2.10 Planning a Chemical Industry - Taiwan, ROC: A Case Study

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The 'Economic Miracle' of Taiwan, based on her successful transformation from an agrarian to an industrial economy, would not have been possible without the establishment of a world-class chemical industry over the past 25 years. This paper attempts to analyse how such a development has been accomplished in a land with a population of 20 million but practically no natural resources and to note the problems caused by this rapid and successful transformation, which resulted in a slow-down in the 1980s, and the strategies for future growth and development (N.B. values are given in US $).

What the Statistics Show

Taiwan's per capita GNP has risen steadily from $919 in the 1950s, through $1671 in the 60s, $3626 in the 70s and $6501 in the 80s to $7358 in 1990, achieving a growth rate of 10% pa in the 70s, as its agrarian economy was transformed into an export-oriented industrial economy:

	1952	1990
Total value of export sales	$0.12 bn	$67.2 bn
% as agricultural, including processed, products	91.9	4.4
% as industrial products	8.1	95.6

In 1990 the total value of industrial production was $165.3 billion and of export sales $67.2 billion (13th in the world), giving her foreign reserves of ca $80 billion (1st or 2nd in the world). The chemical industry is the largest industrial sector, contributing one quarter (24.2%) of the total production value of $165.3 billion but only 8.5% directly to the export sales of $95.6 billion. This demonstrates its strategic importance as a supplier of materials and other chemicals in underpinning the export industry; cf. the electrical/electronic and textile sectors with 16.8% and 11.6% of total industrial production but contributing 23.6% and 15.3% to export sales.

Development of the Chemical Industry

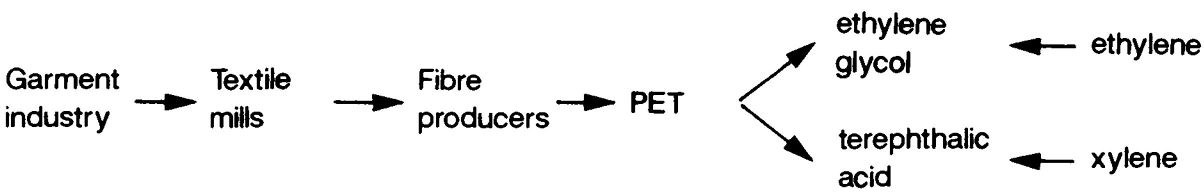
The development of Taiwan's chemical industry can, for convenience, be divided into the following phases:

1913 - 1943 (Japanese colony)	Manufacturing of basic chemicals (eg. fertiliser, chloralkali)
1944 - 1953	Production of substitutes for imported consumer goods (eg. consumer commodities, agricultural products)
1954 - 1967	Development of light industries (emphasising paper/food/textile products etc.)
1968 - 1975	Beginning of backward integration of petrochemical industry (boosting the export of textile products)
1976 - 1988	No. 3 and No. 4 naptha crackers started with the fastest growth of petrochemical industry
1989	Restructured strategy to shift away from commodities to higher valued chemical products and advanced materials

As a result of this growth Taiwan now ranks 1st in the league of world producers for PVC (with a capability of 1.1 million metric tonnes pa) and acrylonitrile-butadiene-styrene polymer (0.63), 2nd for polyester fibre (1.3) and pure terephthalic acid (1.0), but still only 16th for ethylene (0.91)!

Main Factors Contributing to this Success

1. Establishing an integrated chemical industry, eg. integrating backwards from a garment industry depending on cheap labour and imported materials by successively developing the following capabilities (where PET is polyethylene-terephthalate or terylene):



Similarly the shoe industry was strengthened by development of the plastics industry.

2. **Development of a 'Debottle-Necking' Capacity**

The necessary chemical plant could not have been operated successfully without the existence of skilled Taiwanese engineers and technicians able to de-bug and even improve the technology, all of which was originally imported from the US, Japan or Europe. The Taiwan VCM Corporation, for example, started production of VCM (Vinyl chloride monomer) based on the UCC process (ethylene + Cl_2 → ethylenedichloride; cracking → vinyl chloride + HCl) in 1973. The plant failed in 1975 but was reorganised and production increased from the original 120 tonnes/day to 150 tonnes/day in 1976 and eventually to 180 tonnes/day in 1979 with an energy saving of 30% and productivity of 2.07 (exceeding the world standard of 2.05) tonnes VCM per tonne of ethylene.

3. Cooperation between up/mid/down-stream operators which, for example, enabled the effects of the 33% appreciation of the Taiwanese against the US dollar over the four years 1987-90 to be absorbed by the mid-stream operators without adversely affecting export sales. This was accomplished by a joint agreement to price the chemical raw materials, intermediates and products in US currencies with reference to their US Gulf coast contract prices.

4. **Strong Support by the government**

- Tax incentives (4 or 5-year tax holiday).
- Investment incentives (duty-free import of machinery and equipment).
- Well-planned industrial zones.
- Government-owned low-profit raw material and intermediate manufacturers CPC (Chinese Petroleum Corporation) and CPDC (China Petrochemical Development Corporation).
- Production/procurement agreement between CPC and petrochemical suppliers (January 1983 -December 1986).
- Custom/tariff protection.
- Export incentives.

5. An abundant supply of well-educated human resources. Most relevant for building up the chemical industry has been the supply of graduates in chemical engineering, which has increased as shown below:

	BSc	MSc	PhD
1985	954	112	4
1986	932	177	9
1987	950	193	14
1988	956	207	10
1989	942	184	17
1990	948	288	24

The first chemical engineers in Taiwan graduated in 1945 and there are now 36 Chemical Engineering Departments in the country. Many of these graduates emigrate to the USA and Japan but an increasing number return home as the job opportunities increase, bringing with them extremely valuable training and experience. They proved to be invaluable to the current and future development of ROC's chemical industry by their direct participation in the management of the existing institutions and their entrepreneurial efforts in creating new businesses.

Recent Weaknesses and Problems:

- Environmental opposition from local communitities.
- High labour costs due to severe labour shortage.
- High cost of industrial land (300 times higher than in US).
- Shortage of own R and D capability.
- Government policies of liberalisation and internationalisation.
- Offshore diffusion of downstream fabrication factories (eg. shoes, textiles).

This has resulted in the expansion of Taiwanese industry overseas; the chemical industry has invested in the USA (including a $1.7 billion petrochemical complex by the Formosa Plastics Group), Thailand, Malaysia, Philippines, South Africa and Europe. Many foreign chemical firms have also set up plant in Taiwan in the plastics and polymers field, eg. Dow, Dupont, Himont, Hoechst (all completed in 1990), EMS-Chemie, ICI and Rhône-Poulenc (due for completion 1991).

Goals for Future Development

1. Strengthen raw materials supply eg. by boosting ethylene production from 0.7 (in 1980) to 1.5 (in 1995) million metric tonnes pa by the commissioning of two naptha crackers.

2. Develop engineering plastics, advanced materials and other high-valued chemical products, aiming by 2000 to achieve 12% of the world market for engineering thermo-plastics (worldwide market of $12.5 billion forecast), 12.5% of high performance fibres ($2.4 billion), ca 15% of advanced organic matrix composites ($10-12 billion) and 12% of high value-added plastic parts ($24 billion).

3. Increase effort in pollution abatement; direct investments in pollution abatement already include $1.8 billion for CPC's no. 5 cracker and $0.83 billion for FPC's no. 6 cracker.

4. Promote R and D activities by accelerating the trend as shown by the following actual and targeted figures.

	1985	1986	1990	2000
% of chemical industry sales reinvested in R and D	0.22	0.34	1	3
No. of employees engaged in R and D per 1000 chemical industry employees	1.95	2.25	3	6

Possible Lessons for Other Developing Countries

- Provide strong governmental support.
- Establish an integrated chemical industry.
- Obtain (ie. import) the best available production technology but,
- Develop own 'debottle-necking' capability and technology, then own R and D capability.

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