Chemical Industry

VISION2020

Technology Partnership

An Opportunity for Chemical Companies

What is Vision2020?

- Industry-led **partnership** — public and private
- On-going collaborative **process** to foster technology innovation

Goal: Leverage resources to accelerate innovation and technology development

Vision2020 Fits the Times

- Greater pressures on chemical company leadership
- Future growth, profitability, competitiveness require new technology
- R&D self-sufficiency is no longer realistic
- Long term sustainability is increasingly an issue
- Public R&D investment should respond to industry needs
- Pre-competitive collaboration leverages resources

Vision2020 Leverages Funding and Technical Resources

Vision2020 Is Helping Chemical Company Technology Leaders to:

- Strengthen linkages with customers & suppliers
- Better understand long-term technology needs and trends
- Collaborate in pre-competitive research in areas of highest common interest
- Influence and leverage enabling technology development
- Leverage public expertise, facilities and investments
- Explore long-range, high-risk technologies for a sustainable future
- Enhance public perception of the chemical industry

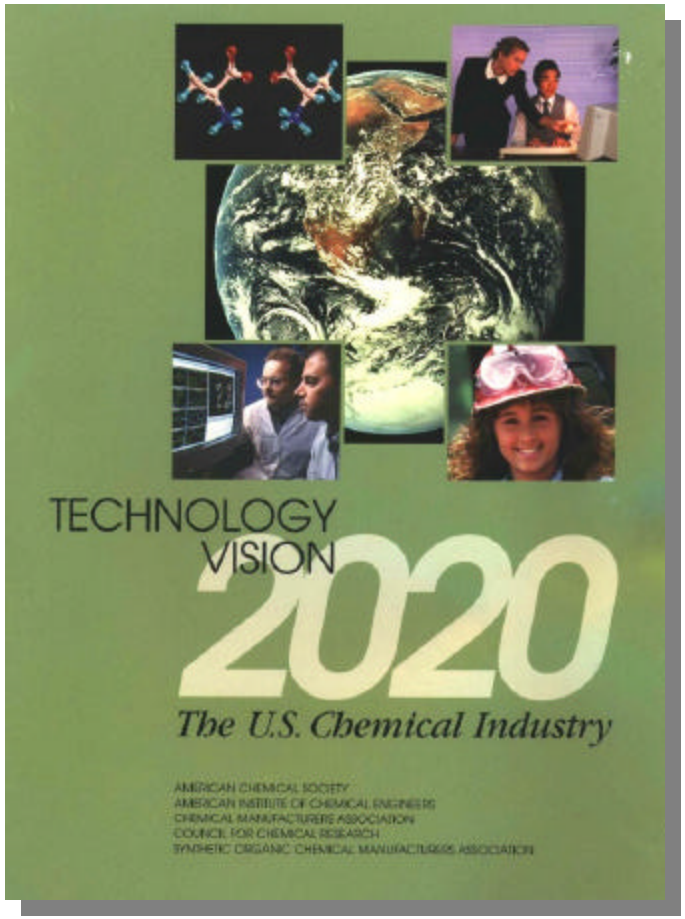
Vision2020 Partners

Vision2020 Industry Partners

Adsorption Research•Arthur D. Little•A.E. Staley Manufacturing•AGA Gas•Air Liquide• AICHE/CWRT•Air Products & Chemicals•Akzo-Nobel•Albermarle•Alcoa Technical Center•Allied Signal•Altus Biologics•Amoco Chemical•ARCO Chemical•Archer Daniels Midland•ARCO Chemical•Autoclave Engineers•Bay Area Bioscience Center•BC International•BF Goodrich•Biofine/Biometrics Inc.•BOC Gases•Bristol Meyers-Squibb•Camp Dresser & McKee•Cargill•Cargill-DOW Polymers•Celanese•Cen CITT•Chemical Information Services•Chevron•Chlor Alkali Chemicals Group•CH2M Hill•CIBA Specialty Chemicals•CIBA-Geigy•Coppe/VFRF/Brazil•Cryo Dynamics•Cytec Industries•Degussa•DOW Chemicals•DOW Corning•DSM Research•DuPont•DuPont Lanxides Composites•Eastman Chemical•Electrolux•Elf Altochem•Eltron Research Inc•Energy BioSystems Corporation•Engelhard Corporation•Equistar•Exxon Research & Engineering•Exxon-Mobil Corporation•Fedegari Autoclavi•FMC•Ford Motor Company•Foster Miller•Fractionation Research, Inc.•GD Searle•Genencor International•Genentech•General Electric•GE Plastics•Global Technologies•Grain Processing Corp•Green Chemistry Institute•Hart Partners, Inc•Haynes International•Hercules Inc•Honeywell•IBM•ICI•IFA Tullin•Inverizon International•Isopro International•Itochu Aviation•Johns Mansville Technical Center•Kellogg, Brown & Root, Inc.•KiwiChem International•Koch-Glitch, Inc.•Koch Processing Technologies•Krupp VDM•Lockheed Martin•Lubrizol•Lucent Technologies Bell Labs•Maxygen•MBA Polymers•Merck•MiCell Technologies•Michigan Biotechnology Institute•Midwest Research Institute•Minnesota Corn Processors•Molecular Simulations, Ltd.•Monsanto•Montec Associates•MTR (Membrane Technology)•MTU•Nitrate Elimination•Nofsinger Inc•Norton Chemical Processing•Novartis Pharma Ltd•Novo Nordisk Biotech Inc•Nuova S.p.A.•Occidental Chemical Corp•Olin Corporation•Organic Technologies•Oxford Molecular Group•Owens Corning•Phillips Petroleum•PPG Industries•PQ Corporation•Praxair•Proctor & Gamble•Pure Energy Corporation•RAND Corporation• Raychem•Raytheon•Reaction Design•Reilly Industries, Inc•Rhone Poulenc•Rohm & Haas•Rolled Alloys•Roquette America•RR Street & Company•Sangamo BioSciences, Inc.•Sciance Consulting•Science & Technology Inc•Shell Chemical•Silicon Graphics•Smith-Kline-Beecham•SPM Technologies•SRI Consulting•Supramics•Symyx Technologies•Texaco•Thar Designs•3M Company•Union Carbide•United Recycling•United Technologies•UOP•Westinghouse-Savannah River Company•Westvaco•Witteman Company, Inc.

Technology Vision2020 — Launched 1996

- Spearheaded by industry groups, OIT
- 300 industry leaders reached consensus
- Future challenges require
  - **New Technology**
    - Chemical Science & Engineering
    - Supply chain management
    - Information Systems
    - Manufacturing & operations
  - **Collaboration**
- Ongoing process details R&D needs and influences funding



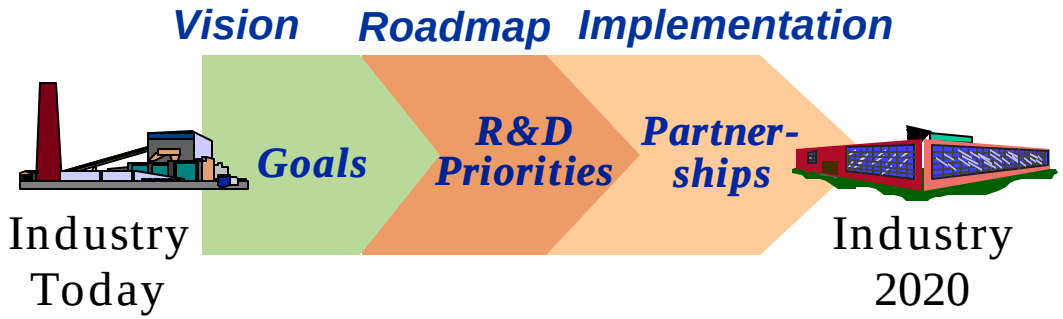
From Vision to Reality

Vision2020 Workshops Completed

- Catalysis
- Biocatalysis
- Alternative Reaction Conditions
- Alternative Reaction Media
- Alternative Raw Materials
- Combinatorial Chemistry
- Computational Chemistry
- Materials (I,II)
- Alternative Polymer Processing
- Chemical Analysis
- Separations (I,II,III, IV)
- Process Control Measurements
- Process Simulation
- Computational Fluid Dynamics
- New Process Engineering
- Reaction Engineering
- Manufacturing and Operations
- Agile Manufacturing
- Supply Chain Management
- Materials of Construction

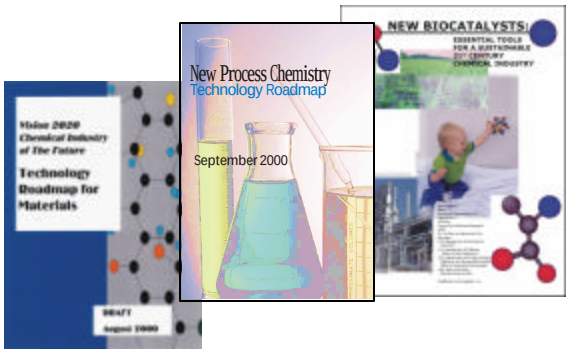
A Roadmap — Framework for Action

- Builds consensus on future needs among stakeholders
- Focuses investment in key areas for technology innovation
- Provides a practical tool and chronological path to get "from here to there"
  - Current State
  - Future State
  - Goals
  - Technical Barriers
  - Priority R&D Needs



Vision2020 Roadmaps Completed

- Biocatalysis
- Combinatorial Chemistry
- Computational Chemistry
- Computational Fluid Dynamics
- Materials of Construction
- Materials Technology
- New Process Chemistry
- Reaction Engineering
- Separations
- Measurements for Process Control



Computational Fluid Dynamics — From Workshop to Consortium

Industry Partners $11.6M

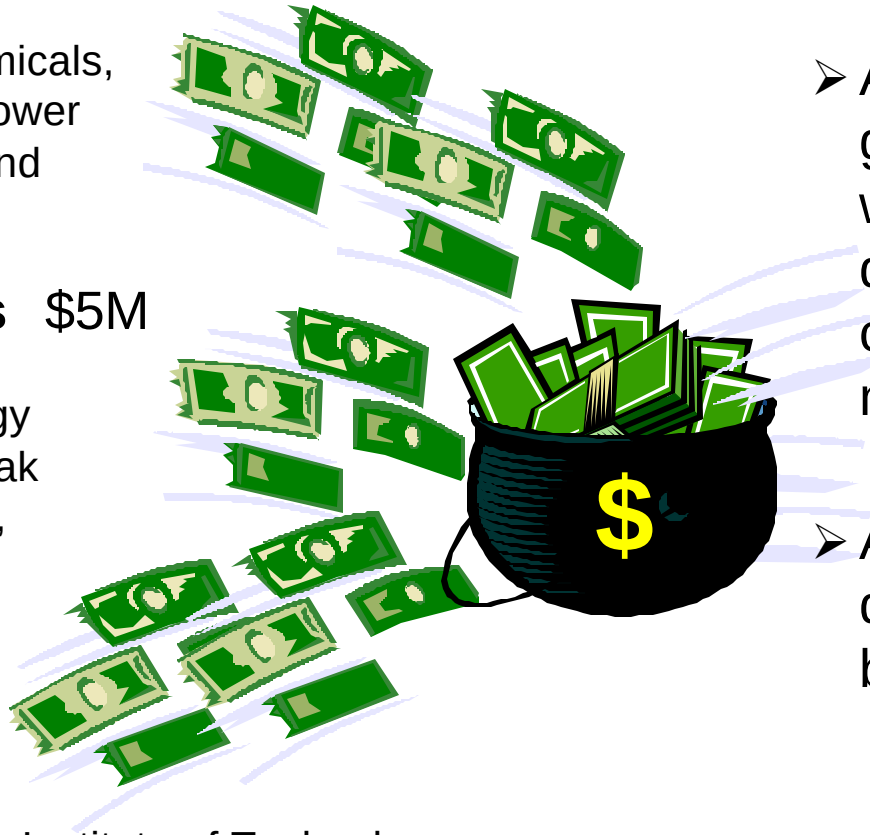
Chevron, Dow Chemical, Dow Corning, DuPont, Exxon, Millennium Inorganic Chemicals, Siemens Westinghouse Power Corp., AEA Technology, and Fluent

Government Partners $5M

Los Alamos National Laboratory, National Energy Technology Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, and Sandia National Laboratories

University Partners

Clarkson University, Illinois Institute of Technology, Princeton University, Purdue University, University of Colorado, University of Michigan, and Washington University-St. Louis



- Accurately model gas-solid transport with experimental data and computational methods/models
- Accelerate development by 5-10 years

Materials of Construction Roadmap

5 Industry partnerships launched in 2000 with the Materials Technology Institute

One example: R&D team formed to develop intermetallic alloys for ethylene cracker tubes that resist coaking and carbonization

- Companies contribute
  - 50% cost-share
  - Technical expertise
  - Test Sites
- ORNL conducts R&D
- Website to share preliminary results

Participants:

- Exxon Chemical Company
- Equistar Chemicals, LP
- Shell Chemical Company
- BP Amoco
- Air Products and Chemicals, Inc.
- Akzo Nobel Chemicals, Inc.
- Sandvik Steel Company
- Inco Alloys International, Inc.
- Duraloy Technologies, Inc.
- Nooter Fabricators, Inc.
- Oak Ridge National Laboratory

Vision2020 Influences More Efficient Investment of Public Funds

- Clusters R&D around major industry-supported themes
- Concentrated in pre-competitive, enabling areas
- Measurable impact
  - DOE-OIT Industries of the Future
  - NIST-ATP
- Still a long way to go

OIT Chemical Industry of the Future Program

- Uses roadmaps to establish funding priorities
- $72 million leveraged through 50/50 industry/DOE cost-share
- $145 million total funding for chemicals
- 26 active collaborative projects
- Co-funds projects with DOE, NIST, NSF, MTI, and AIChE
- May lead to demonstration projects

Our Chemicals Industry of the Future partnership has built a portfolio of over 100 projects valued at $145 million. By working together, we are ensuring that these public/private investments will generate maximum benefits to national energy efficiency and the competitiveness of the industry.

— Denise Swink, Deputy Assistant Secretary
DOE Office of Industrial Technologies

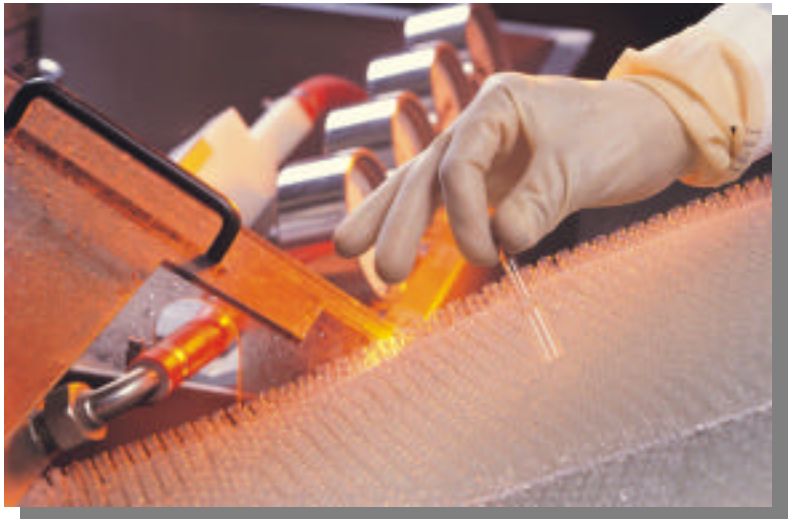
Recent OIT Awards Responsive to Vision2020

Industry's $3M leverages $3M from DOE/OIT

- Autothermal Reformer
- Membranes for Corrosive Oxidations
- Short Contact Time Reactors
- Mesoporous Membranes for Olefin Separations
- Molecular Simulations for Chemical Industry

Vision2020 — Next Steps

- Establish permanent industry-driven steering group
- Expand company participation
- Reinforce and publicize Vision2020's message
- Impact other government funding agencies
- Expand technical topic areas
  - Operations (AIChE will lead)
  - Electronics materials
  - Nanoscience
  - Inorganic chemicals
  - Bioprocess/biotechnology
  - Combinatorial methods
- Pursue overall priorities



Proposed Vision2020 Organization

- 10-15 member steering group
  - ACS, AIChE, CCR, ACC, SOCMA
  - Companies making direct contribution
  - $5-10K membership fee
- Housed in CCR but independently funded and governed
- Sponsors workshops open to all interested parties
- Addresses overall priorities
- Promotes the process and seeks support

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Vision2020 Needs You

- Endorse the Process
- Join the Steering Group
- Send representatives to workshops
- Help choose the best directions

Expect: opportunities for collaborative R&D; influence on public investment and academic research; long-term sustainability

Vision2020 and The Business of Chemistry

- An innovative, science-based industry that conducts research and develops products and processes that benefit society
- Technology Vision2020 is a unique, consensus statement of technical approaches to a future of new products and sustainable operations that benefit society

Vision2020—Metrics for Sustainable Development