

## Technology Vision 2020: The U.S. Chemical Industry

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The U.S. chemical industry's future and its key technology needs and pathways are the subject of a joint effort of the Chemical Manufacturers Association, American Chemical Society, American Institute of Chemical Engineers, Council for Chemical Research, the Synthetic Organic Chemical Manufacturers Association and the chemical industry to:

- ▶ Provide technology vision and establish technical priorities in areas critical to improving the chemical industry's competitiveness.
- ▶ Develop recommendations to strengthen cooperation among industry, government and academe.
- ▶ Provide direction for continuous improvement through step-change technology.

Through the Technology and Manufacturing Competitiveness Task Group, more than 200 people participated in this look at the future for the chemical industry which resulted in the publication of *Technology Vision 2020: The U.S. Chemical Industry* in December 1996.

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## 1. DIMENSIONS

The chemical industry provides the building blocks of a modern society, and its products are essential to a broad range of manufacturing industries and service sectors. These products meet our most fundamental needs for food, shelter, and health, and they are vital to the high technology world of computing, telecommunications and biotechnology. Chemicals are a keystone of U.S. manufacturing, essential to a large range of industries, such as pharmaceuticals, automobiles, textiles, furniture, paint, paper, electronics, agriculture, construction, appliances, and services.

More than 70,000 different products are registered in three broad and diverse categories: (1) basic chemicals; (2) chemical products used in further manufacture (intermediates); and (3) finished chemical products used for ultimate consumption or used as materials in other industries. More than 9,000 corporations develop, manufacture, and market products and processes in the following categories:

- ▶ industrial inorganic chemicals
- ▶ plastics, materials, and synthetics
- ▶ drugs
- ▶ soap, cleaners, and toilet goods
- ▶ paints, varnishes and allied products
- ▶ industrial organic chemicals
- ▶ agricultural chemicals
- ▶ miscellaneous chemical products.

The U.S. chemical industry is the world's largest producer of chemicals (over \$375 billion worth shipped in 1996), representing over 10% of all U.S. manufacturing on a value-added basis, contributing the largest trade surplus of any nondefense-related sector to the U.S. economy (\$16 billion in 1996), and employing over one million Americans enjoying a relatively high standard of living. The energy dimensions of the industry are substantial: over 5.8 quads are used for both feedstocks and fuel/power, even recognizing that energy consumption per unit of output has dropped by over 30% since 1970.

## 2. THE CHANGING BUSINESS ENVIRONMENT

The driving forces that are changing the nature of the business environment and impacting other industries, as well, stimulated this effort to think about the future of the chemical industry.

- ▶ **Increasing Globalization.** The accelerating interdependence of nations and companies challenges the chemical industry to “develop competitive, advanced manufacturing technologies, improve logistics and management of supply chains, and create new products that support the needs of customers globally.
- ▶ **Sustainability.** Societal demands for higher environmental performance present significant challenges and opportunities, and accelerate the development of technologies that use resources - both raw materials and energy - more efficiently. The industry’s commitment to Responsible Care® positions it to be a welcome neighbor and meet the challenges of sustainability: meeting “the economic and environmental needs of the present while enhancing the ability of future generations to meet their own needs.
- ▶ **Financial Performance.** Increasingly, the \$17 billion spent by the industry on R&D is being shaped by shorter term performance. This emphasis on near-term profitability improves stockholders’ satisfaction, but is a significant barrier to funding long-term R&D.
- ▶ **Customer Expectations.** Customers are increasingly asking for products and services that are “faster, better, cheaper, and cleaner”. Thus, opportunities are provided to forge new and stronger relationships. Challenges abound to remove inefficiencies in supplier/customer relationships and operations through reduced product cycle times, improved product quality and continuously improving service.
- ▶ **Changing Work Force Requirements.** More highly skilled workers will be required for tomorrow’s work force given the rapid pace of technological change and the complexity of technology. Computers and automation will make plants easier to run, but will require a more technically advanced understanding of those processes.

### 3. THE VISION

In order to encompass the chemical enterprise, working groups dealing with new chemical sciences and engineering technology, manufacturing and operations, computer utilization and information management, and supply chain management examined key technological challenges and critical success factors for the industry as it enters the next century. Smaller groups dealt with issues such as partnering and sustainable development, and those themes are embodied in the report. The elements of the vision highlight where the industry wants to be in 2020 and have been characterized as a 'call to action, innovation and change':

- ▶ The U.S. chemical industry leads the world in technology development, manufacturing, and profitability. *Profitability pays for technology development and the next generation of manufacturing excellence.*
- ▶ The U.S. chemical industry is responsible for breakthroughs in R&D that enhance the quality of life worldwide by improving energy use, transportation, food, health, housing, and environmental stewardship. *The role that chemicals play in our quality of life is not broadly appreciated and it is hoped that Technology Vision 2020 will help with that message.*
- ▶ The U.S. chemical industry leads the world in creating innovative process and product technologies that allow it to meet the evolving needs of its customers. *Emphasis is placed on both process and product technologies. "Responding to needs of customers in real time increasingly defines financial success for both the customer and the chemical producer."*
- ▶ The U.S. chemical industry sets the world standard for excellence of manufacturing operations that are protective of worker health, safety and the environment.
- ▶ The U.S. chemical industry is welcomed by communities worldwide because the industry is a responsible neighbor who protects environmental quality, improves economic well-being, and promotes a higher quality of life. *These two elements are directly related to the industry's Responsible Care<sup>®</sup> program in which companies are "committed to support a continuing effort to improve the industry's responsible management of chemicals" according to an accepted set of guiding principles.*

- ▶ The U.S. chemical industry sets the standard in the manufacturing sector for efficient use of energy and raw materials. *For example, in 1993, the industrial sector accounted for 86% of all operating cogeneration capacity in the U.S. The chemicals sector alone accounted for 31% of that capacity.*
- ▶ The U.S. chemical industry works in seamless partnerships with academe and government, creating "virtual" laboratories for originating and developing innovative technologies. *The emphasis on partnerships and collaboration recognizes that companies alone will be unable to meet the challenges of the 21st century and that the capabilities and competencies of the academic community and federal laboratories represent a vital resource.*
- ▶ The U.S. chemical industry promotes sustainable development by investing in technology that protects the environment and stimulates industrial growth while balancing economic needs with financial constraints. *Sustainable development represents two balances - firstly, environmental protection and industrial growth; secondly, economic need and financial constraints - that ultimately will have global impacts.*

#### 4. STEPS TO GETTING THERE

A series of steps are outlined for the roadmap toward achieving *Technology Vision 2020*:

- ▶ **Generate and use new knowledge** by supporting R&D focused on new chemical science and engineering technologies to develop more cost-efficient and higher performing products and processes.
- ▶ **Capitalize on information technology** by working with academe, federal and national laboratories, and software companies to ensure compatibility and to integrate computational tools used by the chemical industry; and developing partnerships for sharing information on automation techniques and advanced modeling.
- ▶ **Encourage the elimination of barriers** to collaborative precompetitive research by understanding legislation and regulations that allow companies to work together

during the initial stages of development.

- ▶ **Work to improve the legislative and regulatory climate** by reforming programs to emphasize performance rather than a specific method of regulatory compliance, and increasing consideration of cost, benefits, and relative risk.
- ▶ **Improve logistics efficiencies** by developing new methods for managing the supply chain and by sponsoring an effort to shape information technology and standards to meet the industry's manufacturing and distribution needs.
- ▶ **Increase agility in manufacturing** by planning manufacturing facilities capable of responding quickly to changes in the marketplace using state-of-the-art measurement tools and other technologies for design, development, scale-up, and optimization of production.
- ▶ **Harmonize standards**, where appropriate, by working with governments within the United States and internationally, and with independent standards groups on nomenclature, documentation, product labeling, testing, and packaging requirements.
- ▶ **Create momentum for partnering** by encouraging companies, government, and academe to leverage each sector's unique technical, management, and R&D capabilities to increase the competitive position of the chemical industry.
- ▶ **Encourage educational improvements** by strengthening educational systems and encouraging the academic community to foster interdisciplinary, collaborative research and provide baccalaureate and vocational training through curricula that meet the changing demands of the industry.

## 5. MEETING THE CHALLENGE

One means of summarizing is to reflect on the conclusions of the Task Group regarding the five broad goals that the chemical industry must accomplish over the next 25 years in order to meet the vision.

- ▶ Improve operations, with a focus on better management of the supply chain;
- ▶ Improve efficiency in the use of raw materials, the reuse of recycled materials, and the generation and use of energy;

- ▶ Continue to play a leadership role in balancing environmental and economic considerations;
- ▶ Aggressively commit to longer term investment in R&D; and
- ▶ Balance investments in technology by leveraging the capabilities of government, academe, and the chemical industry as a whole through targeted collaborative efforts in R&D.

These goals are clearly interrelated. For example, an unanswered plea to both the public and private sectors to aggressively commit to longer term investment in R&D could severely impact the ability to improve efficiency in the generation and use of energy for future generations. The answer may lie in balancing investments through targeted collaborative efforts in R&D that create a "multiplier effect" on the pool of resources: people, facilities and capital. More broadly, collaboration, whether it be among chemists, engineers, physicists and biologists; or suppliers and customers; or public and private sectors; or other diverse groups, may be the most important message of *Technology Vision 2020*.

## 6. ACKNOWLEDGEMENTS

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## REFERENCE

1. Technology Vision 2020: The U.S. Chemical Industry. American Chemical Society, American Institute of Chemical Engineers, Chemical Manufacturers Association, Council for Chemical Research, Synthetic Organic Chemical Manufacturers Association. December 1996. Washington, DC.