

## CHAPTER 4

# ELECTRONICS ASSEMBLY MANUFACTURING IN CHINA

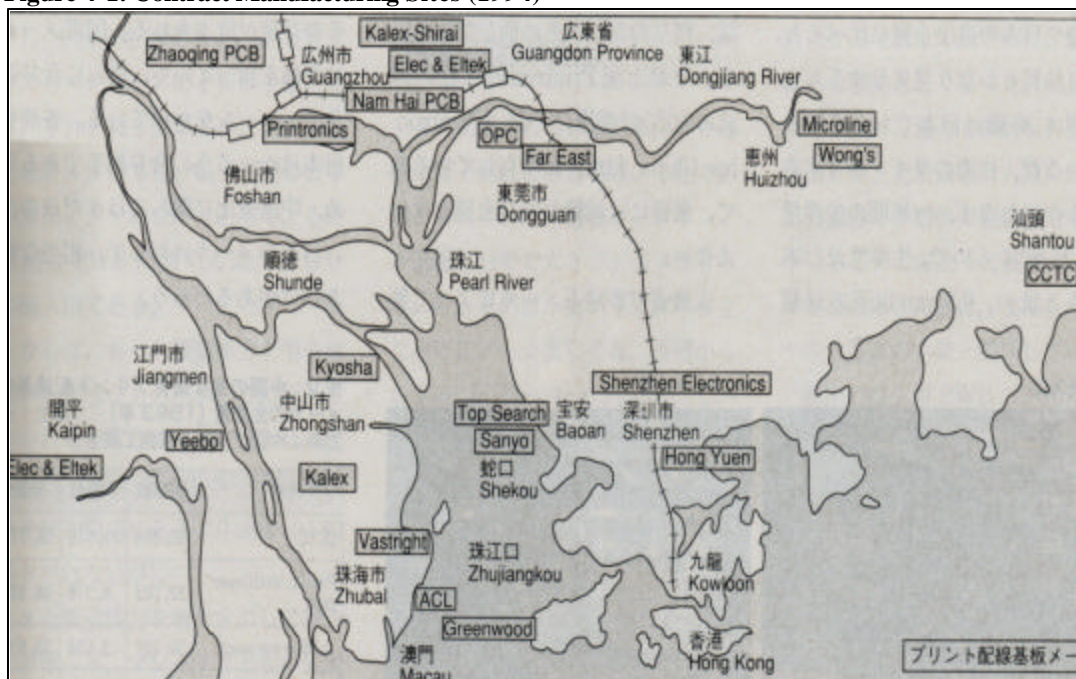
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### INTRODUCTION

The number of electronics manufacturing operations in China has increased dramatically over the last few years. Hong Kong and Shenzhen are well known for low-cost electronics assembly. Since China's opening in 1978, the majority of China's investments have gone through Hong Kong. The primary strategy of Hong Kong firms was to help firms reduce their costs by accessing China's low-cost labor. Some of those established in the early 1990s are shown in figure 4-1. Some of these facilities are traditional state-owned and operated enterprises while others belong to foreign companies.

Over 5000 North American, European, and Japanese companies have also established manufacturing sites, some through joint ventures with existing domestic companies, a few with Chinese government cooperation, others with partners from Hong Kong. Surprising are the number of Taiwan-based companies with new manufacturing facilities. Drivers for the growth in new manufacturing facilities include the availability of low cost labor and the potential to market to one of the largest populations on the planet. Some of this growth is in the contract-manufacturing sector.

**Figure 4-1: Contract Manufacturing Sites (1994)**



Source: NT International.

### LOW COST LABOR: HOW LONG WILL IT LAST?

China is the new Mecca for low-cost electronics manufacturing. Wages for factory workers are low. Many of the factories pay production line workers \$50 to \$100 per month—even this is relatively high compared to a few years ago. In addition to wages, room and board—consisting of a room shared with at least three others—is provided. There are strict employment rules such as curfews for nightly return to the dorms. Regardless of the relatively strict employment rules there is no shortage of workers that are willing to fill these positions. Wafers offered by Chinese electronics manufacturing operations are higher than other sectors and the jobs are considered desirable.

The first workers at some of the contract manufacturing sites were not highly trained or even worldly. Workers came from the countryside far away from the manufacturing zones of Shenzhen or Shanghai. When one company opened its manufacturing facility in Shenzhen ten years ago it found workers marveling over the operation of ball point pens. Times have changed in the and the workers are more sophisticated. Today many workers have acquired highly prized skills and some companies are even constructing married family housing to encourage workers to stay with the company.

While wages in China are low today, they are expected to rise over time—just as wages have historically risen in many of the world's formerly low-cost labor geographic regions. Variation in wages is already apparent in China's different economic regions. The closer one lives to Hong Kong, the higher the wage rate. As shown in table 4-1, Hong Kong's salaries are nearly five times those of China, causing problems for Hong Kong's competition in manufacturing. One must go to further and further inland in the southern economic zones to find the lowest wage structures.

**Table 4-1: Salary differences**

	HK vs. China	
• Head of Government	34,807	266
• Professor	16,287	453
• CEO	15,975	2,865
• Controller	11,022	2,457
• Manufacturing Director	10,150	1,866
• Sales Director	8,454	1,524
• Systems Engineer	3,774	746

## MOVEMENT INTO ADVANCED ELECTRONICS PRODUCTS

Japan's transition from producing transistor radios and cheap consumer products to the high-end, high quality producer of consumer products has been emulated by Taiwan, S. Korea and Singapore. Today, manufacturing operations in China are moving into more advanced products. For example, Namtai Electronics, a joint venture company with Hong Kong financing, Japanese management and technology, and China-based labor provides many advanced assembly services. The company started in 1975 and has moved from mainly calculator assembly to the assembly of products such palm-sized PCs, personal digital assistants (PDAs), electronic organizers and dictionaries, language translators, spell checkers, IC card readers, and cordless phones as shown in Figure 4-2. The focus for the future is personal communications products; the most recent product is an electronic organizer with features similar to a Palm Pilot.

Surprising are the advanced equipment for product design. For example, one company is using a recently purchased NTT DATA CMET He-Cd laser rapid prototyping system that allows the company to make a prototype in 30 hours.

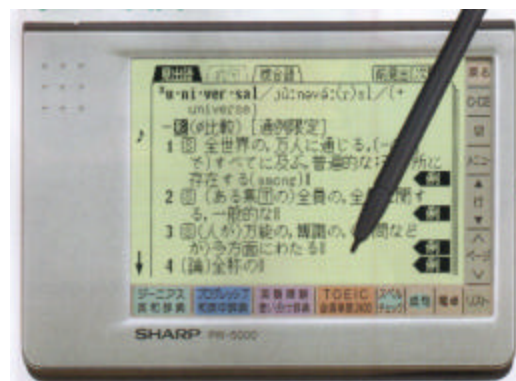
**Figure 4-2: Recent Figure Product Developments**



## AUTOMATION AND THE EXPANSION INTO ADVANCED CONTRACT ASSEMBLY

One of the most striking differences between manufacturing in Japan, Taiwan, and North American is the amount of manual labor. Contract assembly factories contain rooms and rooms of semiautomatic aluminum wire bonders with a worker at each machine. Glob-top dispensing is done manually—by hand with a heated syringe. Many components are hand soldered and inspection is manual. While labor is cheap and capital is expensive, a surprising number of contract assembly houses are purchasing advanced assembly equipment capable of competing in the world market.

Just as contract assembly services around the world have moved into more advanced assembly operations over time, so will China. Whitways, a small contract assembly operation in Shenzhen, has already done BGA placement and even purchased an x-ray inspection system for use with its customer's product. Whitways offers a wide range of services and acquires whatever equipment is needed to service its customers. Table 4-2 provides a full list of equipment available just from Whitways.



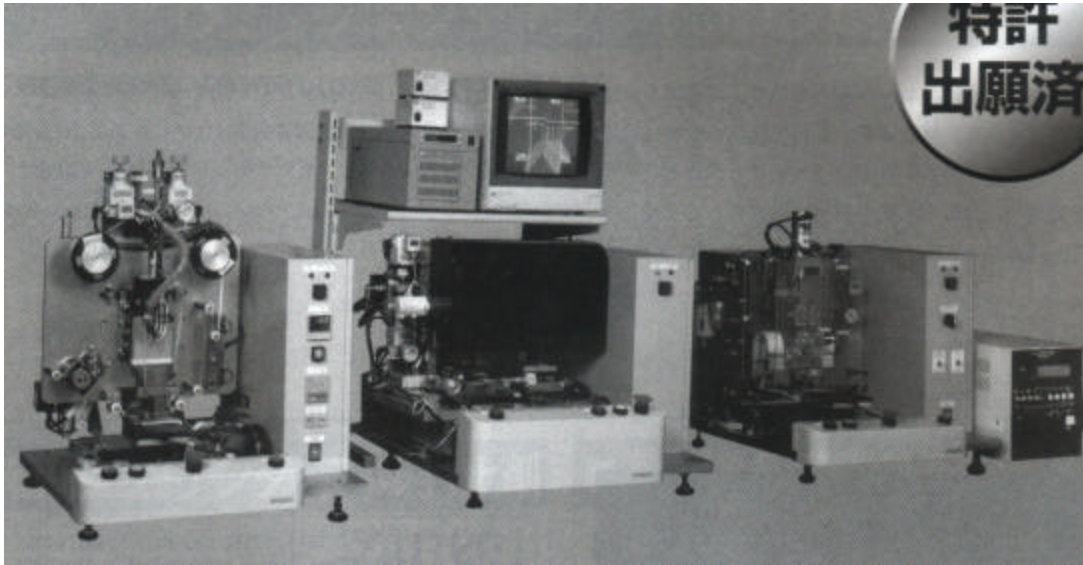
Namtai provides component subassembly of small liquid crystal displays (LCDs) and chip on board (COB). Wire diameter of 25  $\mu\text{m}$  and the bond pad pitch of 100  $\mu\text{m}$  is common today. Namtai has just started moving to 75  $\mu\text{m}$  pitch for COB. LCD modules are manufactured for cellular phones and home appliances. PCB assembly is provided for telephones, cellular communications, and microwave ovens. A tape automated bonding (TAB) and antistropic conductive film (ACF) assembly business for LCDs started three years ago.

**Table 4-2: Whitway's Equipment for Contract Manufacturing**

Descriptions	Make	Quantity
<a href="#">SMT Pick and Place Machine</a> <input type="checkbox"/>	Fuji, Juki, Vitronics	10, 2, 6
Fine Pitch Placement System	Fuji	1
Hot-Air Reflow Oven	Fuji, Vitronics, Kince Worldwide	1, 1, 1
UV/IR Reflow Oven	Universal, Fuji	1, 2
<a href="#">Bonding Machine</a> <input type="checkbox"/>	ASM	8
<a href="#">Wave-Soldering Machine</a> <input type="checkbox"/>	Electrovert, Hollis	3, 2
Washing Machine	Electrovert	3
<a href="#">Auto-Insertion Machine (Axial)</a> <input type="checkbox"/>	Dynapert	4
<a href="#">Auto-Insertion Machine (Radial)</a> <input type="checkbox"/>	Universal	2
<a href="#">Component Sequencer</a> <input type="checkbox"/>	Dynapert, Universal	1, 1
Ultrasonic Welding Machine	Branson	2
Pad Printing Machine		7
Ultrasonic Cleaner		3
End Coil Winders 4 Head Single		2
End Coil Winders 4 Head Multiple		4
<a href="#">Plastic Injection and Tooling Fabrication</a>		
Descriptions	Make	Quantity
<a href="#">Plastic Injection Machine</a> <input type="checkbox"/>	Elite, Chun Hung	15, 4
<a href="#">Electric Discharge Machine</a> <input type="checkbox"/>	Elite	4
Computing Numerical Controller	FV-900SE	2
Milling Machine	100L	10
Drilling Machine		9
Precision Surface Grinding Machine	KEN	2
Measuring Profile Projector	Fuji	1
Major Equipment for Testing		
Descriptions	Make	Quantity
Burn-in Chamber	Allen-Bradley	4

Last year Namtai started a chip-on-glass (COG) operation for LCD modules. Chip-on-film (COF) is the next target. The company uses COG bonders from Japanese equipment suppliers for bond fine pitch parts—minimum pitch is 50  $\mu\text{m}$ . Figure 43 shows small Japanese-made COG mounting equipment made for the Chinese market. This makes the latest technology available to Chinese firms in manual or semi-automated versions that can take advantage of China's low-cost labor markets.

Increasingly, pick and place lines are found running high volumes of boards per day. The throughput on these lines is high for SMT components. Rooms of manual labor handle the odd component placement while wave-soldering operations keep up with demand.



**Figure 4-3: Small Chip-on-Glass Mounting Equipment for the Chinese Market**

**ACF Attachment**

**IC Alignment**

**Main Bonding**

Reliability testing equipment similar to that found in many of the world's contract assembly operations are found in Chinese factories. Many contract manufacturing operations have test areas with ESPEC thermal shock chambers, vibration test, TABAI temperature/humidity chambers, freezers, and HAST ESPEC chamber, ESD test chambers, and high temperature storage equipment.

The level of technical capability and the use of software tools and programming is impressive. Whitways has a IC programming area with many workers programming 6,000 EEPROMs per day. The PCB layout area at many operations features some of the latest computer systems. Software for board designs including PROTEL or AUTOCAD.

There appears to be no restriction on the ability to purchase the necessary or desired manufacturing or test equipment for contract assembly operations in China.

#### **ISO CERTIFICATIONS AND QUALITY CONTROL**

Many companies have received ISO9002 and ISO9001 certification and expect to receive ISO14001 certification in the near future. Several companies are tracking defects and actively working to reduce the number of defects per production area.

Additional changes are expected to improve quality for all aspects of the assembly process. Even clean room technology has become more common in some of the more advanced contract assembly operations. Namtai's assembly operations take place in a clean room (class 10,000 to class 5,000). In more advanced assembly plants, such as LCD and PCB production in China, tighter clean room standards are maintained. As shown in Table 4-3, firms do not need the same level of clean room environment for all applications. Some firms do not even have air conditioning. In fact, air conditioning (AC) causes added electro-static problems which have required firms to install AC with humidity controls. LCD applications require clean operating environments. Operators wear bunny suits and masks. While not all operations in China have clean rooms for assembly and good clean room practices a trend is expected to develop.

**Table 4-3: Clean Room Requirements by Application (Firms A-F).**

	Clean Level (Class)						
	<100	1K	10K	50K	ACH	AC	Non
COB		A	B	C	D	E	F
SMT					A	B	C
LCD	A	B	C	D			
LCM		A	B	C	D	E	F
PCB	A	B	C	D	E	F	G

Source: Grand Joint Technology. Ltd.

Many China-based manufacturing sites conduct 100 percent incoming inspection for all boards and components. PCB substrates at one contract assembly house go through a cleaning process for all incoming boards and glass for the displays are manually cleaned one-by-one with alcohol before assembly. Many companies noted that suppliers have improved their quality for components and PCBs. Quality improvements are expected to continue.

#### **CHINA'S FUTURE AS AN ELECTRONICS MANUFACTURING POWERHOUSE**

A visit to China's electronics manufacturing centers today is a reminder of the advances that have been made in North American and Japanese assembly operations. While many of the facilities are similar to the factories of the more advanced industrialized nations years ago, rapid progress is underway. Workers will become more skilled, the product mix will become more advanced, and labor rates will rise. China is clearly at the beginning of its rise to become a manufacturing giant in electronics assembly, and the rate of change is anticipated to be swifter than has been experienced by other geographic regions. Factors influencing this rapid growth include the tremendous influx of electronics manufacturing expertise from North America and Japan, the close proximity of Hong Kong with its advanced manufacturing operations and Western technology, the insatiable supply of labor, and the desire for rapid development of the electronics industry.

The global cell phone market has surpassed the computer industry for number of units sold and growth (Table 4-4). The four market leaders, Nokia, Motorola, Ericsson and Samsung have production facilities in China. More of the component suppliers are now producing in China. STN LCDs are already produced in China. STN LCD modules are now being produced in China. The leading supplier to the cell phone industry of LCD module, Epson, is planning to produce color STN in China in 2001. Kyocera plans optics for the cell phone video camera beginning in 2001 (Figure 4-4). China already has production of plastic optics for small camera lenses. The most advanced cell phones will be available from firms with manufacturing operations in China.

**Table 4-4: Global cellular phone market (million units)**

	1999	2000(Estimate)
Nokia	76.34(27%)	100
Motorola	47.82(17%)	61.5
Ericsson	29.79(11%)	41
Samsung	17.69( 7%)	24.6
Panasonic	15.58( 6%)	20
Others	96.38(32%)	164
Total	280 (100%)	411.1

**Figure 4-4: Next Generation Cell Phones Production in China**

Along with advanced cell phone technology, we can expect new forms of products to be developed within China and Hong Kong. With the advancements in hard disk drive technology, chip-scale-packages, mobile communication, and advanced microprocessors, firms are now being formed to create new products. With the change in basic components architecture, the playing field has been leveled. Neither Japan nor the U.S. necessarily has the advantage. Japan still supplies the critical manufacturing equipment, and the U.S., Japan, and Europe still have global brand leaders. But China is building its own capabilities and brand names, like Legend, that are proving to be successful competitors in the Chinese marketplace.

