

SAMSUNG ELECTRONICS AND LCD TECHNOLOGY (A)

Professor Charles Dhanaraj and Young Soo Kim prepared this case solely to provide material for class discussion. The authors do not intend to illustrate either effective or ineffective handling of a managerial situation. The authors may have disguised certain names and other identifying information to protect confidentiality.

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It was February 1995. Sang-Wan Lee, chief executive officer (CEO) of the Active Matrix (AM)-Liquid Crystal Display (LCD) division at Samsung Electronics, Inc., and Sang-Soo Kim, director of the AM-LCD project, were just getting out of the San José International Airport with the Electronics Engineering News Bulletin's latest issue in hand. The market research column indicated an oversupply in the LCD market, and prices were expected to nosedive in the near future. Lee and Kim had left Seoul the previous evening after a marathon meeting on the strategy for the next LCD product. Despite a five-hour meeting with the staff from the manufacturing and marketing departments, there was no consensus on whether to pursue an 11.3-inch or 12.1-inch panel. Although the two options were deceptively similar, each required a different set of processes and signalled very different levels of marketing risk. As Lee and Kim drove through the heavy morning traffic, they needed to know what would be an appropriate focus before their scheduled product briefing session with two key customers: Apple and Dell computers.

THE GLOBAL FLAT PANEL DISPLAY INDUSTRY

In the mid-1990s, the University of Michigan's Center for Display Technologies estimated the worldwide market for flat panel displays to be \$18 billion¹ in 2001,

¹All monies in US\$ unless otherwise specified.

more than half of which would be computer screens. LCDs were expected to be the dominant technology in flat panel displays, covering about 86 per cent of the market.

Although a number of LCD patents originated in the United States, worldwide LCD production was dominated by the Japanese manufacturers, with very little being manufactured in the United States or Europe (despite representing half of worldwide demand). This pre-eminence was due to technical achievements and a broad industry base in research, development and manufacturing and was achieved almost completely within Japan, where there had been industrial participation, government guidance and a large domestic market of end-users. In addition, there was a complete infrastructure for components, namely, glass, chemical, printing and machinery industries, to support the LCD industry. A major initiative of the Japanese flat panel display industry was a consortium organized in 1989 (later disbanded in 1994). The Japanese government provided 70 per cent of the funding, and the remaining 30 per cent was provided by 17 member companies, including Thomson of France and Hoechst of Germany. Until 1990, Japan remained the single largest producer accounting for almost 100 per cent of world production. Sharp was the leader with just over one-third of the world market share (35 per cent), followed by Toshiba (approximately 23 per cent) and more distantly by Sanyo (12 per cent), Hitachi (11 per cent), and Matsushita (seven per cent).

Sharp had a complete product line, and the largest popular display was a 10.4-inch screen in 1995. In the late 1980s, Sharp had focused on super-twisted nematic (STN) technology, but during the 1990s, it gradually shifted focus to thin film transistor (TFT) panels. Sharp started producing LCDs for calculators and STN panels for computers in a factory at Nara, Japan, and set up a new factory in 1990 in Tenri, Japan, to exclusively produce TFT panels in a building previously used for LSI (large scale integrated circuit) chip production. The factory set-up allowed production using substrate of 12 by 15 inches, which would accommodate two 10.4-inch notebook computer displays or one 14-inch desktop computer monitor per substrate. It was estimated that Sharp had a capacity of one million AM-LCDs per year from this site. LCD products represented about 10 per cent of overall sales for Sharp. Sharp had developed several process technologies including low temperature technologies, an 11.3-inch personal computer interface LCD panel with super-high resolution quality and a prototype of the world's largest (at 28 inches) direct-viewing TFT-LCD panel.

Toshiba, a close competitor to Sharp, produced both STN and TFT-LCDs at factories in Yokohama, Himeji, and Kawasaki (all Japan). Toshiba's major focus had been STN technology but moved decisively into TFT technology in the early 1990s, starting with a working prototype of a 10.4-inch TFT panel. Toshiba entered a 50-50 joint venture agreement with IBM Japan in 1989. The joint venture, known as Display Technologies International, began with an investment

of ¥30 billion.² One-third of the 377 employees in 1991 were on assignment, each from Toshiba and IBM Japan. Display Technologies was a research and development (R&D) and manufacturing company with no marketing unit; half the products were delivered to Toshiba and the other half to IBM Japan. Display Technologies was producing large size (greater than 10 inch) active matrix LCDs for office automation applications with a capacity of about one million per year in 1995.

In 1995, the market experienced oversupply with a glut of manufacturing capacity for LCD panels, resulting in a major drop in screen prices. However, estimates in early 1996 suggested that market growth was not consistent with the expected growth in industry capacity, particularly in larger size screens. Prices were predicted to fall rapidly. For example, the 10.1-inch color notebook computer screen, which was selling at \$500 in 1995, was expected to sell for \$200 by 2000, and possibly for \$100 by 2005. In a similar manner, the 14-inch desktop LCD monitor that was selling for \$2,000 in 1995 was expected to drop to \$500 in 2000 and \$200 in 2005. The trend was increasing size, increasing resolution and decreasing price.

SAMSUNG ELECTRONICS: BACKGROUND

Samsung Corporation was first incorporated as a trading company in 1938 by Byung-Chull Lee, a Korean entrepreneur, and it became one of Korea's top 10 firms by the 1950s. In the mid-1950s, Samsung entered two manufacturing sectors: sugar in 1953 and textiles in 1956. In 1969, it entered the electronics industry, with the incorporation of Samsung Electronics. Samsung Corporation remained as the parent firm with a number of subsidiaries, such as Samsung Electronics. To acquire know-how and experience in the electronics industry, Samsung entered into several joint ventures with foreign technology suppliers such as Sanyo in 1969, NEC in 1970, and Corning Glass in 1973. By the end of the 1970s, Samsung Electronics Company (SEC), owned by Samsung Corporation, had reached an assembling capability of 10 million black and white television sets and was exporting a considerable volume of these sets to the United States, its only significant overseas market.

The semiconductor memory business, which Samsung Electronics entered in the late 1970s, went on to become the most profitable segment within the company, recording high sales growth. By the late 1980s, Samsung Electronics was the recognized leader in random access memory (RAM) production. However, with the turn of the decade, memory prices were crashing in the industry, and the SEC had to cope with an entirely new environment in the global electronics market. In 1992, Samsung Electronics' numerous and varied product sectors were integrated under a single umbrella, and radical reforms were initiated including the

²¥132 = US\$1.

establishment of a central unit, which served to integrate technologies at various divisions within the company.

The arrival of a pragmatic and entrepreneurial chairman at the helm of Samsung Corporation in 1994 triggered even more dramatic changes with new focus on innovation, globalization and a declared willingness for novel approaches on all fronts. In 1994, Samsung Electronics produced the world's first marketable 256-megabit memory module known as dynamic random access memory (DRAM), developed by a specially assembled Samsung research team. This scientific breakthrough provided a huge advantage for SEC at a time of ongoing price wars among the global semiconductor firms, raising Samsung's global sales to \$21 billion, with over 75 per cent of the sales outside Korea.

In 1995, prices for memory chips plummeted. However, Samsung Electronics hoped to sustain a leading position in the world's DRAM market in the subsequent years but simultaneously started diversifying into non-memory products to escape strong market fluctuations in supply and demand. Flat panel display products showed promise for propelling Samsung to a position of leadership in the electronics market. Essentially, Samsung saw opportunities to side-step to a new technology race, one which it felt it could command.

Samsung's Foray into the LCD Business

Samsung's AM-LCD division was created in 1991 to develop the TFT technology and enter the lucrative monitor and notebook screens market. The first development efforts for LCD were started in 1986 at Samsung Display Devices Co. Ltd, a separate company within the conglomerate that manufactured wide-screen color picture tubes for televisions and computer monitors. By 1990, SDD was manufacturing LCDs, TNs and STNs (see Exhibit 1). Although alternative DSTN technology was of lower cost and much in vogue in the early 1990s, Samsung decided to focus on TFT technology. Management reasoned that, as a display in the upcoming digital era, TFT would be a key to notebooks and PC manufacturers and therefore could command a huge market appeal. Since Japan was the only country in the world that supplied TFT-LCD in the early 1990s, Samsung argued that customers would value alternative sources and therefore would welcome Korean suppliers. In addition, the fact that most of the TFT manufacturers were also semiconductor producers prompted Samsung's management to believe that the firm's capabilities in semiconductors might be transferable to the TFT market.

The initial plan was to spend \$350 million and start mass production within four years. The division started with the R&D line in April 1991 and began mass production in October 1994. A new division for TFT displays was created within Samsung Electronics, and Samsung Display's existing resources were shifted to

Samsung Electronics. Once the decision was made, resources from the entire conglomerate were pulled to make things happen. In particular, three other affiliated companies were actively involved in the new task: Samsung Display was assigned to develop core components related to TFT-LCD, such as 'color filter.' Samsung Electro-Mechanics was in charge of developing raw materials for TFT-LCD, such as tape automated bonding (TAB). And Samsung Corning was responsible for the "thin glass panel," a super-thin but strong glass panel used for TFT-LCD.

The new team, known as the AM-LCD division, was headed by Sang-Wan Lee, director and general manager of the division. Lee had worked with Samsung Electronics in the semiconductor manufacturing program since 1976 and was one of the key personnel involved in setting up the semiconductor manufacturing line for the 4M DRAM. In 1991, he was assigned as overseas sales director of the Application Specific Integrated Circuits (ASIC) product line and had broad exposure to the global customers. Since most memory products were sold to the American and Japanese PC makers, Lee built strong relationships with these manufacturers.

A significant addition to the team was Sang-Soo Kim, who had completed his PhD in Physics in 1990 from North Carolina State University, United States. His doctoral thesis was on TFT technology for flat panel displays. Prior to joining the doctoral program, Kim had worked with Samsung Electronics for some years and, upon completion of his doctorate, was eager to rejoin the TFT group at Samsung Electronics. After being told of the company's decision to move the TFT group to Samsung Electronics, Kim joined Samsung Electronics and was assigned to the newly formed TFT group as a senior engineer for product development. In addition to Lee and Kim, Won-Kie Chang, who was an active member of the manufacturing technology team, was also assigned to the AM-LCD division, and the trio had a mandate to bring a TFT product on stream by 1995.

Less than a year after coming together, the AM-LCD group had a working prototype of an 8.4-inch display. Within a short time, they had also developed technology for the 9.4-inch display. By the end of 1994, the division had started mass production of 10.4-inch TFT-LCD for notebooks.

Much of the development work was done internally, building on the process capability developed within the company for memory technology as the company did not have much of a choice. However, the availability of a Japanese consultant was helpful. In early 1990, Samsung Electronics decided to hire a retired Japanese engineer, who had extensive experience producing LCD panels, as a consultant to the AM-LCD division. The consultant periodically visited the R&D site at Ki-Heung, Korea, and advised the team on the development of the prototype. When Kim wanted to develop a prototype of a VGA screen, the Japanese expert advised

the team strongly against such a move since that would be ‘fundamentally wrong.’ However, Kim argued that:

We had been developing prototypes of several TFT screens, but none of them were coming out to be of good quality. In order to get a good TFT screen, you not only need the panel; you need the liquid crystals and the drivers. So, it could take a long time to develop a prototype. Going the VGA route would provide a quick way to get to a working prototype, and if it worked, we would be able to move quickly in developing the other enabling technologies.

Lee, as CEO of the LCD business, decided to divide the product development into two groups, with Kim working on the VGA technology and the other, headed by Chang, was to follow the expert advice. Within six months, Kim completed a working prototype of the VGA screen that worked flawlessly. Following his demonstration of the prototype, management decided to abandon the other development efforts and let Kim assume overall responsibility of the development. Kim was promoted to principal engineer of the group. By early 1992, Kim had the 10.4-inch TFT panel developed and had perfected the process for mass production. Steps soon followed for setting up the first assembly line in Ki-Heung, and in October 1994, Line 1 was operational with the capacity to produce 120,000 LCD panels per month for the 10.4-inch panel.

MARKETING STRATEGY AND GROWTH OPTIONS IN 1995

The first shipment of LCD panels was to small-scale operators from Taiwan OEM makers that were trying to move into the notebook business. In 1994, 28,000 panels were shipped, contributing to overall revenue of approximately \$29 million. The investment had registered approximately \$1 billion. Major customers for the LCD products were computer manufacturers in the United States and Japan. Notebook computers were experiencing explosive growth in the mid-1990s. Shipments of portable computers had grown from 5.5 million units in 1990 to more than 13 million units in 1994 and were expected to continue double-digit annual growth over the next five years.

The market structure for the laptops was very different from that of the desktop segment. The top three vendors in 1994 were all Japanese firms — Sharp, Toshiba and NEC — with Compaq registered as the fourth largest vendor in the portable PC segment. IBM, Apple and Compaq were the three largest vendors in the desktop PC segment, with NEC and Dell close behind. Sharp and Toshiba did not have a significant presence in the desktop segment. Similarly, Dell did not have a significant presence in the portable PC market, although Gateway, a late entrant in the mail-order business, had registered substantially larger sales than Dell in the portable PC segment. Digital, even though it had a substantial presence in the

desktop market, had only marginal volume in the portable segment. Most manufacturers were expected to substantially increase the share of portables over the next five years.

Prices were often dictated by the market, based on supply and demand. For example, prices for the 10.4-inch panel dropped 30 per cent in 1995 from the previous year, due to overcapacity and excess market supply. Since the PC manufacturers did substantial integration at their end (integrating the LCD panel with drivers and other necessary hardware), the power of the panel suppliers was almost negligible. Operating efficiency decided the relative profitability of the LCD suppliers. There was no significant advertisement involved in the marketing efforts. The end-user, in most cases, was not aware of the identity of the original manufacturer of the LCD panel. The panel purchase was strictly based on the quality of the product and its reliability, which could be established from standard testing procedures.

The 10.4-inch panel market was already becoming saturated, and it was apparent that gaining market share was a difficult proposition. The market had quickly moved from the standard 8.4-inch screen to 9.4-inch and 10.4-inch screens within five years. There was every indication that the market for 11.3 inch, which was the next targeted size, would be picking up. Sharp had already developed and selectively marketed the 11.3-inch model. Early 1995 data suggested that the 11.3 inch had approximately a 30 per cent market share of the laptop screen market. Although it was possible to go for the 12.1 inch, the general belief was that this would not be a viable option. The market research done by Sharp and other Japanese companies suggested that customers might not be willing to pay the incremental cost for the 12.1 inch to offset the resulting manufacturing costs.

Samsung's corporate group had gone through a major revitalization in 1994 when the new chairman came aboard. Despite the profitability figures shown in 1994, management was willing to invest further in the TFT product segment since it was betting that the market would grow, rather than mature, in subsequent years. The major issue was to decide whether the AM-LCD division should proceed with development plans for an 11.3-inch model or for the next size, a 12.1-inch model.

The manufacturing process and investment costs were significantly more complex for a 12.1-inch line than for that of an 11.3-inch line. Several weeks of discussions had not resulted in a consensus. There seemed to be strong arguments for both options. Selected transcripts of the latest meeting are provided in Exhibit 2.

Exhibit 1

AN OVERVIEW OF BASIC DISPLAY TERMINOLOGY

Active Matrix	An LCD technology used in flat panel computer displays. It produces a brighter and sharper display with a broader viewing angle than that of passive matrix screens. Active matrix technology uses a thin film transistor at each pixel and is often designated as a TFT screen.
CRT	Cathode Ray Tube: the tube of a television or monitor in which rays of electrons are beamed onto a phosphorescent screen to produce images — a generic term for a computer monitor.
CSTN	Color Super-Twisted Nematic: a passive matrix LCD technology developed by Sharp.
DSTN	Double-layer Super-Twisted Nematic: a passive-matrix LCD technology that uses two display layers to counteract the color shifting that occurs with conventional super-twisted displays.
FED	Field Emission Display: a display technology that uses vacuum tubes (one for each pixel) with conventional red-green-blue (RGB) phosphors.
Flat Panel Display	A thin display screen that uses any of a number of technologies, such as LCD, plasma and FED. Traditionally used in laptops, flat panel displays are slowly beginning to replace desktop CRTs for specialized applications.
LCD	Liquid Crystal Display: a display technology that relies on polarizing filters and liquid crystal cells rather than phosphors illuminated by electron beams to produce an on-screen image.
LED	Light Emitting Diode: a display technology that uses a semiconductor diode that emits light when charged. LEDs are usually red. LED was the first digital watch display but was superseded by LCD, which uses less power.
LEP	Light-Emitting Polymer: a display technology in which plastics are made to conduct electricity and, under certain conditions, to emit light.
Passive Matrix	A common LCD technology used in laptops. Passive matrix displays (DSTN, CSTN, etc.) are not quite as sharp and do not have as broad a viewing angle as active matrix (TFT) displays, but they have improved dramatically in recent years.
PDP	Plasma Display Panel: a display technology that works on the principle that passing a high voltage through a low-pressure gas creates light.
TFT	Thin Film Transistor: a type of LCD flat panel display screen in which each pixel is controlled by one to four transistors. TFT technology provides the best resolution of all the current flat panel techniques. TFT screens are sometimes called active matrix LCDs.

Exhibit 2**THE MEETING
February 25, 1995,**

The strategic planning meeting started at 7 a.m. Lee, as the director of the group, chaired the meeting; Kim, R&D personnel, and manufacturing were also present. Some excerpts from the conversation are given below.

- Marketing: The market signal is very clear. Everyone is asking for an 11.3 inch. Sharp has already established the market, and there are no immediate plans to launch the 12.1 inch product. It is too early to introduce the 12.1-inch now. What if it turns out to be a lemon? It is a high risk and may end up throwing us totally out of the marketplace.
- R&D: In that case, we need to take the risk. Otherwise, we cannot take over the Japanese. This is the only way. By following them, we will end up playing the catch-up game, and we may not be able to do that for long.
- Kim: All of our competitors are working on an eight-mask process, but we have already established a five-mask process from the memory experience. We may not know the product, but we know the process too well to let go of this opportunity. We have the best process technology. If we can do it in the memory game, why can we not do it in the LCD panels?
- Production: I agree. It takes the same amount of resources to moving to either an 11.3 inch or a 12.1 inch. Why not go for a product that can get us a better price?
- Marketing: Well, the 12.1 inch is just too big. What if customers don't want to go for a bigger size? We know for sure that Digital does not want us to go that big. In fact, the Digital representative, with whom I discussed this, looked at my plan for the 12.1 inch and just wrote it off as just not practical. "Why on earth would a consumer want such a huge screen and such a high price? All he would care for is a decent display!" Even Apple does not want us to go in that direction. Digital and Apple are our core customers. They both think the market may not move to a 12.1 inch so soon.
- Production: IBM in the United States and Toshiba in Japan are our lead customers. Of course, they want us to produce the 11.3 inch since they are in high demand now. But when I asked them what is likely to win over the long term, they were quite confident that it would be the 12.1 inch. We still have a lot of customers who are moving into the laptop market in a big way, like for example, Dell. What if we go with the 11.3 inch and end up in the same way as with our existing 10.4-inch product? Unless we do something different, we cannot gain volume. If we do not gain volume, we do not get profit.
- R&D: I agree. We must consider our earlier experience. We first worked on the pilot line for the 9.4-inch panel, which took us several years to master. But, by the time we were ready to go, the market had already moved to 10.4 inch, and we had to get ourselves ready for the same. A development of this sort, either for an 11.3 inch or a 12.1 inch, is going to take us over a year's time and several millions of dollars. If they both demand the same resources, why not go for the 12.1 inch and be the first one to introduce the product to the market?

Exhibit 2 (continued)

- Production: I think the processing cost is not going to be that much different if we go for a higher fab size. We can go for a higher size of the substrate and get six panels from each substrate, 12.1 inch by 6 inch. That would put us on par with the competitors' costs of an 11.3 inch maker. Of course, we have to look at a whole host of processes of redesign, but we know that we can do it since we have done it in our memory products.
- R&D: Our customers know that we produce a high quality product at a reasonable price. Most of these customers are already buying from us all the advanced memory products such as DRAM. If we can provide a strong support net, I do not see why they would not buy from us a product, even if we are ahead of the market leader.
- Marketing: The problem is that we are really in a tough competitive environment. The prices are coming down sharply for the 10.1 inch since there seems to be an oversupply, and there is overcapacity in the flat panel display market. We are just reeling out of the sharp drop in memory prices, and are we going to increase the stakes by trying this untested strategy? The market quickly moved. Bigger is better, and we know that. But . . .
- Kim: We may lose some customers, Digital and Apple maybe. What we need is a customer (PC manufacturer) who wants to lead the market. A company like Dell, which is widely recognized, may be a potential target for us, and if we make a big sale with Dell, IBM and Toshiba, we may be in for a huge windfall. Taiwan is producing several million laptops a year, and they are importing their panels from Japan. That is also a potential approach. Dell seems to be poised to become a big player, and maybe we need to talk to them.
- Production: We have mastered the production technology now and are easily capable of the 11.3-inch production. There is no question at all. We can really build a higher quality product, if we do not have to go back to the drawing board to get another size of wafer, mask, etc. Are we going to be experimenting forever? When are going to make some money?
- Lee: It looks like half of you want to go with the 11.3 inch but the other half want to go with a 12.1 inch. There is no way we can do both. Our existing personnel and financial resources will not permit that. On the one hand, we need to make a careful move to ensure that we can launch a successful product. However, we need to look much beyond what our customers are driving, and how we can put ourselves on the global map. (With this, the meeting was adjourned.)