INNOVATION IN MAN-MADE FIBRES: CORPORATE STRATEGY AND NATIONAL INSTITUTIONS

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THE THREE COMPANIES

Courtaulds (UK): taken over in 1998 and broken up

Toray (Japan): major Japanese chemical company, with interests in fibres and textiles, composite materials, IT-related products and other products

Lenzing (Austria): leading producer of cellulosic fibres

THE TWO PRODUCTS

Carbon fibre

High-strength material used in aerospace, sporting goods and a wide range of industrial applications

Lyocell (Tencel)

A cellulosic fibre used in textile and non-textile applications

MAN-MADE FIBRES

Cellulosic fibres (based on woodpulp)

Rayon (viscose), acetate, lyocell (*Tencel*)

Synthetic fibres (based on oil)

Polyester, Acrylic, Nylon, Polypropylene

Elastane/Spandex (*Lycra*)

Aramid (*Kevlar, Twaron*)

EVOLUTION OF THE INDUSTRY

1900-1945 Growth of rayon before and after first world war; invention of nylon by DuPont in 1935

1945-1975 Boom time for synthetic fibres (nylon, polyester, acrylic)

1975-2000 Maturity and decline in advanced industrial countries as production of textiles, clothing and later fibres shifts to low-wage countries, principally in Asia

PRODUCTION OF MAN-MADE FIBRES BY REGION (tonnes)

	1977	2007
North America	3.7m (27%)	4.2m (9%)
West Europe	3.3m (25%)	4.8m (10%)
East Europe	2.2m (16%)	0.8m (2%)
Asia	3.2m (24%)	35.7m (75%)
Other	1.0m (8%)	2.0m (4%)
TOTAL	13.3m	47.5m

Source: AFMA

COURTAULDS

1904 Acquires patents to viscose process

1940 Joint nylon company with ICI (BNS)

1961/62 Fights off ICI takeover bid

1965/75 Investment in textiles and clothing

1969 Builds carbon fibre plant

1988 Buys PRC (aircraft sealants) in the US

1989 Demerges Courtaulds Textiles

1992 Launches Tencel

1998 Taken over by Akzo Nobel

COURTAULDS IN 1997-98

	Sales % of total	Profit % of total
Coatings and sealants	49	54
Fibres and chemicals	39	32
Polymer products	12	14

TORAY

1928 Toyo Rayon founded by Mitsui

1950 Begins nylon production

1957 Obtains polyester licence from ICI

1964 Begins acrylic fibre production

1971 Begins carbon fibre production

1996 Starts polyester plant in China

1997 Opens carbon fibre plant in Alabama

TORAY IN 2011-12

	Sales (% of total)	Profit (% of total)
Fibres and textiles	41	36
Plastics and chemicals	25	22
IT-related products	15	27
Composite materials	4	6
Other	15	9

LENZING

1938 Starts production of viscose

1964 Launches Modal speciality fibre

1979 Buys stake in Indonesian viscose plant

1985 Lists shares on Vienna Stock Exchange

2004 Acquires Tencel from CVC

2005 Starts viscose plant in China

2010 Plans new Tencel plant in Austria

LENZING SALES IN 2011

Turnover (millions of euros)		Distribution of sales (% of total)	
Fibres	1,928 (90.0%)	Asia	57
Plastics	171 (8.0%)	Europe	33
Engineering	40 (1.9%)	Americas	7
Other	- (0.1%)	Other	3

CF PRODUCTION CHAIN

- Precursor - usually polyacrylonitrile (PAN)
- Oxidisation and carbonisation, to produce bundles of filaments held together by a resin
- Pre-impregnated sheets (prepregs) and other intermediate materials
- Manufacture of composite parts

CARBON FIBRE

Two key innovations:

1961 Shindo in Japan establishes polyacrylonitrile (PAN) as precursor

1963 Royal Aircraft Establishment in UK develops new process to make stronger and stiffer fibre

COURTAULDS: TWO TYPES OF CARBON FIBRE

Special Acrylic Fibre (made in Coventry): small tow fibre suitable for applications requiring high strength and lightness

Textile Tow Precursor (made at Grimsby): suitable for less demanding applications

COURTAULDS' ALLIANCES

US

Hercules 1970-1979

Dexter 1984-1989

Japan

Mitsubishi Rayon 1971-1991

JAPANESE CF PRODUCERS

Toray

Toho Rayon/Toho Tenax (subsidiary of Teijin since 2000)

Mitsubishi Rayon

Asahi Kasei (withdrew in 1994)

CARBON FIBRE DEMAND IN 1984 (tonnes)

	Europe	US	Japan
Aerospace	330	1110	50
Sports goods	200	400	500
Industrial	180	300	350
Total	710	1810	900

CARBON FIBRE CONSUMPTION

	1978 (tons)	1988 (tons)
US	160	2650
Europe	80	900
Japan	120	950
Others	-	1000
TOTAL	360	5500

US DEFENCE MARKET

In 1987 the US Defense Department ruled that at least 50% of the carbon fibre used in federally funded programmes, and 50% of the precursor, must be made in the US

This prompted a wave of investment in new capacity by American and non-American producers

“DÉTENTE RECESSION”

US carbon fibre demand (tons)

	1987	1991
Aerospace	1500	1080
Sports goods	320	530
Industrial	450	590
TOTAL	2270	2200

LEADING PRODUCERS IN 1988 AND 2008

1988		2008	
Toray	1500	Toray	17600
Toho Rayon	1420	Toho Tenax	10500
Hercules	1050	Mitsubishi Rayon	7400
Courtaulds	750	Formosa Plastics	3000
BASF	450	Hexcel	4200
Amoco	450	Cytec	1900

TORAY IN THE US

1970 Technology agreement with Union Carbide

1981 Torayca T300 chosen for Boeing 757 and 767 secondary structures

1987 Selected for Airbus A320 primary structure – joint company formed with Elf Aquitaine

1997 Starts CF production in US

2005 Fourth CF centre set up in Korea

WHY DID COURTAULDS FAIL?

- Shortcomings in the precursor
- Lack of aerospace quality products
- Management culture based on commodity fibres
- Failure to make best use of partnerships
- Failure to recognise need for long-term market and product development

SOURCES OF JAPAN'S SUCCESS

- Late entry into acrylic fibre
- Shindo patent
- Golf club boom
- Links to Taiwan and Korea for sports goods
- Quality/engineering excellence
- Long-termism – absence of shareholder pressure

VISCOSE VS SOLVENT SPINNING

The viscose process used toxic chemicals that had to be disposed of as effluent – recent improvements, principally by Lenzing, have drastically reduced environmental damage

Solvent spinning is a closed-loop process in which most of the chemicals can be re-used. It also produces a stronger fibre

COURTAULDS AND TENCEL

1992 Go-ahead for US Tencel plant – on stream in 1994

1994 Expansion of US plant approved

1995 Decision to build Tencel plant at Grimsby

1999 Akzo Nobel sells ex-Courtaulds fibres business, including Tencel, to CVC

2004 CVC sells Tencel business to Lenzing

LENZING AND TENCEL

1988 Buys lyocell licence from Akzo

1990 Pilot plant for lyocell

1995 Starts lyocell production at Heiligenkreuz, Austria

2004 Buys Tencel business from CVC

2010 Announces plan for new Tencel plant at the Lenzing site, with capacity of 60,000 tonnes per year

EXPANSION AT LENZING

	2011output	2015 target
Total	705,000 tons	1,185,000 tons
Of which:		
Viscose	450.000 (64%)	765,000 (64%)
Tencel	134,000 (19%)	280,000 (23%)
Modal	121,000 (17%)	140,000 (13%)

WHAT DID COURTAULDS DO WRONG?

- Too pessimistic about viscose, too optimistic about Tencel
- Under-estimated time needed to develop Tencel market and to iron out technical problems
- With other businesses performing poorly in the mid-1990s, Tencel had to succeed and had to succeed quickly

REFLECTIONS

- How far can the outcome be explained by company-specific, managerial factors?
- How far did ownership and governance arrangements that favoured “long-termism” constitute a competitive advantage for Toray and Lenzing?