The Anti-dumping Petition of the Advanced Display Manufacturers of America: Origins and Consequences

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1. INTRODUCTION

ON July 17, 1990, seven small firms producing flat panel displays, who had recently formed a new producer association called the Advanced Display Manufacturers of America (ADMA), filed an anti-dumping petition before the US International Trade Administration of the Department of Commerce and the US International Trade Commission (ITC).[1] The petition was directed against the pricing practices of Japanese flat panel display manufacturers, focusing particularly on Matsushita, Sharp, Toshiba, and Hosiden. It claimed that these manufacturers were engaging in 'predatory pricing'. Predatory pricing is pricing so far below the average cost of production as to eliminate competitors, and thus to secure monopoly or oligopoly rents. The ITC made a preliminary ruling of material injury on 4 September 1990, which gave the green light for a lengthy examination of the production costs of the firms involved. On 15 August 1991, the ITC voted to authorise steep anti-dumping duties on active-matrix liquid crystal displays (AM-LCDs) and electroluminescent (EL) displays from Japan.

The ADMA's anti-dumping petition and the ITC ruling were strongly contested

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[1] *High Information Content Flat Panel Displays and Subassemblied Thereof from Japan* (Washington, DC: Collier, Shannon, and Scott, 17 July 1990). The seven firms are: Planar Systems, Ovonic Imaging Systems (now called Optical Imaging Systems or OIS), Plasmaco, Cherry Corporation, Electro-Plasma, Photonics Technology, and Magnascreen. The petition itself was prepared by the law firm of Collier, Shannon and Scott with the assistance of the Georgetown Economic Services.

not just by the Japanese manufacturers but also by many US computer systems manufacturers. The latter had become dependent on imports of flat panel displays from Japan and supported their Japanese suppliers' contentions that the displays were not being dumped. After the ITC's final decision, several computer manufacturers announced their intention to appeal the decision to the US Court of International Trade and to move their laptop computer assembly operations overseas in order to avoid paying the anti-dumping duties (which were imposed only on displays and display subassemblies and not on final products). The US computer industry criticised the ADMA and the ITC for driving an important source of relatively high-wage employment offshore.

This case deserves detailed examination for a number of reasons. First, it is an example of how US anti-dumping and fair trade laws fail to address the problem of upstream-downstream linkages in industries. Second, it illustrates how problems of administering and enforcing anti-dumping decisions can reduce the effectiveness of anti-dumping laws. Third, it shows how the attempt to pursue the long-term interests of workers and consumers by preventing predatory pricing can hurt the short-term interests of workers and consumers by forcing prices up and assembly operations overseas. Finally, an analysis of the flat panel anti-dumping case may provoke a discussion about how to modify existing fair trade laws to deal better with upstream-downstream linkages and to bring the pursuit of long-term and short-term interests into greater harmony.

This paper begins with a description of the products and manufacturing processes involved in the flat panel case. It then turns to a discussion of the market for flat panel displays and an explanation of the overwhelming strength of Japanese producers. Next, it deals with the decision of the ADMA to file the anti-dumping petition and to stick to that decision during the difficult period that followed. This is followed by a summary of the reasoning behind the ITC's decision to support the petition and impose anti-dumping duties. The conclusion takes up the issue of how US trade laws might be modified to minimise the damage to the short-term interests of workers and consumers while maximising the likelihood of long-term benefits from fair trade.

2. HIGH-INFORMATION-CONTENT FLAT PANEL DISPLAYS

A flat panel display (FPD) is usually a lot thinner (less than 4 inches in depth) and less bulky than the previous generation of displays based on cathode ray tubes (CRTs). The main types of FPDs currently in high-volume production are: liquid crystal displays (LCDs), electroluminescent (EL) displays, plasma display panels (PDPs), and vacuum fluorescent displays (VFDs). A more recent entry to the field of FPDs is the field emission display (FED, also called a cold-cathode or microtip display), but FEDs are still being produced only in very low volumes in research laboratories.

A high-information content (HIC) display can show large amounts of information: 120,000 'pixels' or more.[2] A pixel, short for picture element, is the smallest addressable part of a display. In a black-and-white display, a pixel is a dot which can be either black or white or some shade of grey. In a colour display, a pixel is usually a cluster of red, green, and blue dots (sometimes with an additional white dot) that allows some mixture of those colours to be displayed. Current colour television technology permits a theoretical maximum of 360 horizontal by 360 vertical pixels (around 130,000 pixels total). High definition television (HDTVs) — the next generation of TV technology — will display at least 500,000 pixels. Computer displays of a million or more pixels are already widely available. A typical VGA computer monitor has 640 horizontal by 480 vertical pixels or around 307,000 pixels total.

Not all flat panel displays are high-information-content displays. The FPDs sold currently on the display market are still predominantly low-information-content (LIC) displays. The small LCDs in wristwatches, thermometers, and nearly everything electronic are capable of displaying only a limited number of pixels. The same is true of small EL, PDP, and VFD displays used in medical equipment, jet fighter cockpits, and some automobiles. But the LCDs in hand-held colour TVs and the LCDs, PDPs, and EL displays in laptop computers with VGA monitors are full-fledged HIC FPDs. There is a decided trend toward HIC FPDs in the market, partly because of the success of products like laptop computers and hand-held TVs, but also because the premium paid for HIC performance has been reduced by advances in FPD technologies.

3. HIGH-INFORMATION-CONTENT LCDs

LCD technology was first applied to watches and calculators for relatively small monochrome displays of numerical data by companies like Citizen, Casio, Seiko-Epson, Sharp, Texas Instruments, and Hewlett-Packard. Sharp introduced the first calculator with an LCD in 1973 (Hayes, 1991). LCD technology depends on the ability of liquid crystals to scatter light in the presence of a small electric field.[3]

Monochrome LCDs were scaled upward in the mid 1980s to be used in portable computers and miniature black and white televisions. Because of low brightness,

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[2] The 120,000 threshold for HIC displays is somewhat controversial. Some individuals argue that a display does not qualify for HIC status unless it has at least 500,000 pixels.

[3] If the LCD has one or more levels of grey, grey-scaling is achieved by varying the voltage applied.

low contrast, and slow response-rates, these displays were not initially very successful commercially, so 'supertwist' displays and a variety of new forms of backlighting were developed to make them more attractive to consumers. Colour LCDs have been developed subsequently for many applications, including hand-held televisions and laptop computers. The most recent generation of multiplexed LCDs are brighter and faster than older generations and have been used successfully in a variety of applications.[4]

More recently, colour LCD technology has moved toward active addressing of pixels. An active-matrix LCD (AM-LCD) has a transistor or a diode on the glass panel next to each liquid crystal pixel that switches the pixel. AM-LCDs are theoretically capable of higher degrees of resolution and higher levels of grey-scaling than passive LCDs. This makes active-matrix displays more attractive than passive LCDs for very-high-information-content applications like HDTV and advanced workstations. The average selling price for an AM-LCD, however, is still much higher than that for an equivalently sized passive LCD. For example, a 10-inch diagonal colour AM-LCD for a laptop computer sells for $2,000 per unit or more, while a super-twist LCD of the same size sells for less than $500 per unit.[5]

While AM-LCDs are the main competition of CRTs in HIC display markets, EL displays and PDPs are also useful in certain types of applications. Monochrome EL displays are almost as expensive as colour passive LCDs but have a much higher brightness and contrast ratio, and so are useful for applications that require high visibility in situations of variable ambient lighting such as medical, automotive, and military applications. EL displays are also very compact, durable, and low in power consumption, two factors that count heavily in portable applications. Colour EL displays are still under research and may eventually be produced at lower cost than AM-LCDs.

Plasma displays are also bright and high-contrast displays, but they dissipate more power than either LCD or EL displays and are thus less suitable for battery-operated devices.[6] Monochrome plasma displays were initially quite competitive with monochrome LCDs in laptop computers, but have suffered somewhat from the development and commercialisation of supertwist LCDs. Colour PDPs are still being developed by a number of research units, and like colour EL displays, they may eventually be competitive with CRTs and AM-LCDs in display markets because

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[4] The latest version of super twist technology is called 'triple super twist nematic' (TSTN). An American firm called InFocus Systems uses TSTN to make direct-view and projection LCDs — but all the manufacturing of LCDs for this firm is done by Kyocera of Japan.

[5] The average selling prices of LCDs come from a briefing by Joseph Castellano, Stanford Resources, Inc., 11 December 1991.

[6] There are important distinctions between alternating current (AC) and direct current (DC) PDPs that will not be discussed here.

the manufacturing process for PDPs is somewhat less complex than that for AM-LCDs. For the moment, however, the vast majority of HIC FPDs sold on the market are either passive (super-twist) or monochrome plasma displays, with AM-LCDs just beginning to be sold in the high-end laptop markets.

4. THE MANUFACTURING OF FPDs

Flat-panel manufacturing requires the use of lithography equipment, deposition equipment, and steppers developed originally for semiconductor manufacturing and adapted for flat-panel production. Methods used to increase yields in semiconductor production — such as clean rooms and statistical quality control — are also used in flat-panel production. High-volume production of flat panels, therefore, can be a driver for innovation in semiconductor production equipment. This innovation is not likely to be in the area of making smaller line-width devices but rather in equipment for large-area processing.

The next generation of flat-panel manufacturing equipment will be aimed at integrating displays with LSI, VLSI, and ULSI circuitry on large glass panels. Steppers and advanced lithography equipment for semiconductor manufacturing are designed for relatively low variance in the size of objects on relatively small circular silicon or gallium arsenide substrates,[7] whereas steppers and deposition equipment for integrated displays will have to handle larger variation in the size of objects on a much larger rectangular glass substrate. The approach of companies like Nikon and MRS Technology is to adapt stepper alignment machines to the larger areas. The approach of the Giant Electronics Corporation in Japan to this problem is to move from away from steppers to printing technologies.

Deposition equipment for semiconductors has much in common with deposition equipment for flat panels. Both need to be able to deposit thin films of metal and metallic compounds on substrates. Since many flat panels have multiple layers of thin-film oxides, deposition equipment optimised for oxide deposition may be better for flat-panel processing than the nitride depositon machines used in most wafer fabs. But whatever machines are eventually used, the underlying thin-film deposition technologies remain much the same.

The substrates for semiconductors are usually either silicon or gallium arsenide while the substates for flat panels are usually glass. Glass-handling robots for flat-panel production lines are being marketed which use the same technologies as wafer-handling robots for semiconductors, but are modified to deal with the larger sizes and different physical properties of glass panels.

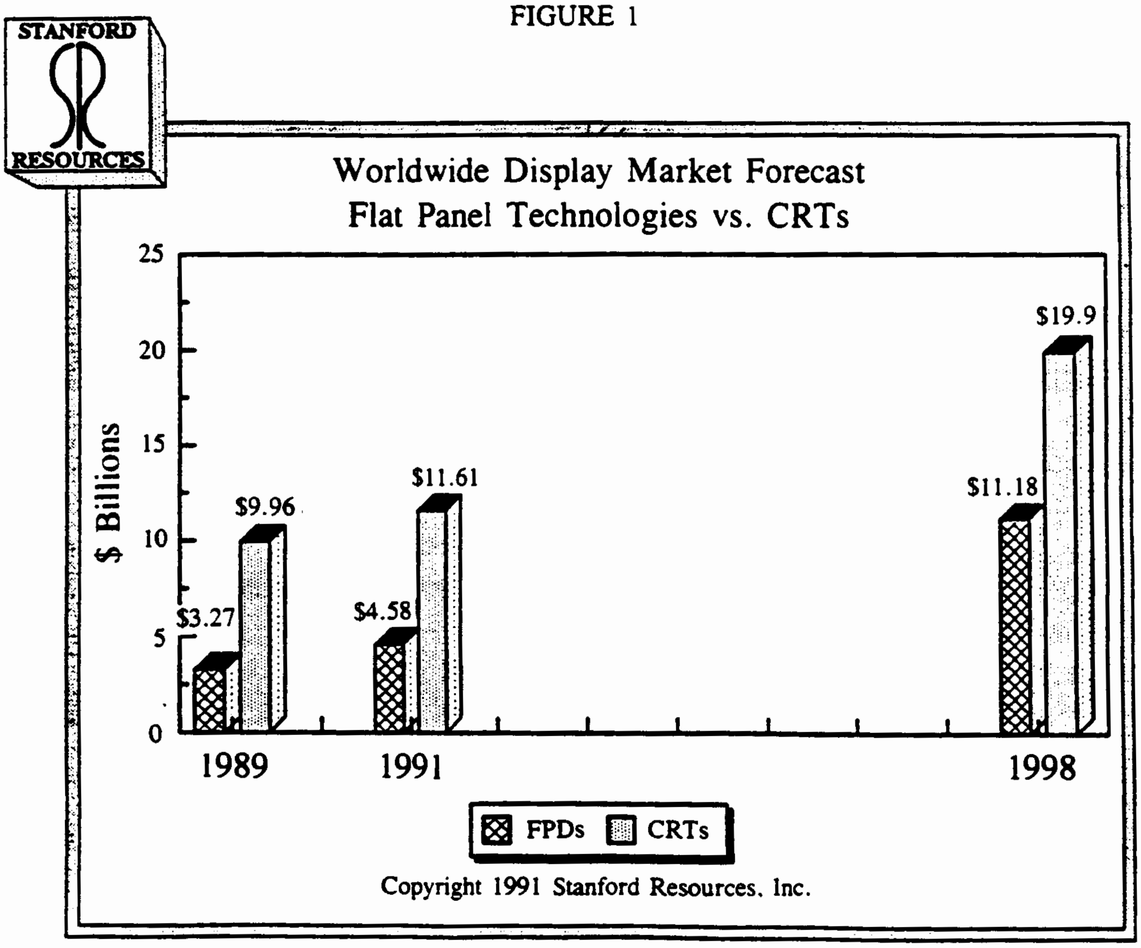
In other words, while manufacturing equipment for advanced displays will be

[7] Leading-edge wafer processing equipment is geared to 8-inch wafers.

different in some respects from that for semiconductors, there will continue to be many common features as well. Therefore, one can expect that firms which manufacture both integrated displays and advanced integrated circuits will have some advantages in overall electronics manufacturing technology over those which specialise only in displays or ICs alone. Similarly, equipment firms which have customers for both IC production machines and flat panel equipment may do better than equipment firms which are limited to one or the other market.

On top of these manufacturing impacts, integrated displays will be more compact, more functional, and eventually cheaper than displays with no integration. Systems manufacturers who are successful in integrating system circuitry into display panels may therefore displace manufacturers who are not. There will be major manufacturing advantages for firms integrating at least some of the electronic circuitry of the system onto the display panel. Even though microprocessors and memory devices are likely to remain on separate circuit boards, driver, logic, and testing circuitry can at least be integrated with the display. This reduces the cost and increases the reliability of interconnecting the display with the rest of the system.

FIGURE 1



Source: Cindra Trish, Flat Panel Display Market Forecasts and Application Trends, Proceedings of Stanford Resources: Eighth Annual Flat Information Displays Conference, 11–12 December 1991.

5. WORLD MARKETS FOR FPDs

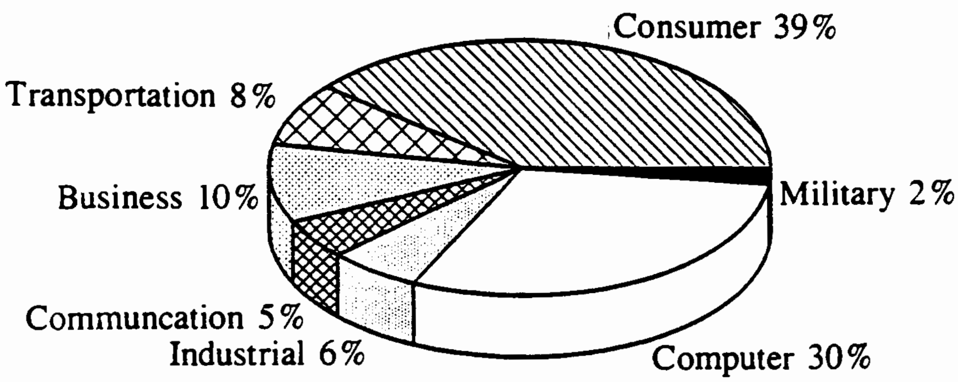
The world market for displays (FPDs and CRTs) was around $11.6 billion in 1991 and was projected to grow to around $31 billion by 1998. The world market for flat panel displays was $4.6 billion in 1989. The FPD market was projected to grow to $11.2 billion by 1998. In short, both FPD and CRT display markets have been growing rapidly, with CRT markets continuing to outpace those for FPDs (see Figure 1).

The demand for flat-panel displays is projected to grow more rapidly in the computer industry than in any other end-user industry (see Figure 2). 'Notebook' computers, which are substantially smaller and more portable than laptops, will account for over 60 per cent of the market for computer FPDs by 1998.

Consumer and computer applications accounted for 69 per cent of FPD sales in 1991 (see Figure 2). LCD-TVs accounted for only about $207 million of the $1.8 billion in consumer-oriented FPD sales in 1991. Most of the rest of the consumer applications of FPDs use low-information-content displays. Computer applications of FDPs consist primarily of computer monitors which require HIC

FIGURE 2

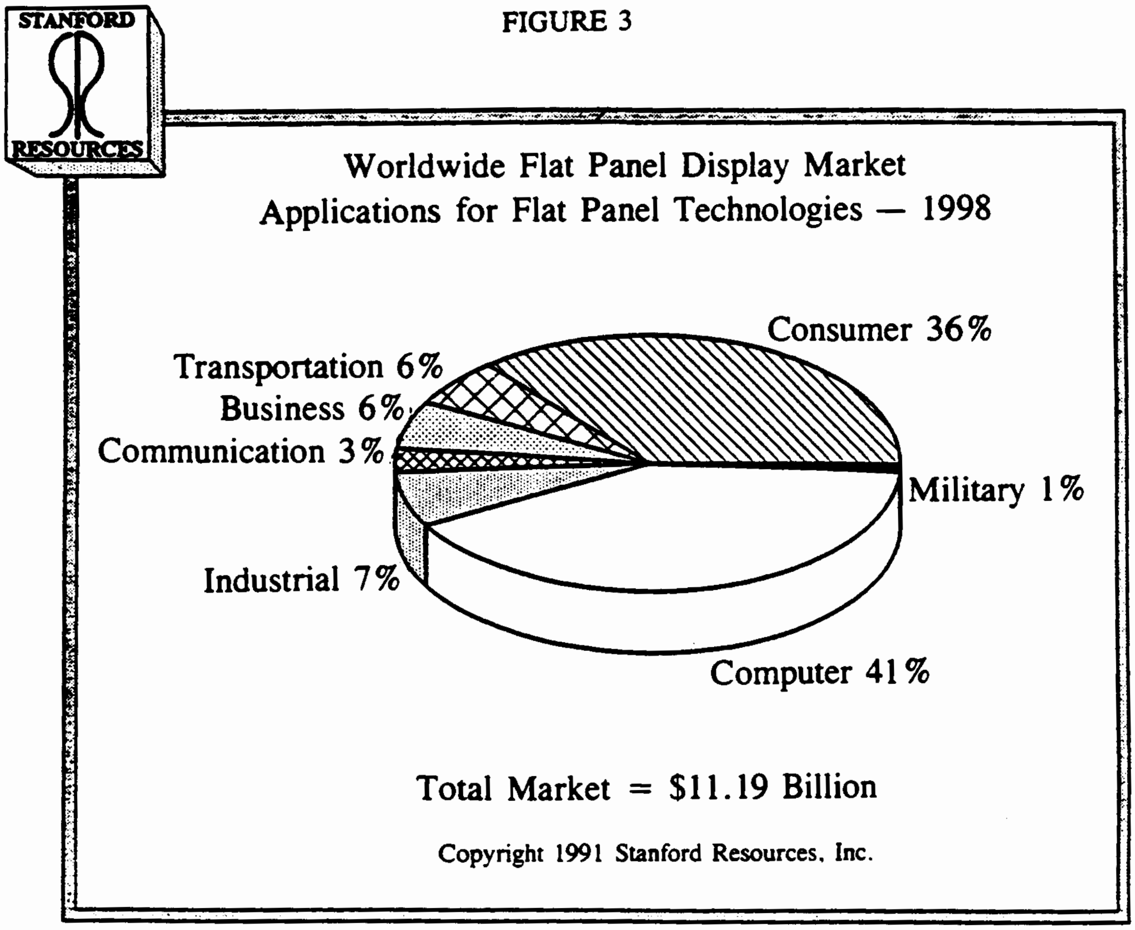
Worldwide Flat Panel Display Market
Applications for Flat Panel Technologies — 1991



Total Market = $4.58 Billion

Source: See Figure 1.

FIGURE 3



Source: See Figure 1.

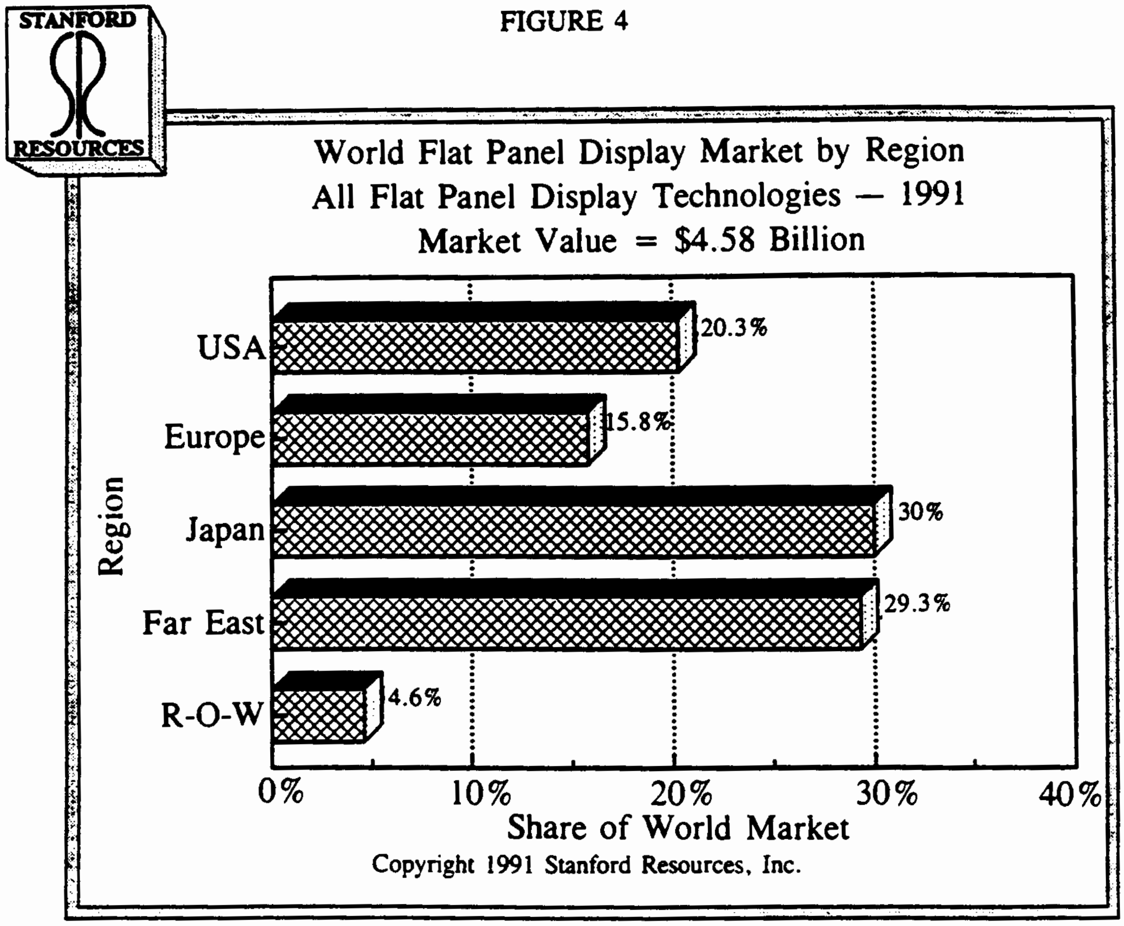
capabilities. The demand for computer FPDs reflects global trends in computer monitors toward greater pixel density (higher resolution), more grey scales, and better colour rendition of images.

Most of the demand for FPDs is in Asia and Japan (see Figure 4), because most consumer electronics and laptop computer production is there also. Nevertheless, demand for FPDs in North America and Europe is projected to grow as rapidly as demand in Asia.

6. JAPAN DOMINATES FPD PRODUCTION

Japanese producers control more than 90 per cent of the world market for LCDs, 69 per cent of the world market for PDPs, and 29 per cent of the world market for EL displays. All the high-volume production facilities for FPDs are in Japan (US Congress, Office of Technology Assessment, 1990). Japanese strength in FPD production is based on a solid commitment by the large, integrated electronics firms to invest in display research and production facilities for long-term payoffs.

FIGURE 4



Source: See Figure 1.

The thirteen largest Japanese producers of FPDs are: Matsushita, Sharp, Optrex, Hitachi, Seiko-Epson, Toshiba, Sanyo Electric, Seiko Instruments, Citizen Watch, Hosiden, Fujitsu, and Kyocera (see Table 1). Other producers are: Casio, Stanley Electric, Shimatori Sanyo Electric, Alpa Electric, and Futaba Electronic Industries. Sharp, Hitachi, and Optrex are the largest producers of high-information-content LCD displays. Sharp and Hitachi make active-matrix and passive LCDs for laptop and notebook computers; Optrex manufacturers passive LCDs for use in equipment panels and cars.

High-volume production of high-information-content LCDs is still mainly in passive LCDs. However, all the major systems firms and a few smaller firms have made large investments (in the $100 to $200 million range) in AM-LCD production facilities, so it is clearly their intention to shift into high-volume production of AM-LCDs as soon as possible.

Japanese firms are approaching the driving of AM-LCDs from two main directions: thin-film transistors (TFT) and metal-insulator-metal (MIM) diodes. TFT AM-LCDs are harder to make but probably better suited to faster and higher-resolution colour displays. MIM AM-LCDs are easier to produce, and therefore

TABLE 1
Major Japanese Firms in Flat Panel Display Markets

Company	*Technologies*	*Estimated 1989 Shipments ($ mill.)*
Citizen	LCD	75
Fujitsu	PDP	45
Hitachi	LCD	210
Hosiden	LCD	50
Kyocera	LCD	36
Matsushita	LCD, PCP	242
NEC	PDP	19
Oki Electric	PDP	28
Optrex	LCD	211
Sanyo Electric	LCD	87
Seiko-Epson	LCD	187
Sharp	EL, LCD	241
Toshiba	LCD	168

Source: Stanford Resources, Inc.

lower in price, but less well suited to colour, faster speeds, and higher resolution.[8]

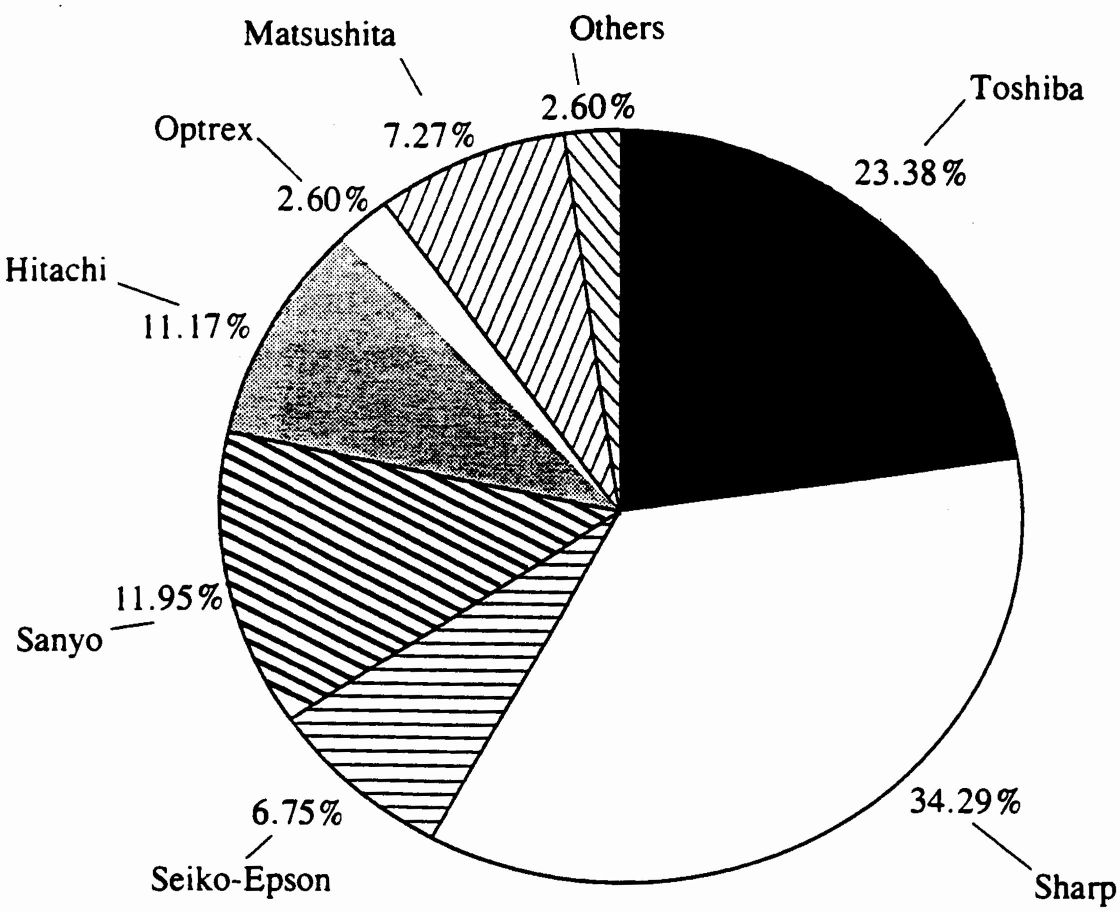
Sharp and Hitachi are clear leaders in TFT AM-LCDs. Hitachi is marketing a very high quality 10-inch colour AM-LCD for laptops and portable workstations. Sharp is selling 6-inch TFT AM-LCDs for televisions and 10-inch high-resolution monochrome AM-LCDs for computer applications. Sharp has marketed an LCD projector called the XV-100 (for NTSC signals at around $3,000 per unit), and a second-generation product called the XV-120. The imaging source for this projector is three monochrome TFT AM-LCDs. Toshiba is using its joint venture with IBM to become a player in the AM-LCD area, oriented toward use in laptops and portable workstations. It appears to be somewhat behind Sharp and Hitachi in this area.

Hosiden is a smaller firm that previously specialised in the production of switches and connectors. Hosiden was an early developer of AM-LCD technology, starting its research around 1979 with financial support from the Ministry of International Trade and Industry (MITI). Hosiden's main customers for AM-LCDs in Japan have been Mitsubishi Electronics Industries (for car TVs), Nippon Telegraph and Telephone (for a PC-fax machine), and the Japan Aviation Electronics Industry (JAEI). Hosiden is now the main supplier of monochrome AM-LCDs to Apple Computer for use in the lower-priced portable Macintosh computers. Hosiden began to produce 10-inch colour AM-LCDs in a facility at Seishin designed to produce

[8] Techsearch International, p. 11.

FIGURE 5

1990 Marketing Share
(Large Size LCD Module mostly STN)



Original Source: Toshiba Marketing & Sales Div.

Source: Larry Tannas, Flat Panel Displays in Japan, Proceedings of Stanford Resources Eighth Annual Flat Information Displays Conference, Santa Clara, California, 11–12 December 1991.

about 30,000 units per month early in 1990. Hosiden is focusing on the computer market and will not produce consumer products or projection displays. They use custom-made production equipment and are trying to maintain their lead through innovations in process technology.[9]

While the main effort in Japanese R&D is in two areas — incrementally improving passive LCDs and developing new AM-LCD technologies — a number of firms have invested in alternative flat-panel and projection technologies. Futaba Corporation is the most important player in vacuum fluorescent displays (VFDs).

[9] See *Japan Company Handbook: First Section Firms* (Osaka: Spring 1990), p. 692; Etsuro Ogisu, *Liquid Crystal Displays (LCDs): LCDs in, CRTs out?* (London: UBS-Philips and Drew, 18 October 1989).

Matsushita and Oki are competitors in the international market for monochrome plasma displays. IBM uses Matsushita plasma displays in one of its PS/2 portable machines. Sharp is the only major Japanese firm in the EL market.[10]

Some of the firms which were initially quite strong in LCDs were watch and calculator firms like Casio, Citizen, and Seiko-Epson. While Seiko-Epson seems to have made the transition to higher information content displays, innovating early and successfully in the technologies for integrating driver circuitry on the LCD substrate, Citizen and Casio have not done so well. But Seiko-Epson was unable to deliver as promised a blue-mode high information-content-display to a small California firm called Dynabook Technologies, so the latter switched to Hitachi.[11] Citizen and Casio have chosen not to develop AM-LCDs.[12]

The supply base for flat-panel manufacturing is stronger in Japan than in any other country. All the necessary tooling and materials activities are located in Japan. At least one Japanese firm is in each activity. For example, (1) Asahi and Nippon Sheet Glass make glass substrates for flat panels; (2) Nikon makes large-area steppers; (3) NEC Anelva makes dry etching equipment; (4) Nitto Denko makes colour filters and polarizers; (5) Dai Nippon Printing and Toppan printing make advanced printing equipment for large-area flat panels; (6) Japan Vacuum Technology makes Indium Tin Oxide (ITO) films for transparent conductors; (7) Canon makes mirror projection systems; and (8) a variety of firms make fluorescent backlights. Even where Japanese firms are not strong, as in the manufacturing of liquid crystal chemicals, grey-scale drivers, and high-performance glass, foreign firms have located in Japan or formed joint ventures with Japanese firms to service the local market. Examples of this phenomenon include Merck Japan, Texas Instruments Japan, and Corning Asahi Video.

7. THE MAJOR EUROPEAN PRODUCERS

The Europeans are far behind the Japanese in the development of advanced displays. The major European firms involved in research on advanced display technologies are: Philips, Thomson, Lohja (and its subsidiary, Finlux — now a division of Planar Systems), Thorn-EMI, AEG, Hoffmann-LaRoche, GEC, Barco, and Olivetti (in a joint venture with Seiko Instruments). Two national laboratories in France, CNET and LETI, have display research teams. In Germany and the

[10] Sharp briefly funded a small American firm called Amtel Video in its efforts to produce a white-light modulator called 'crystal scan' (see section on American firms below).
[11] Interview with Dan Evanicky of DynaBook on 14 August 1990:
[12] Ogisu, p. 4. It should be noted that Citizen produces one of Compaq's LTE laptop models in Japan and that the President of Citizen has stated publicly that he would like his company to become a force in laptop computer markets.

United Kingdom, a number of university teams are working in this area as well. The two biggest players are the two consumer electronics giants — Philips and Thomson.

Philips is using its laboratories in the Netherlands (Eindhoven) to develop AM-LCDs and driver circuitry for advanced displays. Philips recently demonstrated a 6-inch diagonal diode-addressed full-colour LCD. When Thomson purchased the consumer electronics operations of GE in 1987, it also acquired the GE process for making amorphous silicon AM-LCDs. The AM-LCDs developed by GE were designed for military applications rather than consumer applications. Thomson has continued to produce AM-LCDs for military applications and sells them in the United States through a joint venture called Sextant-Avionique. Thomson has pulled back from developing AM-LCDs for consumer products and has put most of its resources instead into AC-plasma and cold cathode displays, peripheral driver circuitry for AM-LCDs (work done mainly at the David Sarnoff Research Center in Princeton, New Jersey), and improved CRT technology.

Lohja-Finlux has developed some innovative EL displays. They are apparently working on using a cadmium selenide AM-LCD to drive an EL display. They have also been active in applying atomic layer epitaxy (ALE), a relatively new form of chemical vapour deposition, to the manufacturing of EL displays. Lohja-Finlux was recently acquired by Planar Systems, a small American firm which dominates world markets for EL displays.

The European Community has been funding research in high definition technologies through the Eureka-95 program. Eureka-95 has been dedicated to the production of prototype equipment for European high-definition standards: 1250/50 for production and HD-MAC for delivery. The Europeans are aware of their relative weakness in display technology and are trying to catch up with Japan, but like the Americans they have a long way to go.

8. THE US PRODUCERS

The main US firms involved in advanced display technologies are: IBM, Xerox, Texas Instruments, Hughes Corporation, Tektronix, Raychem (including its subsidiary, Taliq), Planar Systems, Greyhawk Systems, Optical Imaging Systems (OIS), Plasmaco, Photonics Systems, Magnascreen, Electro-Plasma, Cherry Display Products, Coloray, Amtel Video, Nitor, Hamlin-Standish, and Projectavision [see Table 2]. Except for the first four firms listed, all of these firms are small. The commitment of the larger firms to move to high-volume manufacturing is extremely limited. Of the smaller firms, only Planar Systems, Greyhawk Systems, Hamlin-Standish, and Plasmaco are producing displays in mid- or high-volume facilities. Coloray, Magnascreen, Nitor, Projectavision, Tektronix, and Amtel Video are still working on prototypes. The rest have produced in low

TABLE 2
US Firms in Advanced Display Businesses, 1990

Company	*Headquarters*	*Technologies*
Amtel Video	Palo Alto, CA	white-light mod.
Bellcore	Red Bank, NJ	PDP
Cherry Display Products	El Paso, TX	PDP
Coloray	Fremont, CA	FED
Electro-Plasma	Millbury, OH	PDP
Greyhawk Systems	Milpitas, CA	X-Y laser addressed AM-LCD
Hamlin-Standish	Lake Mills, WI	AM-LCD
Hughes Corporation	Carlsbad, CA	light-valve
IBM	Armonk, NY	AM-LCD
Magnascreen	Pittsburgh, PA	AM-LCD
Nitor	San Jose, CA	laser projection
Optical Imaging Systems	Troy, MI	AM-LCD
Photonics Systems	Northwood, OH	PDP
Planar Systems	Beaverton, OR	EL
Plasmaco	Highland, NY	PDP
Projectavision	Westbury, NY	LCD projection
Raychem	Menlo Park, CA	AM-LCD
Tektronix	Beaverton, OR	plasma-addressed AM-LCD
Texas Instruments	Dallas, TX	deformable mirror
Visulux	Sunnyvale, CA	laser projection
Xerox	Palo Alto, CA	a- and p-silicon AM-LCD

Sources: US Congress, Office of Technology Assessment, *The Big Picture: HDTV & High-Resolution Systems* (Washington, DC: USGPO, June 1990), p. 71; Interview Materials.

volumes for customers, primarily contractors of the Department of Defense, with specialised needs.

IBM's effort is mainly in a joint venture with Toshiba, already mentioned in the section above on Japan. Although there have been rumours about IBM's desire to establish an AM-LCD production facility in the United States, these rumours do not seem to be well founded (Corcoran, 1991). Xerox is working on applying new poly-silicon fabrication technologies to high-volume production, in a Japanese joint venture called Fuji-Xerox and an American one with Hamlin-Standish. Texas Instruments is developing a display based on 'deformable mirrors'. Hughes is attempting to use its light-valve technology, developed for military applications, in commercial video projectors. None of these large firms is involved in even low-volume production of flat panels or projection displays, however.

US firms have some important strengths from which it may be possible to build an advanced display industry. Planar Systems, for example, is the world market leader in monochrome EL displays. If it can develop EL colour displays at reasonably low prices, then it might be able to compete with Sharp, its main competitor in Japan. Coloray is developing an innovative approach to manufacturing cold cathode displays which, if successful, will produce more compact, bright, and energy-efficient displays than those made by AM-LCD producers. Photonics is keeping up with Matsushita and Thomson in inventing colour plasma displays. Tektronix has an ingenious way to actively address LCDs without using either transistors or diodes to switch the pixels. Greyhawk Systems has a patented system for X-Y laser addressing of LCDs, which can produce very high resolution images for flat-panel or projection displays. Amtel Video has a unique approach to modulating white light for video projection. Nitor will have access to inexpensive red, green, and blue lasers from Spectra Physics. Projectavision has figured out how to remove the pixel structure from LCD projectors and to increase the brightness several times. Each firm has something to add to solving the difficult technological problems of making advanced displays.

However, each US firm, even the large ones, are quite vulnerable to competition from Japanese firms which have a lot of experience with high-volume manufacturing, access to patient capital, and strength in a broad range of display technologies. None of the US firms can match this competition in the absence of correctives to the US business environment.

9. WHY US SYSTEMS FIRMS ABANDONED ADVANCED DISPLAYS

Table 3 lists the US firms which either closed a flat-panel production facility or sold one prior to 1990. The list includes many large systems firms: e.g., AT&T, Control Data, Exxon, GE, GTE, Hewlett-Packard, IBM, NCR, and Texas Instruments. The factors involved in these decisions vary considerably from firm to firm. Certain common factors emerge, however: (1) the belief that advanced displays are not central to the strategy of the firm, (2) the amount of capital required for establishing a world-class manufacturing facility is too large a proportion of the total capital expenditure of the firm, (3) the fear that Japanese competition will be so strong in this area that prospects for profitability are bleak, and (4) the belief that advanced displays can be purchased on the open market at reasonable prices without fear of delays or interruptions in supply (i.e., a belief in the continued existence of an honest merchant market).

10. ORIGINS OF THE ADMA AND THE DECISION TO FILE AN ANTI-DUMPING PETITION

The seven companies that formed the Advanced Display Manufacturers Association in the summer of 1990 had had several opportunities to discuss the

TABLE 3
US Firms Which Closed or Sold Flat panel Operations

Company	*Type of FPD*	*Sold or Closed*	*Date*
AT&T	Plasma	Closed	1986
Control Data	Plasma	Closed	1980
Crystal Vision	AM-LCD	Closed	1984
Exxon (Kylex)	AM-LCD	Sold	1983
General Electric	AM-LCD	Sold	1989
Hewlett-Packard	LCD	Closed	1980
Honeywell (Alphasil)	AM-LCD	Closed	1988
GTE	EL	Closed	1987
IBM	Plasma	Sold	1987
LC Systems	AM-LCD	Closed	1988
NCR	Plasma	Closed	1984
Panelvision	AM-LCD	Sold	1986
RCA	AM-LCD	Sold	1987
Sigmatron Nova	EL	Closed	1988
Texas Instruments	LCD	Closed	1980
Texas Instruments	Plasma	Closed	1983

Sources: See Table 2.

formation of such a group. The Defense Advanced Research Projects Agency (DARPA) decided to fund research in high definition display technology at the end of 1989. A Broad Area Announcement (BAA) was issued in December 1988 for a competition for grants for the development of advanced displays. The Department of Defense, and particularly DARPA, was concerned that there were virtually no domestic suppliers available for high-resolution displays for military systems. So they included displays as part of a larger attempt to deal with the likely difficulties of US participation in future markets for high definition television (HDTV).

Four future ADMA members were awarded research contracts by DARPA in mid 1990: Planar Systems, OIS, Photonics Technology, and Magnascreen. Planar Systems was awarded a contract for research colour EL technology; OIS for research on manufacturing AM-LCDs; Photonics for colour PDPs; and Magnascreen for the tiling of small AM-LCDs into large-area displays. Several other US display firms were awarded contracts that did not join the ADMA: e.g., Projectavision, Nitor, Xerox, and Tektronix.

After deciding to fund a number of display research efforts, DARPA convened several meetings of its new display contractors (and others) as part of its policy of creating informal networks of contractors to supplement the bilateral ties between itself and the individual contractors. During these meetings, representatives of the various US-owned firms had a chance to get to know one another and to share information about the difficulties they were encountering in the market.

One thing they had in common was a concern for the attempts by Japanese display manufacturers to engage in predatory pricing. Not only did low prices threaten their profitability, more importantly they threatened their ability to obtain investment funds from private capital markets. Many of the smaller display firms approached venture capitalists in the initial phases of product development, and most of these expressed strong concern that US firms would not be able to compete with larger Japanese concerns.

One manufacturer complained that he was unable to win large display supply contracts because he was always being underbid by his Japanese competitor for these contracts. This meant he was unable to add productive capacity, which made it difficult for him to win other large contracts.

Another claimed that he had been unable to persuade US computer systems manufacturers of the importance of having local suppliers of displays. This lead to a consideration of the reasons for the abandonment of the FPD efforts by most US integrated firms (see the discussion on this above), and an effort by the US display firms within the American Electronics Association to convince other AEA members of the strategic importance of displays. That effort ultimately failed, but it strengthened the resolve of the smaller firms to defend themselves in their own producer association.

The sharing of this sort of information and the development of sufficiently high levels of interpersonal trust among the managers of the small US display firms, plus the backing of DARPA and other government agencies, led eventually to the decision to form the ADMA and to file an anti-dumping petition with the ITC and the Department of Commerce in July 1990.

11. A BRIEF HISTORY OF THE PROCESSING OF THE ADMA's PETITION

The petition filed by the ADMA on 17 July 1990, focused on dumping (selling at less than fair value) by twelve Japanese producers[13] and the material injury that dumping had caused the industry. The petition cited an interview in the *Japan Economic Journal* with an executive of Toshiba, in which the individual was quoted as saying that the company 'is prepared to accept red ink for the first five or six years' in order to participate in the FPD business. It requested that anti-dumping duties be imposed on high information content flat panel displays and subassemblies by 'an amount equal to the amount by which the foreign market value exceeds the United States price of the merchandise.'

The petition used a 'constructed cost' basis for estimating the extent of dumping.

[13] They were: Fujitsu, Hitachi, Hosiden, Kyocera, Matsushita Electric Industries, Matsushita Electronics, NEC, Optrex, Seiko-Epson, Seiko Instruments and Electronics, Sharp, and Toshiba.

Based on these numbers, the petitioners requested duties of from 71 to 318 per cent to be imposed on the appropriate Japanese producers.[14] The petition did not call for the imposition of duties on assembled products, only on displays and subassemblies, because the ADMA had been advised by representatives of the Customs Bureau that it would be impossible for them to determine which assembled products did or did not contain HIC FPDs.[15]

The petition contained detailed discussions of the industry and the technologies involved, as well as estimates of the production costs of Japanese producers. It asked the ITC and the Department of Commerce to consider the HIC FDP industry as a single industry, despite the fact that there were several types of HIC FDPs involved in the petition (AM-LCDs, PDPs, and EL displays). The common feature of the various types of HIC FDPs highlighted in the petition was their use in computer displays.

On 14 August 1990, a notice of initiation was issued for an investigation on the ADMA's petition. On 4 September the ITC voted 3–1 that there was a reasonable indication that the US display manufacturers had been materially injured and that a full anti-dumping investigation should be initiated. On 27 September, the Department of Commerce presented a questionnaire to Hosiden, Matsushita, Sharp, and Toshiba to determine the constructed value (CV) of the products in question. Replies to these questionnaires were received in October and November. A supplemental questionnaire was developed and delivered on 21 December. On 10 January 1991, the Department of Commerce initiated a cost of production (COP) investigation for Sharp and Toshiba.

On 14 February 1991, the Department of Commerce issued a preliminary ruling that Japan was selling HIC FPDs at below fair market value. The initial dumping margins assigned to specific producers were quite modest: 4.6 per cent or less. The initial margins for Hosiden, an important AM-LCD producer, were zero. It is common, however, for preliminary rulings to contain modest estimates of dumping margins, and so both sides claimed victory at this point. The preliminary ruling also found that all the different HIC FPDs should be treated as a single class or kind, despite arguments of the representatives of Japanese producers and US computer firms (see below) that each type of FPD should be considered separately (Lachica, 1991).

The final ruling by the ITC was initially scheduled for 29 April 1991, but was not actually made until 15 August 1991. The Department of Commerce did not

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[14] See *High Information Content Flat Panel Displays and Subassemblies Thereof from Japan: Anti-dumping Petition Before the International Trade Administration of the US Department of Commerce and the US International Trade Commission*, public version, Inv. No. A-351, 17 July 1990, pp. 1–2; *Flat Panel Display Anti-dumping Petition: Possible Impact on Display Suppliers and Users* (San Jose, Calif.: Stanford Resources, Inc., July 1990).

[15] Interview materials.

finish its investigation until July 1991. The Department of Commerce recommended that dumping duties be imposed on AM-LCDs and EL displays. It argued specifically that some Japanese producers of AM-LCDs, notably Hosiden, had overstated their production yields and underestimated their research and development costs. The Department of Commerce said that it had not found pricing below fair value in the case of PDPs, so for the two Japanese producers of PDPs, Toshiba and Matsushita, zero dumping duties were recommended.

In its final ruling, the ITC voted 3–1 to authorise dumping duties of 62.67 per cent on imports of AM-LCDs and of 7.02 per cent on imports of EL displays from Japan. These were exactly the duties recommended by the Department of Commerce. This ruling provoked strong reactions from Japan and from US computer manufacturers dependent on Japanese FPDs. Before describing these reactions, however, it will be useful to review some of the arguments made by the parties during the period of ITC and Department of Commerce investigations and deliberations.

12. ARGUMENTS MADE AGAINST THE PETITION

The reaction to the filing of the petition was heated and swift. The Japanese producers denounced the move as injurious to US–Japanese economic relations. A number of important US computer companies joined with the Japanese government and firms to oppose the petition, claiming that there was not enough of a US display industry for it to have been injured by Japanese pricing strategies. The Commerce Department was deluged with letters from US firms talking about the potential harmful effects of dumping duties (Rice, 1991). They apparently missed the point that the ADMA was trying to make that the reason for the small size of the US industry was Japanese predatory pricing policies.

The US firms with the greatest stakes in the outcome of this dispute were IBM, Tandy, Compaq, and Apple. These firms all imported substantial numbers of FPDs for use in domestically assembled laptop computers. Apparently around 80 per cent of the imports of Japanese HIC FPDs, worth at least $100 million annually, were destined for assembly in laptop computers by US computer firms. IBM had a joint venture with Toshiba to produce AM-LCDs in Japan and did not want its Japan-produced displays to be subject to anti-dumping duties. In addition, the IBM model P-70 portable computer was being assembled by Matsushita in its Illinois plant with plasma displays imported from Japan.[16]

At the initial ITC hearings on the petition, held in Washington on 13 August 1990, Andrew Wechsler, an economist representing IBM, Tandy, Compaq, and

[16] Interview materials; Lachica, 'Technology.'

Apple, argued that dumping was not involved because 'Most US firms simply are not mass producers of panels for the portable computer market.' US firms had no choice but to go to Japanese suppliers for the FPDs. Similarly, James Burger, chief counsel for Apple Computer, said that 'There was simply no US manufacturer of active matrix LCDs capable of supplying the quantities we needed.' James Aden of Hitachi American's electron tube division said: 'These petitioners may have dreams and ambitions, but to the best of my knowledge, nothing more.' These sentiments were echoed in the oral arguments of the other American executives and attorneys employed by Japanese producers and also in written statements from executives in Japan (Robertson, 1990).

Andrew Wechsler explained the low productive capacity of US FPD manufacturers by asserting that they 'preferred to stay in small niche markets, such as military products, where they did not face Japanese competition.' He claimed that the US firms did not have the ability to supply displays in large volumes, nor did they have viable business plans for expanding capacity. In other words, there could be no injury to an industry that did not effectively exist. It should be noted that neither the Japanese producers nor the US computer firms made great efforts at this point to counter the argument that the displays were not being priced below fair value. Later on the Japanese firms would attempt to do this in their answers to the questionnaires presented to them by the Department of Commerce.

Representatives of the ADMA rebutted the claim that the US FPD industry did not effectively exist by arguing that Japanese suppliers also had limited production capacity prior to signing contracts with US computer firms and that they invested in new plants only after securing those contracts. The present and CEO of Planar Systems, James Hurd, who was also the leader of the ADMA, said that 'Matsushita only built its flat panel capacity after getting orders from Compaq, and Hosiden built up capacity after getting the Apple contract. At the time US computer firms signed major volume orders, there was no more production capacity in Japan than in the US: (Robertson, 1990).

James Kehoe, president of Plasmaco, supported the testimony of James Hurd and recounted how his firm had attempted to raise funds on the private capital markets for operating expenses and plant expansions, but was unsuccessful because investors were concerned about the possibility that his products would be underpriced by Japanese competitors. Zvi Yaniv, present of OIS, told a similar story.

ADMA representatives also attempted to explain the exit of the integrated electronics firms from FPD production ventures in terms of their perceptions of likely Japanese predation. The attorney for the ADMA, Paul Rosenthal, argued that the American computer firms 'were driven by short-term pricing consideration' in buying displays from Japanese firms. He added: 'I hope the US computer industry doesn't become dependent on their major competitors. In 10 years we will hear from the computer industry when it is struggling with Japan, as we are now.' (Robertson, 1990).

This last argument is the key to the eventual success of the ADMA strategy in defending its petition. The ITC and the Department of Commerce eventually accepted the ADMA's argument that the reason the US FDP industry was so small was that it was the victim of predation. It rejected the argument of the Japanese manufacturers that the petition should be broken into separate petitions for each type of FDP product. It rejected the data on production costs from Japanese producers that was supposed to show that they were not pricing below fair value after the Department of Commerce cost investigations were completed. Finally, and perhaps most importantly, the ITC accepted the argument that there was a distinction between the short-term costs of imposing dumping duties on AM-LCDs and EL displays from Japan — higher display prices and offshoring of assembly — and the long-term benefits of doing so — encouraging US computer firms to stop purchasing components from foreign suppliers that were engaging in predatory pricing.[17]

13. THE AFTERMATH

Immediately after the 15 August 1991, announcement of the ITC and Department of Commerce, a storm of protest arose from the US computer manufacturers. A number of firms immediately announced the transfer of laptop assembly operations to other countries. Toshiba, for example, said that its American plant in Irvine, California, would cease production of laptops with AM-LCDs, and that it would move all such production back to Japan. Sharp said it would suspend laptop operations in Texas and move them to Canada. Hosiden said that it had suspended shipments of AM-LCDs to Apple Computer. Apple said that it would move assembly of its Macintosh laptop from California either to Cork, Ireland, or to Singapore. Compaq also indicated that it was considering moving its laptop assembly offshore (Sanger, 1991). At a news conference in Tokyo in November 1991, John Akers, chairman of IBM, said that IBM was considering moving assembly of laptops offshore, even though very few of IBM's laptop products contained either AM-LCDs or EL displays (Sanger, 1991).

Spokespersons for the ADMA tried to counter these announcements by claiming that plans for offshoring laptop production had been in the works for a long time, so the announcements were just a kind of sour grapes. However, negative articles and editorials appeared in the *New York Times*, the *Washington Post*, and the *Wall Street Journal*, criticising the ITC, the Commerce Department, the ADMA, and the trade laws for forcing the manufacturers to move their domestic laptop assembly

[17] This is a brief summary of the final determination. See *Certain High-Information Content Flat Panel Displays and Display Glass Therefor from Japan: Determination of the Commission Investigation NO. 731-TA-469 Final Under the Tariff Act of 1930 Together with the Information Obtained in the Investigation* (Washington, DC: US International Trade Commission, August 1991).

operations overseas. A good example is in an editorial by T.R. Reid, the Tokyo Bureau Chief of the *Washington Post.*

> The administration's new tariff won't hurt the Japanese. In the fast-growing global market for laptop computers, they will make just as much money shipping display screens somewhere else. The only losers will be the American workers who might have had jobs building laptop computers — until the Commerce Department stepped in (Reid, 1991).

14. ATTEMPTS BY ADMA TO NEUTRALISE THE US COMPUTER FIRMS

The ADMA had anticipated this negative reaction to the petition itself and to the final ITC decision on the part of the US electronics industry. It had taken pains early on to approach the semi-conductor producer association, the Semiconductor Industry Association (SIA), as well as the relatively recently formed association of computer systems producers, the Computer Systems Policy Project (CSPP), to ask for support or at least acquiescence.

The SIA had been involved in its own trade dispute with Japanese producers of semi-conductors beginning in 1985. That trade dispute had created tensions between component suppliers in the semiconductor industry and their clients in computer systems manufacturing. Tensions had escalated until an agreement was reached in 1990 to end the semiconductor trade agreement which was negotiated with Japan in 1986 and aimed at setting floor prices for imported Japanese components (Hart, 1989). The ADMA was hoping to forestall the kind of divide and conquer tactics which it believed the Japanese had used successfully in the semiconductor case.

Neither the SIA nor the CSPP responded to the peace-making initiatives of the ADMA, however. The SIA did not want to upset the delicate compromise it had finally reached with the CSPP, and the CSPP thought, erroneously, that nothing would come of the ADMA's petition.

In April 1991, James Hurd of Planar Systems was attending the same board meeting of the American Electronics Association as an important executive of IBM, Paul Lowe. Hurd suggested to Lowe that there be an effort to reconcile the conflicting interests of the US display manufacturers and computer firms, but again nothing came of this effort.[18] Neither the display nor the computer manufacturers were forced to consider the impact of their actions on the other and so they did not. The outcome was clearly bad for everyone at least in the short-term and possibly also in the long-term, because the ITC/Commerce decision did not prevent Japanese producers from continuing to dump in third markets and Japanese or US computer

[18] Interview materials.

firms from exporting the dumped displays to the United States in final products. In the process, quite a few laptop assembly jobs would be lost to offshore production.

15. CONCLUSIONS

This case illustrates a number of weaknesses in US trade law. The main ones are: (1) the failure of that law to take into account the interests of both upstream and downstream industries in linked families of manufacturing; (2) the difficulty of enforcing product-specific anti-dumping laws, especially with respect to components in technologically sophisticated products; and (3), because of the previous two points, the ease with which major trading partners of the United States can exploit conflicting interests within the US manufacturing sector to neutralise the impact of fair trading laws. These points require some elaboration.

If the US display and computer firms had been forced to iron out their differences with respect to the potential impact of this dispute after the final ruling had been made, perhaps through the good offices of the Secretary of Commerce, then it is quite likely that they would have agreed not to impose dumping duties but to use some other mechanism — e.g., subsidies to the display firms — to compensate the display industry for the predation of their Japanese competitors and to give the computer firms time to wean themselves from their overwhelming dependency on Japanese suppliers. It may be argued, of course, that forcing the two industries to negotiate after a dumping case would not necessarily result in any such agreement, but my rebuttal would be that at least there would be some pressure on them to do so, whereas the current situation provides no such pressure.

The recommendation of the Customs Bureau to exclude assembled systems from the petition eventually backfired because it left open the possibility of offshoring assembly. It is natural for Customs agents to be worried about an administrative measure that requires them to disassembly complex products in order to determine the nature of specific components. I find it a little strange, however, in this case, because it is not that hard to distinguish among the different types of displays without disassembling the final product. Nevertheless, there are enough similarities between passive colour LCDs and AM-LCDs to make this somewhat of a chore, and in any case I suppose Customs agents do not want to have to take apart the containers and the special packaging that generally enclose electronics products in order to get a good look at the display. There were some reports, by the way, that after the August 1991 ruling, importers of *passive* LCDs received large bills for dumping duties from the Customs Bureau.

One way out of this problem is to insist, as was done in the 1986 Semiconductor Agreement, that there be no 'third-party dumping.' This means that components cannot be dumped offshore and then imported as assembled products. Apparently, the United States and Japan were able to work out ways of ensuring that this did not occur, but I suspect that the experience with the administration of this aspect of the Semiconductor Agreement may have had something to do with the Customs Bureau's strong opposition to including assembled systems in the original petition.

Finally, I accept the logic and the importance of the broader point that the ADMA and its attorneys were trying to make in this case: that it was dangerous for the economic health of any country to allow domestic assembly firms to prosper on the basis of predatory pricing of imported components. There are often important positive externalities connected with the local production of critical electronic components. It is not just a question of jobs and revenues, but also of technological competence and adaptability to change. When an important set of generic technologies and human skills are lost as a result of the offshoring of component production, it is often difficult to stay at the technological frontier in related industries. A good example of this was the inability of the United States to commercialise its indigenous VCR technologies after the offshoring or selling off of most of its consumer electronics industry. This is not always the case, of course, but it happens often enough, especially in high technology electronics, to be a legitimate concern.

However impeccable the ADMA's logic, in the absence of trade laws that force the authorities to take into account the interests of both upstream and downstream industries and in the presence of difficulties in administering fair trade decisions concerning technologically sophisticated products, the result was bound to be negative. So you may ask yourself, 'Why bother with fair trade laws at all?' This is a legitimate question, but I am afraid that it has no definitive answer. One is left with the idea that strict enforcement of fair trade laws can be at best a deterrent to predation, but obviously no guarantee of positive long-term outcomes for the enforcers. This is one reason why many economists favour the use of anti-trust laws rather than trade laws to deal with predatory pricing.

Because fair trade laws are basically unilateral (although we are beginning to see more bilateral fair trade agreements), they will always be vulnerable to the failure of some third party to honour their anti-predatory intent. Multilaterialisation of fair trading is an expensive but possible option, and may be necessary in any case because of the recent rapid proliferation of anti-dumping laws (thanks in no small part to aggressive US leadership in this sphere). A better alternative would be international harmonisation of anti-trust and competition law enforcement. Neither of these two options are very likely to be implemented.

We are in a world where first-best solutions do not exist. Possibly, even second-bests are beyond our reach. The optimum would be for all trading nations not to engage in predation. Next best would be a harmonisation and multilaterialisation of fair trade and anti-trust laws. Way down on the list, I would put revision of US anti-dumping laws to take into account upstream-downstream linkages and a formal recognition of the limits of administration. But the current situation is even further down the list, as the ADMA's anti-dumping case so beautifully illustrates.

REFERENCES

Corcoran, E. (1991), 'Flat Horizons: US Pursues Research But Little Development of Advanced Screens', *Scientific American* (June), 112–114.

Hart, J.A. (1989), 'The Origins of the US–Japan Semi-conductor Dispute', in S. Haggard and C-I Moon (eds.), *Pacific Dynamics* (Boulder, Colo.: Westview).

Hayes, F. (1991), 'Displays — Down the DRAM Drain?' *Byte* (February), 232.

Lachica, E. (1991), 'Technology: Some Japanese Computer Display Firms Face US Duties, but Others are Spared', *Wall Street Journal* (9th July), B5.

Reid, T.R. (1991), 'The Commerce Department's Bonehead Play', *The Washington Post National Weekly Edition* (23–29th September), 28.

Rice, V. (1991), 'Dumping Case Splits Electronics Industry', *San Jose Mercury News*, (13th February), 1F.

Robertson, J. (1990), 'IBM, Apple, Compaq, Tandy Warn Against Display Duties', *Electronic News* (13th August), 1.

Sanger, D.E. (1991), 'US Tariff Appears to Backfire', *New York Times* (26th September), C1.

Sanger, D.E. (1991), 'IBM Chief Issues Threat on US Tariff', *New York Times* (8th November), C4.

US Congress, Office of Technology Assessment (1990), *The Big Picture: HDTV and High-Resolution Systems* (Washington DC: USGPO, June), 70.