

Challenges and Opportunities for the Chemicals Industry in Argentina

CLAUDIO DELPINO
M. SOLEDAD DIAZ

PLANTA PILOTO DE INGENIERÍA QUÍMICA,
UNIVERSIDAD NACIONAL DEL SUR

Boosted by domestic and international companies, Argentina's chemicals industry continues to grow as demand for its products increases — even in the face of challenges posed by feedstock availability and the need for increased investment.

With revenues of US\$30.2 billion in 2012 (1), Argentina's chemicals industry was responsible for 12% of the country's total manufacturing revenues, making it a major contributor to the nation's gross domestic product (GDP). From 2000 to 2011, Argentina's GDP grew an average of 9% per year (2), and the country's chemicals industry revenue grew 10.5% per year.

This recent growth has placed increasing demands on the chemicals sector, and has exposed challenges related to the need for increased investment and the availability of raw materials. Such factors contributed to a slowing of the industry's growth to only 3.7% in 2012. That year, the Argentinian chemicals industry's trade deficit rose to \$5.1 billion, in spite of strict constraints imposed on imports.

This article presents an overview of Argentina's chemicals industry and its main products, and describes the industry's current challenges and opportunities, including those related to shale gas and shale oil resources.

The industry's origins

In the early 20th century, two World Wars and associated restrictions on imports of essential products encouraged the growth of Argentina's domestic chemicals industry. However, its roots were established in 1888 when

Palma & Bros., an acids producer in Zárate, Buenos Aires province, started to produce dynamite at the nation's first chemical complex. In 1891, another Buenos Aires company — eventually purchased by Refinerías de Maíz — began making ethanol from corn and later expanded its product line to include other corn derivatives.

It is important to note that by the turn of the 20th century, Argentina had already developed a thriving agricultural sector. Hundreds of agricultural colonies were producing staples such as wheat, corn, flax, and barley, in addition to wool, leather, and beef. By 1910, Argentina was the world's third-largest exporter of wheat.

The processing of imported oil began in 1906, by the Oil National Co. at a facility near Buenos Aires. In 1914, Argentina's first state-controlled oil refinery began processing domestic crude oil, which had recently been discovered in the Patagonian region at the southern end of South America.

That same year, France's Air Liquide — one of the first international chemical firms to operate in Argentina — opened its La Oxígena plant for the production of oxygen and other industrial gases.

The next two decades saw the construction of plants for such chemicals as coagulants, pesticides, pharmaceuticals, and sulfuric acid, as well as paper mills. Major milestones came in 1922, when Argentina's state oil company — Yacimientos Petrolíferos Fiscales (YPF) — was established,

Note: All monetary quantities are in U.S. dollars.

Global Outlook

and in 1925, when it inaugurated its first oil refinery, in Ensenada, a suburb of Buenos Aires.

Argentina's diverse and growing economy made the country an attractive destination for immigration and investment, and this era saw the arrival of numerous international chemical companies. In 1932, French chemical manufacturer Rhône-Poulenc established a plant in Buenos Aires under the name Rhodia Argentina, which began production of rayon acetate and other artificial fibers in 1935. Other chemical companies with overseas roots — including Imperial Chemical Industries (ICI), DuPont, and Bunge & Born — were also developing their interests in Argentina at this time.

The 1930s were characterized by the startup of new plants for the production of artificial fibers, cellophane, pharmaceuticals, basic inorganic and organic chemicals, paints, and pigments. In 1939, Atanor, a domestic chemical company that remains one of Argentina's most prominent, opened an industrial complex near Buenos Aires for the production of peroxide, acetic acid, and acetates.

Toward a stronger domestic chemicals industry

Argentina's petrochemicals industry was launched during World War II, with the establishment of two pioneering Latin American operations. In 1942, Argentina's Ministry of Defense and its General Directorate of Military Industries (DGM) opened the first petrochemical plant in Argentina, which produced toluene for use in trinitrotoluene (TNT). In 1944, YPF began to produce isopropyl alcohol from propylene at a 1,200-ton/yr plant. Both of the DGM and YPF plants used domestic feedstocks and were operated by a workforce of domestic engineers as well as engineers who had emigrated to Argentina from Europe during the war.

At the end of World War II, Argentina adopted what it called a policy of substitution that was aimed at reducing imports and substituting domestic products in order to strengthen domestic industries. This policy was characterized by tax reductions and customs exemptions for suppliers in domestic industries that were considered vital to the national interest, as well as higher tariffs on imported products.

As a result, the period from 1944 to 1957 saw growth in new domestic industries associated with foods and beverages, paper, and furniture — industries important to the government's socio-economic vision — as well as in chemical industry segments that used non-petrochemical feedstocks. Meanwhile, industries such as iron, steel, and petrochemicals stagnated. The lack of capital investment in those sectors further hampered Argentina's post-World War II petrochemicals industry as its equipment and infrastructure began to fall into disrepair.

Still, several chemical plants were built after the war to satisfy the modest domestic market of 16 million people. New plants of this era produced ammonia, nitric and sulfuric acids,

ammonium sulfate, and ammonium nitrate (Grupo Químico Río Tercero); methanol from syngas obtained from wood combustion (Atanor); resins (Atanor; Monsanto); and basic inorganic and organic chemicals, as well as herbicides and pharmaceuticals (by a variety of producers). In 1956, Argentina's first thermoplastic polymer production plant opened.

The rise of the petrochemicals industry

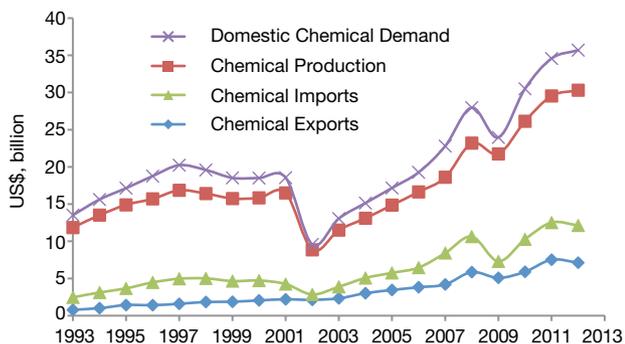
Between 1958 and 1969, Argentina's government placed renewed emphasis on the development of its domestic hydrocarbon and oil resources as well as the promotion of basic industries. Because the investment in industry by domestic companies was no longer sufficient to support the industrial development that the government was planning, two 1958 laws encouraged foreign capital investment in Argentina by providing international companies with the same tax incentives that domestic companies received. A 1961 decree stimulated investment in the petrochemicals industry, which was considered to be in the national interest.

One of the government's key goals was to neutralize the country's trade imbalance, as oil had become Argentina's main import. Supported by both YPF and contracts with international companies, Argentina tripled its oil production, from 5.7 million m³ in 1958 to 15.6 million m³ in 1962 (3). This made it possible to satisfy the nation's entire domestic demand for oil, both as fuel and feedstock for the chemicals industry.

The ascent of the petrochemicals industry generated an estimated \$300 million in new petrochemicals industry investment from 1958 to 1969. Domestic and international companies alike built new plants for basic and intermediate chemicals. This period also saw the construction of three integrated petrochemical complexes: Duperial (ICI) and Petroquímica Argentina SA (PASA, a consortium of Conoco, Cities Service, Uniroyal, WITCO, and Fish Engineering), both located in San Lorenzo, Puerto General San Martín, and Industrias Petroquímicas Koppers (Ipako) in Ensenada. Meanwhile, Dow Chemical, Ipako, Hydrocarbon Research, and PASA were drawing up plans for new ethylene plants, paving the way for the major petrochemical complex that opened in Bahía Blanca in 1981.

The 1970s saw the creation of two new petrochemical companies: the state-owned Petroquímica General Mosconi (PGM), and Petroquímica Bahía Blanca (PBB), which was mostly state-owned. These new firms aimed to boost Argentina's production of basic petrochemicals and to motivate the creation of petrochemical complexes that could compete with those in Europe and the U.S.

To support this development, a law was promulgated in 1973 to regulate foreign investment and introduce tax breaks and other incentives for the petrochemicals industry. In addition to fostering industrial growth, the new regula-



▲ **Figure 1.** From 1993 to 2012, Argentina's chemicals industry saw a tapering off of growth, as well as a shortfall in production versus demand. Source: (1).

tion sought to establish the minimum plant capacities of key products such as ethylene, high- and low-density polyethylene, ammonia, and urea to be produced by the companies. Another objective was to keep the production of basic and intermediate petrochemical products in the new plants under state control. For example, the production of ethylene was reserved for wholly state-owned firms. Even though this constraint was later lifted, it served to delay the launch of several projects — including the PBB complex — and discouraged private investment.

PGM, launched in 1974 and located in Ensenada, was owned by the state companies YPF and DGF, and was dedicated to aromatics and derivatives production using naphtha provided by YPF. PBB started operations in 1981, with its ethane raw materials feedstock provided by a cryogenic natural gas processing plant owned by Gas del Estado, another state-owned company. Meanwhile, Polisor opened two polyethylene plants that used ethylene feedstock provided by PBB. Resident companies at the PBB complex soon added plants for vinyl chloride monomer (VCM), polyvinyl chloride (PVC), and high-density polyethylene. New plants for polystyrene and polypropylene started up in the 1980s.

The petrochemicals industry moves toward privatization

The domestic hyperinflation of 1989 and the depression of international petrochemical prices in 1993 affected Argentina's petrochemical companies, which lost competitiveness in the international market and had to reduce their domestic prices while their debts were increasing (3). This situation paved the way for a reconversion process that included plant shutdowns, company mergers, and privatization.

At the beginning of the 1990s, two new laws aimed to deregulate Argentina's economy and encourage privatization of state-owned companies. In 1999, YPF — the state gas and oil company — was sold to Repsol, and established

overseas investors (such as Petrobras, Dow, Akzo Nobel, and Solvay) bought most of Argentina's refineries and petrochemical facilities. Soon, Argentina became the only Latin American country in which the state had divested itself of the petrochemicals industry.

In 1995, a consortium of Dow Chemical, Itochu, and YPF acquired the state-owned part of PBB, as well as three nearby polyethylene plants. This major complex was renamed PBB-Polisor. Within the same complex, Solvay bought 51% shares of the VCM and PVC plants, and called its new group Solvay Indupa.

In 1997, Dow, Repsol-YPF, and Petrobras created Compañía MEGA to process natural gas and provide ethane as raw material for the PBB-Polisor complex. By 2000, new plants were being built for glyphosate (Atanor; Monsanto), polypropylene (Petroken, now Basell Polyolefins), and methanol (YPF). Another new company, Profertil, became a major supplier of ammonia and urea. Toward the end of the decade, Petrobras built a new plant for ammonia thiosulfate and extended its capacity for styrene and aromatics.

The chemicals industry today

Today, Argentina's chemicals industry employs more than 100,000 people, around 8% of Argentina's industrial workforce (4). In 2012, Argentina's chemicals and petrochemicals industries generated revenues of \$30.2 billion. Total exports by the chemicals industry were \$7.12 billion, while total imports were \$12.14 billion (1). Figure 1 compares the values of domestic demand, production, imports, and exports for the period 1993–2012.

While the relatively steady increase in Argentina's chemical production is apparent, the country also has an increasing trade deficit (\$5.02 billion in 2012), despite regulations that have been imposed on imports during the past two years. In 2012, the growth of Argentina's chemicals industry slowed to only 3.7%, mainly due to the lack of policies to encourage investment, as well as limited supplies of petroleum and natural gas.

Table 1 shows the evolution of the different segments of the chemicals industry from 2000 to 2012. Overall, these

Table 1. Distribution of revenues in different segments of Argentina's chemicals industry, 2000–2012.				
Segment	Revenue, US\$ billion			Growth
	2000	2006	2012	
Basic Chemicals	4.1	6.4	8.0	95.1%
Agrochemicals and Fertilizers	2.1	2.6	3.9	85.7%
Consumer Products	10.2	7.6	18.3	79.4%
	16.4	16.6	30.2	



▲ **Figure 2.** The geographic distribution of some of the Argentinian chemicals industry's key regions and chemical-complex locations.

segments nearly doubled in the past ten years despite the economic crises of 2001 and 2009 (1).

The map in Figure 2 shows the locations of key petrochemical complexes in Argentina. Here are a few of the major locations:

- The Bahía Blanca complex, owned by Dow Chemical and Solvay, is located on the Atlantic coast southwest of Buenos Aires, and draws most of its liquefied natural gas (LNG) raw materials from the YPF plant in the Loma La Lata (Neuquén) gas field, about 600 km away. Petrobras operates a refinery at the Bahía Blanca complex, and Profer-til (a joint venture of YPF and Agrium) operates one of the

world's largest urea and ammonia production plants.

- Ensenada, an Atlantic port city south of Buenos Aires, is the site of Argentina's second-largest petrochemical complex. A YPF oil refinery, the country's largest, supplies naphtha that is converted to aromatics. The complex (formerly PGM, now owned by YPF) was expanded in the early 1990s to include the production of oxo alcohols, butene, methanol, and methyl *tert*-butyl ether, in addition to aromatics, liquefied petroleum gas (LPG), propellants, and polypropylene.

- Another petrochemical site in the Buenos Aires province is located near Campana. At that location, Cabot produces carbon black, Dow produces plastics and derivatives, Viridian (the domestic branch of Eastman Chemical) produces polyethylene terephthalate (PET), Petrobras produces polystyrene, and Bunge Argentina produces ammonia and urea.

- The San Lorenzo site, located in Puerto General San Martín, Santa Fe province, includes a Petrobras-owned complex (formerly PASA), and is grouped around naphtha reforming plants and a small propane cracker. The site produces benzene, toluene, and xylenes (BTX), as well as ethylene, ethylbenzene, styrene, styrene-butadiene rubber, and nitrile butadiene rubber. Also at this site, ICI Argentina (now Akzo Nobel) produces carbon sulfate and sulfuric acid, Dow produces polyols and their derivatives, and BASF operates a polystyrene plant.

- Atanor has several plants in the Buenos Aires province that produce a variety of chemical intermediates and resins. Atanor also produces ethanol from sugarcane at plants in the northwestern provinces of Salta, Jujuy, and Tucumán, as well as glyphosate — an herbicide that has become vital to the production of soy, a major Argentinian agricultural export.

- Plants in other regions include methanol production at a YPF refinery in Plaza Huincul, polypropylene and derivatives production at a Cuyo Petrochemical facility in Mendoza province, and a toluene diisocyanate plant at Río Tercero in the Córdoba province.

Table 2 lists some of the largest chemical and petrochemical companies and their installed capacities in 2012 (5).

Current trends and trade policies

Argentina has always been a net agricultural commodities exporter. By the 1990s, the use of genetically modified seed had a significant impact on agricultural production, as well as the country's economy. Whereas in the 1890s agricultural production was about 1 million ton/yr, most of that wheat, it is currently around 100 million ton/yr, mostly soybeans.

A strong biotechnology industry has arisen from this agricultural model. The growth in biotechnology has stimulated Argentina's pharmaceuticals industry, represented by more than 200 companies, 60% of which are domestic.

The sector's growth has been spurred by biomedical

Table 2. Some of Argentina's largest chemical companies and key products (5).

Company (Location)	Products	Capacity, ton/yr
Bunge (Campana)	Ammonia	135,000
	Ammonia thiosulfate	140,000
	Urea	212,500
	Urea ammonium nitrate	547,500
DAK Americas (Campana)	Polyethylene terephthalate	185,000
PBB Polisor (Dow) (Bahía Blanca)	Ethylene	700,000
	High-density polyethylene	560,000
	Linear low-density polyethylene	440,000
	Low-density polyethylene	90,000
Petrobras (Puerto General San Martín)	Benzene	150,000
	Ethylbenzene	180,000
	Ethylene	52,000
	Heavy aromatic solvents	150,000
	Styrene	160,000
Petroken (Ensenada)	Polypropylene	190,000
Petroquímica Cuyo (Luján de Cuyo)	Polypropylene	130,000
Profertil (Bahía Blanca)	Ammonia	750,000
	Urea	1,100,000
Solvay Indupa (Bahía Blanca)	Chlorine	163,000
	Dichloroethylene	266,000
	Polyvinyl chloride	230,000
	Sodium hydroxide	194,000
	Vinyl chloride monomer	231,000
YPF (Ensenada)	Benzene	120,000
	Cyclohexane	95,000
	Metyl <i>tert</i> -butyl ether	60,000
	Toluene	175,000
	Xylenes	155,000
YPF (Plaza Huincul)	Methanol	400,000

research and development, a strong tradition of public education and science training, and an open market for generic and branded generic products that encourages participation by small companies.

In 2012, Argentina's Ministry of Industry presented its Strategic Industrial Plan 2020. The plan covers 11 value chains considered vital to the national interest, including chemicals, petrochemicals, and medicines. It also focuses on reigning in the growing trade imbalance by supporting domestic industries. One obstacle to this proposed industrial growth is a limited supply of domestic petrochemical feedstocks. Moreover, recent restrictions on imports have impacted companies that rely on imported raw materials.

Policies that cap domestic gas and oil prices have led

to a decline in exploration for new gas and oil wells, with a tailing off of production as demand continues to increase (Figure 3). Various regulations imposed on natural gas prices have kept its average domestic value between \$1.00 and \$1.50 per million Btu during the past 15 years. Similar policies have been applied to electricity prices.

With the energy sector's growing demand for natural gas surpassing the nation's production of hydrocarbons, Argentina has been forced to import LNG. Such energy imports, which were estimated to total \$13 billion in 2013, not only accelerate the nation's trade deficit but have also forced the slowdown or shutdown of several petrochemical plants during the winter, when natural gas is most needed by household consumers.

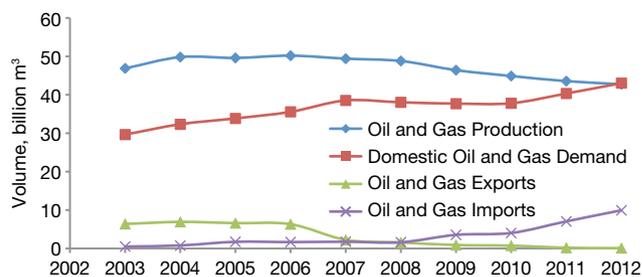
By 2012, constraints on imports impacted most of the chemicals industry. One such constraint requires companies that import goods to export other products of the same value. Furthermore, policies that regulate prices and renationalize companies have been introduced. For example, Repsol S.A. was required to reduce its 57.4% share in Repsol-YPF to 6.4%.

In a recent study (4), 40% of Argentina's chemical companies reported that their production was affected by limited availability of feedstocks, and 63% of the companies were affected by problems in electric power supply. The resulting economic uncertainty was reported to be the main reason behind declining investment in the chemicals industry.

Future challenges and the promise of shale reserves

The promise presented by Argentina's shale gas and shale oil reserves has caught the attention of the international fossil fuel production community. According to recent reports from the U.S. Energy Information Administration (EIA) (8, 9), Argentina ranks fourth, after Russia, the U.S., and China, among countries with technically recoverable shale oil resources, with 27 billion barrels of the total 345 billion bbl worldwide.

The 2013 EIA report (9) ranks Argentina second, after China, among countries with technically recoverable shale gas resources, with 802 trillion cubic feet of the estimated



▲ **Figure 3.** Recent trends in Argentina's natural gas industry show a trade deficit and increasing domestic demand. Source: (5-7).

7,299 trillion ft³ of total world reserves.

Argentina's shale gas and shale oil reserves are located mainly in the Neuquen Basin, with additional shale potential in three other untested sedimentary basins: San Jorge, on the Patagonian Atlantic coast; Austral, in Argentina's southernmost region; and Parana, which extends into Brazil and Uruguay. Within the Neuquen basin, the most promising formations are at Vaca Muerta and Los Molles.

By 2012, Vaca Muerta had 67 wells, 49 of which belonged to YPF. Factors contributing to the economic appeal of the Vaca Muerta formation include mean depths of 6,000 ft and high reservoir pressures, which make drilling projects not excessively expensive. The formation thickness of 500 ft allows for vertical wells (11). In all, the formation's 308 trillion ft³ of technically recoverable shale gas resources consist of 194 trillion ft³ of dry gas, 91 trillion ft³ of wet gas, and 23 trillion ft³ of associated gases.

Fifty-nine of Vaca Muerta's wells are for oil production (11). Estimates of the formation's technically recoverable resources range from 16.2 billion bbl of shale oil (9) to more than 21 billion bbl of oil equivalent (10).

Los Molles has 275 trillion ft³ of technically recoverable shale gas resources and 3.7 billion bbl of shale oil (9).

The nation's shale gas resources have the potential to double the volume of Argentinean natural gas production over the next 10 years. The currently state-controlled YPF is negotiating with Chevron and other companies to jointly develop these resources, and Chevron has agreed to invest up to \$1 billion to drill 100 wells with YPF in the Neuquen Basin.

Thus, the exploitation of existing shale gas reserves constitutes an important opportunity for Argentina, and provides an invaluable alternative for energy and raw materials production, both for the domestic and international markets. Challenges include the creation of a reliable framework to attract investment, recruitment of personnel qualified in both technical and business practices, and coordination with experienced private partners.

LITERATURE CITED

1. **Ministry of Industry**, Center for Production Studies, www.industria.gob.ar/cep/informes-y-estadisticas (2013).
2. **National Institute of Statistics and Census (INDEC)**, Estimador Mensual Industrial, www.indec.gob.ar.
3. **Silveti, E.**, "La República Argentina y su Industria Petroquímica," Argentinean Petrochemical Institute (1999).
4. **Cámara de la Industria Química y Petroquímica**, "La Industria Química Argentina: Situación Actual y su Potencial Hacia el 2020," www.ciqyp.org.ar/documentos/Industria%20Qu%EDmica%20Argentina%202010%20-%202020.rar (2010).
5. **Argentinean Petrochemical Institute**, "Statistical Information on the Chemical and Petrochemical Industry in Argentina," www.ipa.org.ar/index.php?option=com_content&view=article&id=57&Itemid=66 (2013).
6. **Argentinean Petrochemical Institute**, "Statistical Information on the Chemical and Petrochemical Industry in Argentina," www.ipa.org.ar (2010).
7. **Argentinean Petrochemical Institute**, "Statistical Information on the Chemical and Petrochemical Industry in Argentina," www.ipa.org.ar (2006).
8. **U.S. Energy Information Administration**, "World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States," U.S. EIA, Washington, DC, www.eia.gov/analysis/studies/worldshalegas/pdf/fullreport.pdf (Apr. 2011).
9. **U.S. Energy Information Administration**, "Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States," U.S. EIA, Washington, DC, www.eia.gov/analysis/studies/worldshalegas/ (June 2013).
10. **Ryder Scott**, "Ryder Scott Confirms Major Argentina Oil Shale Play," *Reservoir Solutions*, **15** (1), www.ryderscott.com/Newsletters/312nsltr.pdf (2012).
11. **Giampaoli, H. N.**, "Vaca Muerta: Dos Años de Shale en Argentina, Análisis Estadístico de la Producción a Noviembre de 2012," *Petrotecnia*, **2**, pp. 40–52 (2013).

Final thoughts

Argentina's potential to increase its feedstocks supply through investment in the oil and gas industry, as well as through the development of shale oil and gas reserves, is promising in the long term. Meanwhile, the existence of well-integrated and efficient chemical and petrochemical companies, along with a skilled workforce, will support the growth of the country's chemicals industry. 

CLAUDIO DELPINO is currently a PhD student at the National Southern Univ., at the Pilot Plant of Chemical Engineering (PLAPIQUI), Bahía Blanca (email: cdelpino@plapiqui.edu.ar). He holds a BS in chemical engineering from the NSU. His research interests are in process design and optimization, focusing on chemical plants and biorefineries.

M. SOLEDAD DIAZ is Principal Researcher at the National Research Council's (CONICET) Pilot Plant of Chemical Engineering (PLAPIQUI), in Bahía Blanca, Argentina, and an associate professor in the Dept. of Chemical Engineering at National Southern University (NSU), Buenos Aires (email: sdiaz@plapiqui.edu.ar). She holds a BS and a PhD in chemical engineering from the NSU. She was the recipient of a Fulbright Research Award in 2003 while she was a visiting scholar at Carnegie Mellon Univ. She has published more than 100 papers on modeling and optimization of chemical and biological processes, including petrochemical and natural gas processing plant design, mixed-integer nonlinear optimization, dynamic optimization, and supply chains. Her research interests also include strategies for eutrophication control in water bodies. Within PLAPIQUI, she has carried out projects for Dow Chemical, Compañía MEGA, Profertil, and YPF. She is a cofounder of the Petrochemical Process Engineering MSc Program at the NSU. She is a member of PLAPIQUI's Directive Board, a member of the Chemical Engineering Dept. Board, and the Vice Head of the Chemical Engineering Dept. She is also a member of the Consulting Board on Industrial Process Engineering and Biotechnology in the National Research Council.