] EU Commission,"Harbinson Draft Won't Bridge the Gaps," media release, Feb. 13, 2003.

[59] See, "Agriculture Modalities: Final Countdown," *BRIDGES Weekly Trade News Digest*, vol. 7, No. 11, Mar. 26, 2003; "Little Progress as WTO Deadline Looms," *Feedstuffs*, Mar. 31, 2003; and Jacqueline Den Otter, "Positions Remain Divided on Agriculture Talks at WTO," (email distribution), The Netherlands Executive Director's Office, World Bank, Mar. 26, 2003.

[60] WTO, Agricultural Negotiations. Farm Talks Miss Deadline: But 'Work Must Go On,' Says Supachai," WTO media release, Mar. 31, 2003, found at *http://www.wto.org/english/news_e/pres03_e/pr336_e.htm*, retrieved Apr. 7, 2003.

[61] "Gloomy Harbinson Says WTO Deadline On Agriculture Modalities to Be Missed," *International Trade Daily*, Bureau of National Affairs, No. 61, Mar. 31, 2003, p. 4.

[62] "Supachai Reaffirms Commitment to January 2005 Doha Round Deadline," *International Trade Daily*, Bureau of National Affairs, No. 63, Apr. 2, 2003, pp. 15-16.

[63] Ibid.

Some have suggested that this unfavorable negotiating climate will clear only after the war in Iraq is completed.[64] Others, within and outside Europe, have suggested that a resolution on reform of the Common Agriculture Policy due by this fall (box 3) will be useful to push the WTO agriculture negotiations forward.[65] Chairman Harbinson has pledged to continue informal consultations after the April Easter break. Special sessions of the agriculture negotiating group have also been scheduled for June and July in the hope that a decision on the modalities for future talks could be reached this summer.

Box 3
Reform of the Common Agriculture Policy and the European Union (EU) World Trade Organization (WTO) Negotiating Position

The confluence of three major EU policy dynamics, each conceived and developed independently of the other, have the potential for significant interplay. The individual timelines for EU Common Agriculture Policy (CAP) reform, EU enlargement, and the WTO agriculture negotiations overlap and progress made in each area could serve to influence the outcomes in the other areas.

The accession of 10 new member states to the EU places obvious pressure on the current EU system of agriculture support, the CAP. EU incorporation of several eastern and central European states by May 2004 includes those countries' farmers. In its CAP reform discussions in January, EU ministers agreed to cap 2006-2013 direct payments to farmers at 2006 levels, adjusted for inflation. On one hand, this policy keeps CAP spending at its current high level, pointing toward a status-quo position by the EU on domestic support levels in the WTO. However, the combination of capping total expenses while bringing in more farmers will reportedly put pressure on the EU to make deeper reductions in payments per farmer, which could give EU negotiators more flexibility to liberalize in the WTO talks. Capping support also leaves little room for future increases.

The CAP reform proposal thus far includes decoupling aid from production and installing a single farm payment, the concept of modulation (transferring a portion of direct aid payment to strengthen rural development), and adjusting intervention prices. The keystone of the reforms is the total decoupling of EU direct payments to farmers. Decoupled payments would be classified as non-trade-distorting according to the WTO and placed in the "Green Box." If agreed, a system of decoupled payments in theory would allow the EU to agree to more ambitious reductions in trade-distorting domestic support in the WTO arena. It could also lessen the EU insistence on maintaining the Blue Box (direct payments not subject to reduction commitments) which is currently at odds with the U.S. and Cairns Group proposals for its elimination.

The outcome of the CAP reform discussions, due to be decided just about the time of the Cancun Ministerial, reportedly may give the EU more flexibility to agree to broader liberalization in the WTO agriculture talks. U.S. Agriculture Secretary Veneman and U.S. Trade Representative Zoellick have indicated that an agreement on CAP reform is necessary before the Cancun Ministerial in order for the WTO talks to be successful. Minister Fischler, however, has indicated that CAP reform is being carried out for internal reasons and that the EU negotiating proposal in the WTO agriculture talks does not depend on the outcome of CAP reform.

Source: Chris Horseman, "Central and Eastern Europe: Overview of EU Enlargement and Its Impact on Primary Commodity Markets," Agra Europe (London) Ltd., *USDA Agricultural Outlook Forum*, Feb. 20, 2003; Toblas Buck, "Fischler Warns Against EU Farm Reform Failure," *Financial Times*, Jan. 16, 2003; and "North/South Split Over 'Modulation,'" AgraNet, AgraEurope (London) Ltd., Oct. 14, 2002.

[64] Carl Mortished, "WTO Fails to Agree Agriculture Deal," *London Times*, Mar. 29, 2003, p. 52; Frances Williams, "Doha Talks in Crisis as Farm Reform Deadline Set to Be Missed," *Financial Times*, Mar. 31, 2003, p. 1; and Guy de Jonquieres, "How Enlightened International Co-operation Has Turned into a Showcase for Indecision," *Financial Times*, Mar. 31, 2003, p. 13.

[65] "European Official Says CAP Reform Will be Helpful to Progress in WTO," *International Trade Daily*, Bureau of National Affairs, No. 61, Mar. 31, 2003, p. 7.

Catalysts: An Innovative Industry Responds to Technological and Competitive Challenges

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Catalysts are substances that generally accelerate the rate of chemical reactions. Because catalysts are critical in several key industries, especially in chemical and petroleum refining, they play a vital role in the U.S. economy. In fact, most commercial chemicals used today could not be produced without catalysts. Although dwarfed by the value of products produced through catalysis (i.e., through developing and applying catalysts to enhance technology), U.S. catalyst sales are nonetheless significant, comprising a multibillion dollar industry. The rapidly changing catalyst industry depends on advances in research and development (R&D), a trend that will likely accelerate with the advent of new technologies such as biocatalysis. This article examines (1) the basic characteristics of catalysts, (2) their principal commercial applications, (3) the structure of the industry, (4) major challenges facing the industry, and (5) prospective future applications. **[Note: A glossary of the technical terms highlighted by bold italics is located at the end of this article.]**

Catalysts accelerate chemical reaction rates by reducing the energy input required to form a new product from two or more reactants but the catalysts are not consumed themselves (in theory) by the reaction.[2] A critical region within the catalyst is the ***active site***, the portion of the catalyst that specifically facilitates the formation of the desired product by bringing the reactants into close proximity. Most commercial catalysts are ***heterogenous***, in which the catalyst and the reactants are in different phases; usually the catalyst is a solid and the reactants are either in a liquid or gaseous phase.[3] Catalysts may be metals (e.g., nickel and palladium), ***inorganic chemicals*** (e.g., aluminum oxide and sulfuric acid), ***organic chemicals*** (e.g., ***enzymes***), ***organo-metallic compounds*** (e.g., triethylaluminum), or combinations of different substances.

Key Catalyst Applications

Although catalysts are widely used throughout the chemical and related industries, they are particularly well established in five types of applications: petroleum refining, emissions and pollution control, polymers and plastics, pharmaceuticals and fine chemicals, and basic chemicals. Industry sources note that each application tends to have its own set of demand drivers and its unique industry and market characteristics. There is, however, considerable overlap throughout these applications, especially for the technologies used to develop and characterize catalysts. Environmental concerns have emerged as a key demand driver in virtually all of these applications, although their relative importance varies.

[1] The views expressed in this article are the author's. They are not the views of the U.S. International Trade Commission (USITC) as a whole or of any individual Commissioner.

[2] In practice, however, a catalyst can be "***poisoned***" by reacting irreversibly with a chemical, thereby becoming deactivated.

[3] Many heterogenous catalysts are supported catalysts, in which the active catalytic substance, often a metal, is deposited on the surface of a relatively inert, porous support structure.

Petroleum Refining

The critical industrial processes that transform crude petroleum into useful fuels (e.g., gasoline and heating oil) and ***petrochemicals*** are highly dependent on a wide range of catalysts at almost all processing stages. The largest single end use for ***petroleum refining*** catalysts is for ***catalytic cracking***, the splitting of longer and heavier ***hydrocarbons*** by ***fluid cracking catalysts*** (FCCs) into shorter and lighter units. Catalytic hydrotreating reduces concentrations of sulfur, nitrogen, and other contaminants by catalyzing the reaction of the hydrocarbon ***feedstock*** with hydrogen gas. Catalytic reforming accelerates the conversion of low-***octane*** hydrocarbons into high-octane hydrocarbons either by increasing the concentration of ***aromatics chemicals*** or branched-chain structures, both of which have a higher octane value than straight-chain structures.[4]

Efforts are currently underway, depending in part on development of new catalysts, to extract more gallons of gasoline from a barrel of crude petroleum;[5] to enhance integration between petroleum refining and petrochemical production; and to improve refinery capabilities for treating less-desirable, heavier, and more impure crude petroleum. Likewise the refining industry is also seeking alternatives to FCC by greater reliance on other refining processes such as hydrocracking that employs a greater concentration of hydrogen than FCC.[6]

Emissions and Pollution Control

In emissions control applications, catalysts interact with the combustion products from automobile engines and industrial plants to reduce the level of pollutants in the emissions. Catalysts produced for catalytic converters in automobiles represent one of the largest segments of the catalyst industry. Consumption of such catalysts is growing worldwide as automobile emissions controls tighten in the United States, the European Union (EU)[7], and other countries, including some developing countries such as China and India. These catalysts primarily use ***platinum-group metals*** (PGMs)[8] to convert hydrocarbons, carbon monoxide, and nitrogen oxides released in gasoline and diesel engine exhausts to less-toxic carbon dioxide, nitrogen, and water. Table 1 shows the current reduction in emission pollutants achieved by catalytic converters for typical gasoline and diesel engines.

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[4] The competitive significance of this process is illustrated, historically, by the Battle of Britain in 1940 which was won, in part, as a result of U.S. research in catalysis that succeeded in increasing the octane level of aviation fuel to 100-octane. This new fuel provided for 50-percent faster bursts of acceleration allowing British pilots to outclimb and outmaneuver German pilots whose planes were using 88-octane gasoline. Between July 10 and Oct. 31, 1940, the British lost 915 planes versus 1,733 for the Germans. National Research Council (NRC), *Catalysis Looks to the Future*, (Washington, DC: National Academy Press, 1992), p. 11.

[5] Advances in petroleum refining catalysts that increase the amount of gasoline and other energy products that can be produced from a barrel of crude petroleum have significantly reduced U.S. dependence on crude petroleum and, in turn, have reduced the U.S. trade deficit for crude petroleum. It is estimated that the use of ***zeolite*** catalysts to increase cracking efficiency resulted in a saving of at least 400 million barrels of petroleum per year, or more than $8 billion annually (based on a price of $20 per barrel). Ibid., p. 19.

[6] "Zeolites=More Miles per Barrel," *Ceramic Industry*, Nov. 2001, p. 16.

[7] In the EU, more stringent emission requirements are set for automobiles manufactured from 2004. "Catalysts Enjoy Regulation Growth," *Chemical Week Associates Custom Publication*, Mar. 13, 2002, p. s3.

[8] The relative scarcity and cost of PGMs are major concerns to catalyst producers; see "Challenges Facing the U.S. and Global Catalyst Industry" below.

Table 1
Comparison of emissions from gasoline and diesel cars with and without catalysts

(*Grams per kilometer*)

Item	Carbon monoxide	Hydro-carbons	Nitrogen oxides
1.8 liter gasoline (with closed loop fuel injection):			
No catalyst	5.99	1.67	1.04
With catalyst	0.61	0.07	0.04
1.9 liter diesel (direct injection):			
No catalyst	1.20	0.38	0.54
With catalyst	0.17	0.05	0.42

Source: Johnson Matthey Company, "Comparison of Emissions," found at *http://www.matthey.com/environment/cutting pollution/02.html*, retrieved Mar. 3, 2003. Information used with permission.

Not all pollution-control devices in automobiles treat automobile exhaust emissions. Although environmentally beneficial in the upper atmosphere, ozone is a pollutant and smog component at ground level. ***Catalysis*** plays a key role in reducing surface ozone.[9] Catalysis R&D also plays a key role in other environmental applications such as the search for alternatives to ***chlorofluorocarbons*** (CFCs). After discovery of HFC-134a as a reasonably satisfactory environmental substitute for many CFCs, the problem arose that the common synthesis routes for this chemical proved to be uneconomical. After an intense development effort, an improved catalyst containing nickel and zinc-modified chromium oxides allowed the production of HFC-134a at greatly increased efficiency.[10]

Polymers and Plastics

Catalysts have been a key tool for the ***polymer*** industry since before the 1950s, enabling mass production and the tremendous growth in world consumption of synthetic polymers, such as ***plastic***s. Many producers or developers of specialty catalysts for polymers are petrochemical manufacturers, as many basic petrochemicals (e.g., ethylene and propylene) are building blocks in the manufacture of polymers. However, older catalysts are facing increased competition from a newer class of ***single-site catalysts*** (SSCs), with active sites sharing the same physical and chemical properties. SSCs are divided into two types: ***metallocene*** and nonmetallocene catalysts. Because the catalytic activity of SSCs is more uniform than conventional catalysts, they enable the manufacture of more finely tailored and controlled polymers in terms of physical characteristics such as molecular weight and geometric orientation, and ultimately, the design specifications of the plastic.

Increased control over the production process makes it possible to create polymers with improved impact resistance and toughness, increased clarity, and easier sealability. For example, bananas covered with polyethylene plastic films produced with conventional catalysts were frequently punctured by the pointed end of the banana bunch leading to spoilage. Substitution of tougher plastic films produced with metallocene-based catalysts eliminated the spoilage problem.[11] Although metallocene technology has dominated recent

[9] "For example, Engelhard has developed PremAir, a base-metal catalyst coated on an automobile radiator which converts ozone contained in the air into oxygen. Alexander H. Tullo, "Going Platinum," *Chemical & Engineering News*, Aug. 26, 2002, p. 19.

[10] Mitch Jacoby, "Catalysis Around the World," *Chemical & Engineering News*, Sept. 3, 2001, p. 39.

[11] Alexander H. Tullo, "Single-Site Catalysts," *Chemical & Engineering News*, Aug. 7, 2000, pp. 35-36.

catalyst R&D aimed at preparing improved polymers, significant advances also are being achieved in the area of nonmetallocene SSCs and improving older types of catalysts.

Pharmaceuticals and Fine Chemicals

Catalysts for the production of pharmaceuticals and ***fine chemicals*** have experienced some of the highest growth rates in the industry.[12] Much of this growth is attributable to the development of several new technologies including ***biocatalysis*** (box 1) and ***chiral*** synthesis. In chiral synthesis, catalysts (including enzymes) are selected that preferentially produce molecules with a specific geometric structure.[13]

In the past few years, use of chiral or single-enantiomer drugs has grown rapidly.[14] Global sales of single-enantiomer drugs were about $133 billion in 2000, growing more than 13 percent a year, and could reach $200 billion in 2008. Demonstrating the rapid sales growth of these drugs, the share of dosage-form drugs sold as single enantiomers rose from about one-third in 1999 to 40 percent a year later.[15]

Basic Chemicals

Catalysts for the preparation of basic industrial (commodity) chemicals account for a significant portion of the industry and of R&D expenditures designed to enhance these processes. Much work is being conducted to develop catalysts to allow for the replacement of raw materials of individual feedstocks with others that are significantly less expensive and more naturally abundant (for example, the replacement of ***alkene*** feedstocks with ***alkane*** feedstocks). In addition to cost savings, catalytic R&D is being conducted to modify chemical production processes with reduced or less-toxic waste byproducts.

The ability to more efficiently produce a commercially important basic chemical may depend on the optimization of a single, key step in the production process. For example, the ability of chemists in 1913 to synthesize ammonia from its constituents (nitrogen and hydrogen) in a cost-effective manner made possible today's synthetic fertilizer industry with incalculable benefits for enhancing the world's food supply. Likewise, enormous advances could accrue in such exploratory fields as ***fuel cells*** and ***biomass*** exploitation if certain key chemical steps could be optimized through technological breakthroughs in catalysis.

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[12] "Fine Opportunities Emerge," *Chemical Week Associates Custom Publication*, July 24, 2002, p. s3.

[13] Many but not all organic chemicals consist of two forms (***enantiomers***) that are identical in composition but differ in their spatial configurations which are nonsuperimposable, mirror images of each other. This phenomenon (i.e., chirality) can be detected because the right-handed (R) and left-handed (S) enantiomers rotate plane-polarized light in opposite directions. However, many organic chemicals that, in principle, exhibit chirality are more readily available commercially as a mixture containing equal amounts of both enantiomers (i.e., the chemical as manufactured will not rotate polarized light); such a mixture is called a ***racemate***.

[14] Chirality is important to pharmaceuticals because the biological effects of the individual enantiomers differ to the extent that one enantiomer can be beneficial and the other can be harmful. For example, thalidomide was initially sold in Europe in racemate form as a sedative, based on the action of the R-enantiomer. However, it was not known at that time that the S-enantiomer is a powerful teratogen, an inducer of birth defects in an embryo or fetus.

[15] Based on information provided by Technology Catalysts, International, Falls Church, VA, cited by Stephen C. Stinson, "Chiral Pharmaceuticals," *Chemical & Engineering News*, Oct. 1, 2001, p. 79.

Box 1
Biocatalysis

Biocatalysis relies on natural catalysts (enzymes), either unmodified or modified, to facilitate the development of useful products and processes. Biocatalysis encompasses not only some of the oldest technologies (e.g., fermentation) but also the most up-to-date techniques of biotechnology and genetic engineering.[1] The following tabulation compares the characteristics of specialized biocatalysis to conventional chemical synthesis:[2]

Advantages	Disadvantages
Mild reaction conditions	Poor operational stability
Highly stereo-, regio-, and chemoselective	Unwanted reactions with impure preparations
Unique and varied chemistry	Low volumetric productivity
Environmentally friendly	High cost

For pharmaceuticals, specialized enzymes are increasingly becoming the synthetic method of choice, given their high ***specificity***, high yields (approaching 100 percent), and low toxicity. In contrast to many chemical catalysts, enzymes in biocatalysis do not contain toxic, heavy metals. Moreover, biocatalysis research and development are being conducted for many other applications and have been enhanced by the development of new techniques. One example, applied in the pharmaceutical industry, is directed evolution in which genetically engineered microorganisms are mutated repeatedly while subject to a stimulus that enhances the survival probability of those microorganisms exhibiting a desired property.

[1] To distinguish between the two, the term "industrial enzymes" is sometimes used to denote the use of low-unit value commodity enzymes. The term "specialized enzymes" is sometimes used to denote the use of high-unit value proprietary enzymes, modified by biotechnology and genetic engineering, which are mainly used in low-volume, high-unit value products such as pharmaceuticals but are also increasingly being developed for industrial-scale applications. Carolyn Wilhelm, "Enzyme Transition from Commodities to Specialties," *Chemical Market Reporter*, Mar. 20, 2000, pp. 19-20; and interview by USITC staff with industry observers, July 19, 2002.

[2] Ann M. Thayer, "Biocatalysis," *Chemical and Engineering News*, May 21, 2001, p. 33. Information used with permission.

Source: Various trade journals, including specific sources noted.

U.S. Catalyst Manufacturers in a Global Industry

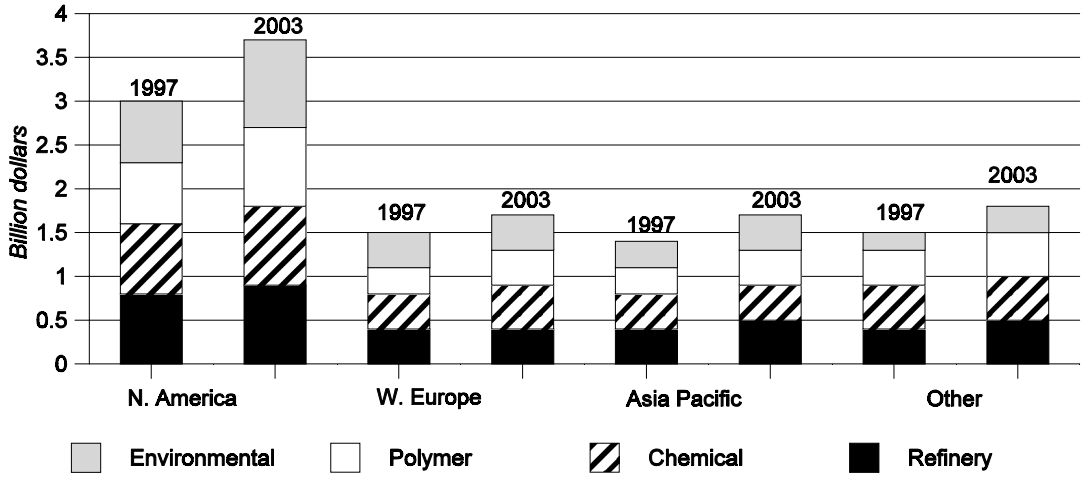
The catalyst industry is global and most catalyst companies in the United States are also active internationally. Industry sources contacted were virtually unanimous in their opinion that whether a catalyst company was headquartered in the United States or in Western Europe made little difference given the global orientation of the industry. As with other technology applications, most catalyst production and R&D facilities are in North America, Western Europe, and Japan. Some countries are disproportionately active in catalysis beyond what might be anticipated from their GDP. For example, the Netherlands is a major force in catalytic R&D.[16] As growth of chemical and plastics production is largely focused outside of the

[16] Mitch Jacoby, "A Dutch Success Story: Catalysis," *Chemical & Engineering News*, June 3, 2002, pp. 32-45.

developed world, growth of catalyst production is largely occurring in many of the "advanced" developing countries such as China and other countries in the Far East.

Catalyst consumption is far greater in North America than any other region, including Western Europe. (figure 1).[17] Accounting for part of this difference, according to industry sources, is the higher petroleum refining activity in North America. Global market-value growth for catalysts use was highest for environmental and fine chemicals (e.g., pharmaceuticals) applications, intermediate for polymer synthesis, and lowest in the refining and petrochemicals applications (table 2).

Figure 1
Worldwide catalyst market by region and application



Source: The Catalyst Groups; The Intelligence Report; "Global Shifts in the Catalyst Industry", *Chemical Week/Today's Refinery*, Sept. 1999, p. 54. Reprinted with permission.

Table 2
Global catalysts market value, 2001-2007

Item	2001	2004	2007	Average annual growth rate 2001-2007
	----------*Million dollars*----------			*Percent*
Petroleum refining	2,218	2,323	2,473	1.9
Petrochemicals	2,069	2,150	2,069	0.0
Polymers	2,268	2,646	3,042	5.7
Fine and intermediate chemicals and other products	1,100	1,364	1,628	8.0
Environmental	2,502	2,862	3,713	8.1
Total	10,157	11,345	12,925	4.5

Source: The Catalyst Group Resources' "Intelligence Report: Business Shifts in the Global Catalyst Industry 2001-2007," *Chemical Week*, July 24, 2002, p. s7. Reprinted with permission.

[17] Statistics are limited to the merchant market and exclude catalysts manufactured and consumed internally within a company. Data on environmental catalysts include manufacturing fees only and exclude the value of precious metals and ***substrate***s in automobile catalysts. The Catalyst Group: The Intelligence Report: "Global Shifts in the Catalyst Industry," *Chemical Week/Today's Refinery*, Sept. 1999, p. s4.

U.S. Industry Structure

Catalyst producers and developers in the United States are diverse and not always easy to characterize.[18] Prior experience would be one factor determining a company's product focus. For example, a company that has specialized in PGMs would be more likely to specialize in emission control applications or fuel cells which make use of these metals in their catalysts. Similarly, a company with experience in petroleum processing or biotechnology would be more likely to specialize in petroleum refining catalysts or biocatalysis, respectively. Some companies focus on only one specialized product line, e.g., petroleum refining catalysts, whereas other companies develop a broad range of catalysts differing both in their physical/chemical structure and enduse. Catalyst producers and developers also range in size from small technology companies to large multinational companies, with most being chemical and petroleum producers with a product/marketing base far more diverse than catalysts.

Consolidation of the chemical and petroleum refining industries has often resulted in fewer, but larger, customers with increased leverage over negotiating catalyst price and performance requirements. To cope with these challenges, catalyst manufacturers have also undergone consolidation through mergers and acquisitions, cooperative and joint ventures, and other strategic partnerships.[19] Catalyst manufacturers may engage in acquisitions to expand production, increase market share, or to gain entry into new markets. One of the largest consolidations, the merger of Mobil and Exxon in November 1999, combined Mobil's expertise with zeolite and synthetic type catalysts with Exxon's specialization in metallocene catalysts.[20] Alternatively, operations that are no longer part of a company's core business or long-range goals may be divested.[21]

Nor is the company that develops a catalyst necessarily the manufacturer. Increasingly, there has been a trend by companies who have developed innovative catalysts to contract the manufacturing responsibilities to third-party companies specializing in that area. This trend has developed because many companies that have developed catalysts in-house lack the scale-up and manufacturing expertise to efficiently commercialize and market these catalysts at optimal efficiency and cost. Other companies that previously manufactured their own catalysts may now consider it more cost-effective to outsource that responsibility to another company specializing in catalyst manufacturing.

U.S. International Trade

Reflecting the increased globalization of the catalyst industry and the continued importance of the United States as a global supplier, the portion of U.S. consumption for process catalysts supplied by imports during 1990-2000 rose from 10 to 24 percent (in terms of value) whereas the portion of U.S. process catalyst production exported rose from 24 to 41 percent.[22] In the same period, U.S. process catalyst imports rose from $170 million to $630 million, whereas U.S. catalyst exports rose from $520 million to $1.4 billion, widening the U.S. trade surplus for process catalysts from $350 million to $770 million. Growth of U.S. catalyst exports also reflects the relative maturity of some segments of the U.S. industry for which exports provide

[18] A selected listing of catalyst vendors in North America is provided by the North American Catalysis Society on its website at *http://www.nacatsoc.org/vendors.asp*.

[19] *Chemical Week/Today's Refinery*, Sept. 1999, pp. S3-S5; and The Freedonia Group, *Catalysts to 2005*, 2001, ch. 9.

[20] Ibid.

[21] The Freedonia Group, *Catalysts to 2005*, ch. 9.

[22] Trade data and analysis in this section are based on a study prepared by The Freedonia Group, *Catalysts to 2005*, Nov. 2001. The study was limited to process catalysts which include petroleum refining, chemical processing, and polymerization catalysts but exclude environmental catalysts.

opportunities to enhance sales and profits.[23] According to industry sources, U.S. exports, in volume terms, consist largely of catalysts for petroleum refining and petrochemicals synthesis. These exports may reflect the involvement of U.S. petroleum and petrochemical companies in joint ventures worldwide, with many in developing, energy-rich countries.

In 2000, about one-half of U.S. process catalyst imports, by value, were from Western Europe, especially Germany, the Netherlands, the United Kingdom, and Denmark. Japan provided about one-quarter of U.S. catalyst imports, whereas Canada and Mexico accounted for most of the remainder. About one-third of U.S. process catalysts exports were marketed in the Asia-Pacific region. The exports to Asia are expected to continue growing (especially to China) because of anticipated strong demand and the relative paucity of catalyst producers in that part of the world. Other major markets for U.S. process catalyst exports in 2000 were Western Europe (24 percent) and Canada (17 percent).[24]

Innovation—Key to Industry Performance

In general, the catalyst industry, driven by the need to innovate, is highly dependent on R&D. Two specific aims of R&D in catalysis are (1) to accelerate the process by which catalysts designed to promote a useful chemical reaction are selected and developed; and (2) to provide a database of materials and processes that could be referred to in the design of new catalysts and catalytic techniques.[25] Development of a new catalyst is an expensive and labor-intensive process involving many different functions including basic research, technology and process development, process licensing, process engineering and construction, catalyst manufacture, and instrumentation and maintenance.[26] In recent years, R&D in catalysis has been greatly aided by the development of various types of technologies, including biocatalysis and ***high throughput screening/combinatorial chemistry*** (box 2).

Factors which have facilitated R&D, such as increased cooperation between catalyst-related companies and the development of new technologies (especially high throughput screening/combinatorial chemistry), have enabled product development time to be reduced from about 5 years to as little as 2 years. Other methods that may shorten product development time include simulation techniques using miniaturized pilot plants, improved software, and increased emphasis on parallel processing.[27] Companies are also speeding up their rate of patent acquisition, anticipated to yield significant, if yet undetermined, competitive advantages in the future.

To protect intellectual property rights, catalyst companies are developing patent portfolios.[28] However, it is unlikely that any single catalyst company can acquire all the required technological knowhow. Thus, many also have entered into strategic agreements to expand their product line and/or access to

[23] Ibid.
[24] Ibid.
[25] NRC, *Catalysis Looks to the Future*, p. 16.
[26] "The Catalyst Industry: Dynamic Technology in Rapidly Changing Industries," *Chemical Week/Today's Refinery*, Sept. 1999, p. s3.
[27] "Catalysts: Stepping Toward a New Paradigm," *Chemical Week*, Sept. 13, 2000, pp. 52-55.
[28] Patents are not the only way a catalyst company can protect its intellectual property. Some catalyst companies have decided to keep the formulation of a particular catalyst, particularly a complex product, a trade secret because reverse engineering often cannot be used to determine how to formulate a given catalyst. Recently, however, according to one industry observer, some of the more traditionally proprietary-oriented companies have moved in the direction of protecting a greater share of their catalysts through patents.

Box 2
High throughput screening/combinatorial chemistry

As a technique of general applicability, high throughput screening/combinatorial chemistry has emerged as an important tool to speed up catalyst development, thereby reducing development costs. In this technique, a large number of closely related potential catalysts are generated, frequently using automated instrumentation. These compounds are then screened for useful properties in a manner that enables a large number of tests to be conducted in a relatively short time. The screening technique determines (1) the catalysts that are most suitable to optimize yields for a desired chemical reaction and (2) the optimal conditions in conjunction with a given catalyst to maximize yield.[1] Given the high degree of expertise required for this technique, technology companies have been seeking to license their services to the chemical industry and other users.[2]

Symyx Technologies, a technology company that specializes in assisting firms apply high throughput screening/combinatorial chemistry to their individual needs, has produced cost comparisons for research and development teams using traditional techniques versus teams using Symx technology:[3]

Item	Traditional research	Symyx discovery
Cost/year	$500,000	$500,000
Experiments/year	500-1,000	20,000-50,000
Cost/experiment	$500-1,000	$10-25

[1] "Advances in Catalysis: Using High Throughput Screening," *Chemical Week*, Sept. 13, 2000, p. 60; and Cynthia Challener, *Chemical Market Reporter*, Oct. 2, 2000, p. 20.
[2] Andrew Wood, "Combinatorial Chemistry," *Chemical Week*, July 18, 2001, pp. 18-20.
[3] According to Symyx, each team consists of one chemist and one technician. Information used with permission. Symyx Technologies. Copyright 2002, 2003.

Source: Various trade journals, including specific sources noted.

particular markets. These strategic partnerships and joint ventures are designed to alleviate possible patent infringement concerns, allow access to technology, spread investment risks, and facilitate entry into new areas of catalyst R&D.[29] The polymers/plastics industry is one of the most active in joint ventures and licensing. According to an industry observer, two trends have predominated:[30] (1) consolidation through mergers, joint ventures, or other cooperative efforts and (2) the resolution of previously contentious patent disputes in metallocene and SSCs.

The U.S. Government has been an active supporter of R&D in many catalytic areas with a focus on environmental protection, sustainable technologies, and new materials.[31] Federal Government support

[29] For example, Royal Dutch Shell maintains a 50-50 venture through its CRI International subsidiary with PQ Corporation. The resulting firm, Zeolyst International, produces zeolite powders and a variety of petroleum refining and petrochemical synthesis catalysts. The Freedonia Group, Catalysts to 2005, ch. 11.
[30] John Murphy, Howard Blum, and Clyde Payn, "Worldwide Catalyst Report: Consolidation, Patent-Dispute Resolution in Polyolefins Industry Affect Partnerships, Licensing,"*Oil and Gas Journal*, Oct. 9, 2000.
[31] Federal agencies that have been active in supporting R&D in catalysis include the U.S. Department of Energy (USDOE), the U.S. Department of Defense, the National Science Foundation, the National Institutes of Health, and
(continued...)

includes funding of national laboratories and grants to U.S. companies and universities. Research areas that have benefitted from government support include fuel cells, new material syntheses, chemical synthesis (with a focus on cost-cutting), biomass conversion to fuels, biopolymers, optical devices, and emission control equipment.

Universities are actively engaged in catalysis R&D, frequently with support from technology-oriented companies and the Federal Government. Generally, a company supports R&D with the aim of achieving concrete results in a relatively short time frame whereas universities engage in research that is innovative or longer range in scope. Nevertheless, universities have been major contributors to commercially oriented R&D in catalysis, as evidenced not only by their large number of research contracts but also by their considerable portfolio of patents. In most cases, even when university research is funded by a company, the university keeps any patent rights that may accrue but will assign an exclusive license to the sponsor for a number of years.

In addition, the contract research organization has emerged as a significant force in catalysis. This is an organization of researchers (who could be associated with a university) offering its services for a fee by forming a start-up company. The tendency toward contract research organizations is increasing, particularly as universities are branching out to more entrepreneurial areas and forming industrial parks. Their customers are often chemical companies in need of R&D assistance that do not want to be committed to a catalyst company.

The annual amount of U.S. industry expenditures on catalysis R&D in the early 1990s was estimated at between $500 million and $1 billion.[32] However, some industry observers believe that these expenditures have declined since then as companies have responded to economic and competitive pressures. One observer indicated that even if the U.S. industry's role in catalytic R&D is dominant in terms of expenditures, universities are increasingly becoming the vehicle for research and manpower whereas the industry's efforts are increasingly directed toward the development and commercialization phase which consumes most of the expenditures.[33]

Industry Challenges

The United States has long been viewed as a world leader in catalysis and many in the industry still consider it to be highly competitive. However, a few industry observers have expressed concerns that the U.S. competitive edge in catalysis has been eroding, especially vis-a-vis Europe and Japan, echoing a 1992 report of the National Research Council (NRC). In addition, the report stated that U.S. R&D efforts in catalysis were lagging in basic research and were insufficiently focused and not long-term oriented.[34] The report attributed a perceived decline in U.S. industry funding for catalysis R&D (during a period when Europe and Japan have been heavily investing in catalysis R&D) to competitive pressures, corporate mergers, and the diversification of company resources outside its main activities.[35]

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[31] (...continued)
the National Institute of Standards and Technology.

[32] NRC, *Catalysis Looks to the Future*, p. 66.

[33] Interview by USITC staff with an industry observer, Sept. 18, 2002.

[34] The NRC's 1992 report stated that the United States was losing, or was at risk of losing, its competitive edge in polymer science, basic research in chiral synthesis, catalytic materials, and instrumental analysis. NRC, *Catalysis Looks to the Future*, p. 5, 25, 29, 48, 53, 64, 66, 70, 71, 74.

[35] Ibid., pp. 5 and 71. Fuel cells (see later section under "Fuel cells") is an application in which catalysis R&D is critical and where some industry observers expressed concerns about U.S. competitiveness relative to Europe, China and Japan.

According to one industry source, a substantial percentage of expenditures by U.S. companies for contract catalysis R&D is now spent overseas whereas staffing in company-funded catalysis has been reduced as a result of increased focus on the bottom line, which has also led to reduced U.S. university enrollment in catalysis-related R&D. In contrast, also according to this observer, Europe and Japan, as well as China and Korea, are aggressively supporting catalytic R&D because it is considered essential to their economic and technological growth. A critical problem, according to this source, is that short-term needs predominate in the United States, whereas in Europe, there is a more coordinated, concerted effort, including a number of consortia often heavily supported by the government, which focuses on key catalyst applications.[36]

The U.S. industry faces several major challenges in the next few years; each is discussed more fully below.

Scarcity of PGMs

Although producers have substantially increased the efficiency of PGM catalysts by a factor of 5 to 10 as compared to 20 years ago,[37] consumption of these metals is nevertheless expected to increase as emission controls are tightened for automobiles and industrial plants, and as new developments stimulate increased use of PGM-containing products such as fuel cells. The projected increase in PGM demand poses a major concern for the catalyst industry because of the metal's relatively high cost and scarcity. Although much effort already has been expended to further increase the efficiency of PGM catalysts, further efforts are underway to find cheaper metal and nonmetal substitutes and to increase the durability of such substitutes (which currently lag behind those of PGMs).[38] Ford Motor Co. and Catalytic Solutions are seeking to replace PGMs, in part, with less-expensive rare earth oxides[39] and ceramic oxides,[40] respectively. Similar efforts are underway to replace PGMs in industrial and chemical plants with less-expensive metals.[41] Another approach has been to develop new ***promoters*** to increase the efficiency of the catalyst.

Environmentally Conscious Manufacturing

Increasingly stringent environmental regulations require catalyst companies to become more aware of the environmental problems associated with catalyst production, including disposal of the depleted catalysts, particularly the metal component. Whereas PGMs have been recycled for years because of their relatively high unit value, other less-valuable metallic components are now being recycled with the assistance of several firms specializing in the recycling of spent catalysts, primarily to meet the increasingly stringent

[36] Interview by USITC staff with an industry official, Mar. 21, 2003. A description of the network of associations and programs that bind catalysis research in the Netherlands reportedly enhancing the competitiveness of R&D in that country, is discussed in Mitch Jacoby, "A Dutch Success Story: Catalysis," *Chemical & Engineering News*, June 3, 2002, pp. 32-45.

[37] Tullo, "Going Platinum," p. 17.

[38] Ibid., Aug. 26, 2002, p. 18.

[39] Renate F. Mas, "Ford's New Catalytic Converter will Utilize Rare Earth Oxides," *American Metal Market*, Apr. 15, 2002, p. 4.

[40] Ivan Lerner, "Upstart Catalytic Solutions Shakes Auto Catalyst Oligarchy," *Chemical Market Reporter*, July 1, 2002, p. 10.

[41] Vadim O. Strots, Grigorii A. Bunimovich, and Yuri Matros, "Base metal for VOC Oxidation," *Pollution Engineering*, July 2002, pp. 14-17.

waste disposal regulations.[42] For example, in 1999, the U.S. Environmental Protection Agency (EPA) added hydroprocessing catalysts to its list of hazardous wastes.[43]

Barriers to Commercialization

The fact that a technology shows promise does not by itself guarantee successful commercialization. For example, despite demonstrated advantages of SSCs, some observers have noted that SSCs penetration of polymer markets has been slower than anticipated. Barriers cited by industry observers include processing problems, concern about patent infringement,[44] and high catalyst costs. Some industry observers expressed concern, moreover, that catalysts developers may be losing some of their ability to exploit new technologies, particularly in the short term. Hence, although new technology development is accelerating, market application development has not always kept pace.[45] The mere fact that a new catalyst shows promising technical properties does not guarantee that the newer catalytic technology will supersede the older technology as rapidly as expected, especially if the traditional technology is recognized as being reliable and well characterized.

Mature Markets

Catalyst producers, like other manufacturers, are subject to business cycles; to shifting supply and demand patterns; and to competitive pressures. As might be expected, not all catalyst industry segments are experiencing rapid growth. Some industry observers have attributed problems experienced by petroleum-refining catalyst producers such as low prices, in part, to the consolidation of the petroleum refining industry, which has increased the leverage of petroleum refiners relative to catalyst producers.[46] One industry source stated that although most catalysts are technically specialty chemicals, poor market conditions caused some catalysts to be bought and sold as if they were commodities.

Future Prospects and Sustainable Technologies

Breakthroughs in catalysis R&D are improving the quality of life and are likely to be even more significant in the foreseeable future. Some of the more promising areas in which catalysis R&D is likely to have an impact are discussed below.

Emissions Control

Increasingly stringent environmental controls are prompting major investment upgrades to petroleum refineries which, in turn, is resulting in increased R&D in catalysis. The upgrades are designed both to reduce the emission of atmospheric pollutants from the petroleum refineries themselves and to reduce the level of emissions when the motor fuels produced in these refineries, e.g., gasoline, undergo combustion in an automobile engine. Examples of the former are more stringent EPA requirements limiting nitrogen oxides and sulfur oxides in industrial plant and refinery emissions and an EPA regulation reducing refinery emissions

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[42] Other solutions have been developed to dispose of the catalytic material, such as, incorporating the catalyst in the final product.

[43] Report Group, Technical Insights, *Advanced Catalysts*, (New York: John Wiley & Sons, 2000), pp. 20-21.

[44] Frederic Alarcon, Patrick Leaney, Peter Maddox, and Brian Turtle; "Innovene™ Metallocene Technology: Unlocking the Future," BP Chemicals, Metcon 2001, Houston, TX, May 17-18, 2001.

[45] Ken Sinclair, "Mattallocenes and Single-Site Catalysts: Global Status & Future Trends," 27th Annual World Petrochemical Review, Mar. 19-21, 2002.

[46] Karen Watkins, "Catalyst Producers Get Cracking," *Chemical & Engineering News*, Oct. 22, 2001, pp. 40-42. Prices have reportedly declined by 10 to 30 percent (after inflation) much of the last decade.

of hazardous air pollutants by 87 percent (11,000 tons per year).[47] Examples of the latter are EPA regulations mandating reduced sulfur content[48] for gasoline and diesel fuels that are to be phased in beginning in 2004 and 2006, respectively. In the EU, proposed legislation will require all refineries to have sulfur-free fuels available by 2008.[49]

In the United States, emission control restrictions are also tightening at the state level. California, which currently accounts for about 10 percent of the U.S. automobile market, has historically been an important influence on automobile emission controls, often imposing more stringent controls than those mandated by the EPA. Many of California's regulations are gradually adopted by the rest of the nation. In 1990, the California Air Resources Board adopted a program requiring that automakers sell zero emission vehicles (ZEVs) with major ZEV marketing efforts beginning no later than 2003.[50] Recently, California was the first state in the nation to pass legislation requiring a reduction in the amount of greenhouse gases emitted from the tailpipes of passenger vehicles.[51]

Overall, global consumption of automobile catalysts is anticipated to grow by about 3 to 4 percent annually compared with a growth rate of about 1 to 2 percent per year for the number of automobiles produced.[52] Worldwide, it is estimated that over 80 percent of new automobiles are fitted with catalytic converters as standard equipment.[53]

Industrial Waste Management and Bioremediation

Currently, most environmental-control catalysts have been developed for emissions control of automobiles and industrial plants and refineries. However, it is likely that catalysts for environmental applications will increasingly focus on industrial waste management and bioremediation, the use of biological processes including biocatalysis to clean up or biodegrade contaminated soil or water.[54]

Researchers at Lehigh University and Georgia Pacific Corp. have developed a new catalytic process based on conventional, i.e., non-ezymatic, chemical techniques that not only cleans up pulp and paper mill waste streams but also recovers valuable chemical products from the waste stream.[55] Also, enzymes from microorganisms have been developed that help degrade polychlorinated biphenyls (PCBs), used in electrical equipment and lubricating fluids, that pose difficult disposal problems.[56] Alternatively, the environment can be protected by replacing materials that do not decompose readily with biodegradeable materials. Genetically

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[47] "Catalysts Enjoy Regulation Growth," *Chemical Week, Associates Custom Publication*, Mar. 13, 2002, p. s3; "Catalysts, Dynamic Technology in Rapidly Changing Industries," *Chemical Week/Today's Refinery*, Sept. 1999, p. s4; and *Octane Week*, p. 1, Apr. 15, 2002.

[48] Sulfur in gasoline acts as a poison for catalytic converters. Consequently, reducing sulfur concentrations in gasoline to very low levels would result in lower tailpipe emissions. Reports Group, Technical Insights, *Advanced Catalysts*, p. 59.

[49] "Catalysts Enjoy Regulation Growth," p. s3.

[50] California Air Resources Board, "Fact Sheet: California's Zero Emission Vehicle Program," found at *http://www.arb.ca.gov*, retrieved Apr. 24, 2003.

[51] William Booth, "California Takes Lead on Auto Emissions," *The Washington Post*, July 22, 2002, pp. A1 and A5.

[52] Tullo, "Going Platinum," p. 17. The unit of measurement for catalyst consumption refers to the ceramic ***substrate*** on which the active catalytic component (the PGM) is deposited.

[53] Johnson Matthey company, "Comparison of Emissions," found at *http://www.matthey.com/environment/cutting pollution/02.html*, retrieved Dec. 3, 2002.

[54] *Catalysis Looks to the Future,* p. 41.

[55] Mitch Jacoby, "Catalytic Cleanup at the Pulp Mill," *Chemical and Engineering News*, Mar. 25, 2002, pp. 39-40.

[56] NRC, *Catalysis Looks to the Future*, pp. 40-42.

engineered microbes have been programmed to produce materials for a variety of plastics that are stable in tap water but biodegrade in soil.[57]

Biomass-based Fuels and Chemicals

Biomass production using advanced technology has already been commercialized but to only a small degree relative to its potential. One of the largest uses of biomass is for producing ethanol. In 2000, there were 58 fuel ethanol plants in the United States producing bioethanol from cornstarch.[58] Moreover, corn residues modified by enzymes have been used for years to produce sweeteners for soft drinks and currently plans are being implemented to use corn residues for production of a plastic.[59] There is widespread recognition of the potential of biomass technology. For example, Dupont Corp. has set a goal of deriving 25 percent of its revenues from renewable raw materials such as carbohydrates by 2010.[60]

Biocatalysis is a critical technology in biomass applications and a key R&D goal is to reduce enzyme production costs so that biomass technology will become competitive with other technologies. Waste ***cellulose*** as a feedstock in the production of fuels and chemicals is the focus of intense R&D because of the enormous amount available and its applications are more limited unlike cornstarch, which has more extensive food and feed uses.[61] Scientists estimate the cost of producing cellulase, the enzyme that breaks down cellulose (a necessary first step to produce fuels and chemicals from cellulose) must be reduced by a factor of about 10 before large-scale production of ethanol from cellulose becomes commercially feasible.[62]

Liquid Fuels from Nonpetroleum Sources

The ***Fischer-Tropsch Synthesis*** (FTS) process enables fuels and chemicals to be produced from non-petroleum sources such as coal, ***natural gas***, and biomass.[63] These energy sources could be used to a greater extent and more efficiently were FTS and related technologies improved.[64] An especially important related technology is ***gas-to liquids*** (GTL) processes, that convert natural gas into useful fuels, such as gasoline. Because the fuels produced through this process are low in impurities, the technology may become a universally accepted means to obtaining clean fuels.[65] FTS remains the principal process to produce fuels and chemicals in South Africa[66] but is of interest in other countries as well. China has claimed that it reduced

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[57] "Bugs as Catalysts," *The Economist Technology Quarterly*, Mar. 15, 2003, p. 28.

[58] Organisation for Economic Co-operation and Development (OECD), *The Application of Biotechnology to Industrial Sustainability*, (Paris: OECD Publications, 2001), p. 23.

[59] David Jones, "DOE Funds Six R&D Projects to Ramp up Biomass Refining,"*McGraw-Hill's Federal Technology Report*, Nov. 14, 2002; and NRC, *Catalysis Looks to the Future*, pp. 14-15.

[60] "New Catalyst Shows Promise for Making Chemicals, Fibers," *McGraw-Hill's Federal Technology Report*, Oct. 18, 2001, p. 10.

[61] OECD, *The Application of Biotechnology to Industrial Sustainability*," p. 23.

[62] Cellulase production costs must be reduced from about 30 to 40 cents per gallon of ethanol produced to less than 5 cents per gallon. Ibid., p. 19.

[63] Typically, steam is passed over a carbon-rich substance such as coal in the presence of a catalyst to form ***synthesis gas*** which is then converted by FTS into fuels and chemicals. FTS may have contributed to prolonging WWII by enabling Germany to meet its fuel needs despite the loss of most of its petroleum supplies.

[64] For example, natural gas in remote sites is frequently flared. This loss could be reduced if a more economical process to convert natural gas to liquid fuels could be developed.

[65] "Catalysts Enjoy Regulation Growth," *Chemical Weeks Associates Custom Publication*, Mar. 13, 2002, p. s3. According to one observer, GTL and related technologies may constitute a key future market even larger than the market for catalysts in fuel cells. "Catalysts: Stepping Toward...," Sept. 13, 2000, *Chemical Week*, pp. 52-55.

[66] Robert J. Farrauto and Calvin Bartholomew, *Fundamentals of Industrial Catalytic Processes*, (London: Blackie Academic & Professional: 1997), p. 341.

the costs of converting coal to finished oil by about 83 percent.[67] Australia, with its large natural gas reserves, is actively pursuing catalytic conversion of natural gas into liquid fuels and chemicals, which may be used to produce diesel fuels for Southeast Asia.[68]

R&D in FTS and related technologies, including GTL, is continuing at a rapid pace and is highly focused on developing suitable catalysts to optimize these process technologies. Advancements will be key to developing process technologies that can help replace declining petroleum reserves with other feedstocks such as coal, natural gas, or biomass.

Advanced Materials

In recent years, solid materials have been discovered that exist in novel geometrical forms with the potential for forming materials with useful properties. Examples include fullerenes (spherical aromatic molecules with hollow structures having very high tensile strengths) and nanotubes (microscopic tubes less than about 100 billionths of a meter in diameter). Were it possible to assemble fullerenes and nanotubes into crystal structures that can be controlled, then advanced materials might be designed with unique properties. These advanced materials could possibly then be used in electronic equipment such as memory devices, solid state optical converters for communication applications, and sensors to detect poisons and/or biological agents.[69] The key role for catalysis in these applications is to enable the synthesis of structures with the desired architecture and at sufficiently high yields for cost-effective manufacture of commercially useful products.

Fuel Cells

Fuel cells directly convert chemical energy into electrical energy, similar to a battery, except that the fuel cell can be operated continually. The major advantages of fuel cells over an internal combustion engine are that they are far more energy efficient (at least by factor of two) and, because the hydrogen fuel cell produces only water as a byproduct, in principle, they emit close to zero levels of pollutants.[70] Although several types of fuel cells are currently being developed, the only practical fuel source is highly purified hydrogen gas which is ***oxidized*** by air in the presence of a PGM catalyst to form water. For automobiles, there are currently two modes of thought as to how the hydrogen gas can be delivered to the automobile engine: either the hydrogen gas would be delivered into the automobile's fuel tank from a central storage facility (equivalent to a gas pump) or, alternatively (and at least in the short term, some scientists think more realistically),[71] each automobile would contain a small-scale reformer that extracts hydrogen from gasoline, methanol or another hydrogen-containing chemical. In either system, chemical energy released from the fuel-cell reaction is converted into electrical energy to drive an electric motor.

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[67] "Coal to Oil, Market Potential is Huge,"*Asiainfo Daily China News*, Nov. 16, 2001, p. 1.

[68] Net Resources International Limited, "Gas to Liquids (GTL) Plant, Australia" found at *http://chemicals-technology.com/projects/gtl/*, retrieved Apr. 22, 2003.

[69] "Nanoelectronics: Carbon-Based FETs Best Silicon," *Chemical & Engineering News*, June 3, 2002, p. 9.

[70] Current technologies for converting organic compounds into a hydrogen-rich gas for use in fuel cells emit significant amounts of carbon dioxide, the principal "greenhouse gas." Were it economically feasible to develop processes that produce hydrogen-rich gases from renewable energy sources, then the full environmental benefit of the fuel cell would be realized.

[71] ExxonMobil, "Fuel Cells in our Future?," *The Washington Post*, Nov. 14, 2001, p. A31.

Fuel cells are beginning to emerge as a commercially feasible possibility, in part because of a 20-fold reduction of the costs of fuel cell catalysts over the past decade.[72] There are at least two major challenges that catalyst developers must meet if the fuel cell is to be successfully commercialized in automobile applications. The first is to sharply scale back the amount of PGM required or, alternatively, find a replacement or partial replacement for the PGM. The second is to modify the catalyst so the hydrogen gas need not be highly purified. Currently, in the presence of contaminants such as carbon monoxide, the catalyst reacts irreversibly and is deactivated.

Fuel cells also have a major potential application for use in residential and office buildings as stand-alone power sources. According to one projection, by 2010, fuel cells will likely be used in 2.5 million homes and in 600,000 automobiles (about 1 percent of automobile production).[73] The possibility that fuel cells research will be successfully commercialized has been enhanced because the U.S. Department of Energy has taken a leading role in developing this technology and, in collaboration with U.S. automakers, is moving toward solving the technical and cost barrier problems necessary to enable the industry to produce affordable fuel-cell vehicles.[74] Recently, President Bush has stated that he will request increased funding for fuel cell R&D and related technologies, such as vehicle technology and distribution issues, to about $1.5 billion over a 5-year period, with $273 earmarked for fiscal year 2004.[75]

Other Catalytic Technologies

Catalytic technologies in the industry sectors examined previously will likely lead to new and useful products and have an important, if as yet unforeseen, impact on materials use. For example, the class of materials known as zeolites are of particular interest to many researchers as a possible source of new and useful catalysts. Many analysts envision that the revolution in polymer synthesis brought about largely by new catalysts will not only continue but also increasingly substitute for metals and glass in construction applications.

Catalysis technology is being revolutionized by advances in many underpinning technologies including analytical techniques (such as instrumental analysis, and theoretical and computer modeling), high throughput screening/combinatorial chemistry, chiral synthesis, and ***nanotechnology***. Hence, the pace of catalysis R&D is anticipated to accelerate despite budgetary and other constraints. Of the various catalytic-related technologies, industry sources are virtually unanimous in their assessment that the biocatalysis field is likely to grow the fastest. Table 4 summarizes key development goals set for biocatalysis for the foreseeable future based on a workshop held in 1996.[76]

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[72] Alex Scott, "Fuel Cells Power toward the Mass Market," *Chemical Week*, Feb. 28, 2001, pp. 41-44. Catalysts are used in many of the processes occurring in a fuel cell and in reformers. Specifically, they are used in a reformer to facilitate the reactions that convert a hydrogen-rich chemical such as gasoline or methanol into hydrogen gas and carbon dioxide.

[73] Ibid.

[74] Spencer Abraham, Secretary of Energy, "Home-Grown Hydrogen," *The Washington Post*, Oct. 5, 2002, p. A19.

[75] Peter Behr and Greg Schneider, "Hydrogen-Powered Vehicles at Least a Decade Away," *The Washington Post*, Jan. 30, 2003, p. A9.

[76] According to an attendee at the workshop, some of the estimates might be different if the workshop was held today.

Table 4
Goals for biocatalyst development

Operational objective	Competitive imperative	Current chemical varieties	Current biocatalysts	Biocatalyst of the future
Faster	Speed to market	2-5 years	10 years	2-3 years
Cheaper	Cost to manufacture	$1-10/kg	$10-100/kg	$1-3/kg
Better	Range of products	Broad	Narrow	Broad

Source: U.S. Department of Commerce, National Institute of Standards and TechnologyAdvanced Technology Program workshop, Oct. 1996, in *New Biocatalysts: Essential Tools for a Sustainable 21st Century Chemical Industry*, Table 2. Information used with permission.

Glossary[77]

Active site: The specific portion of the catalyst where the catalyst acts on the reactants to speed up the rate of a reaction.

Alkane: A hydrocarbon in which the carbon atoms are attached by single bonds only to each other.

Alkene: A hydrocarbon containing two or more adjoining carbon atoms which are connected by a double bond.

Aromatic chemicals: Chemical compounds which contain at least one benzene ring.

Biocatalysis: The process and overall technology in which biological catalysts (e.g. enzymes) are used to achieve a desired goal.

Biomass: Any biological product from which fuels or chemicals are produced.

Catalyst: A substance that changes (usually accelerates) the rate of a chemical reaction but which reverts to its original form after it is activated.

Catalysis: The process and overall technology in which catalysts are used to achieve a desired goal.

Catalytic cracking: The process in which organic molecules derived from crude petroleum are decomposed in the presence of catalysts to eventually produce useful products such as motor fuels and petrochemicals.

Cellulose: The basic constituent of plant tissues such as wood, grass, and cotton and the most common organic material in nature.

Chiral/Chirality: The property in which many organic chemicals exist in both right-handed and left-handed forms (analogous to right- and left-handed gloves) as mirror images of each other. The right and left handed forms of these molecules are referred to as enantiomers. An organic chemical in which the right and left handed forms of the molecule are present in equal amounts is referred to as a racemate.

Chlorofluorocarbons (CFCs): A class of compounds containing carbon, hydrogen, chlorine and fluorine which has been banned in many countries including the United States because they contribute to depletion of stratospheric ozone which protects the earth's surface against harmful ultra-violet UV rays.

Enantiomer: See chirality

Enzyme: A biological catalyst consisting principally of proteins.

Feedstock: A starting material used to manufacture fuels and chemicals.

Fine chemicals: Chemicals which are produced with high purity and in relatively small volumes.

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[77] *Hawley's Condensed Chemical Dictionary*, 12th ed., Van Nostrand Reinhold Co., 1993; Robert J. Farrauto and Calvin Bartholomew, *Fundamentals of Industrial Catalytic Processes* (Blackie Academic & Professional, 1997), pp. 730-742; and other reference sources.

Glossary—*Continued*

Fischer-Tropsch Synthesis (FTS): A technology for producing hydrocarbons, including liquid fuels such as gasoline, from coal, coke, natural gas and other sources.

Fluid cracking catalysts (FCCs): A widely used process employing finely divided catalysts which are maintained in a fluid state to crack or break down crude petroleum molecules into smaller units.

Fuel cell: A device for the direct conversion of chemical energy into electrical energy for use as a source of power.

Gas to liquids (GTL): Processes which convert natural gas to liquid fuels such as gasoline.

Heterogenous catalyst: A catalyst in a different phase than the reactants (e.g., the catalyst is a solid and the reactants are in the liquid or gas phase). In contrast, a homogenous catalyst is in the same phase as the reactants.

High throughput screening/combinatorial chemistry: A technique utilized to speed up the period for new material development of products such as catalysts, thereby reducing development time and costs.

Hydrocarbon: A molecule containing only the elements hydrogen and carbon.

Inorganic chemical: A chemical which consists of elements other than carbon. Also, certain relatively simple carbon-containing molecules, especially oxides of carbon, (e.g, carbon dioxide) which do not exhibit the characteristics typical of most carbon-containing molecules.

Metallocene catalyst: A type of single-site catalyst used in the synthesis of polymers. It consists of a transition metal (e.g., zirconium, titanium, or hafnium) which is in sandwiched between two cyclopentadienyl rings (five-membered rings containing two double bonds).

Nanotechnology: The applied science of developing technologies utilizing structures that are of atomic or molecular dimensions

Natural gas: A mixture of lighter hydrocarbons, principally methane, that is obtained naturally from under the earth's surface.

Octane/octane number: A measurement of the ability of an automotive fuel to resist knocking, a spontaneous oxidation reaction in a gasoline engine that impairs engine efficiency.

Organic chemical: A carbon-containing molecule other than a few relatively simple forms that exhibit inorganic characteristics.

Organo-metallic compound: An organic chemical containing at least one metal atom which is directly attached to a carbon atom.

Oxidize/oxidation: The chemical reaction of a compound with oxygen. Also, any reaction in which a molecule loses electrons.

Petrochemical: A chemical produced from petroleum or natural gas.

Glossary—*Continued*

Petroleum refining: The processes by which crude petroleum is transformed into useful fuels and chemicals.

Platinum group metals (PGMs): A group of closely related precious metals consisting of platinum, palladium, rhodium, iridium, ruthenium, and osmium.

Plastic: A large polymer, often also containing additives, which can be shaped under heat and pressure to the desired dimensional structure.

Poison/poisoned: In catalysis, a substance, such as carbon monoxide that reacts with the active site of a catalyst, thereby destroying or poisoning it, (i.e., destroying or reducing its activity).

Polymer: A relatively large molecule formed by the chemical union of five or more identical components called monomers.

Promoter: A material which is added to a catalyst to enhance its performance.

Racemate: See chirality.

Single-site catalyst (SSC): A type of catalyst in which all the active sites possess the same chemical and physical properties so that the action of the catalyst is relatively specific and uniform.

Specificity: The property in which a catalyst reacts only with one particular chemical grouping to help form the desired product and no other.

Substrate: A solid surface on which a coating is deposited.

Synthesis gas: a gaseous mixture, principally composed of carbon monoxide and hydrogen, produced by reacting a carbon-containing source such as coal, natural gas, biomass, or methane with steam. Synthesis gas is used to synthesize many organic and inorganic chemicals.

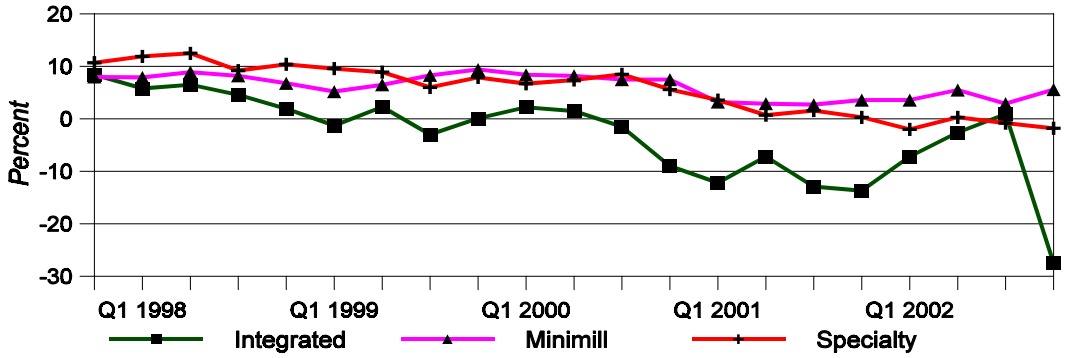
Zeolites: Natural or synthetic hydrated alumino-silicates, also containing either sodium, calcium, or both used in cracking catalysts, water softening, and detergents, adsorbents and dessicants, and in solar collectors.

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

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

STEEL

Figure A–1
Negative returns for integrated producers attributable to non-recurring expenses during fourth quarter 2002



[1] Operating income as a percent of sales. Integrated group contains 5 firms. Minimill group contains 7 firms. Specialty group contains 4 firms.

Note.--Fourth quarter 2002 operating incomes reflect accounting practices implemented in 2002 to comply with the Sarbanes-Oxley Act and revised Securities and Exchange Commission guidelines.

Source: Individual company financial statements.

- Despite bankruptcy court recognition of AK Steel as the lead bidder to acquire the assets of National Steel, US Steel began talks with the United Steelworkers of America (USWA) in an attempt to develop a labor contract covering National Steel's sites and its own sites represented by USWA. See *http://www.ussteel.com* and *http://www.uswa.org*
- The Pension Benefit Guaranty Corporation (PBGC) announced its intention on March 7, 2003 to assume responsibility for the pension plan sponsored by WHX Corporation which covers 9,400 workers and retirees. Since October 1, 2001, the PBGC has booked more than $8 billion in claims from steel companies, including Bethlehem Steel, LTV Steel, National Steel, Acme Metals, CSC Steel, GS Industries, and Empire Specialty Steel. See *http://www.pbgc.gov*
- The board of directors of Bethlehem Steel Corporation voted on March 13, 2003 to sell substantially all of the company's assets to Cleveland-based International Steel Group (ISG). ISG's acquisition of Bethlehem's assets will create the largest integrated steelmaker in North America, with over 16 million tons of annual capacity. See *http://www.bethsteel.com*
- Nucor Corporation purchased the shuttered North Star Steel facility in Kingman, Arizona on March 24, 2003 for $35 million. The Kingman facility, completed in 1996, has an annual melting capacity of 650,000 tons and a rolling capacity of more than 500,000 tons. See *http://www.nucor.com*

Table A–1
Semi-finished imports increase substantially in 2002 compared to 2001, especially during fourth quarter 2002 compared to fourth quarter 2001

Item	Q4 2002	Percentage change, Q4 2002 from Q4 2001	YTD 2002[1]	Percentage change, YTD 2002 from YTD 2001
Producers' shipments *(1,000 short tons)*	24,358	4.6	99,191	-0.3
Finished imports *(1,000 short tons)*	6,418	4.2	23,842	0.9
Ingots, blooms, billets, and slabs *(1,000 short tons)*	2,258	23.7	8,844	37.3
Exports *(1,000 short tons)*	1,581	3.6	6,009	-2.2
Apparent supply, finished *(1,000 short tons)*	29,195	4.6	117,024	0.1
Ratio of finished imports to apparent supply *(percent)*	22.0	[2]-0.1	20.4	[2]0.2

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

Source: American Iron and Steel Institute.

STEEL

Table A–2
Service centers: Shipments decline during fourth quarter 2002 compared to third quarter 2002, consistent with seasonal demand trends

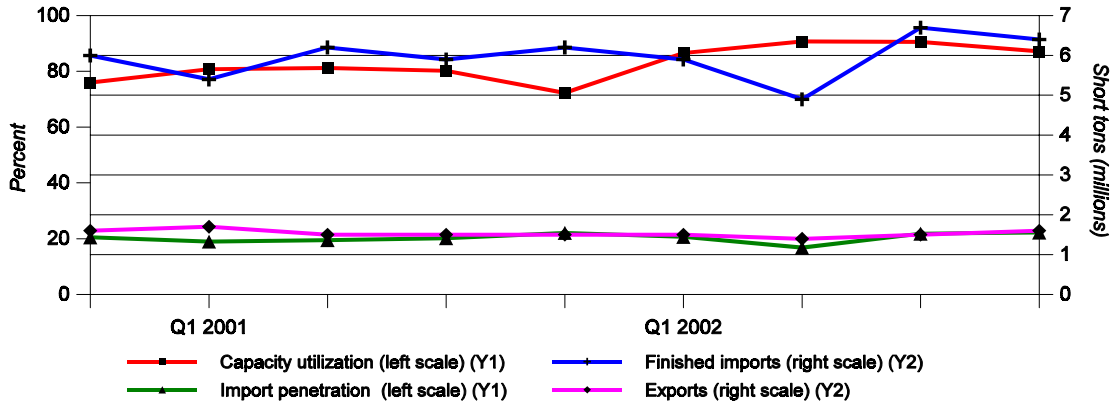
Item	Sept. 2002	Dec. 2002	Percentage change, Dec. 2002 from Sept. 2002	Q4 2001	Q4 2002	Percentage change, Q4 2002 from Q4 2001
Shipments *(1,000 short tons)*	1,995	1,674	-16.1	5,685	5,734	0.9
Ending inventories *(1,000 short tons)* . . .	7,529	7,985	5.7	7,556	7,985	5.4
Inventories on hand *(months)*	3.6	4.3	([1])	4.0	4.3	([1])

[1] Not applicable.

Source: Metals Service Center Institute.

- According to the Metals Service Center Institute, U.S. service center steel shipments reflected a seasonal drop in orders during fourth quarter 2002 compared to third quarter 2002. However, fourth quarter 2002 shipments, and inventories, are slightly higher than fourth quarter 2001 shipments and inventories (table A-2). See *http://www.ssci.org*
- The American Institute for International Steel import market survey (March 2003) reports either no increase or a drop in import orders for the next 3 to 5 months for most steel products, while import orders for pipe and tube remain essentially unchanged. See *http://www.aiis.org*
- The International Iron and Steel Institute (IISI) announced on January 20, 2003 that annual world crude steel production set an all-time record in 2002, with final figures expected to exceed 990 million short tons. Crude steel production increased in all steel-producing regions compared to 2001, with the largest increases in Asia and South America, and the smallest increases in Europe and North America. See *http://www.worldsteel.org*
- Domestic capability utilization dropped below 90 percent for the first time since f irst quarter 2002, while export volume increased slightly (Figure A-2). See *http://www.steel.org*

Figure A–2
Steel mill products, all grades: Capability utilization drops below 90 percent during fourth quarter 2002 but remains well above capability utilization during fourth quarter 2001



Note.--Capability utilization is the raw steel tonnage produced divided by the tonnage capability to produce new steel for a sustained full order book. If an individual production unit is not available due to a scheduled outage, it is not included in the tonnage capability.

Source: American Iron and Steel Institute.

AUTOMOBILES

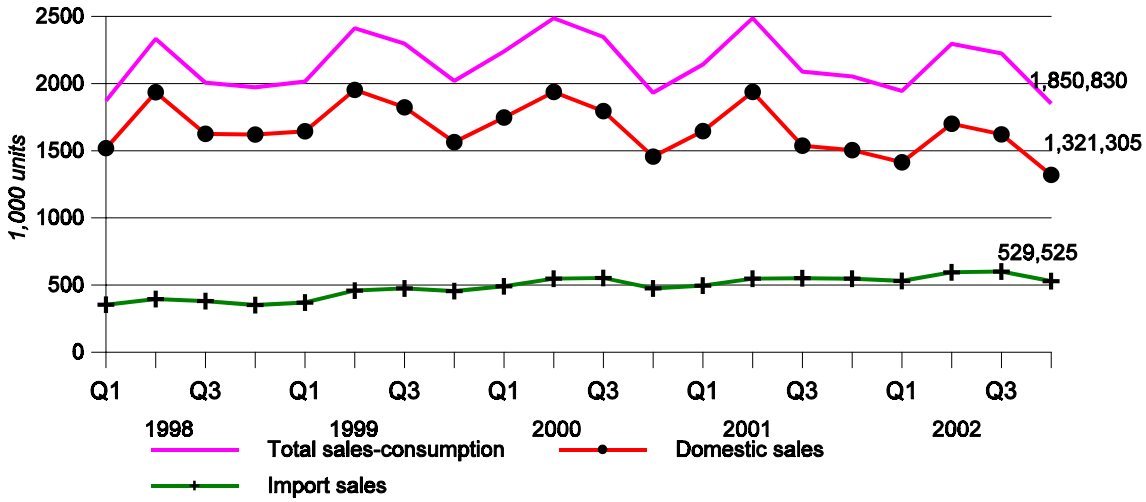
Table A–3
U.S. sales of new automobiles, domestic and imported, and share of U.S. market accounted for by sales of total imports and Japanese imports, by specified periods, January 2001-December 2002

Item	Oct.-Dec. 2002	Jan.-Dec. 2002	Percentage change: Oct.-Dec. 2002 from July-Sept. 2002	Percentage change: Jan.-Dec. 2002 from Jan.-Dec. 2001
U.S. sales of domestic autos (*1,000 units*)[1]	1,321	6,059	-18.6	–6.6
U.S. sales of imported autos (*1,000 units*)[2]	530	2,257	-12.0	4.4
Total U.S. sales (*1,000 units*)[1, 2]	1,851	8,316	-16.8	-3.9
Ratio of U.S. sales of imported autos to total U.S. sales (*percent*)[1, 2]	28.6	27.1	5.8	8.6
U.S. sales of Japanese imports as a share of the total U.S. market (*percent*)[1, 2]	13.7	12.0	11.3	13.3

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

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

Figure A–3
U.S. sales of new passenger automobiles decreased in fourth quarter 2002, capping a year in which domestic autos lost market share to imports

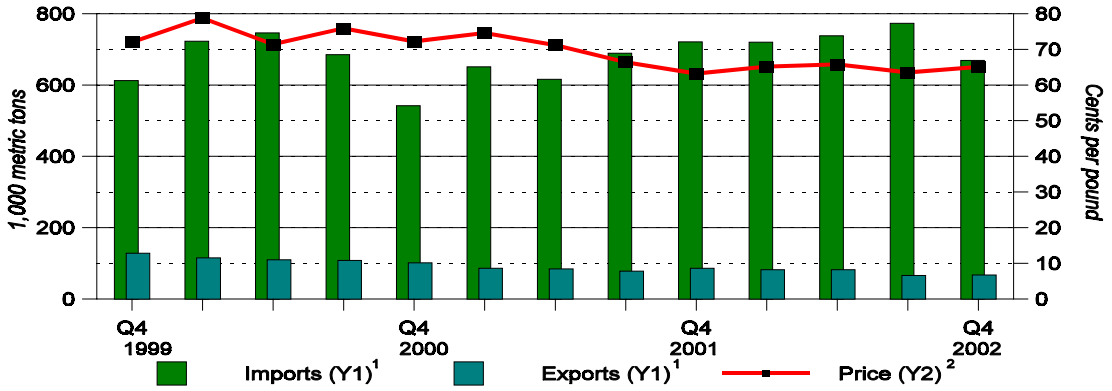


Note.–Domestic automobile sales include U.S.-, Canadian-, and Mexican-built automobiles sold in the United States; these same units are not included in import sales.

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

UNWROUGHT ALUMINUM[1]

Figure A–4
Supply constraints and an anticipated decrease in U.S. primary aluminum production led to price increase in the 4th quarter of 2002



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

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

- Uncertainty over power costs in the Pacific Northwest is continuing to cause restructuring in the U.S. aluminum industry. Spot power prices have doubled in the past three months and Bonneville Power Administration announced that they will raise contract electricity rates charged to the aluminum smelters by 15 percent in October 2003. As a result, Goldendale Aluminum announced they will close two potlines, Alcoa plans to delay restarts of a potline at its Ferndale facility, and Kaiser has decided to sell its Tacoma smelter, affecting about 200,000 metric tons of capacity. These developments are expected to decrease U.S. production in 2003.
- Prices for unwrought aluminum rebounded by almost 2 cents a pound because of a strike in Venezuela which caused delayed shipments of aluminum to the United States, freezing temperatures in Russia that prevented ships loaded with aluminum from leaving the port in St. Petersburg, and developments which may impact the U.S. market in 2003.

Table A–4
Import penetration dropped 3.5 percentage points in the 4th quarter as marginally increased U.S. primary production and declining consumption slowed U.S. imports

				Percentage change	
Item	Q4 2001	Q3 2002	Q4 2002	Q4 2002 from Q4 2001	Q4 2002 from Q3 2002
Primary production (*1,000 metric tons*)	627	702	708	12.9	-0.9
Secondary recovery (*1,000 metric tons*)	769r	759r	743	3.4	-2.1
Imports (*1,000 metric tons*)	721	773	669	-7.2	-13.5
Import penetration (*percent*)	35.5	36.1	32.6	[1]2.9	[1]-3.5
Exports (*1,000 metric tons*)	86	66	67	-22.1	1.5
Average nominal price (*cents/lb*)	63.2	63.5	65.1	3.0	2.6
LME inventory level (*1,000 metric tons*)	821	1,290	1,243	51.4	-3.6

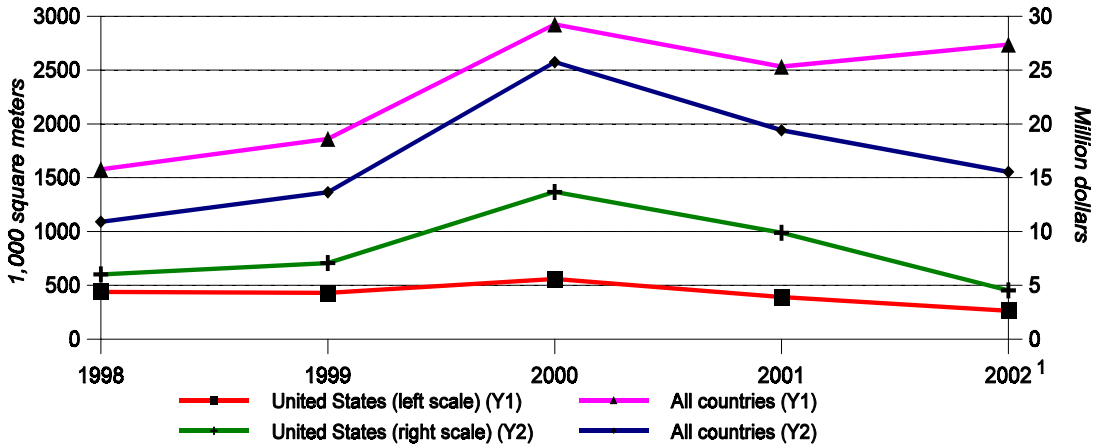
[1] Percentage point change
Note.–Revised data indicated by "r."

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

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

FLAT GLASS

Figure A–5
Japanese monthly average imports gain during 2002



[1] Data for full-year 2002 (Latest available data).

Source: Compiled from "World Trade Atlas: Japan" at *http://www.globaltradeatlas.com* on Mar. 20, 2003 which uses official statistics provided by the Government of Japan.

Background

- Although the U.S.-Japanese agreement which sought to increase access and sales of foreign flat glass in Japan expired on December 31, 1999,[1] the U.S. Government continues to urge the Japanese Government to take steps to promote access and competition in it's glass market and continues to work with U.S. industry to achieve these goals.[2]

Current

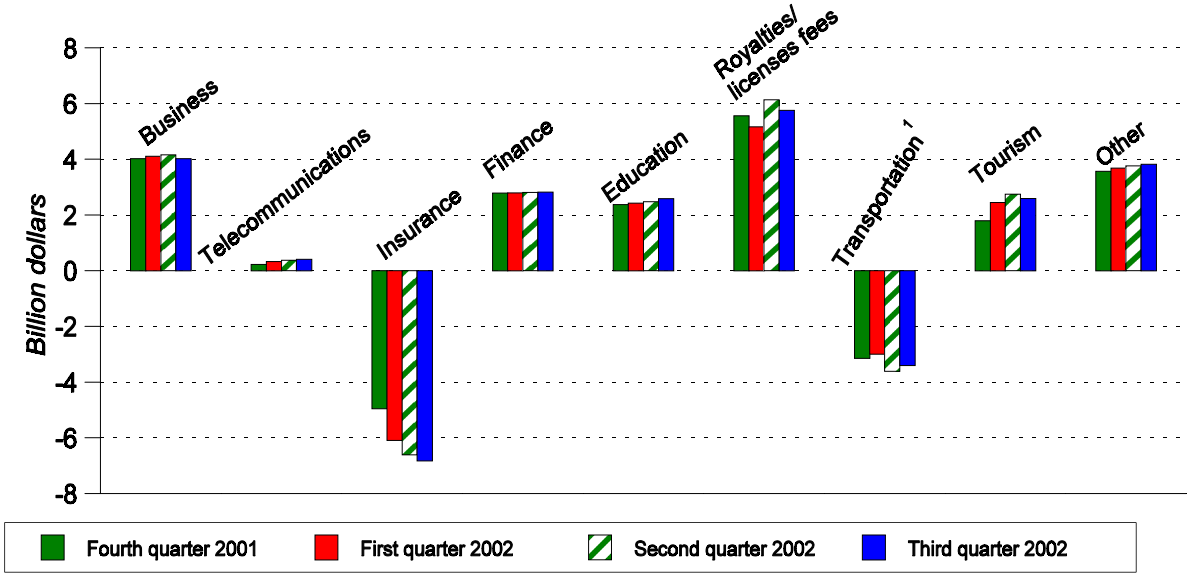
- Increased Japanese demand for imported flat glass raised the average monthly quantity of Japanese imports from all countries by 8 percent for the entire year of 2002 to 2.7 million square meters compared with the same period of 2001, while the average monthly value of such imports decreased by 20 percent to $15.5 million. However, imports from the United States decreased by quantity and value (down 32 percent to 265,000 square meters and 54 percent to $4.5 million, respectively), and imports from the United States lost market share to imports from Thailand and China during this period.

[1] Office of the U.S. Trade Representative (USTR), *The President's 1999 Annual Report on the Trade Agreements Program*, p. 227, downloaded from *http://www.ustr.gov/reports/tpa/2000/index.html* on Mar. 3, 2000.

[2] U.S. Department of State cable, *2003 National Trade Estimate Report - Japan*, message reference no. 8640, prepared by U.S. embassy, Tokyo, Dec. 16, 2002.

SERVICES

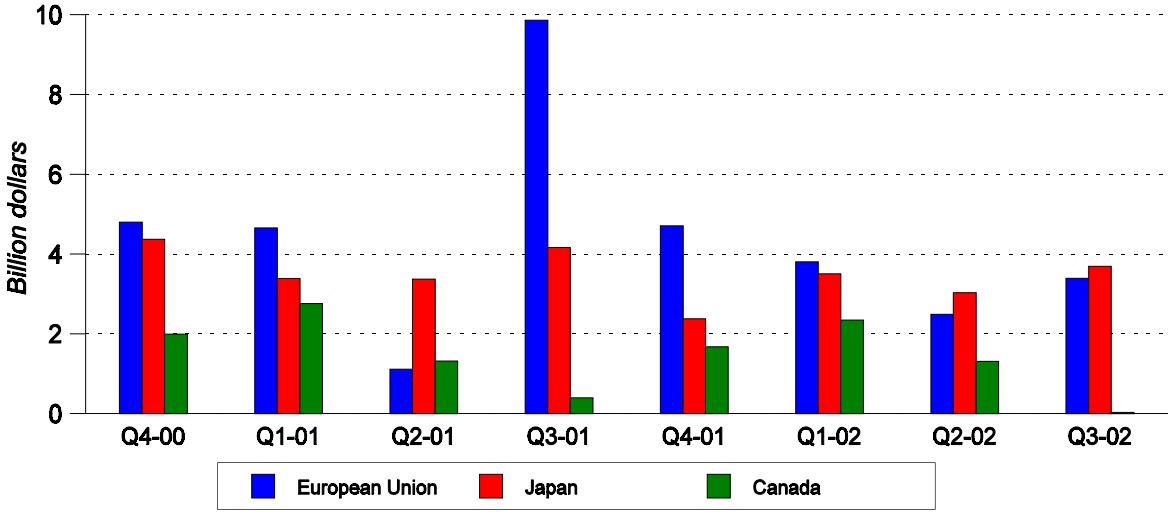
Figure A–6
Balance on U.S. service trade accounts, by quarters, 2001-2002



[1] Includes port fees.

Source: Bureau of Economic Analysis, *Survey of Current Business*, Jan. 2003, p. 35.

Figure A–7
Surpluses on cross-border U.S. services transactions with selected trading partners, by quarter, 2000-2002[1]



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

Source: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, Jan. 2003, pp. 42-45; Oct. 2002, pp. 60-63; July 2002, pp. 78-81; Apr. 2002, pp. 68-71; and Jan. 2002, pp. 52-57.

NORTH AMERICAN TRADE HIGHLIGHTS

U.S. trade with its North American partners is highlighted in table A-5. The following is a summary of key developments during 2002.

- Reduced manufacturing output in the United States and lower prices in the energy sector in 2002 contributed to a 1.6 percent ($9.2 billion) decrease in U.S. trade with its NAFTA partners ($573 billion) in 2002 compared with 2001. A significant share of U.S. trade with Canada and Mexico involves U.S. exports of components and machinery and imports of finished goods.[1] U.S. manufacturing output declined by 1.1 percent ($42 billion) in 2002,[2] reducing demand by U.S. producers for goods assembled by subsidiaries or contractors in Canada and Mexico.

- The U.S. merchandise trade deficit with Canada ($68 billion) decreased by $4.2 billion during 2002, whereas the deficit with Mexico ($48 billion) increased by $8.1 billion. A large decline in U.S. energy sector imports (e.g., natural gas) was the largest single-product contributor to the reduced merchandise trade deficit with Canada. Additionally, the rapid rise of the Canadian dollar relative to the U.S. dollar increased the cost of assembly in Canada and was instrumental in the reduction of two-way trade with the United States.

- The increase in the U.S. trade deficit with Mexico was due in part to a large rise in U.S. imports of crude petroleum. This expansion occurred despite declining world prices in 2002 as Mexico's share of total imports rose during a period of volatility in the supply of petroleum from Venezuela and Nigeria.

- Mexico's economy grew by 0.9 percent in 2002,[3] despite continued weak demand for its exports to the U.S. market which accounts for nearly 89 percent of Mexico's total exports. Although the Government of Mexico anticipates economic growth to be 3 percent for full-year 2003, the pace of economic recovery in the United States and the anticipated increase in supply of petroleum from Iraq may hamper Mexico's near-term growth. Mexico is heavily dependent on revenues from the export of crude petroleum to finance social and infrastructure investments. A sustained downturn in the worldwide price of oil in 2003 may push Mexican economic growth below the projected 3 percent.

    - U.S. exports to Mexico fell 5 percent ($4.5 billion) to $86.1 billion in 2002, reflecting lower demand in both the Mexican and U.S. markets for products of assembly operations, including intermediate U.S. goods used by Mexican assembly plants. Leading the decline were telephone and telegraph apparatus, television broadcasting equipment, semiconductors and integrated circuits, motor vehicle parts, and apparel. U.S. merchandise trade with Mexico is affected by manufacturing integration and is tied closely to the performance of the U.S. manufacturing sector.[4]

    - U.S. imports from Mexico increased 3 percent ($3.6 billion) to $134 billion in 2002. Crude petroleum, the leading product imported from Mexico, increased by 32 percent to $10.5 billion in 2002. Other leading industry sectors showing increased growth in imports were seats, wiring harnesses, and other parts for motor-vehicles which together contributed to a $1.7 billion (16 percent) rise in U.S. imports in 2002. U.S. vehicle buyers took advantage of low interest rates and deep-discounts offered by automobile manufacturers throughout most of 2002.

    - Foreign direct investment (FDI) in Mexico totaled $13.6 billion during 2002. Approximately $6.6 billion of the total FDI was from new investments. The manufacturing sector accounted for the largest share of FDI in Mexico during 2002 (42 percent of the total). Other industry sectors accounting for substantial increases in FDI were financial services (30 percent of the total) and the commercial sector (nearly 12 percent). The United States and Canada together accounted for 73 percent of total FDI in Mexico during 2002; the EU followed with about 18 percent, and East Asian countries accounted for 5 percent of the total.

[1] The linkage betweeen industrial production in the United States and Mexico's exports is discussed in Fernando Clavijo, "Wither Mexico," *Poder,* Mar. 2003, p. 18.

[2] U.S. Census Bureau, "Manufacturers' Shipments, Inventories, and Orders: February 2003," Current Industrial Reports, Apr. 2003.

[3] Lisa Anderson, "Mexico GDP-First Take," found at http://www.dismalscientist.com/economy/release/gdp/htm, retrieved Mar. 17, 2003, p. 1.

[4] For added background on developments regarding production-sharing operations, see recent July issues of *Industry Trade and Technology Review* posted on USITC Internet server at *www.usitc.gov* ("Publications").

NORTH AMERICAN TRADE

Table A-5
North American trade, 1997-2002

Item	1997	1998	1999	2000	2001	2002	Percent change 2001/02
	Value *(million dollars)*						
U.S.-Mexico trade:							
Total imports from Mexico	85,005	93,017	109,018	134,734	130,509	134,121	3
U.S. imports under NAFTA:							
Total value	62,837	68,326	71,317	83,995	81,162	84,747	4
Percent of total imports	74	73	65	62	62	63	[1]1
Total exports to Mexico	68,393	75,369	81,381	100,442	90,537	86,076	-5
U.S. merchandise trade balance with Mexico[2]	-16,612	-17,648	-27,637	-34,292	-39,971	-48,045	-20
U.S. -Canada trade:							
Total imports from Canada	167,881	174,685	198,242	229,060	216,836	210,518	-3
U.S. imports under NAFTA:							
Total value	88,949	111,675	115,715	123,052	113,179	115,807	2
Percent of total imports	53	64	58	54	52	55	[1]3
Total exports to Canada	134,794	137,768	145,731	155,601	144,621	142,543	-1
U.S. merchandise trade balance with Canada[3]	-33,087	-36,918	-52,511	-73,459	-72,215	-67,975	6

[1]Percentage point change.
[2] The negative (-) symbol indicates a loss or trade deficit. The $40.0-billion deficit in U.S. merchandise trade with Mexico in 2001 was partially offset by a $3.4-billion U.S. surplus in bilateral services trade.
[3] The $72.2-billion deficit in U.S. merchandise trade with Canada in 2001 was partially offset by a $6.0-billion U.S. surplus in bilateral services trade.

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

- Canadian GDP grew 3.4 percent in 2002.[5] Canada remained the largest market for U.S. exports and the principal source of U.S. imports in 2002. Bilateral trade with Canada is strongly influenced by the highly integrated nature of North American manufacturing, facilitated by shared infrastructure and markets, and high levels of foreign direct investment.
    - U.S. exports to Canada declined 1 percent ($2.1 billion) to $142.5 billion, led principally by significant decreases in optical fibers, printed circuits, printing and writing papers, ships and boats, and rail locomotives and rolling stock. A reported weakening in Canadian investment, particularly in the machinery and equipment sector, and existing high inventories in Canada contributed to the decline in U.S. exports.
    - U.S. imports from Canada dropped by 3 percent ($6.3 billion) to $211 billion, reflecting decreases in the value of imports of electrical energy, natural gas, aircraft, newsprint, wood pulp, lumber, and unwrought aluminum. Weak business and consumer spending dampened U.S. demand.
- Canada exported auto parts to Mexico valued at $410 million in 2002, nearly a four-fold increase since 1994. Canadian and U.S. auto-parts suppliers anticipate increasing their exports to Mexico when Mexico phases out its local content requirement for vehicles assembled in Mexico beginning January 1, 2004, as agreed to in NAFTA. Until recently, Mexico's auto decree had required that all vehicles assembled in Mexico contain 29 percent Mexican-made parts.[6]

[5] Michael Burt, "Canada GDP-First Take," found at http://www.dismalscientist.com/economy/releases/gdp/htm, retrieved Mar. 17, 2003, p. 2.
[6] Marlene Habib, "Mexico Tapped As Growing Auto Market," *Toronto Star*, Mar. 27, 2003.