

# ECONOMICS OF THE CHEMICAL PROCESSING INDUSTRIES

JAMES WEI

*University of Delaware  
Newark, Delaware*

**E**CONOMICS IS CENTRAL to every engineering effort, seeking to obtain the most useful results by expanding the least resources. The more efficient processes and the more desirable products continuously displace the obsolete ones from the market place. An engineer needs to master science and engineering, so he can understand nature and can make useful devices; he should also appreciate humanities and economics, so he can understand what should be made and by what route. A technician is told what to make, an engineer should participate in policy decisions.

Most chemical engineers work for the chemical processing industries (CPI), while the rest work for related industries (such as construction, equipments, teaching, consulting, government regulations). The purpose of the CPI is to provide our society with needed goods and services (with occasional disservices), mostly in the form of processed materials needed in final manufacturing. The fortune of the CPI and the individual firms depend on their ability to anticipate society's needs, to provide for these needs at acceptable costs, and to refrain from public nuisance while performing their tasks.

## **COURSE DESIGN**

This course is designed to teach the students the forces that are the carrots and sticks to the CPI, the dynamics of competition that alters the fates of processes and products, the external threats and internal strengths of companies, the impact of dwindling natural resources and environmental protection. The theater of this course is narrower than macro-economics, or the economics of the world and of this nation; it is broader than nano-economics, or the Process Economics taught in conjunction with the senior design course. It is suitable for seniors and graduate students, and it acquires an extra dimension when

---

The theater of this course is narrower than macro-economics, or the economics of the world and of this nation; it is broader nano-economics—as taught in conjunction with design courses.

---

the class contains a sprinkling of students with industrial experience. Students without previous experience with macro-economics, micro-economics (or the economics of a firm), and accounting must do additional reading to catch up. The catch-up list consists of:

- “Economics” by Paul A. Samuelson, McGraw-Hill, 1973
- Chapter 2. Central Problems of Every Economic Society
  - 4. Supply and Demand
  - 5. Business Organization and Income
  - 11. National Income and Product
  - 20. Determination of Price by Supply and Demand
  - 21. The Theory of Demand and Utility
  - 22. Cost and Supply
  - 24. Equilibrium of the Firm: Cost and Revenue

“Management Accounting” by Robert N. Anthony, Richard D. Irwin, 1964

- Chapter 2. Basic Accounting Concepts
- 3. Measurement of Income
- 6. Fixed Asset and Depreciation
- 7. Income Measurement in Manufacturing
- 11. Financial Statement Analysis

After a few review lectures on basic principles of economics and accounting, the students were assigned reading materials to prepare for each class discussion. The reading materials consist of a textbook, “The Economics of the Chemical Industry” by Jules Backman, Manufacturing Chemists Association, 1970; a Senate Subcommittee Hearing “Economic Dislocation Resulting from Environmental Controls”, 1971; the most recent issue of “Facts and Figures” from the Chemical and Engineering News; and a number of recent journal articles and case histories:

- “The \$66 billion mistake” a Mobil Oil advertisement in New York Times concerning automobile pollution reduction

- "W. R. Grace & Co." and "Eli Lilly" from Forbes, 1971-2
- "Dark Cloud on Sulfur's Horizon" and "Catalysts" from Chemical Week, 1971-2
- "Outlook for Energy in the U.S. to 1985" a study by the Chase Manhattan Bank, 1972
- "Macro-economics of Unbalanced Growth" by W. J. Baumol in American Economic Review, 1967
- "What's Happening to the U.S. Lead in Technology" by Harvey Brooks in Harvard Business Review, 1972
- "Research, Technological Progress and Economic Growth" by L. S. Thurow; "America's Technological Dilemma" by J. H. Holloman and A. E. Hagen, Technology Review 1971
- "Industrial Chemicals, Inc." a Harvard Business School Case concerning the problems in the organization of a research and development laboratory
- "Mobil Chemical Company" a Harvard Business School Case concerning the development project of a plastic milk container

The class discussion was dialectic in nature, appropriate in problems where all the facts are not known, and where there is no single neat and correct solution. Woe to the student who thinks that he has the right answer, but cannot provide a convincing set of reasons. A skillful instructor should not let his personal opinion be known in advance, and should concentrate on stimulating the students to challenge the faulty logic and misinformation of the other students.

#### ECONOMIC PROBLEM ANALYSIS

ANOTHER PART of the course consisted of doing analysis on economic problems, where the engineering students can delightfully flex their mathematical muscles. The topics include:

- Micro-economics of the firm, productions functions including the Cobb Douglas function
- Price elasticities of supply and demand
- Optimum production rates under atomistic competition, oligopoly and monopoly
- Input/output analysis of Leontieff
- Income statements and balance sheets firms, such as Texaco and Monsanto
- Price forecast by the Experience Curves

A number of guest speakers were invited to address the class and to answer questions. The class read up on the subject before the guest lec-



James Wei is the Allan P. Colburn Professor of Chemical Engineering at the University of Delaware. He received his B.Ch.E. from Georgia Tech. in 1952, and his Sc.D. from M.I.T. in 1955; he graduated from the Advanced Management Program from the Harvard Business School in 1969. He worked for Mobil Research and Development from 1955 to 1968, and was the Manager of Long Range Analysis and Strategy at Mobil Oil Corporation from 1969 to 1970.

turers arrive, so the questions can be penetrating and substantial. The speakers in the past had been:

- Harvey Taufen, Vice President of Hercules, on the "Oil Import Program" and "Multi-National Corporations"
- Robert McBride, Product Manager of DuPont, on "New Product Development"
- James Donnelly, Planning Associate of Mobil Oil, on "Energy Supply"
- J. S. Whittaker, Corporate Environmental Coordinate of Union Carbide, on "Curbing Sulfur Dioxide Emission in Marietta, Ohio"

#### PRACTICE IN ECONOMIC THINKING

Finally, each student prepared a term paper on a product or a company, which gave them experience on how to find and use economic data, and how to do comprehensive economic thinking. A term paper on a product must include:

- (a) **Marketing:** who needs it, how much is needed at what price, what are the competitive products and relative merits, what new uses can be developed, what are the external threats;
- (b) **Manufacturing:** what process or processes are used, what are the recent and anticipated innovations, what is the probability of obsolescence by another process, what

(Continued on page 179)

tion, but motivation has not proved to be a problem, because the interest of the student in the topic is very high.

Perhaps the best measure is the performance of students in subsequent courses, research, and employment. Students have proved their ability to use modern methods of polymer analysis without further instruction, and their organization and development of research projects has been sound. Some have taken more advanced courses and performed very well. Finally, several former students who have entered the polymer field have reported that they were prepared for their assignments and have succeeded in handling them very capably.

There are no entirely suitable texts for the courses and few problems for assignments are available. About one and one-half to two manyears has been spent in collecting and collating lecture material, preparing notes, and designing problems for assignments. Problem preparation has proven to be the most difficult task, but problems are an absolutely essential part of the instruction. Even though the instructional burden has been heavy, the success of the courses has made it worthwhile. Ideally, the sequence should be taught by two or more instructors who are specialists in particular topics and who co-operate to preserve the continuity of the sequence. This is our next objective. □

(Continued on page 210)

---

## ECONOMICS OF THE CHEMICAL PROCESSING INDUSTRIES: Wei

(Continued from page 173)

are the major cost elements and reduction possibilities, is there security of raw material supply;

- (c) **Environmental impact:** what nuisance is created during manufacturing, use or transportation, what are the harmful effects and do they outweigh the benefits, can the bad effects be controlled and at what cost.

A term paper on a company must include:

- (a) **Function:** what business is the company in, who are the customers and are they likely to prosper in the future, does it have a mix of products to render it less vulnerable to market changes;
- (b) **Dynamism:** is the company an aggressive growth oriented company, making unique chemicals for outstanding profit margin, or a mature company making bulk commodity chemicals for low markup; is innovation of new products, processes and markets an important activity;
- (c) **Past Record:** what is the last ten years' record of sale, profit, earning per share, stock price; how does this company compare with a competitor company and with the chemical industry; how does its growth rate compare with the Gross National Product and population;
- (d) **Strengths and Weaknesses:** is this company in possession of special skills or unusual assets, what are its weak points,

what can a good chemical engineer accomplish here;

- (e) **Threats and Opportunities:** what are the external forces that can materially affect this company, and cause it to prosper or to decline.

Topics of the term papers prepared by the students include:

- Air Products and Chemicals, Atlantic Richfield, Foster Wheeler, Joseph Schlitz, Smith-Kline-French;
- Petroleum in Nigeria, titanium dioxide in South Africa, fertilizer in Brazil;
- urea, acrylic fibers, lead alkyls, nylon 66.

Selected term papers were presented orally in class, where a jury of fellow students would rate the talks according to organization, comprehensive coverage, analysis, and clarity of presentation.

The course was given twice, to classes numbering 26 and 30. The classes were divided roughly in equal parts of seniors, full time graduate students, and extension graduate students. There were also a handful of students from chemistry, electrical engineering and civil engineering. Student rating at the end of the course ranged from very good to excellent. The rating on the usefulness and interest in the course is 4.3 out of a possible 5.0. 95% of the class would recommend this course to friends. We are planning to continue to offer this course in the Spring term, with continuous updating of topics and reading materials. □