

Where India fits within Flextronics global supply chain

By
Yaakov (Kobi) Ben-Simon

B.S. in Communication Systems Engineering, Ben-Gurion University Israel, 2002

Submitted to the Sloan School of Management and the
Department of Electrical Engineering & Computer Science
In Partial Fulfillment of the Requirements for the Degrees of

Master Of Business Administration

And

Master Of Science In Electrical Engineering & Computer Science

In Conjunction with the Leaders for Manufacturing Program at the
Massachusetts Institute of Technology

June 2007

© 2007 Massachusetts Institute of Technology. All rights reserved.

Signature of
Author _____

MIT Sloan School of Management
Department of Electrical Engineering and Computer Science
May 11, 2007

Certified
by _____

Donald Rosenfield, Thesis Supervisor
Sloan School of Management

Certified
by _____

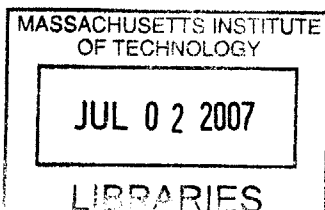
Charles Sodini, Thesis Supervisor
Professor of Electrical Engineering and Computer Science

Accepted
by _____

Debbie Berechman, Director of Master's Program
Sloan School of Management

Accepted
by _____

Art Smith, Chairman of the Graduating Committee
Electrical Engineering and Computer Science



BARKER

This page is intentionally left blank.

Where India fits within Flextronics global supply chain

By

Yaakov (Kobi) Ben-Simon

Submitted to the MIT Sloan School of Management and Department of Electrical Engineering & Computer Science on May 11, 2007 in Partial Fulfillment of the Requirements for the Degrees of

Master Of Business Administration

And

Master Of Science In Electrical Engineering & Computer Science

ABSTRACT

This project focuses on Flextronics International manufacturing strategy regarding its global supply chain design, and its export strategy from India. It also focuses on the application of the Flextronics case to the question of India's role in global electronics manufacturing.

Following China's successful economic model, India is establishing itself as a global manufacturing hub by attracting multinational companies. Over time, India has the potential to become a large end-market for electronic products. In addition, India's low-cost labor-base may allow it to become a lucrative manufacturing location for export markets. On the other hand, the infrastructure is problematic, the component supply base is extremely undeveloped, and extensive competition exists from well-developed, low-cost Asian countries.

This thesis examines the competitive advantage and disadvantage of export-oriented electronic manufacturing in India. It studies the business environment in India in terms of infrastructure, taxes, bureaucracy, and government policies. The thesis also identifies high potential products for manufacturing in India, and compares the total cost in India to the cost in China for the manufacture of a mechanical enclosure. For the mechanical enclosure, this analysis establishes that India can be as competitive as China on a cost basis. The study also looks beyond cost to identify the key challenges for high-volume manufacturing in India and suggest ways to address them.

Thesis Advisor: Donald B. Rosenfield
Title: Senior Lecturer, MIT Sloan School of Management
Director, Leaders for Manufacturing Program

Thesis Advisor: Charles Sodini
Title: Professor
Department of Electrical Engineering & Computer Science

ACKNOWLEDGEMENTS

First, I would like to thank Flextronics for sponsoring my internship and making this thesis possible. A special thanks to Gururaj, my project coach, for all of his excellent guidance and coaching that allowed me to be successful in my internship. I also want to thank Patrick Hehir, my project sponsor, for giving me this challenging high-level opportunity and supporting me throughout my internship.

Also, thank you to the following Flextronics employees whose support made this thesis possible: Peter Tan, Deepak Martin, Ajay Aurora, Ganesh S, Nil Madhab, Milton Dean, and Rachel Serafini, and especially Michael Rubin whose warm friendship made my stay in India a remarkable experience.

I am grateful to the MIT Leaders for Manufacturing Program for providing me a fantastic and extremely rewarding learning opportunity that I will always cherish.

I would like to thank Don Rosenfield and Charles Sodini, my thesis supervisors, for their ideas and support.

Lastly, thank you to my family for their love and support, especially Hila, whose patience, love and understanding has made it possible for me to achieve my goals.

NOTE ON PROPRIETARY INFORMATION

In order to protect proprietary Flextronics information, the data presented throughout this thesis does not represent actual values used by Flextronics. The dollar values have been disguised and the project names have been removed in order to protect competitive information.

TABLE OF CONTENTS

ABSTRACT	3
ACKNOWLEDGEMENTS	4
TABLE OF CONTENTS	5
LIST OF FIGURES	7
LIST OF TABLES	7
1. INTRODUCTION	9
1.1 FLEXTRONICS OVERVIEW.....	9
1.1.1 <i>Flextronics India</i>	10
1.2 PROBLEM STATEMENT.....	11
1.2.1 <i>The Industrial Park Model</i>	13
1.2.2 <i>Foreign Exchange Hedging</i>	14
1.3 APPROACH	15
2 THE ELECTRONICS MANUFACTURING SERVICES (EMS) INDUSTRY .	16
2.1 OVERVIEW	16
2.2 PORTER’S FIVE-FORCES ANALYSIS	17
2.2.1 <i>Buyers Power</i>	18
2.2.2 <i>Suppliers Power</i>	19
2.2.3 <i>Threat of New Entry</i>	19
2.2.4 <i>Threat of Substitution</i>	20
2.2.5 <i>Competitive Rivalry</i>	20
2.2.6 <i>Conclusion</i>	21
3 INDIA’S ECONOMY	22

3.1	BASIC FACTS	22
3.2	THE EVOLUTION OF INDIA’S ECONOMY (1991-PRESENT)	24
3.3	THE BUSINESS ENVIRONMENT	26
3.3.1	<i>Tariffs and Taxes</i>	27
3.3.2	<i>Physical Infrastructure</i>	29
3.3.3	<i>Special economic zone</i>	33
3.3.4	<i>Corruption and bureaucracy</i>	34
4	VALUE CHAIN ANALYSIS	37
4.1	TOTAL COST OF MANUFACTURING MODEL	38
4.1.1	<i>Tools</i>	39
4.1.2	<i>Model Output</i>	39
4.1.3	<i>Model Assumptions</i>	39
4.1.4	<i>Cost Components</i>	41
4.1.5	<i>Supply Chain Scenarios</i>	42
4.2	BASE STATION ENCLOSURE ANALYSIS	45
4.2.1	<i>Manufacturing Process</i>	46
4.2.2	<i>Operations and Logistics</i>	47
4.2.3	<i>Analysis Results</i>	48
4.3	CONCLUSION	53
5	CAN INDIA EXECUTE?	54
5.1	LOCAL SUPPLY BASE.....	55
5.2	INFRASTRUCTURE	57
5.3	LABOR FORCE	59
6	RECOMMENDATIONS.....	63
	BIBLIOGRAPHY	66

LIST OF FIGURES

Figure 1: Flextronics market breakdown.....	10
Figure 2: Porter’s Five-Forces Model	18
Figure 3: India GDP growth 2001-2005.....	23
Figure 4: India FDI growth 2001-2005	23
Figure 5: India Import & Export 2001-2005	24
Figure 6: Index of Corruption by Indian states for 2005.....	35
Figure 7: Bill of Material Structure.....	47
Figure 8: Total Unit Costs Comparison	49
Figure 9: Logistic Cost Comparison	52
Figure 10: Comparison of Inventories by Status	52
Figure 11: Total Cost vs. Order Cycle Time	53
Figure 12: Positive Reinforcement Loop	64

LIST OF TABLES

Table 1: Comparison of subscriber base of China and India.....	12
Table 2: EMS Revenue Ranking – 2005	17
Table 3: India Corporate Tax Rate.....	27
Table 4: Transport links with associated costs and transit times.....	44

This page intentionally left blank.

1. INTRODUCTION

This thesis is the result of a joint effort between Flextronics International and the MIT Leaders for Manufacturing (LFM) Program. The objective of this work is to analyze the competitiveness of Electronic manufacturing facilities in India, and how should Multinational Corporations integrate India into their global supply chain.

This thesis is broken into several chapters. Chapter 1 provides an overview of Flextronics and their recent investment in India. In addition it reviews the problem statement and the approach taken to address it. Chapter 2 takes a high level look at the Electronics Manufacturing Services (EMS) industry, where Flextronics operates, and analyzes the different forces in its value chain. Chapter 3 reviews India's economic and business environment and the challenges multi-nationals face when doing business in the country. Chapter 4 compares two possible value chains for manufacturing a mechanical enclosure, namely using India as the manufacturing center and another with China. Chapter 5 discusses limitation to large scale manufacturing in India and how Flextronics should address them. Chapter 6 is a summary of the thesis findings and final recommendations.

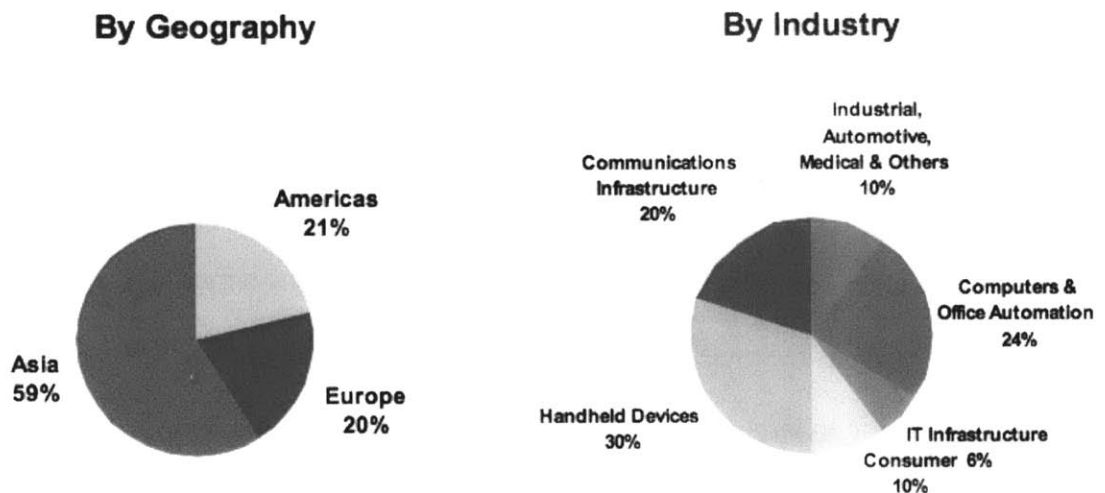
1.1 Flextronics Overview

Flextronics is an international company registered in Singapore with \$15.3 Billion in sales for fiscal year 2006. Flextronics provides advanced electronics manufacturing services (EMS) to OEMs across a broad range of products and industries. Flextronics integrated model spans all the way from the product design stage to manufacturing,

shipping products to consumers, and reverse logistics. The company operates production facilities in over 30 countries and has 130,000 employees.

In 2006 Flextronics rearranged its organization around market products to form seven business segments: Mobile (Handheld Devices), Computing (including office Automation), Infrastructure (IT & Communications), Consumer Digital, Automotive, Medical, and Industrial. For the break down of Flextronics revenue in terms of segment and geography see Figure 1.

Figure 1: Flextronics market breakdown



1.1.1 Flextronics India

Flextronics first established a presence in India back in 2001 when it acquired a plant in Bangalore that used to manufacture pagers from Motorola. Today the factory specializes in low-volume, high-mix products mainly serving Indian OEMs. In addition, Flextronics

also owns several design centers, software development, and a global Business Process Outsourcing (BPO) group that handles back office operations for the entire organization. This thesis will focus only on the manufacturing services Flextronics provide.

Following the rapid growth in India's economy, Flextronics decided in early 2006 to expand its presence in the country with a fully vertically-integrated industrial park using the same model it operates in other low-cost areas like China, East Europe, and Brazil. After considering different locations Flextronics acquired a 250-acre plot at Sriperumbudur, Tamil Nadu, located 50 KM from the city of Chennai (previously known as Madras) in the southern part of India. The site is within a Special Economic Zone (SEZ), enjoys close proximity to Chennai's international airport, seaport, and the highway that connects Chennai to Bangalore, Mumbai, and Delhi. Chennai is also a center for automotive manufacturers with a strong mechanical supply base. The facility started operations in November 2006.

1.2 Problem Statement

Flextronics, as a leading manufacturer of mobile handsets and cellular infrastructure, could not ignore the booming Indian market. With mobile subscribers in India growing at around 85% a year since 1999, reaching 4M new subscribers a month, India is the fastest growing mobile market in the world. Table 1 describes the subscriber base growth for both China and India in the past ten years. Given India's government policy for local manufacturing content in all public contracts, Flextronics decided to make a bold move and build a large-scale factory in India. Flextronics was the first EMS to make such a

decision and at the time it was made, early 2006, the focus was completely on serving the needs of the fast growing domestic market.

Table 1: Comparison of subscriber base of China and India

Year	Fixed Line (Mn)		Cellular Line (Mn)	
	China	India	China	India
1997	70	14.54	15	0.34
1998	90	17.8	20	0.88
1999	110	21.59	40	1.2
2000	130	26.51	85	1.88
2001	180	32.44	145	3.58
2002	210	37.94	210	6.43
2003	263	40.62	269	12.69
2004	312	42.58	335	33.6
2005	350	45.91	390	52.21
2006	359	46.78	410	93.04

Source: National Bureau of statistics of China, MII and TRAI

Through this project and the internship, Flextronics senior management goal is to explore a more global strategy for their recent investment. Looking to learn if the new facility can be integrated into Flextronics global supply chain and grow beyond just a regional facility. It is not a straightforward assumption that such a strategy is needed. Many at Flextronics believe that the future growth in the country is enough to justify such an investment and Flextronics India should not seek to become a global manufacturing hub. After brainstorming with the project stakeholders, the motivation for the project was defined around two major drivers. These drivers are: leveraging the industrial-park model and currency exchange hedging.

1.2.1 The Industrial Park Model

From the 1970s there is a clear global trend towards disintegration of production¹. Helped by globalization, many manufacturing companies “sliced up their value chain”² and outsourced parts of it to low-cost areas. Two famous example of this trend are Nike and Cisco that outsource their entire supply chain. On the receiving side, electronic contract manufacturer took over the “slices” OEMs were looking to outsource. Flextronics and its competitors transformed from PCB boards stuffing shops into vertically integrated manufacturing services providers. Chapter 2 will cover the industry in more depth.

Vertical integration³ is a key part of Flextronics operational strategy. As part of the strategy Flextronics uses vertical integrated industrial parks to collocate all the supply chain, from the component production to final assembly and test, in one facility. The rational behind this model, first introduced by Flextronics and later adopted by the rest of the industry, is economy of scale benefits through extremely high volume production.

For its new industrial park in India, where all the output is shipped to the local market, Flextronics is running the risk of operating a high-mix/low-volume kind of operation. This will not allow the company to receive the ROI it requires. By integrating the Chennai park into the global playing field, like all the other industrial parks Flextronics operates, the company can achieve the scale it need to support its business model.

¹ Feenstra 1998, “Integration of Trade and Disintegration of Production in the Global Economy”

² Kurgman 1996, “Does third world growth hurt first world prosperity?”

³ Flextronics uses the term “vertical-integration” to describe its manufacturing services. Flextronics is not a pure vertical-integrated company like Samsung for example.

1.2.2 Foreign Exchange Hedging

Foreign exchange exposure is defined as the effect of unexpected changes in the real exchange rate on firms. The risk can be divided into two types of economic exposure. Short-term exposure is the effect of unexpected changes in exchange rate on the firm cash flows and monetary assets. Firms with global operations can easily use financial-hedging methods such as currency derivatives to reduce cash flow variation⁴. The long-term exposure, also called operating exposure, is the foreign exchange effect on the firm real (non-monetary) assets and liabilities. To offset long-term exposure a firm must use operating adjustments such as shifting production to countries where significant sales revenue is expected⁵. Studies show that the use of operational hedges in conjunction with foreign currency derivatives increases firm value⁶.

For Flextronics, India can become part of its global operational hedging strategy. Manufacturing cost in China is rising rapidly and the Chinese currency is appreciating against the dollar in a trend predicted to continue. By building manufacturing capabilities in India, similar to what can be found in China, Flextronics can provide its customer base a way to hedge their foreign exchange risk while gaining more flexibility. This can also serve as a differentiation factor from Flextronics main competitor, Foxconn, which operates mainly from China.

⁴ Geczy, Minton, Schrand 1997, "Why Firms Use Currency Derivatives"

⁵ Pantzalis, Simkins, Laux 2001, "Operational Hedges and the Foreign Exchange Exposure of U.S. Multinational Corporations"

⁶ Allayannis, Ihrig, Weston 2001, "Exchange-Rate Hedging: Financial versus Operational Strategies"

1.3 Approach

In order to achieve the expected outcome of this project, it was essential to understand the unique business conditions in India. The first half of the internship took place in India along side Flextronics India team as they make the transition from a small local factory to one of Flextronics major manufacturing facilities in Asia. Through interview sessions held with Flextronics management, employees, customers, suppliers, and partners, we were able to identify the unique business culture in India and how it can affect Flextronics long-term strategy in the region. Next, a value chain model was used to compare the total cost of manufacturing in India vs. China. This was done to understand whether Flextronics could bring value to its global customers by using the new industrial park in Chennai as an alternative to other low cost options in Asia.

2 The Electronics Manufacturing Services (EMS) Industry

2.1 Overview

The term Electronics Manufacturing Services (EMS) is used to describe companies that provide design, test, manufacturing, and distribution services to Original Equipment Manufacturers (OEM). During the 1980s and 1990s, EMS companies that used to provide straightforward manufacturing services, like board assemblies, started to expand their capabilities and services to handle all aspect of the production process. From early design to packing and shipping the final product with the OEM brand name, to become a “virtual factory” to their customers.

For the OEMs, the option to outsource their manufacturing operations presented an opportunity to focus more on product design and marketing, areas they believe is where their strength and competitive advantage lays. It is also a way to benefit from the economies of scale an EMS can provide by serving multiple customers. During the 1990s the EMS companies experienced tremendous growth that usually came through acquisitions. To win contracts with OEMs, EMSs agreed to take over the existing manufacturing assets and employees, usually in high cost areas. In recent years there is a clear shift towards low-cost areas where EMS companies are setting up new manufacturing facilities and design centers. Looking at the industry today, China has clearly emerged as the center of gravity for commodity electronics.

The industry also went through a big consolidation period as players seek to gain more economies of scale to cover for the very low-margin they receive for their services.

Today, the top six EMS players control more than half the market. See Table 2 for the Top 10 EMS providers.

Table 2: EMS Revenue Ranking – 2005

Rank	Company	2005 Rev (\$M)
1	Foxconn	27315
2	Flextronics	15582
3	Sanmina-SCI	11343
4	Solectron	10207
5	Celestica	8471
6	Jabil Circuit	8057
7	Elcoteq	5179
8	Benchmark	2257
9	Venture	2007
10	Universal Scientific	1622
Top 10 EMS Total		92040
All Other		45088

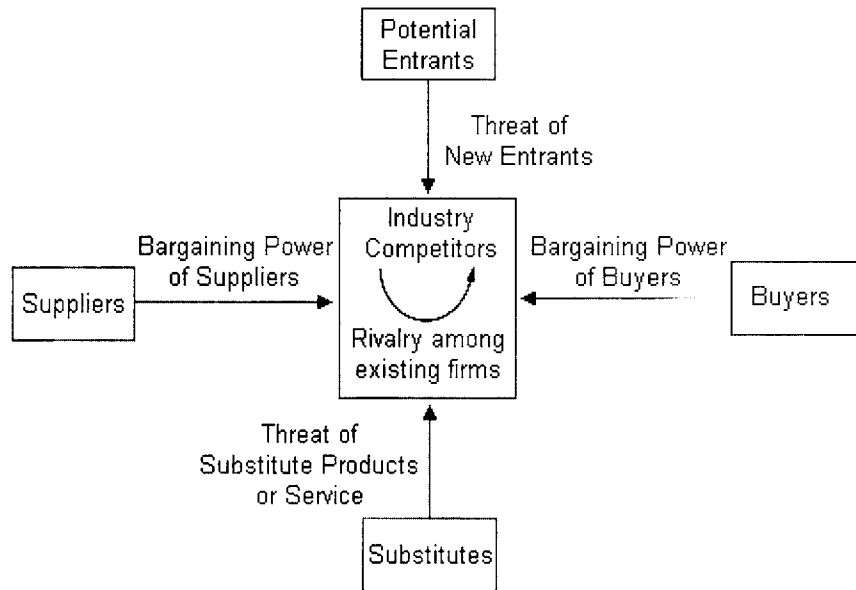
Source: iSuppli Corp, May 2006

2.2 Porter’s Five-Forces Analysis

The Porter Five-Forces analysis is a strategic framework developed by Michael Porter in 1979 to derive the forces that determine the attractiveness of a market in terms of the value firms in the market (or looking to enter) can capture. This model involves a relationship between competitors within an industry, potential competitors, suppliers, and buyers (see Figure 2) to better understand the context in which firms within the industry operate. The forces directly affect a firm ability to serve its customer and make a profit and should be taken into account when forming a business strategy. This analysis can be

used to illustrate why profit margin in the industry is low, and why growth and scale are so important.

Figure 2: Porter's Five-Forces Model



Lets examine each force in the context of the electronics manufacturing market, performing the analysis from the viewpoint of the leading EMS firms:

2.2.1 Buyers Power

Negative. The buyers in this case are the OEMs. Since most of the manufacturing used to be done by the OEMs in house, they are intimately familiar with the processes needed to support manufacturing and the cost associated with them. If the EMS provider will try to charge above a certain margin than the OEM is willing to accept, the OEM can easily decide to bring that service back home.

Switching costs from one EMS firm to another are relatively low and limits the negotiating power EMS firms have with their customers. Most OEMs are working with more than one EMS firm as a way to reduce risk but also to put pressure on the EMSs to keep prices low.

2.2.2 Suppliers Power

Positive. Any one of the leading EMS firms is spending billions of dollars annually on component purchases. They hold a significant procurement power on the electronic suppliers who operates in a commodity market. For the high-end components that are not commoditize yet, such as mobile camera modules and high end displays, the EMS firms make sure to backward integrate through acquisitions in order to benefit from the higher margins. A recent example is the acquisition of International DisplayWorks, a manufacturer of small LCD displays for cell phones and MP3 players, by Flextronics in September 2006.

2.2.3 Threat of New Entry

Positive. In a business that is all about low-cost, economies of scale plays a significant role. It will be very hard for a new entrant to achieve the cost advantage needed to compete. Current players gained their scale mostly through acquisitions but as the industry consolidates, and since most of the major OEMs already outsourced their manufacturing assets, there are only a few acquisition opportunities left.

Beside scale, manufacturing capabilities are key in achieving cost advantage. The current incumbents are already down the learning curve. It will take years for a new entrant, even

if it has the necessary scale, to build the capabilities in high-volume manufacturing in order to compete effectively.

2.2.4 Threat of Substitution

Neutral. In the context of the EMS industry, substitution can mean returning to the old model where OEMs were vertically integrated. The chances of that happening in the near future are very slim. OEMs will have a hard time justifying the big investments only years after they outsourced their factories. In addition, the economics of scale EMS companies achieved, combined with the capabilities they built in low-cost areas, make it uneconomical for the OEMs to completely backward integrate at this point. Nevertheless, it is possible for OEMs to bring back some of the services they currently outsource such as product design or material procurement while still using EMS providers for labor and capital intensive tasks, such as final assembly and board stuffing, that are usually low-margin services.

2.2.5 Competitive Rivalry

Negative. Competition is high with several first-tier firms fighting for the leading OEM accounts, and many second and third tier competitors trying to work their way up. In the past ten years the competition map changed as a different firm took the lead every few years. Most recently, Taiwan based Foxconn is the industry leader with 2005 sales double the second player Flextronics. In general, all the players are finding it hard to differentiate. They are trying to climb the value chain with new services, such as Original Design Manufacturing (ODM), in order to stand out.

2.2.6 Conclusion

Looking at the recent performance of the top EMS firms, it is obvious that they are operating in a very competitive environment. The Five-Forces analysis highlights the challenges in the industry, mainly fierce competition that in turn result in massive buyer power. This can explain the consolidation trend we see and the intense focus management put on the top line growth. The belief is that once the industry matures with a small handful of firms, all with high production scale, they will be able to reduce the OEMs buying power and extract more value out of the chain using the positive forces that work on their behalf. From the OEMs point of view, EMS firms deliver more value than just low-cost manufacturing. They provide an efficient way to smooth demand variations by aggregating production from several OEMs.

As for Flextronics, any proposed strategy will have to take the market conditions into account. Understanding the market also help us understand why Flextronics is so focused on growth and the rational behind the company's vertical-integration strategy. Later we will examine how this market analysis fits with the strategy in India.

3 India's Economy

This chapter will provide economic background information in order to set up the context for the discussion to come. Starting with basic facts about the current state of the economy, followed by a review of India's economic development history from 1991 to present. The last section will explore the business environment and challenges foreign investors and Multi National Corporations (MNC) face while doing business in India.

3.1 Basic facts

With a gross domestic product (GDP) of 4.042 trillion, measured by purchasing power parity (PPP), India is the fourth largest economy in the world after the US, China, and Japan⁷. India is among the fastest growing economies in the world, achieving 8.5% GDP growth in 2006 and an annual average of more than 7% in the decade since 1996. 60% of India's 509.3-million labor force earn its living in the agriculture sector but only contributes 20% of the GDP⁸. Service is the largest sector, responsible for 60.7% of GDP and 28% of the workforce. India huge population, estimated at 1.1B, results in a per capita income of \$3,400 PPP and \$714 nominal which classifies the country as a low income economy according to the world bank⁹. 25% of the population lives below poverty line, down 10% from 1996. Unemployment rate stands at 7.8% (2006 estimate).

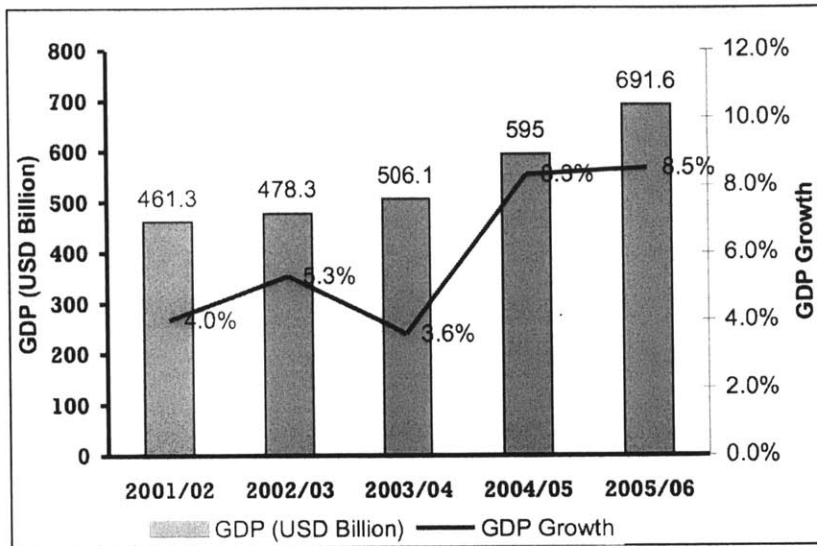
Figure 3 through figure 5 presents India's major economic indicators.

⁷ CIA – The world Factbook - India

⁸ The Economist Intelligence Unit, India Country Profile 2006

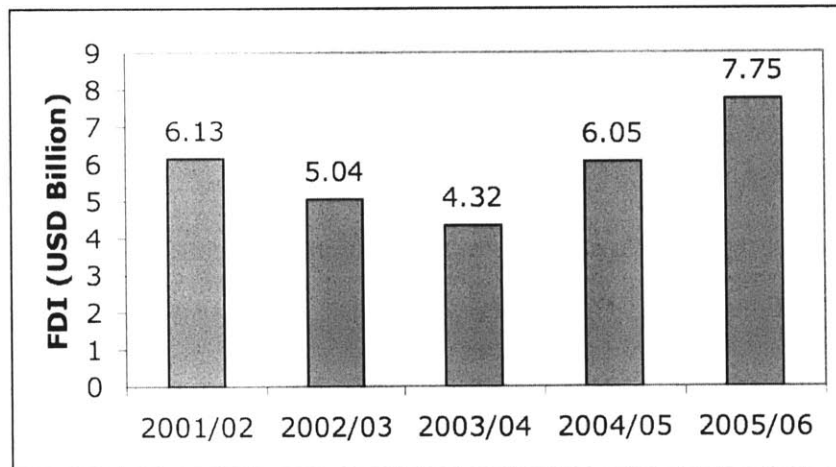
⁹ World Bank Country Classification Groups, (July 2006 data)

Figure 3: India GDP growth 2001-2005



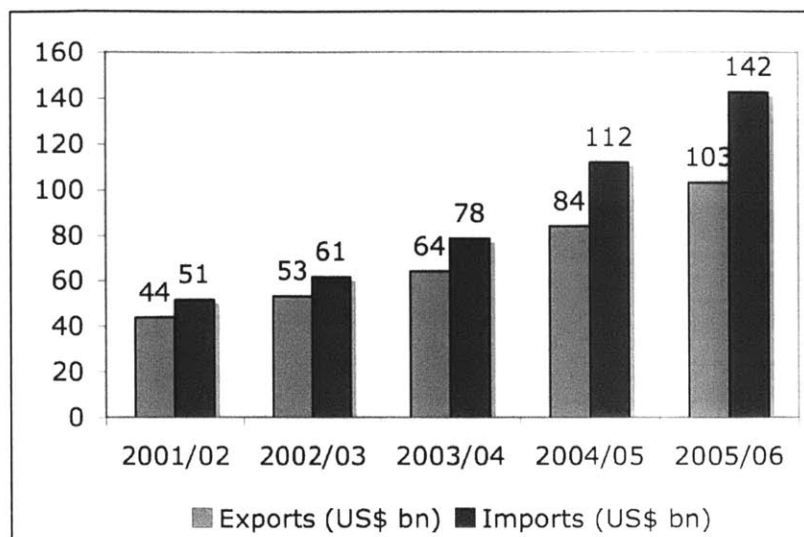
Source: Economist Intelligence unit

Figure 4: India FDI growth 2001-2005



Source: Export-Import Bank of India (EXIM)

Figure 5: India Import & Export 2001-2005



Source: Export-Import Bank of India (EXIM)

3.2 The Evolution of India's Economy (1991-Present)

Since its independence in 1947 and until 1991, India's economy followed a socialist approach with tight government control over the private sector, foreign trade, and foreign direct investments (FDI). The slow pace of economy growth, averaging 1.5% annually, during this period was known as the "Hindu rate of growth" because of the unfavorable comparison with growth rates in other Asian countries, especially the "East Asian Tigers"¹⁰.

Following the balance-of-payments crisis of 1991, the newly elected government under Prime Minister Narasimha Rao and Finance Minister Manmohan Singh, initiated a series

¹⁰ Williamson, John and Zaghera, Roberto (2002). "From the Hindu Rate of Growth to the Hindu Rate of Reform"

of economic reforms that set India on a path of stronger economic growth. First to go was the License Raj that was used by the government to control the economy. Prior to 1991 the government issued licenses to business that specified what and how much each business could produce, foreign investments and ownership was discouraged, and trade quotas were set and controlled by the state. The trend of liberalization continues to the present even though the current government in power is backed by a coalition of left and communist parties.

The pace of reform in India is considered slow but if we look at the cumulative effect from 1991 we can see substantial achievements¹¹:

- **Privatization** – more and more sectors have been opened to private investment, including power, steel, oil refining and exploration, road construction, air transport, telecommunications, ports, mining, pharmaceuticals and the financial sector.
- **FDI** – except in a few strategic sectors, policy makers are working to encourage foreign direct investment. From an average of \$200M a year between 1985-1991, FDI increased to \$8.3B in 2005 and is estimated to reach \$12B in 2006. Still way behind China's \$72.4B in 2005.
- **Trade** - Trade policy has been liberalized. All quantitative restrictions on imports were lifted and replaced by tariffs.
- **Exchange rate** – The government relaxed its control on setting the rupee exchange rate, and in 1993 a market determined exchange rate was introduced. All restrictions

¹¹ The Economist Intelligence Unit, India Country Profile 2006

were removed on foreign exchange business transactions as well as travel, education, medical expenses, etc.

- **Capital Markets** - Capital markets have reformed. Private mutual funds, foreign institutional investors, and country funds are active investor. The stock market is now subject to more rigorous regulation.

India has still a long way to go in term of reforms. No government so far had the courage to deal with labor laws reform and the strong union and lobby groups. Agriculture subsidies are also a very delicate issue that has not been addressed. These issues are considered a constraint for sustaining future growth at current rates and are going to be a huge challenge for India's government looking forward. After the 2004 election, a coalition led by the congress party and backed by the communist party came to power thanks to the support of poor rural voters. It is left to be seen how Prime Minister, Manmohan Singh, can push forward sensitive and unpopular reforms.

3.3 The Business Environment

This section will cover the major incentives foreign investors can expect to receive when setting up local operations in India. It will also cover topics like the tax structure and infrastructure conditions. To be aligned with the subject of this paper, this section will mostly focus on export related policies affecting foreign multinationals aiming to set up manufacturing in India and looking to export some or all of their output. The business environment in India is changing very fast. All policies mentioned are true for the end of 2006.

3.3.1 Tariffs and Taxes

The India tax structure defines the authority of the federal government, states and local bodies to collect taxes. The central government levies taxes on income, customs duties, central excise and service tax. Value Added Tax (VAT), stamp duty, state excise, land revenue and tax on professions are levied by the State Governments. Local bodies are empowered to levy tax on properties and for utilities like water supply, drainage etc. The taxation system is undergoing tremendous reform to make it simpler and to align tax rates to other developing countries. As of the end of 2006 these are the tax rates levied on corporations¹²:

- **Corporate Income Tax** – The tax system distinguish between domestic and non-residential corporations. Every company incorporated in India is considered domestic even if it is 100% foreign owned. A domestic company is required to pay taxes on its global income. Foreign corporations are required to pay tax on income earned from a business connection in India. Table 3 shows the different tax rates for domestic and foreign corporations. In addition, all corporations have to pay dividend distribution tax at the rate of 12.5%.

Table 3: India Corporate Tax Rate

	<i>Domestic</i>	<i>Foreign</i>
Basic Rate	35%	40%
Surcharge	3%	3%
Wealth tax	1%	1%
Total	39%	44%

Source: India Tax Department

¹² “Taxation System in India”, Embassy of India <http://www.indianembassy.org>

- **Capital Gains Tax** – For Capital assets held more than 3 years and equity shares and mutual funds held more than one year, a long-term capital gain of 20% is levied. Short-term capital gain is taxed at normal corporate income rate. Long-term and short-term capital losses are allowed to be carried forward for eight consecutive years.
- **Excise Duty** - Manufacturing of goods in India attracts Excise Duty at the rate of 16%. Excise duty is levied on 'add value' basis or based on the maximum retail price in some cases.
- **Customs Duty** - Imported goods in India attract basic customs duty and additional customs duty. The rate of basic customs duty are specified under the Tariff Act and can be found at the Website of the Central Board of Excise and Customs¹³. The peak rate for industrial goods is 15%. Additional customs duty is equivalent to the excise duty payable on similar goods manufactured in India.
- **Service Tax** - Service tax is levied at the rate of 10% on certain identified taxable services provided in India by specified service providers.
- **Sales Tax/VAT** - Sales tax is levied on the sale of movable goods. Most of the Indian States have replaced Sales tax with a new Value Added Tax (VAT) from April 01 2005. VAT is imposed on goods only and not services. VAT is administrated by the local states at the rate of 4% on industrial inputs, capital goods, and items of mass consumption. 12.5% on everything else.

¹³ India Central Board of Excise and Customs <http://www.cbec.gov.in>

3.3.2 Physical Infrastructure

In 2002 India only spent 6% of its GDP (\$30B) on physical infrastructure, far behind China with 20% of GDP (\$260B). Everything from roads and rails to water supply and power generation needs improving. The inadequate infrastructure limits growth and prevents India from taking a greater part in the global supply chain. The costs associated with moving cargo in India are among the highest in the world at 11% of landed cost compare to a global average of 6%. Traditionally, development of infrastructure was completely in the hands of the public sector and was plagued by corruption and bureaucratic inefficiencies. In recent year the government realized that in order to sustain high growth rates, India needs private sector participation and foreign investments. In this section we will cover latest development in manufacturing related infrastructure development.

3.3.2.1 Roads

Roads are the dominant mode of transportation in India today. They carry almost 90 percent of the country's passenger traffic and 65 percent of its freight¹⁴. However, the Indian highway network is limited and in poor condition. In its 2002 transport report, the World Bank identified only 2% of the national highway system as being 4 lanes. In the regional network, no state highways were 4 lanes and only 23% were 2 lanes. Road maintenance is significant under funded with only 2% of the government recurrent expenditure. The results for users are high transport cost, extended journey time, increased risk for cargo damage, and the need to maintain high levels of inventory.

¹⁴ The World Bank, "India Transport Sector" - <http://web.worldbank.org/>

Most recently, however, capital expenditure on roads has been increasing, reflecting increased investment on connections to rural villages and improvements to the national highway system. The largest expressway project in India is the Golden Quadrilateral (GQ), which consists of 5,846 KM of four/six lanes highway connecting Delhi, Mumbai, Kolkata and Chennai. The project, that was jointly financed by the public and private sector, consist of the first controlled access toll road in India (the Mumbai – Pune Expressway). As of May 2006, 92% of the entire work has been completed.

3.3.2.2 Rail

Indian Railways is the largest railway in Asia and the second largest in the world under a single management. It transports over 5 billion passengers and over 350 million tones of freight annually. The railways suffer from chronic underinvestment and under pricing, and unsound cross-subsidization policies¹⁵. Passenger traffic is heavily subsidized by higher freight charges. The Tata Iron and Steel Company place the ton/km cost at three times the one in China. As a result, the movement of freight is increasingly shifting from railways to roads.

The major challenge is the severe capacity constraints in all the country's high-density rail corridors. For cargo transport, good connectivity from container ports inland is essential especially in the western region, which is the major cargo transfer center in

¹⁵ The Economist Intelligence Unit, India Country Profile 2006

India with Mumbai as the biggest port complex. The lack of both track and railcar capacity in the area is forcing ocean carriers to look for alternative gateways elsewhere.

3.3.2.3 Air

India's effort in deregulation and liberalization is most evident in the air sector with an international 'open sky' policy in place. India has 60 airports, including 11 international airports but only 4 of them (Mumbai, Delhi, Chennai and Kolkata) are allowed to handle international air cargo. Private sector led development is currently underway with the green field construction of Bangalore and Hyderabad airports which are expected to become international airfreight gateways by 2008. Privatization has proven to be difficult. The plan to sell Air India has been dropped and the proposed plans to move the Delhi and Mumbai airport to private management is progressing slowly. The international airfreight market is export oriented, with outbound traffic exceeding imports by a factor of 1.7 and growth over the past ten years averaged 6.2%¹⁶.

3.3.2.4 Container Ports

India has 12 major ports (seven on the west coast and five on the east) managed by the Port Trust of India, and 185 small ports managed by the local state governments. The major ports handle 75% of the traffic and the west coast port handle 68%. Container traffic is growing at an average rate of 13.4% a year over the last decade, reaching 4.39 million twenty-foot equivalent units (teu). Productivity is improving with average turnaround time dropping from 8.5 days in 1996 to 3.4 days in 2005, but overall cost is

¹⁶ Drewry Shipping consultants. "Connecting India - Transport Challenges and Opportunities". October 2005

still relatively high. Congestion, poor port governance, and inefficient customs clearing translate into high costs. An identical shipment of textiles to the US from India costs on average 20% more than from Thailand, and 35% more than from China¹⁷. For India to develop its ports into a significant hub, more than capacity and efficiency will be required. The Indian government should change its regulation that requires international and domestic vessels to operate under the Indian flag. This restriction is deterring international companies from taking a role in the sector.

The Government understands that private sector involvement is critical and plans to promote joint ventures between Indian ports and foreign ports. The government also instituted an automatic approval policy for up to 100% foreign equity in port and harbor construction projects. The most notable example has been the development of the Jawaharlal Nehru Port (JNP) international container terminal by P&O (Peninsular & Oriental) Ports of Australia.

Port development can be seen as a huge opportunity for future economic growth. With road and rail infrastructure in bad shape, sea transport can take a much bigger role in the North-South domestic routes. Also, the south ports of Chennai, Cuchin and Tuticorin can participate in the east-west route and benefit from the growth in South East Asia. But in order to become a major hub and take transshipments away from Colombo, major investment is needed especially in deep water facilities to accommodate large vessels.

¹⁷ The Economist Intelligence Unit, "Country Profiles" 2006.

3.3.3 Special economic zone

A Special Economic Zone (SEZ) is a geographic area that is treated as foreign territory for the purposes of trade operations, duties, and tariffs. Governments set up SEZs in their countries in order to create a hassle free business environment with the goal of attracting more foreign investment, specifically from export-oriented industries. SEZs were first introduced in China in the early 1980's and since been adopted by several other countries like: Russia, Poland, Iran, Jordan, and the Philippines. Shenzhen, the most successful SEZ in China has developed from a small village to a 10 million people city within 20 years.

In April 2004 the Indian government introduced SEZ policies in the country, following closely the Chinese model. Immediately after, the government converted eight Export Processing zones into SEZs, allowing them to benefit from more liberal policies. Since then, Companies have filed more than 400 applications to set up SEZs, and 212 have been approved¹⁸. The major incentives under the India policy are:

- **Customs and Excise** - SEZ units may import or procure from the domestic sources, duty free, all their requirements of capital goods, raw materials, consumables, spares, packing materials, office equipment and etc. They also enjoy duty free import/domestic procurement of goods for setting up the SEZ units.
- **Income tax** - 100% exemption for the first 5 years and 50% for 2 years thereafter. Carry forward of losses are recognized.

¹⁸ The Economist. "India's Special Economic Zones". Print edition. October 12 2006.

- **Foreign Direct Investment** - 100% foreign direct investment is allowed in manufacturing sector in SEZ units except for manufacturing of arms and ammunition, explosive, atomic substances, narcotics and hazardous chemicals, distillation and brewing of alcoholic drinks, and any tobacco products.
- **Banking** - Setting up Off-shore Banking Units is allowed in SEZs. In addition more financial flexibility is provided, including the freedom to make overseas investments with export proceeds, make commodity hedging, and the ability to ‘write-off’ unrealized export bills.
- **Central Sales Tax** - Exemption to sales made from Domestic Tariff Area to SEZ units.
- **Service Tax** – Full exemption from Service Tax.

Under the current policy, The SEZs are obligated to become net foreign exchange earners but they are not subject to any pre-determined export performance requirements.

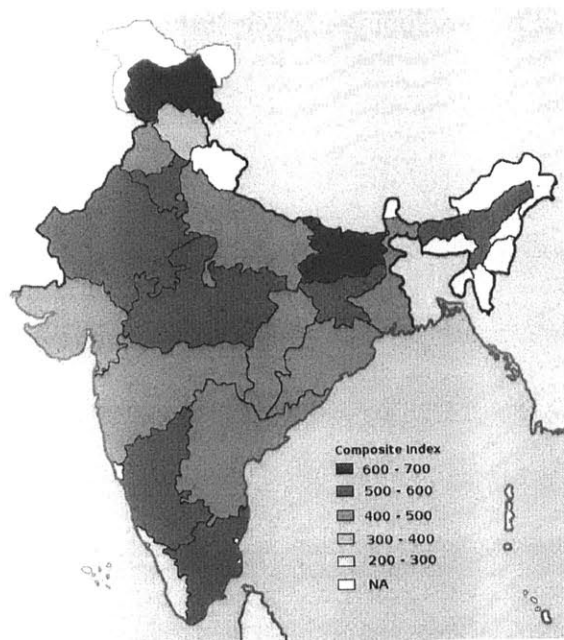
3.3.4 Corruption and bureaucracy

In its 2005 annual report, Transparency International (TI) ranked India 88 among 158 countries surveyed with unflattering Corruption Perceptions Index (CPI) score of 2.9 out off the perfect 10¹⁹. On the survey, TI found that more than half the people surveyed had to personally pay a bribe to get a job done in a public office. In the World Bank ranking

¹⁹ Transparency International's Annual Report 2005

for “ease of doing business”²⁰ India is ranked 134 out of 175 countries – way below China in number 5 and Singapore in the top place. The survey states that the average time to secure a clearance to open a startup in India is much greater than in other developing nations. Figure 6 shows the Index of Corruption by Indian states. The ranking of public services and the States on petty corruption is based on a “composite index” developed by TI²¹. Darker regions are more corrupt. TI’s study points to a strong correlation between corruption and poverty among the different states.

Figure 6: Index of Corruption by Indian states for 2005



Source: Transparency International – India study 2005

The consciousness of this gloomy situation to the Indian economy is obvious. It is hard to attract foreign investments, tax revenues are lost, and the high cost of inefficiencies in

²⁰ <http://www.doingbusiness.org/EconomyRankings/>

²¹ "India Corruption Study 2005: To Improve Governance Volume – I: Key Highlights"

places like: healthcare, education, and the police. The government has taken action to fight corruption and bureaucracy. The 1991 reforms and the cancellation of the License Raj had improved things for the private sector. The Right to Information Act (2005) is trying to force more transparency on the state and federal government. The international bodies recognize the current efforts and India is expected to improve its CPI ranking in 2006. As foreign corporations enter the Indian market, the hope is things will improve much faster. Western companies are much more sensitive nowadays to corruption issues in their global operation and they are expected to demand higher standard. Similar trends have been observed in other developing markets that opened their gates to foreigners.

4 Value Chain Analysis

After looking at the EMS industry (Chapter 2) and the business environment in India (Chapter 3), we can focus more on the specific challenges Flextronics face. But before we can discuss how Flextronics can incorporate its new India facility into its supply chain, we need to understand how the Total Cost of Manufacturing in India stands in comparison to other low cost regions in the world and more specifically in Asia. Cost is obviously not the only factor to consider and in the next chapter we will discuss other factors that can prevent India from becoming a global manufacturing hub for Flextronics, but cost is definitely a starting point in an industry famous for its low margins and constant pressure to drive cost down.

Flextronics already made a big investment in establishing a presence in India. The industrial park in Chennai is one of the biggest capital investments the company took in recent years. The financial logic behind the move was based on local market demand for electronics. Combined with import protection policies from the Indian government, the local market forecast established the case for manufacturing in India. This study will address the total cost of manufacturing in export-based scenarios. Given the initial investments to set up the industrial park already have been made, we will focus on the additional cost associated with manufacturing product in India and shipping it elsewhere. Again, this study does not try to answer whether or not Flextronics should have made the move into India, but how to use its existing presence in their global supply chain.

Throughout this section we will look at the total cost of manufacturing in India in comparison to China. Flextronics has a big presence in China and it is considered a center for efficiency and scale. For Flextronics to promote India to a global hub it must be competitive with the current operations in China. The purpose of the following cost analysis is to find a scenario where manufacturing in India can be competitive to the point where Flextronics can consider manufacturing in the country as the basis for a global hub.

4.1 Total Cost of Manufacturing Model

When trying to figure out countries competitiveness for exports, many factors have to be considered. First, what is the final destination in the value chain? India may have advantage over China for certain destinations and disadvantage for others. Second, Flextronics manufactures a very large and diverse portfolio of products and each has a different cost structure. Looking at the average cost makes no sense so we must look at specific product lines independently. Furthermore, not all cost components used by the company are relevant for this analysis. To make a “fair” comparison we can use in long-term strategic decision-making, we have to neutralize short-term differences between the two countries like different depreciation schedules between the brand new plant in Chennai and the established one in China.

The cost model used has evolved throughout the course of the internship. Brainstorming sessions with Flextronics finance department were held to identify the costs components that were perceived to be significant. Similar brainstorming sessions with the project

stakeholders took place to define the products and supply chain scenarios that are most likely to benefit from using India as the manufacturing point.

4.1.1 Tools

To perform the analysis, a proprietary supply chain planning software tool was used called SimFlex. SimFlex is owned by Flextronics and is used for internal supply chain planning and optimization and as an added service for external customers. The software is capable of modeling, analyzing, and optimizing complex supply chain scenarios²².

Using the software made it possible to easily perform sensitivity analysis, multi-currency analysis, inventory analysis and more.

4.1.2 Model Output

For each scenario analyzed, the output of the model is a per unit landed cost of manufacturing a product in Flextronics industrial park in Chennai vs. the same cost if the product was manufactured in one of Flextronics factories in China. The model cannot be used as a tool for pricing. It is intended for internal use to support strategic decision making in regards to resource allocation and long term investments.

4.1.3 Model Assumptions

Since the cost analysis refers to future products, certain assumptions must be made. Also, since Flextronics has no experience in large-scale manufacturing in India, the data we

²² Jain, Workman, Collins, Ervin, 2001. "Development of a high-level supply chain simulation model"

relied on was less accurate than data available from operational plants in China. The following list describes the general assumption taken:

- To compare “apples to apples”, the Chinese plants used for the analysis were treated as brand new plants. Since any production in India will require pursuing all the tools and machines needed for the process, the assumption was made that the same investment should be made in China as well.
- Indian labor is as capable and efficient as the Chinese. If a process in China requires certain direct labor man-hours per item, the same amount will be required in India. This is not an obvious assumption, but from Flextronics experience in both countries we felt comfortable using it.
- Currently there are very few local suppliers in India approved by Flextronics so most of the materials and component need to be imported (mainly from China). For the analysis we had to look at each component and make an assumption regarding local supply in the future. If Flextronics outsourcing team believed they could approve a supplier for that part in the next year, we assumed in the model a local supplier for it. Otherwise we used imported parts from Flextronics suppliers in Asia.
- All labor, logistic and material cost is based on quotes for purchase by September 2006.
- Forward logistic is done by ocean transportation using 40 ft Full Container load (FCL).

4.1.4 Cost Components

In the model we calculate cost with the following major components:

$$\textit{Total Cost of Manufacturing} = \textit{Materials} + \textit{Manufacturing} + \textit{Labor} + \textit{Logistics}$$

Lets take a look at each component:

- **Materials** – The landed cost to bring all material and component into the factory. This is broken down to the purchase price of raw material and components from Flextronics authorized suppliers and the cost of bringing the material to Flextronics factory (“Freight In”). Since Flextronics factories reside in Special Economic Zones, there is no need to include import taxes or duties.
- **Manufacturing** – The cost to transform the raw material into the final product not including the cost of labor. In this component we include the machine and tooling costs, facility overhead, and outsourcing cost of parts Flextronics manufacture using external partners.
- **Labor** – All labor cost involved in the manufacturing process. This is broken down to direct labor for line workers directly involved with the manufacturing process, and indirect labor for support team like engineering, procurement, facility administration, ext.
- **Logistics** – The cost of transporting final goods from Flextronics factories to the final port of destination. This is broken down by inventory cost and transportation cost. Any export taxes and duty are also included. The model

use Inventory Rate of 15%²³ that covers capital and non-capital costs (including obsolescence, mark-downs, depreciation, insurance).

4.1.5 Supply Chain Scenarios

Since India is a “green field” country in term of large-scale electronic manufacturing, the process of analyzing manufacturing costs is difficult and expensive. The average product is manufactured using hundreds of sub component and for each we need to figure out if it can be supplied locally, what the price is going to be, and will it be cheaper to import it from other places. For time and resource constraints, the number of different scenarios was limited. The challenge was to find the most likely scenarios where the value chain will benefit from using India as the central manufacturing place. Together with the internship stakeholders from Flextronics we came up with the following guidelines:

4.1.5.1 Product selection

Flextronics is divided to seven divisions around different market segments. For the analysis we were trying to focus on products that are relevant to the local Indian market. Economy of scale is a major driver in the EMS industry and Flextronics aim is to find products they can manufacture in India both for the local market and for export. While it is still early to know what exactly Flextronics is going to manufacture in Chennai, we can assume that products that are typical for emerging markets are going to be key. India is investing heavily in telecommunication infrastructure with major development in its cellular network. For this reason we decided to focus on products from Flextronics Infrastructure and Mobile divisions.

²³ Based on Flextronics financial assumptions

Second, we decided to focus on products with higher than average labor content.

Flextronics direct labor cost in India is 70% the cost in China. Products that require intensive labor in the manufacturing process can benefit from being built in India.

Next we looked for products with relatively high mechanical content vs. electronic.

India's mechanical supply base is much more developed than the electronic one. Chennai is known as a major center for the automotive industry and is home to many mechanical suppliers. At least in the near future, for products with high mechanical content, Flextronics is likely to use more local suppliers and will be less dependent on imports.

Last, we looked for products with relatively low-volumes. From Flextronics experience, it takes much longer to go down the learning curve for very high-volume product.

Mobile handsets are a major product for the Indian market but manufacturing and shipping efficiently millions of units a year is a very complicated task that requires advanced skills. At the end we selected the Base Station Enclosure as the most suitable product for this analysis. Later we will cover this product in more depth.

4.1.5.2 Target Markets for Export

To analyze a value chain we choose markets that are likely to benefit from India as a manufacturing hub. From the very first stage of the internship Flextronics wanted to focus on the emerging markets of Africa and the Middle East. This was actually part of the original motivation for this thesis. Flextronics looks at Africa as a future growth engine for the company and wants to plan ahead. With its geographic proximity and

strong political and economic ties, India can be a good candidate for serving these markets.

Beside Africa and the Middle East, Europe is also a good candidate. Flextronics currently operates several industrial parks in East Europe but it also ships final products and sub-assemblies from its factories in China, especially when low cost labor is critical to its customers. India is geographically closer to the main ports of Europe, and it will be interesting to learn if it can compete with China on total landed cost.

Looking at the major ports into Sub-Sahara Africa, we can see that South Africa and Nigeria are the biggest and most developed markets. South Africa serves as an entry base to many Multi National Corporations, and Nigeria operates the most important port in East Africa (Lagos). Egypt is the biggest market in North Africa and Iran is developing quickly as a major economic force in the Gulf area and the Middle East. For Europe, Germany is the major port Flextronics uses for shipments from Asia. Table 4 compares transit time and shipping cost per container for all links used in the cost model. It is based on data provided by DHL and is accurate for shipments by the end of 2006. DHL provides door-to-door service from Flextronics to a warehouse in the destination port.

Table 4: Transport links with associated costs and transit times

<i>From</i>	<i>To</i>	<i>Mode</i>	<i>FCL Cost</i>	<i>Transit Time</i>
Changzhou	Alexandria	Ocean	\$5,180	37d
Changzhou	Durban	Ocean	\$4,874	29d
Changzhou	Hamburg	Ocean	\$4,080	33d
Changzhou	Lagos	Ocean	\$5,880	52d
Changzhou	Tehran	Ocean	\$3,000	28d

<i>From</i>	<i>To</i>	<i>Mode</i>	<i>FCL Cost</i>	<i>Transit Time</i>
Chennai	Alexandria	Ocean	\$3,604	24d
Chennai	Durban	Ocean	\$3,630	23d
Chennai	Hamburg	Ocean	\$2,500	29d
Chennai	Lagos	Ocean	\$5,750	39d
Chennai	Tehran	Ocean	\$2,850	20d

4.2 Base Station Enclosure Analysis

A Base Station is an infrastructure device used in cellular networks. The Base Station is a radio receiver/transmitter that serves as the hub of the local wireless network, and may also be the gateway between a wired network and the wireless network. The Base Station enclosure is the box that holds the power supply, fans, electrical connectivity, and the RF module. The enclosure is similar to a PC enclosure before the Mother Board is installed (but much bigger in size).

The outdoor version of the enclosure is used in rural area deployments, where the cellular base station (the “cell”) is located in the open and not inside a building. The outdoor version is more rugged and designed to operate in extreme weather conditions. It is also bigger and holds components that are usually separated from the main unit in the indoor version like power backup, cooling system and the RF module to communicate with the wireless antenna.

Flextronics Infrastructure division manufactures base station enclosures (indoors and outdoors versions) for the leading wireless communication OEMs. For the purpose of the

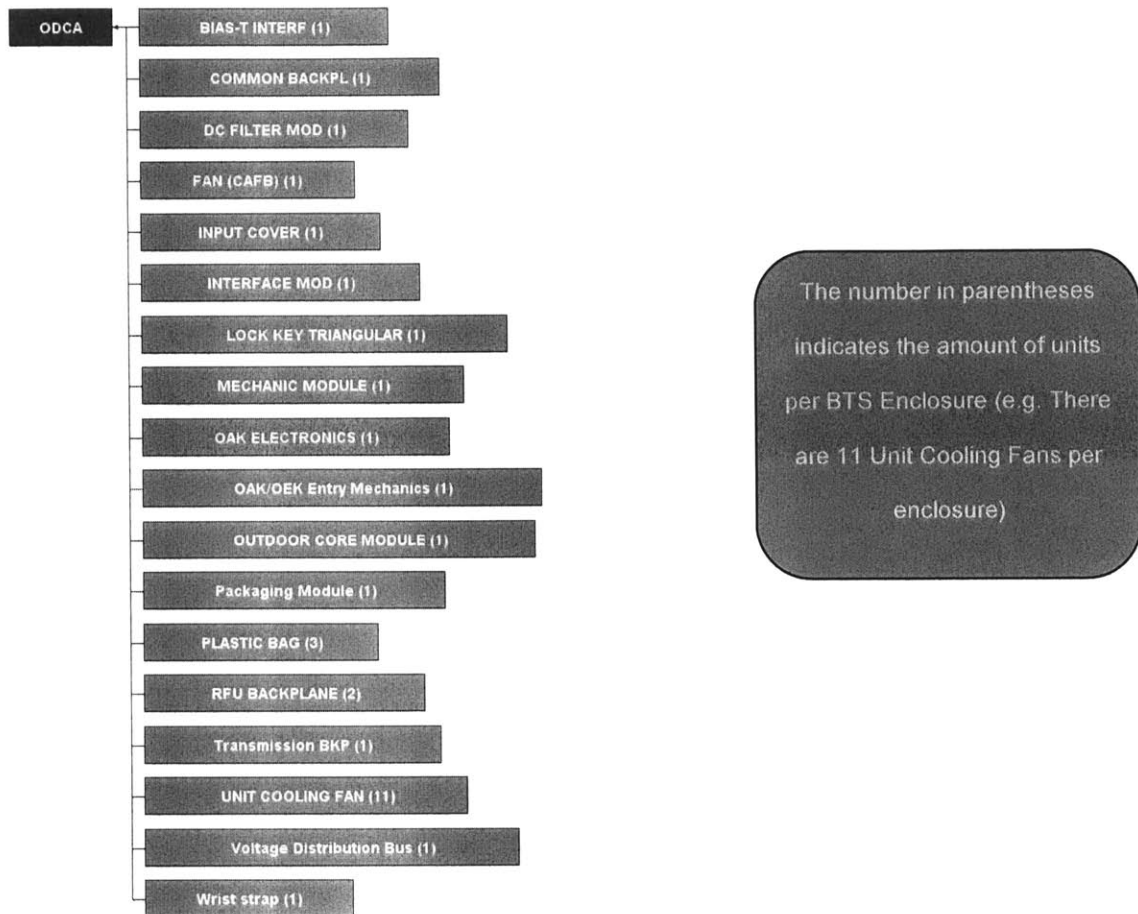
analysis, the Outdoor version of a leading OEM was chosen. The 300 Kg metal enclosure is currently manufactured in Flextronics mechanical factory in Changzhou (near Shanghai) and is targeted to undeveloped markets. After the manufacturing process, the enclosure is shipped to the OEM distribution center in the target market where it is coupled with the electronic board. Then the local cellular carrier installs it in the field. The same model is also sold in India and is scheduled to be one of the first products to be manufactured in the new factory in Chennai.

The Base Station enclosure fits all the requirements defined earlier. It is mainly a mechanical device with raw metal as the main input material to the manufacturing process. It has high-labor content compared to the consumer devices, and is manufactured in relatively small and predictable volumes. Since the enclosure is already in production in China and is soon to be manufactured in India, data for the analysis could be easily collected.

4.2.1 Manufacturing Process

The enclosure production process can be broken down into 3 independent subassembly processes, and a final assembly process that combines the output of the 3 subassembly processes together with purchased and outsourced components. Figure 7 breaks down the final assembly components.

Figure 7: Bill of Material Structure



4.2.2 Operations and Logistics

The following assumption were made regarding customer demand and operation variables:

- **Customer Demand** – 5,000 units will be manufactured annually for each of the 5 target markets in Africa the Middle East and Europe. Total of 25,000 units per year, distributed evenly throughout the year.
- **Inventory** – Basic inventory models were used to calculate the average days of production inventory in each of the manufacturing sites. When evaluating

the equations below, assume economic order quantity²⁴, unit cost, and service level are constant for both India and China. The only items varying by site are the safety stock levels that are driven by the change in lead-time for raw materials and components.

$$\text{Average Inventory} = [(\text{Economic Order Quantity} \div 2) + \text{Safety Stock}] \times \text{Unit Cost}$$

$$\text{Safety Stock Level} = \sigma \times \text{Service Level} \times \text{Lead Time}$$

From the data collected and data used by Flextronics, it turned out that China needs to hold 5 days of production inventory and India needs to hold 10 days.

- **Logistics** - All forward logistic is done by ocean freight using 40 ft. containers. Each container carries 26 enclosures.

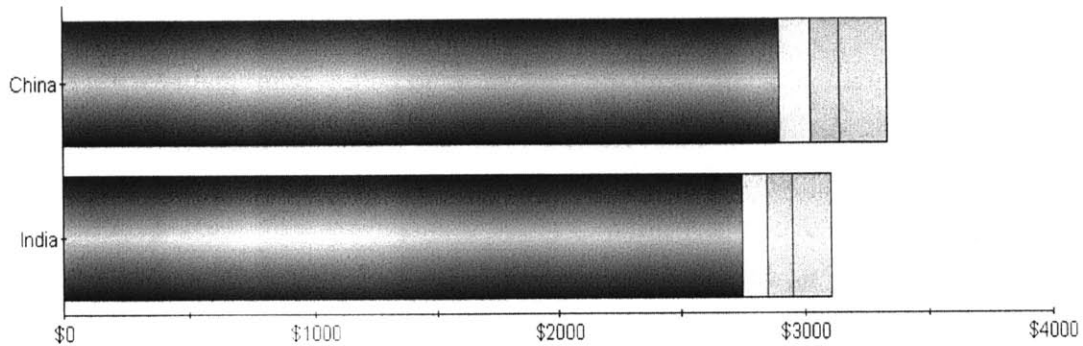
4.2.3 Analysis Results

Starting from the bottom line, the total per unit landed cost was 6.8% cheaper in India than in China (\$3,101 vs. \$3,331). This significant difference makes a case to consider Chennai as a global center for infrastructure/mechanical, but we first need to take a closer look at the cost drivers. Figure 8 breaks the total landed cost based on the cost components we defined in section 4.1.4. From the results we learn that in this specific

²⁴ Economic Order Quantity (EOQ) is the number of units that a company should add to inventory with each order to minimize the total costs of inventory

supply chain scenario, India has a cost advantage in all the cost components. Lets examine each in more depth:

Figure 8: Total Unit Costs Comparison



Cost Category	China	India
Material Costs	\$ 2,898	\$ 2,747
Manufacturing Costs	\$ 124	\$ 101
Labor Costs	\$ 118	\$ 100
Logistics Costs	\$ 191	\$ 155
TOTAL COST	\$ 3,331	\$ 3,103

4.2.3.1 Material Costs

As can be seen from the results, the Material component is the biggest cost driver for the base station enclosure with 88% of the total landed cost. It is also responsible for \$151 out of the total \$228 per unit difference between the two scenarios (or 66%). This is a surprising finding. China has a much more established and efficient supply base and we expect the material cost purchased there to be lower or at least comparable.

Looking closer at the material list and breaking it down we can see that for most of the purchased component and Materials, the cost is comparable. The biggest cost driver is

raw metal with 28% of the total cost for the China scenario (\$815 out of the total) and here India has an advantage with total raw metal only costing \$680. Three factors are responsible for this discrepancy:

- Metal classification – The type and quality of raw metals manufactured and sold in India is different from the global standard. In this analysis we used local Indian metal that is different and considered to be lower in quality from the one used in China. Although the OEM approved the local version, it is not an “apple to apple” comparison.
- Indian government is currently restricting the export capacity of Iron and Metal manufacturers, forcing them to sell part of their output locally. This policy combines with limited logistic infrastructure in India’s ocean ports, results in lower prices for the commodity in the local market compare to the global ones.
- Another fact to consider is that the prices used in this analysis for the China scenario were based on “real” data from a running operation. For the India scenario we used estimated quotes from suppliers hoping to secure a contract. This is less reliable and should be followed up later.

To conclude, India has a strong and developed Mechanical supply base, mainly thanks to the developed automotive industry. Manufacturing mechanical products and sub-assemblies can be done in India in a cost efficient way.

4.2.3.2 Labor Costs

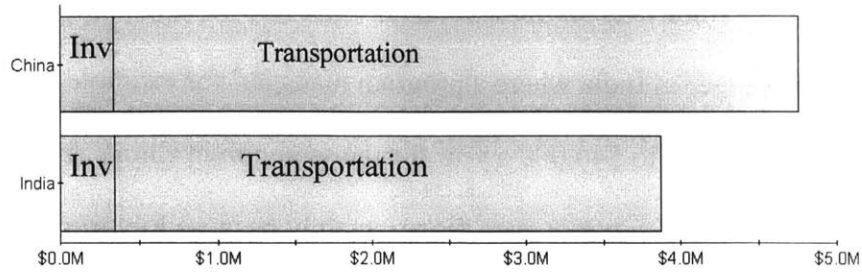
Flextronics direct labor rate for India is \$0.85/hour compared to \$1.25/hour in China²⁵. Indirect labor is also much cheaper in India where a program manager, for example, earns on average \$17,000 a year compared to \$40,000 a year for the same job in China. For senior management positions the difference is even bigger, mainly because Flextronics employees many Ex-Pats in China while all the Indian managers are locals. It will be interesting to see if this will still be the case once the Chennai factory ramps up and becomes more critical for the company global performance.

4.2.3.3 Logistics Costs

Figure 9 shows the break down of the total logistic cost to the Inventory and Transport components. The difference in Transportation cost is due to the geographic proximity of India to all the target markets and is based on the Transportation cost from Table 4. For the inventory cost, China holds an advantage for 'In-Facility' inventory levels while India has an advantage for 'In-Transit' inventory levels thanks to the shorter transit times to the export markets. At the end, the two type of inventory cost offset each other. Figure 10 shows the total inventory levels for the tested scenario and how the cost varies between the two countries. Figure 11 shows the average order cycle time vs. the total annual cost.

²⁵ Based on Flextronics global rate tables

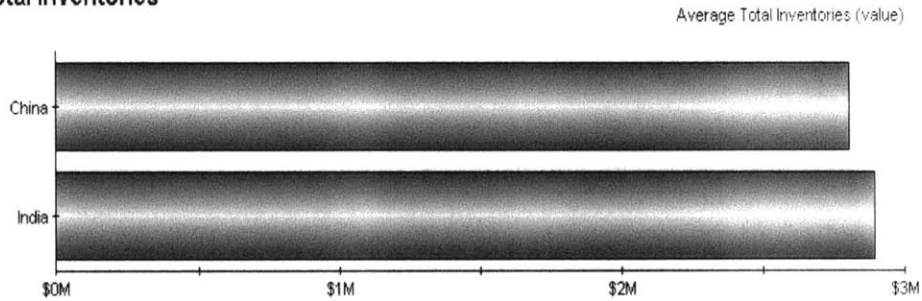
Figure 9: Logistic Cost Comparison



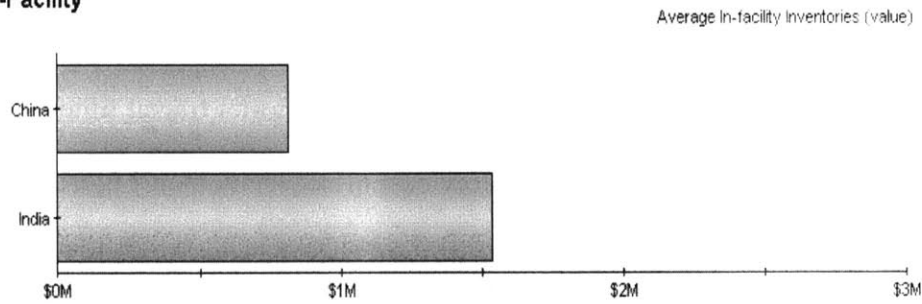
Cost Category	China	India
Inventory costs	\$ 0.3M	\$ 0.3M
Transportation Costs	\$ 4.4M	\$ 3.5M
TOTAL LOGISTICS COSTS	\$ 4.8M	\$ 3.9M

Figure 10: Comparison of Inventories by Status

Total Inventories



In-Facility



In-Transit

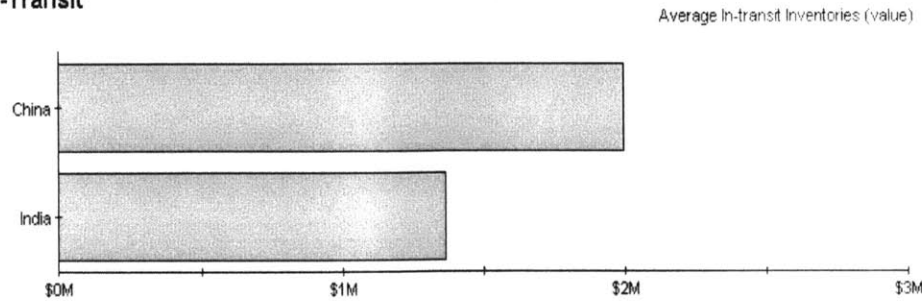
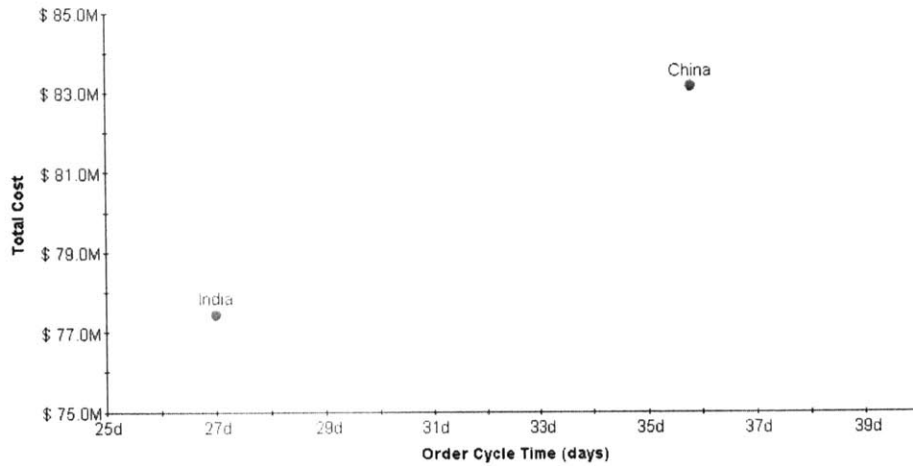


Figure 11: Total Cost vs. Order Cycle Time



4.3 Conclusion

The purpose of the value chain analysis in this chapter was to show that there is economic potential for integrating India into Flextronics global supply chain, and for using the industrial park in Chennai for customers outside India. By looking at the Base Station Enclosure, manufactured in two different scenarios, we concluded that for markets in Africa, the Middle East, and Europe, India has an average 6.8% cost advantage over China. Taking this gap as a fact would be a mistake. Things change very fast in Asia nowadays and prices and conditions vary from month to month. Using data from a different point in time may result in a different cost gap. What we can conclude at this point is that for certain type of products India is comparable to China in term of cost. This should give Flextronics the motivation to further investigate the subject. In the next chapter we will see if India can execute at the level of efficiency and quality that is required by the OEMs. Only than can we make a recommendation regarding Flextronics strategic plans for India.

5 Can India Execute?

After concluding in Chapter 4 that India can be as competitive as China for Mechanical Manufacturing, we need to investigate if India can execute as well as China. Competing on price is important but not sufficient. For Flextronics to incorporate India into their global supply chain, we need to look for the following:

- Reliability – The whole supply chain needs to operate in a predictable and reliable way. In a very low margin business with fierce competition there is no room for error. Production and logistics need to happen according to plan.
- Scalability – As mentioned before, economies of scale are very important in the EMS industry. Making India a global manufacturing hub means it will need to scale over time to reach high volume production while cutting cost. The country infrastructure, the supply base, and Flextronics logistic partners all have to support it.
- Stability – Political and economical stability are crucial if India wants to compete globally in manufacturing. The economic reforms started in 1991 seem to hold its pace even though the ruling party changed a few times over the years. But this needs to continue. Changing course or going back to old policies will mean big setbacks for companies like Flextronics.

The following sub sections are some of the major challenges for large-scale operation that were identified over the course of the internship. Things are changing very fast in India so there is almost no literature that is relevant. The following is based on interviews I made during my stay in India and personal assessment of the local conditions. For each

challenge, I tried to provide recommendation on how to overcome it and a personal assessment on how big is the problem and what are the consequences.

5.1 Local supply base

A well-developed local supply base is critical for large-scale manufacturing. To achieve its cost and efficiency target Flextronics, like any other electronics manufacture, needs its suppliers close by to guarantee short lead-time, to allow low inventory levels, and to save on cost and complexity related to imports and logistics. To understand how developed is the India market in term of supply base, we should look at each one of the three different component types Flextronics use:

- Mechanical supplies – For metal sheets, Fans and cooling systems, industrial hardware, fasteners, wires, plugs and sockets, and Printed Circuit Boards (PCB).
- Electro-Mechanic Supplies – For devices that combine electrical and mechanical parts such as: Switches, electric motors, Antennas, loudspeakers, ext.
- Electronics – Passive components such as: capacitors, resistors, and fuses. Active (Solid State) components such as: diodes, transistors, analog and digital integrated circuits (IC).

The current availability of supplies varies according to the type. The Mechanical supply base is by far the most developed. Flextronics center in Chennai reside in the middle of a major automotive industrial hub with the Hyundai plant just miles away. This location provides Flextronics access to a well-developed supply base that can provide the same

level of service Flextronics receive from its suppliers in China and Mexico. Furthermore, the automotive industry is known for its high quality standards. All suppliers must adhere to the QS-9000 requirements that are more demanding than the ISO standards used by global electronic manufacturers.

For Electro-Mechanics, while the supply base is not as developed as for Mechanics, Flextronics can find local sources for its needs even today. As a closed economy until not long ago, India manufactures most of its demand for basic appliances like TVs, PCs, washing machines, and refrigerators by companies like BPL and Wipro. Flextronics will have to work with the suppliers to bring them up to the global standard they require. Suppliers are also scattered around the country and logistics can be challenging.

Electronic components are the biggest challenge for Flextronics. While passive components can be sourced locally even today, the high-end components like integrated circuits are nowhere to be found and Flextronics must rely completely on its Asian suppliers. India has no Semiconductor Fabrication (FAB) facilities and taking into account the complexity and capital expenditure needed to establish one, it is safe to assume that Flextronics will continue to rely on imports for at least the short to medium time horizon. There is a plan to build a “Fab City” in Hyderabad. A joint venture between local entrepreneurs and the federal government, called “SemIndia” was established recently to build the first Semiconductor Fabrication plant. Flextronics is part of the joint venture with a small equity stake, but it is hard to predict how successful it is going to be. Looking at countries like Singapore, it is clear that massive government support is

essential for the semiconductor industry. It is hard to see how the Indian government can provide the same level of support in terms of capital and infrastructure.

Conclusion

In 2006 many OEMs and EMS companies established manufacturing facilities in India. Just next to Flextronics site in Chennai, major players like Dell, Motorola, Foxconn, and Samsung started building their factories. Nokia is already operating a mobile handset factory 6 km from Flextronics Park. This growth provides the incentive for first tier suppliers to join, and they are doing so already. If the current trend continues at the same rate, Flextronics India will have the local supply base it needs to support global manufacturing in a matter of 2-3 years, with the exception of Integrated-Circuits (IC).

5.2 Infrastructure

India's infrastructure is in a poor condition. Section 3.3.2 cover the states of the roads, rails, container ports and airports. India is years behind China in terms of infrastructure and the gap just keeps getting wider with China investing 20% of its GDP in infrastructure vs. India's 6%. At its 2006 special report on India²⁶, the Economist conducted an experiment to illustrate the difficulties Indian business face. They followed a journey of a typical cargo truck traveling the 1,340 miles between Kolkata and Mumbai, two of India's major metropolitan cities. It took the driver 8 days to reach its customer, achieving an average speed of 7 miles per hour after he spent 32 hours waiting in 26 different tollbooths and checkpoints. This is a major challenge for manufacturing

²⁶ The Economist. "The long journey". Print edition. June 3rd, 2006

especially if they plan on large-scale operations. It is one thing to deal with the domestic market, which is familiar with the situation, but it is going to be hard for a company like Flextronics to serve global customers like its European OEMs that expect a high level of reliability in their supply chain.

When Flextronics was scouting for a place to build its Indian factory, infrastructure played a major role in the decision process. Flextronics needed to be in a close proximity to international airport with enough capacity. Choices were very limited with only Delhi, Mumbai and Chennai. Adding the requirement for international seaport and only Mumbai and Chennai were left on the list. At the end Chennai was chosen for its educational infrastructure and for the support of the local state (Tamil Nadu).

Chennai's infrastructure is above the country average. Flextronics enjoys very easy access to the airport, seaport, and to the major highway, the Golden Quadrilateral, and therefore is less constrained than manufacturers elsewhere in India. The Chennai port is scheduled for major expansion in 2008, providing more flexibility for Flextronics in planning its operation. That said, the conditions in Chennai are less favorable than the ones Flextronics enjoy in other parts of the world. The factory is only one hour away from the city center but the one lane road is often clogged and the journey can easily take 3 hours. As production ramp up, Flextronics will need to figure out how to bring workers to and from the factory and how to plan its local supply chain so infrastructure will not become a limiting factor.

Conclusion

Infrastructure is a major challenge for Flextronics if they plan to make India a part of their global supply chain. Thanks to the favorable conditions in Chennai, export is not totally impossible but Flextronics will be limited in the scope and scale of its operations. It is hard to imagine that Flextronics can operate a mobile handset center like the one they have in Malaysia, where they build and ship millions of units each month, but they can transform India to a major hub for their infrastructure group where volumes are lower and logistic challenges are simpler.

5.3 Labor force

India is famous for its young and educated labor force. On the road from Flextronics park to the city of Chennai there are seven engineering schools, and the state of Tamil Nadu alone produce around 70,000 engineers every year. Most of the educated class speaks English and that make it easier for Multi Nationals to outsource parts of their operation to Indian companies like Infosys and Wipro. India also has good management talent and infrastructure for management development. Unlike China, Flextronics operates in India with almost no ex-patriots, which help to lower cost and avoid mistakes due to cultural differences.

Taking a closer look at Flextronics human resource structure, we can identify major challenges related to its direct and in-direct labor force. First, attrition rates for Flextronics India are significantly higher than the global average. This is a common problem in India where workers switch jobs very frequently supported by very favorable labor laws. For Flextronics things are even tougher. With no strong brand equity and

playing in a very low margin industry, Flextronics has to compete with OEMs like Dell, Nokia, and Motorola. For engineers, Flextronics even competes with IT companies like Wipro, which for a lack of talent are willing to recruit industrial and mechanical engineers for IT related jobs.

Second, labor mobility in India is very low. Every state in India has its own local language. Workers are not willing to move to a state where they feel at disadvantage. In addition, the Indian culture and values require people to stay close to their families. Going back to China, a big part of the success story there is thanks to the “dormitory” model manufacturers are using. In China a firm get a supply of workers, coordinated by the government, which usually arrive from villages all over China. They all come for a fixed period of time, usually 2-4 years, and they physically live in the factory premises the whole time. Companies find it very easy to recruit workers and thanks to the relatively long tenure, they can develop the skills and expertise needed for world-class manufacturing. This model is obviously not a good fit for the Indian labor market and Flextronics will have to manage its HR in a very different way.

The major risk for Flextronics in Chennai is to become a “training camp” for the OEMs. Nokia, the fist major manufacturer in the area, has to transport workers for 60 miles away because it cannot find enough workers close by. When the rest of the OEMs start operating during 2007, it safe to assume competition for workers will be fierce. Flextronics is going to have hard time competing with brand name companies that can

afford to pay more, and it can find itself training new workers just so companies like Dell or Motorola can reap the benefits.

Without a professional work force, Flextronics India will never be able to compete with the quality and efficiency of other global factories. An urgent need for a strategic HR plan is required to build the work force in Chennai. Flextronics needs to be creative since solutions from other countries are not likely to fit. In order to give incentives for workers to stay, the company needs to somehow put a “price” on leaving the company.

Flextronics can initiate a program where the company contributes a certain amount on top of the employee salary to a saving account that the employee receives after two years, if he is still with the company. Another program can be to provide housing and schools for employees and their families, making it more inconvenient for the employee to change jobs since now he has to relocate to a new home. These solutions are not cheap and Flextronics needs to realize that they cannot treat India as a low labor cost area where they do not need to invest in any retention plans. After all, the “dormitory” model in China is expensive and Flextronics will need to invest similar amounts in India if they want to receive the same benefits.

Conclusion

Labor is a huge challenge for Flextronics India and should be addressed by a creative retention plan if Flextronics hopes to achieve the same scale it has in China. As of the end of 2006, Nokia and Flextronics are the only electronic firms operating in Chennai. This is going to change later in 2007 when several other OEMs and EMSs will start production.

Flextronics will need to retain its workforce if it does not want to pay for training its competitors, or customers, labor force.

6 Recommendations

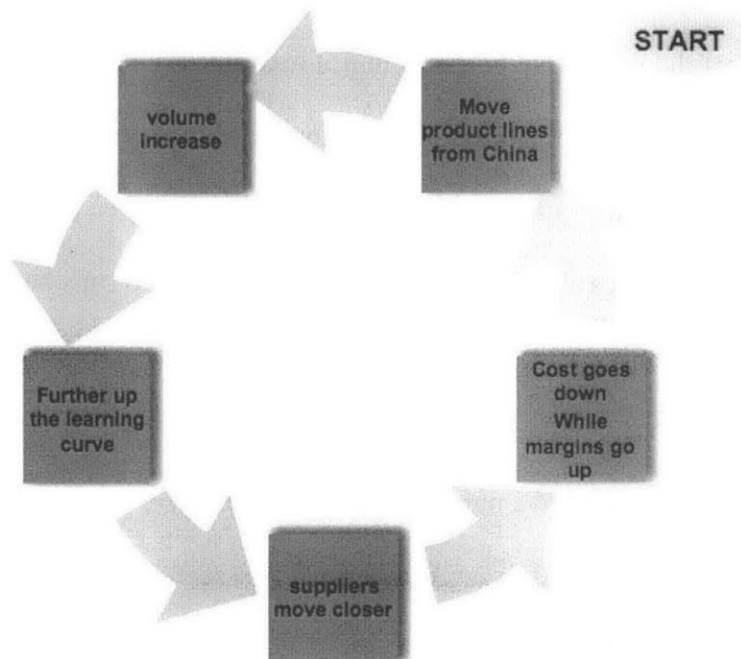
Chapter 4 established that under certain conditions India is as competitive as China. In Chapter 5 we covered the main challenges for large-scale manufacturing. We can now discuss what strategy should Flextronics use to integrate India into its global supply chain. As we discussed at the beginning, Flextronics has a lot to gain by using India as a global manufacturing hub. Such a strategy would help hedge against global risks, provide flexibility to the supply chain, and help utilize the industrial park concept that is all about high-volume low-mix manufacturing.

A possible strategy is for Flextronics to stop viewing the park in Chennai as a regional facility only manufacturing product for the Indian markets. Instead they should view the park as a global center of excellence for one or more of their products and put it under the management of the respective business unit. Flextronics should analyze its product portfolio for the most suitable products, but for the purpose of the discussion we can look at Mechanical Enclosures under the infrastructure segment as a possible candidate. Under this strategy Flextronics should decide that all new orders for mechanical enclosures received from Europe, Africa, the Middle East and parts of Asia would be fulfilled from Chennai. In addition, it will gradually, over a period of 1-2 years, move existing production lines for the above markets to India from where they are manufactured today. Lets look at the benefits and risks of this strategy:

By transforming Chennai into a global center for mechanical enclosures, Flextronics will initiate a loop that will result in lower cost and more efficiency while rapidly building

manufacturing capabilities in India. For each account Flextronics actively moves to Chennai, the production quantities will obviously go up, providing the local operation an opportunity to go down the learning curve faster, and for suppliers a higher incentive to relocate near by. More production efficiency and a more localized supply base means lower per unit costs and higher margins. Now Flextronics can allow itself to relocate more accounts and the loop will keep reinforcing itself. Figure 12 illustrates this reinforcing loop effect. In order to get the loop started, Flextronics should be willing to take a hit initially on its margins since it is probably more efficient in the present to manufacture the enclosures elsewhere. In a low-margin industry like the EMS, this is a hard move to make but it is only for the short term.

Figure 12: Positive Reinforcement Loop



There are also risks associated with this strategy. Execution in India needs to be up to global standard for customer satisfaction not to be hurt. If the transition turns out to be a bad experience for one of the OEMs they might leave for a competitor, taking other parts of their business with them. Another problem is more internal. By moving accounts to India, Flextronics faces the risk of cannibalizing other parts of the organization. This can not only hurt profitability but can also cause internal frictions and political rivalry.

Any future plan should leverage India's strength in mechanical manufacturing and the low-labor rate while keeping in mind the infrastructure limitation. For Flextronics, India can represent a competitive advantage. Making the first move in the country and building capabilities fast can turn out to be a big advantage for customers looking to enter the market or looking for alternative options for low-cost manufacturing in Asia.

In general, the analysis illustrates the benefits and risks associated with manufacturing in India. For electronic manufacturers, OEMs or EMS firms, India is a key market with tremendous opportunities. This study highlights the key issues to consider when evaluating the roll India needs to take in the supply chain. Physical and labor infrastructures are the most challenging obstacles for high-volume manufacturing. Choosing the right location and putting the right HR policies in place are critical for success.

BIBLIOGRAPHY

Michael E. Porter, "Competitive Strategy: Techniques for Analyzing Industries and Competitors", Free Press: 1st Free P edition (June 1, 1998)

Brealey Richard A. & Myers, Stewart C. Principle of Corporate Finance, New York: McGraw- Hill, 2003.

Robert C. Feenstra. "Integration of Trade and Disintegration of Production in the Global Economy", *The Journal of Economic Perspectives*, Vol. 12, No. 4. (Autumn, 1998), pp. 31-50.

Christos Pantzalis, Betty J. Simkins, Paul A. Laux. "Operational Hedges and the Foreign Exchange Exposure of U.S. Multinational Corporations", *Journal of International Business Studies*, Vol. 32, No. 4. (4th Qtr., 2001), pp. 793-812.

George Allayannis, Jane Ihrig, James P. Weston. "Exchange-Rate Hedging: Financial versus Operational Strategies", *The American Economic Review*, Vol. 91, No. 2, Papers and Proceedings of the Hundred Thirteenth Annual Meeting of the American Economic Association. (May, 2001), pp. 391-395.

Christopher Geczy, Bernadette A. Minton, Catherine Schrand. "Why Firms Use Currency Derivatives", *The Journal of Finance*, Vol. 52, No. 4. (Sep., 1997), pp. 1323-1354.

Telecom Regulatory Authority of India. Study Paper On Financial Analysis of Telecom Industry of China and India. 27 June 2006. www.trai.gov.in

iSuppli, "Foxconn's strategic coup: How does Terry Guo Build Success?", July 2006. <http://www.isuppli.com/whitepapers/pdf/EMSO.pdf> (October 2006)

Williamson, John and Zagha, Roberto (2002). "From the Hindu Rate of Growth to the Hindu Rate of Reform". Working Paper No. 144. Center for research on economic development and policy reform.

The Economist. "Can India Fly?". Print edition. June 3rd, 2006

The Economist. "India's Special Economic Zones". Print edition. October 12 2006.
http://www.economist.com/world/asia/displaystory.cfm?story_id=8031219

The McKinsey Quarterly. 2005 special edition: fulfilling India's promise.

Embassy of India. "Taxation System in India". <http://www.indianembassy.org>

Transparency International's Annual Report 2005.

<http://www.transparency.org/content/download/8101/51449/file/TIAR2005.pdf>

The Economist Intelligence Unit, "Country Commerce" 2006. MIT VERA Database

The Economist Intelligence Unit, "Country Profiles" 2006. MIT VERA Database

The Economist Intelligence Unit, "Country Reports" 2006. MIT VERA Database