

Managing Technology To Achieve Industrialisation: The Korean Nylon Producers in the 1960s-70s

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Introduction

Capturing the challenges firms face in developing economies, Nathan Rosenberg argued that technology transfer is not once-and-for-all affair, ‘which happens at a single point in time,’ but ‘an ongoing activity,’ the success of which depends on ‘the domestic capacity to alter, modify, and adapt in a thousand different ways.’¹ Transfer of technology across firms and geographical boundaries requires active and conscious efforts, and is neither costless nor rapid. Challenges in technological transfers appear to be more comprehensive than previously assumed, and abstraction of the process—in an effort at alternative conceptualisation to account for the experience of developing economies and highlight the salient characteristics—has revolved around capturing the broad range of technological issues for latecomer economies. This conceptualisation has resulted in what is referred in the literature as ‘technological capabilities,’² or the development and acquisition of capabilities at three stages (production, investment, innovation) to manage technology and claim mastery.

This experience in technology transfer was certainly true for the Korean textile industry as it first imported foreign technology in the 1960s. This was the industry that spearheaded Korea’s economic take-off in the 1960s. In fact, few industries better represent the rapid, compressed character of Korea’s development than the textile industry, which pioneered both import substitution and export-oriented phases of industrialisation. In order to maintain competitiveness once industrialisation was under way, the Korean firms had to face a range of technological issues which went beyond importing, transferring, and assimilating. Characterising this as ‘managing’ captures the complex dimension of dealing with technology. In the case of the Korean textile industry, the technology- and capital-intensive part was located upstream with the synthetic fibre producers, not the firms downstream in fabric and textile goods production. What became to be identified as a Korean pattern of promoting exports with efforts to localise production of all but basic inputs forced the synthetic industry to experience import substitution and export promotion simultaneously, and the tensions between import-substituting fibre producers upstream and export-oriented textile producers downstream pushed the fibre producers towards becoming more competitive by developing their technological capabilities (**Figure 1**). But compared to the other industries in which Korea later developed comparative advantage, surprisingly little has been said on the synthetic fibre industry despite its historical relevance in Korea’s industrialisation. It is this synthetic fibre industry which is the subject of my research.

The research makes use of case studies to evaluate firm efforts to absorb foreign technology and develop indigenous capabilities. Assessment of managing technology involves looking at the range of capabilities in production, investment, and innovation, relying on evidence in corporate, industrial, and government sources. The proposed paper compares the two leading nylon producers based on their technological capabilities, and argues that while the technology inflows in the

¹ Rosenberg, Nathan. 1982. *Inside the Black Box: Technology and Economics*. Cambridge: Cambridge University Press. p. 272.

² Westphal, Larry E., Linsu Kim, and Carl J. Dahlman. 1985. “Reflections on the Republic of Korea’s Acquisition of Technological Capability,” in *International Technology Transfer: Concepts, Measures, and Comparisons*. Nathan Rosenberg and Claudio Frischtak eds. New York: Praeger. An in-depth review of the literature on technology in the Third World is provided in ch. 1 of my thesis.

synthetic fibre industry conform to the established channels of transfer in Korea—that is, through capital goods imports rather than technology assistance and FDI—the few recorded instances of technology assistance and joint ventures may have been more relevant in upgrading the firms’ technological capabilities. In nylon, Kolon pioneered synthetic fibre production with the establishment of a plant in 1963. Dongyang did not enter the market until 1965 but soon caught up and by 1971 outpaced Kolon’s production capacity, forging ahead as the leading nylon producer (**Figure 2**). Once established, both continued to expand their output capacity, and relied on foreign resources (capital and technology) to achieve growth and economies of scale. At every stage, the firms faced tradeoffs between adopting the best technology available versus minimising their dependence on foreign resources, and this resulted in different outcomes across firms. In the 1960s-70s, the firms were also more successful mastering the ‘know-how’ than the ‘know-why’ in technology.

Primary Sources³

Owing to the extent and intensity of state involvement in the economy, corporate activities are well documented in government records at the National Archives and Records Service since 1962. For this paper, the following primary sources have been consulted: firms’ applications for foreign capital and technology inflows under the Foreign Capital Inducement Act (FCIA); contemporary research papers by the Korea Development Institute; the Korea Chemical Fibers Association’s *Chemical Fiber Handbook* since 1976, and quarterly publication *Chemical Fiber* since 1968. Corporate sources publicly available are minimal compared to government sources, and research relies mainly corporate history publications for cross-referencing with government sources: Kolon (*40-Year History*, 1997), founder’s memoirs (1977); Dongyang Nylon (*30-Year History*, 1996); founder’s memoirs (2000).

³ The data and analysis in this paper are based on the sources cited above.

Figure 1. Illustration of synthetic fibre production in Korea, 1960s-70s⁴

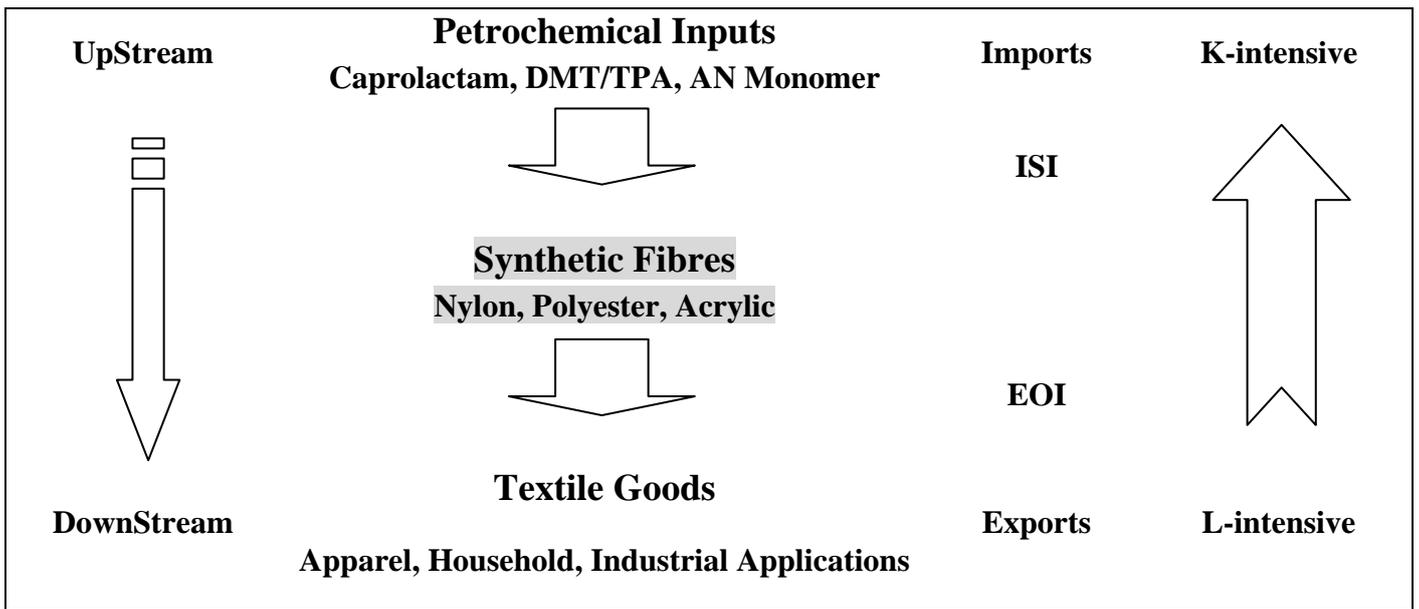
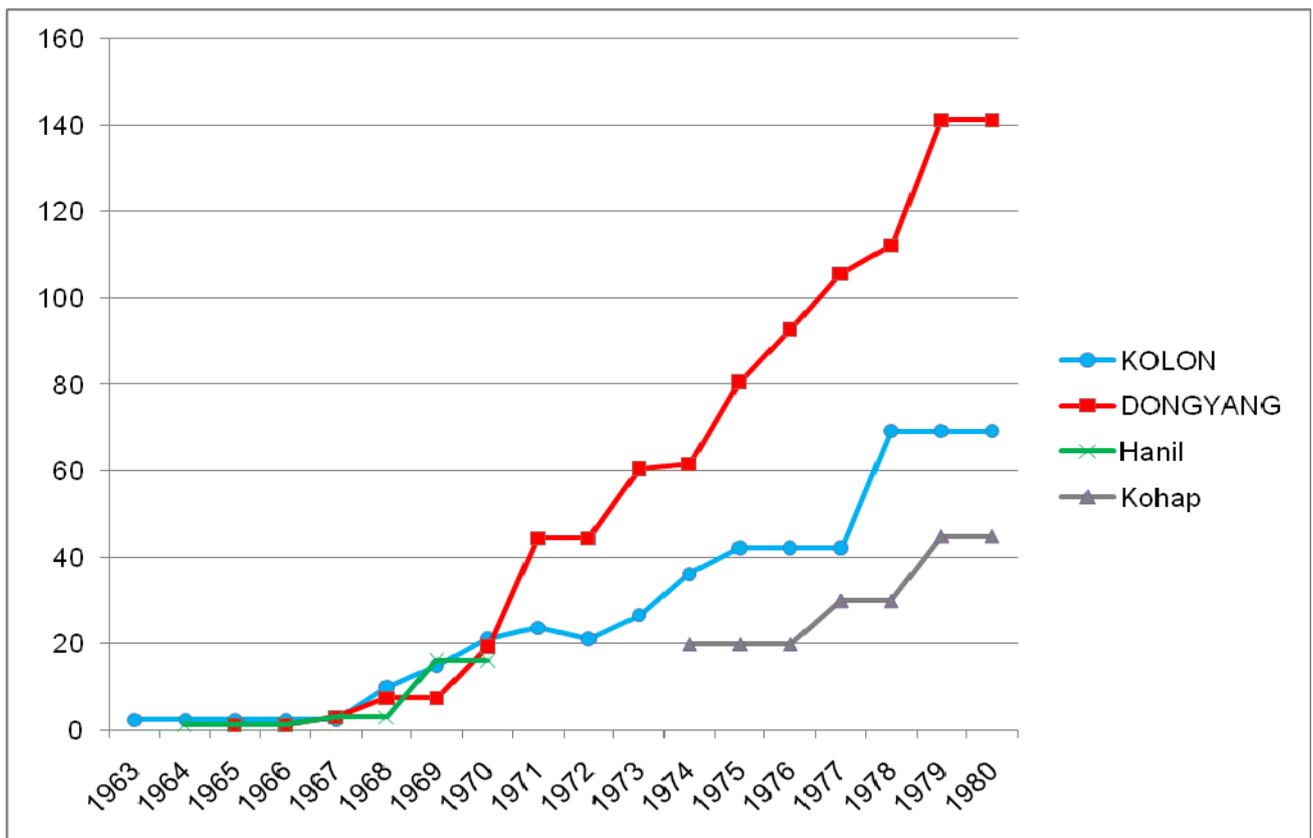


Figure 2. Nylon filament output capacity, 1963-80 (metric tonnes per day)



⁴ This pattern of industrialisation is dealt in ch. 4 of my thesis.

Table 1. Foreign capital inflows for nylon production, 1960-80⁵

TYPES	YEAR	FIRMS	SOURCES	PURPOSE	TERMS (US\$ 1,000)
Loans	1960	KOLON	DLF	Plant Establishment	3,200
Joint venture	1962	KOLON	Chemtex (US)	Establishment	575 (Chemtex 50%)
Tech. Assistance	1963	KOLON	Toray (Japan)	Establishment	
Loans	1966	KOLON	AID	Expansion	5,810
Loans		DONGYANG	Vickers Zimmer (Germany)	Plant Establishment	2,080
Loans		DONGYANG	Itoh C. (Japan)	Establishment	6,140
Loans		KOLON	Mitsui (Japan)	Expansion	4,278
Loans	1967	DONGYANG	Heberlein & Co. (Switzerland)	Manufacturing facilities	207
Loans	1968	KOLON	EXIM Bank (US)	Expansion	3,420
Loans	1971	KOLON	Chemtex (US)	Expansion (tyre-cord fabric)	4,040
Loans		KOLON	Mitsui; Associated Japanese Bank (GB)	Import of caprolactam	3,000
Joint venture		KOLON	Toray (Japan)	Expansion (tyre-cord fabric)	1,989 (Toray 45%)
Tech. Assistance		DONGYANG	Teijin (Japan)	Expansion (tyre-cord fabric)	100 (3 yrs)
Loans	1972	DONGYANG	Marubeni Benelux (Belgium)	Import of caprolactam	3,000
Tech. Assistance		DONGYANG	Teijin (Japan)	Manufacturing of shrinkproof nylon filament	250 (3yrs)
Loans	1974	DONGYANG	Bank of Montreal (Canada)	Expansion	14,000
Loans	1975	DONGYANG	Marubeni Benelux (Belgium)	Expansion	5,000
Loans		DONGYANG	IFC	Expansion	6,900
Joint venture		DONGYANG	IFC	Expansion (tyre-cord fabric)	2,100 (IFC 9.87%)
Loans		DONGYANG	Marubeni (Netherlands)	Expansion	7,400
Loans		KOLON	Chemtex (US)	Expansion	14,100
Loans	1976	KOLON	Canadian American Bank S.A.	Expansion	10,000
Loans	1978	DONGYANG	Bank of Montreal (Canada)	Expansion (tyre-cord fabric)	15,400
Tech. Assistance		KOLON	Mitsui Toatsu Chemicals (Japan)	Manufacturing of nonylphenol	50 (+ 2.3% net sales; 10 yrs)
Tech. Assistance		DONGYANG	Kanebo (Japan)	Manufacturing of low-shrink nylon filament	300 (3 yrs)

⁵ Korea's FCIA regime, which regulated the inflows of foreign capital and technology, is dealt in ch. 2 of my thesis.

Characteristics of firms' management of technology: Pioneer (Kolon) and Latecomer (Dongyang)

First, the timing of market entry mattered in the firms' choice of technology. As an importer of stretched nylon in Tokyo in the early 1950s, Kolon was well-placed to experience firsthand the popularity and potential for nylon and to capitalise on the demand for this 'miracle fibre' in the Korean market. Kolon's founding family at the time was a commercial agent for exports of stretched nylon filament yarns into Korea, but by 1956 their interests evolved to stretching the filament themselves, leading to the establishment of Korea Nylon in 1957. By and large the most successful in the nylon business, Kolon soon became interested in backward integration into local production of nylon filament, and formed a joint venture in 1962 with the US engineering firm, Chemtex, for the construction of a nylon filament plant.

Dongyang, on the other hand, did not consider producing nylon until the mid-1960s, and even then, was more interested in petrochemical processing than synthetic fibres. But Dongyang's ambitions of refining oil, or producing lubricant, or polyester rather than nylon, or backward integration into supplying caprolactam for nylon were all deemed premature at the time and were thwarted by the market, competitors and the government. For instance, in weighing synthetic fibre production, Dongyang felt that polyester had better future prospects, but realised the firms downstream had neither the technology nor the experience to use polyester. It was risky to consider the superiority of the fibre only, when the production of fibres was tightly linked with the downstream manufacturing sector in fabrics and textiles and related dyeing and blending processes. Production in fibres could meet its promises upstream if the downstream sector could also grow in conjunction ('like flowing water'). Unfortunately, the reality of Korean textile production left a lot to be desired in the early 1960s: the downstream sector was much too small, and its level of technology much too low, for Dongyang to pursue prematurely a large-scale plant in polyester. Of the man-made fibres, nylon had the best and most realistic prospects for the Korean economy at the time. Not only did nylon meet the clothing needs in Korea, but in other developed economies, it was also being commercialised beyond apparel end-uses for industrial applications such as tyre-cord fabrics, ropes, fishnets, and the Korean entrepreneurs anticipated wider uses if they could assimilate the manufacturing technology.

Second, Japan was the influential foreign source for technology, management and capital. Given the proximity of the Japanese market, the compatibility between the firms, or Japan's own recent experience in initiating the synthetic fibre industry, it is not surprising that the Korean firms found Japanese sources or suppliers to be low-cost, low-risk choices. If Kolon or Dongyang had any intention of restraining Japanese influence, they soon found out their options were limited. Kolon's joint venture with the US engineering firm, Chemtex, in 1962 was the first of its kind in Korean corporate history, but although Chemtex was helpful in raising capital in the United States, the establishment of the first nylon plant in 1963 was beset with problems—not only from the lack of experience in Kolon's plant personnel but also Chemtex's own shortcomings in designing the plant and subsequently helping Kolon with its operation. To overcome these difficulties, Kolon sought production technology and management expertise from its long-time supplier, Toray, via a technical assistance agreement. Kolon's ties with Toray went back to its commercial days in Tokyo, and were further cemented as a joint venture in 1971, as Kolon sought expansion into industrial applications of nylon as well as polyester.

The latecomer, Dongyang, was acutely aware of path-dependency problems with Japanese firms and its market entry strategies reflect such concerns. Dongyang struggled with what they perceived as newcomer disadvantage (versus the incumbent Kolon), and this made it more circumspect in the selection of foreign suppliers and technology for the construction of the nylon filament plant, which related directly to production costs and quality of the products. Dongyang scrutinised the value of each candidate (e.g., Snia Viscosa (Italy), Vickers Zimmer (Germany), BASF (Germany), Kureha (Japan), Unichika (Japan), Ubeko (Japan)), and narrowed the field down to Vickers Zimmer (Germany) and Unichika (Japan). Compared to its competitors, Unichika

produced a superior quality nylon, particularly in industrial applications, and Dongyang also valued the Japanese firm's accumulated know-how in production. Unichika's main drawback for Dongyang, however, was that it was a Japanese firm, in other words, potentially a competitor in export markets. Dongyang speculated that if partnered with Unichika, the relationship would eventually create many obstacles in importing technology or expanding existing plants and facilities. The other candidate, Vickers Zimmer, was an engineering firm specialising in technology assistance. It may not have had the management experience of Unichika but boasted a higher level of technology, and Dongyang came to settle on Vickers Zimmer as its main foreign source of technology.

Third, what is of more interest is how the Korean firms took ownership of managing technology, when their options were under heavy constraints. **Table 1** conforms to the general pattern reported for Korean firms during industrialisation: an overwhelming preference for purchasing capital goods (with commercial loans) over technical assistance and joint ventures as means of acquiring foreign technology. But the mix and match of the three types of inflows through the 1960s-70s suggest that where necessary or advantageous, the firms employed the range of options available, and this did not result in the same outcome across firms. Kolon chose to forge long-term relationships with Chemtex and Toray, both of which were critical in its expansion to industrial uses of nylon, polyester, and eventually plant exports.

Dongyang, on the other hand, developed a divide-and-rule strategy to manage and master technology. Dongyang minimised its reliance on Vickers Zimmer by assigning to the German firm only the core part in plant design while it made great efforts to increase the involvement and participation of Dongyang in the minutest of the plans, e.g., by seeking ways to allow the local personnel to absorb and learn the contents through joint participation and interaction. Dongyang did not rely on whole or turnkey purchase of the plant and technology, and the firm combed through specialist machinery makers for each and every part of the plant, asking for quote from each maker, instead of relying on Vickers Zimmer to take care of everything. Dongyang's US\$14 million expansion project in 1974 (increasing daily output from 60 to 82 metric tonnes, inclusive of industrial applications in tyre-cords and fishnets) was also a typical case of ownership by divide-and-rule. Purchase of machinery and technical services was divided across three Japanese suppliers (with Marubeni in charge of the core polymerisation and spinning stages, and Itoh C. and Murata Machinery of drawing and twisting parts), and each of these suppliers oversaw a number of 'subsuppliers worldwide'. When Dongyang sought technical assistance from Teijin (Toray's main competitor in Japan), the contract terms were very specific, e.g., in the 1972 agreement for improvements in nylon manufacturing, the terms were limited to 'processes beginning with feeding nylon 6 polymers into melter, ending with draw-twisting'.

The more relevant point from **Table 1** may be that technical assistance and joint ventures are advantageous in initiating higher-risk ventures, whereas commercial loans funded operation of plants, purchases of petrochemical inputs and equipment, i.e., continuation or expansion of projects. In other words, technical assistance and joint ventures were sought out when Kolon and Dongyang could not gain access otherwise to technical information and expertise which could not grow from their existing stock of resources or mere capital imports.

Conclusion

While it is true that the hierarchical relations with the government have created a highly constraining, mediating, and regulatory environment for the firms, the dynamic nature of technology implies that no uniform, singular or optimal path of development exists for firms, and this creates a breathing space and room for manoeuvre vis-à-vis the government. Empirical evidence for development of technological capabilities is found mostly at the firm-level, not the government-level. Even aggregate indicators for science and technology would not reveal much about acquisition of technological capabilities beyond initial conditions for such development. Therefore, a firm-level approach through case studies would have more value in assessing technological capabilities, so long as they are feasible, that is, given the availability of primary sources.

This paper compared the two leading nylon producers during Korea's industrialisation based on the development of their technological capabilities, and the research suggests that while the technology inflows in the synthetic fibre industry conform to the established channels of transfer in Korea—that is, primarily through capital goods imports—the few recorded instances of technology assistance and joint ventures may have been more relevant in upgrading the firms' technological capabilities. For now, this is a preliminary conclusion pending the second case study into the polyester producers, two of which Kolon and Dongyang, but it shall be of interest whether the patterns and characteristics observed for Kolon and Dongyang apply also for their ventures into polyester.