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This case study explores how LGE has adopted modular product architecture to both PDP and LCD TV across both upstream and down stream supply chain. Besides, LGE has implemented unique operational management practices (LG Production System) applying Toyota Production System. Such integration of product architecture and operational practices has secured its globally competitive market position. This case study suggests the importance of integration of both business model and operational practices for sustainable competitive advantages.

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1. Introduction

With the increasing use of digital broadcasting and internet broadband, more customers expect content rich and high density video expression in media. In this context, the main stream of display is moving away from traditional CRT (Cathode-Ray Tube) to flat panel display (FPD)(Park, 2005). For a long time it seemed that the commercialization prospect of OLED technologies was remote, though FPD TV Industry was bloomed utilizing LCD and PDP technologies. By the end of 2007 Sony was successful in developing OLED TV and testing in the market by utilizing the OLED technology. The display TV market will intensify competition with the products using combinations of the LCD, PDP and OLED technologies.

Although the marketing effort of OLED TV started at the end of 2007, its commercialization success for the large screen market requires overcoming major technological limitations. On the other hand, the competitive boundaries of LCD and PDP have almost disappeared. Prior to 2000, LCD technology was fitting to smaller screens instead of the larger screen ones. However, through successful applications of TFT-LCD technologies from the middle of 2000s, rapid price competition among large screen LCD TV

is in progress.

TV assembly manufacturers (quite different from their color TV days) are experiencing continuous deterioration of their financial performance (Ogasawara and Matsumoto, 2006). For an example, this trend is quite obvious in price change of LCD panel that is used for LCD TV. After 2005, continuous LCD panel price reduction caused the drastic drop in terms of the firm's operating income rate (top 4 firms) from 19% (in 2004) to 7% (in 2005) (LG Economics Institute, 2006a). Such downward profit spiral of LCD panel firms has impacted the performance of FPD TV firms that produce LCD TV.

In a sense, the above changes are explained by the disappearance of the market boundary between LCD and PDP. More importantly, they are in response to the element of product architecture. Product architecture is an essential concept that explains the patterns of relationships among functional and structural requirements that satisfy core components of a product. In terms of interdependence of part design, two classification methods are either modular or integral. In terms of the extent of standardization characteristics, the organizational system is grouped either open or closed (Fujimoto, 2003). Particularly, the key word that signifies today's firm characteristics is modularity (Baldwin and Clark, 2000; Aoki and Ando, 2002). With the widespread use of internet in the middle of 1990s the inter-firm relationships have evolved to be more open and therefore, even the products that had been characterized as closed-integral product architecture are becoming more open-modular product architecture. Such environmental changes have impacted FPD industry. In general, LCD product architecture of upstream (component suppliers) is close to integral pattern while downstream architecture (LCD TV) adopt modular one (Park et al., 2007b). As a result, the FPD TV prices charged to ultimate customers have significantly dropped over the years and naturally the pressures to panel prices have been intensifying. Although the upstream component manufactures certainly feel the heat of such sustained cost reduction, the extent of price pressures are most obvious to the prices of final TV products.

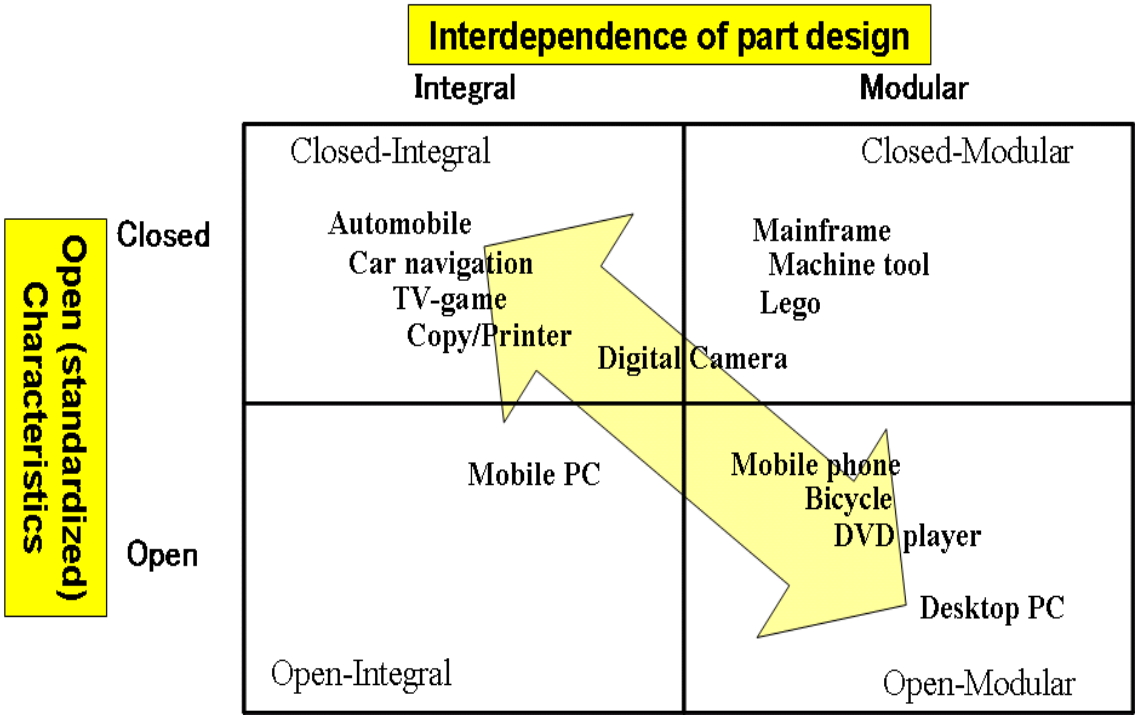
However, such modularized products must focus on cost reduction through efficient operations management unless innovation occurs in the fundamental business model level. This case study focuses on LG Electronics that produces both FPD TV and FPD panel that are heavily affected by modularity trends. Quite different from venture firms that do not maintain any production factories, LG Electronics has difficulty in quickly implementing innovative business model throughout its supply chains. This study therefore examines how LG

Electronics (with both production of FPD TV and panel) have implemented effective operations management practices. Particularly, this study presents how LG successfully adopted (1) supply chain management in preparation to global dispersion of the components manufacturing plants in response to the modularity demand and (2) LGPS (LG Production System) in manufacturing assembly of electronic products.

2. Product Architecture and Operation Management

2.1 Integral Product Architecture and Modular Product Architecture

Product architecture is an essential concept that explains the patterns of relationships among functional and structural requirements that satisfy core components of a product. In terms of interdependence of part design, two classification methods are either modular or integral. In terms of the extent of standardization characteristics, the organizational system is grouped either open or closed (Fujimoto, 2003; Park et al., 2007b). Automobiles take closed integral architecture with the complex product functions and process structures and naturally they are not so open with the outside firms.



Source: Park et al.(2007a)

Figure 1 - Type of Product Architecture

On the other hand, electronic products (e.g., personal computers) are close to open-modular architecture with clear-cut one relationship among product functions and process structures. They tend to be more open relationships among firms (Fujimoto, 2003; Nobeoka et al., 2006; Park et al., 2007a).

With the widespread use of internet from the middle of 1990s the inter-firm relationships have evolved to be more open and therefore, even the products that had been characterized as closed-integral product architecture are becoming more open-modular product architecture. Nobeoka (2006) argues that one factor for strong modularity is in case that the customer needs of product function have reached limitation. Although firms with their continuous product development efforts introduce new products with higher function, customer needs do not necessarily require beyond certain level and therefore the process of modularity is accelerated through product standardization-specialization. For example, customer demands for pixel of digital camera are adequate to five million pixel. Firms may introduce new products beyond five million pixel with heavy investment on R & D but few customers are willing to pay higher prices for such new products. So called excessive product quality phenomena in Japanese electronic product manufacturers show that product purchasing power no longer expands if customer needs do not respond to beyond certain price level. Therefore, firms focus more on cost reduction rather than new innovative products with excessive functionality beyond required level of customer needs. Naturally, the modularity trends are accelerated through the applications of standardization and specialization. Such modularity phenomena impact market segment not only in local market but also in the global market. For example, global mobile phone markets have two market segments—high end market for advanced nations and low-end market focusing on Brazil-Russia-India-China (BRICS). There are the integral markets for the customer needs that require high value added functionality and the modular markets for customers that prefer to low priced functional mobile phones (Park et al., 2008).

In some cases, firms may deliberately accelerate modularity process. Firms that have developed core technology may standardize assembly product and interfaces using their own technologies and therefore speed up the modularity process. For example, Intel has standardized its products based on MPU and Cisco did the same for its external network and interfaces based on Router (Ogawa, 2007). As many players acquire their own innovation

capabilities through system modules, the relationships between producers of core products and suppliers of complementary products rapidly changes and accordingly, modularity tendency becomes more visible (Song, 2006 ; Park, 2006). Besides, network technology development like internet has product architecture become more open modular and yet, even for personal computers that are regarded as modular products, the core CPU is integral product architecture that other firms may not easily imitate. Even for modular products, too often many internal components of the sub-system adopt integral architecture (Nobeoka, 2006). The subsequent section is devoted to explain the product architecture hierarchy in electronic products that are close to modular architecture and in particular about product architecture of FPD.

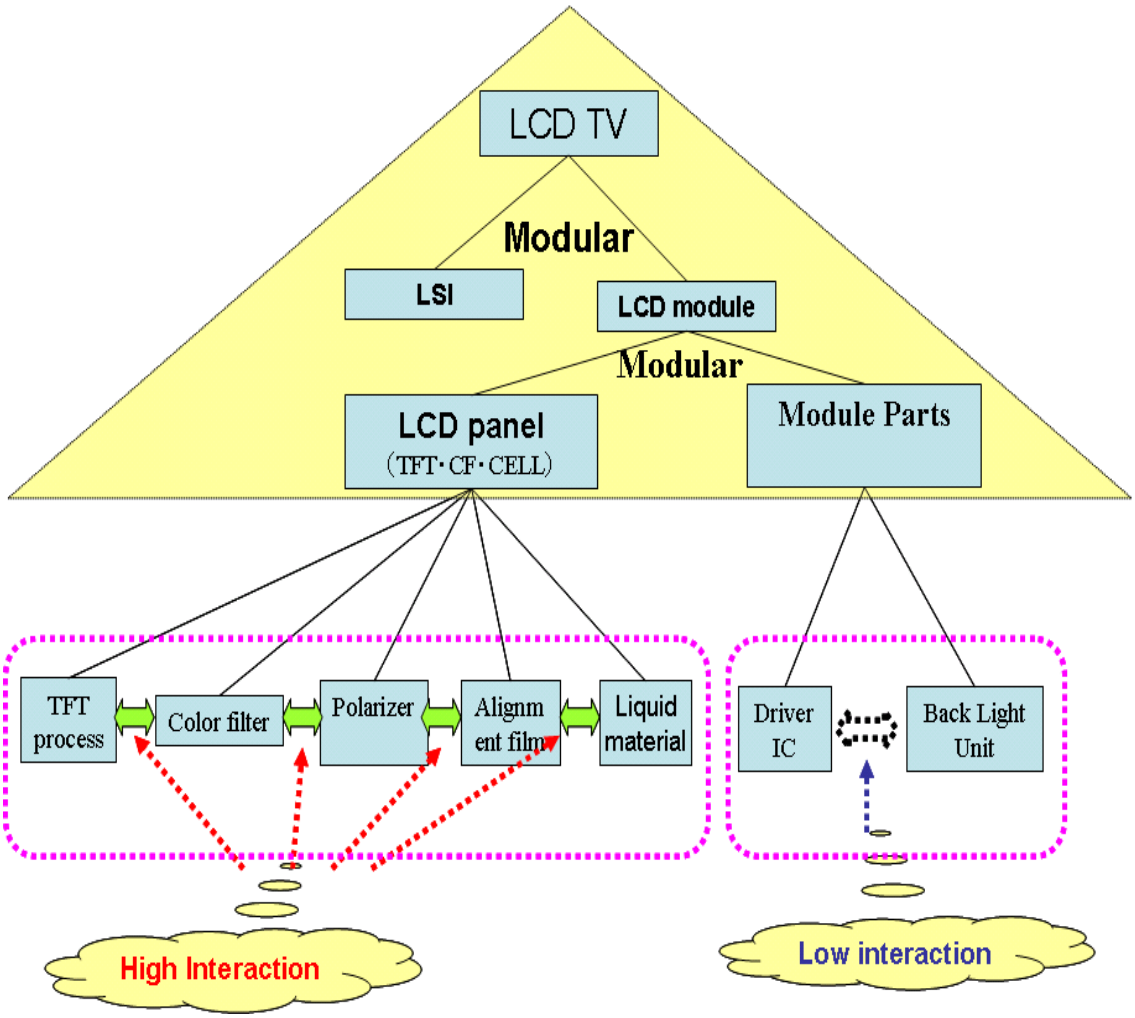
2.2 Hierarchy of Product Architecture in FPD TV

Product architecture is hierarchical, even modular products contain integral product architecture in their sub-system level (Clark, 1985; Fujimoto, 2003; Nobeoka, 2006). The representative study of product architecture of subsystem is on DVD player (Shintaku et al., 2006). In case of DVD player, which is regarded as modular product, integral product architecture are used for subsystem which centralized some control elements. LCD products (one of FPD display) also show such patterns. The closer to the upstream components parts, the more integral product architecture is applied; the closer to the down stream areas, the more modular product architecture is common (Park et al., 2007b). As below product architecture of LCD TV is described, LCD TV of downstream includes LCD TV module which is the assembly of the three core components (i.e., LCD panel, driver IC and Back light unit) and the final additions of image processing LSI. As seen from the upper structure, it appears that the manufacturing process is simple assembly of modularized component parts. In reality, it is close to integral architecture in that LCD panel requires the complex interrelationships among component parts (Shintaku et al. 2007).

Because of the above characteristics, firms that produce modularized products pursue price competitive strategy through production cost reduction. On the other hand, firms that produce core components in modular elements tend to exercise platform leadership. In today's numerous industries, mutual interdependency of diverse products and widely dispersed innovation capabilities dictate firms (regardless of their size) to consider the activities of other firms for their basic business decision making (Gawer and Cusumano, 2002).

As mentioned above, FPD TV has three kinds--LCD, PDP and OLED. LG Electronics

produce both LCD TV and PDP TV in its Factory A. This is possible because of the architecture characteristics of FPD TV. PDP TV is similar to LCD TV in terms of structures. In the next section, the characteristics of LCD TV and PDP TV are compared and their differences are explained.



Source: Adopted from Shintaku et al.(2007)

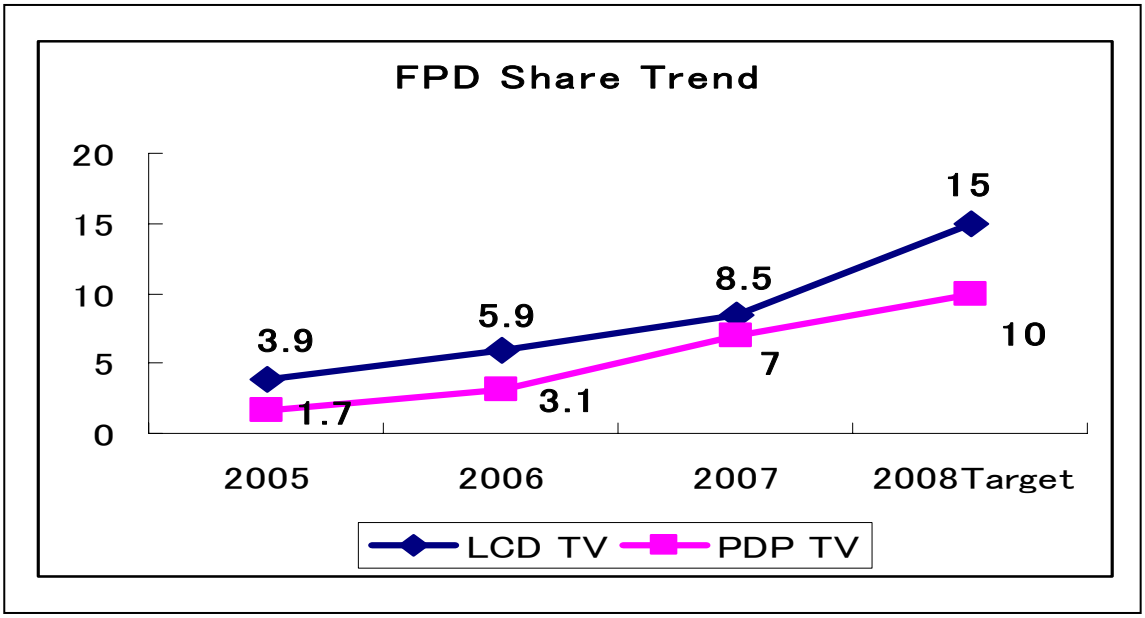
Figure 2 - Product Architecture of LCD TV

2.3 LCD and PDP

CRT TV has dominated TV market for a long period. With the rapid expansion of FPD TV market, the market share of FPD TV is noticeably increasing. Figure 3 shows the FPD market share trend since 2006. It is predicted that in 2008 its market share would be more

than 25%.

Technological characteristics of LCD and PDP are somewhat different, although they both belong to the FPD display family. PDP technology became popular in 1997 as firms commercialized 102 cm (40 inch) size TV for the purpose of public viewing by hanging in the wall (inews24, Dec 19, 2007). At the beginning of 2000 mass production system for its production was already established in Korea and Japan. At that time LCD technology, having been successfully applied in small digital technologies (e.g., mobile phone), was being considered for TV market. By 2005 the serious competition between LCD TV and PDP TV became quite real in the market. Since then, PDP TV was acknowledged for its cost advantage, smooth video image-presentation and wide viewing screen capacity. In contrast, LCD was not so appealing to the market because of high cost and the poor viewing quality --particularly at the time of reproduction of video images. With the successful resolution of such LCD technological problems the competitive boundaries between LCD TV and PDP TV soon disappeared.

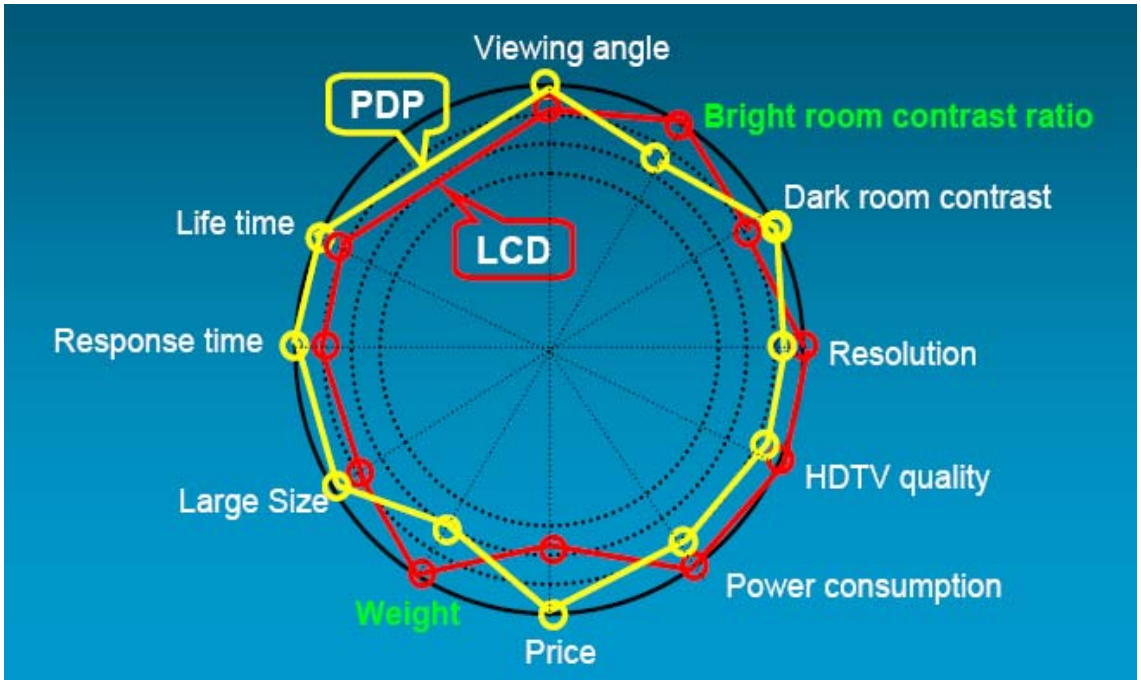


Source : NPD, LGE(2008.2)

Figure 3 - FPD Market Share Trend

Since PDP technology was developed for the purpose of wide screen product characteristics, it is difficult for the size minimization. In the areas of DID (digital information display) LCD

(with the introduction of new technologies) is positioning to replace both interior and exterior advertising billboards. LCD (although started for small size display) accelerated its move toward the larger screen through series of technological breakthroughs and therefore by the late 1990s, the competitive boundaries between LCD and PDP no longer exist. LCD is used in the wide range from small and medium equipments (e.g., mobile phone, notebook and monitor) to various IT technological products including medium and large TV. 2008 market prospect is that LCD fits to 40 inch TV and PDP is for beyond 50 inch TV. Figure 4 shows that both LCD and PDP technologies have reached somewhat similar performance standards except that PDP has relative price and size advantage while LCD maintain its comparative superiority in terms of weight and bright room contrast ratio.



Source: LG Electronics (2006.11)

Figure 4 – Comparison of LCD and PDP

From the product architecture standpoint, product architecture of LCD/PCD module (located in upstream of LCD TV and PDP TV) has noticeable differences. Compared to LCD module, PDP module is closer to integral architecture in view of its strong mutual interdependence of manufacturing processes. PDP is quite effective in reproducing smooth and quality video images since PDP use the principles of analogue phenomena that transform ultraviolet rays made by high voltage electricity into fluorescent elements. However, if

troubles in manufacturing processes of PDP panel occur, it is much more difficult to response them because of analogue technical constraints (e.g., electric discharge) of PDP (Ogawa, 2007). On the other hand, LCD module assembly is close to modular structure in that key component parts (e.g., Driver IC and Back Light Unit) of the highly mutually interdependent LCD panel can be independently assembled without having any serious problems. Therefore, entire front-end manufacturing processes of LCD module are done domestically, back-end assembly processes are done in overseas plants. In this way, the differences occur in LCD/PDP (placed in between LCD TV and PDP TV) module architecture.

However, in the final TV assembly processes, complete open modularity is possible if LCD/PDP modules and other component parts (e.g., image processing LSI chip and cases) are purchased separately. Because of these characteristics Chinese firms and American venture firms (e.g., VISIO), without any LCD/PDP module manufacturing facilities, can compete in US FPD market against major brands such as Samsung, Sony, LG and Sharp. Entry to the area of component parts close to integral architecture and entire panel manufacturing is not easy. However, by purchasing all modules and TV component parts, firms can easily supply cost competitive TV without having any prior TV assembly technologies. Therefore, in the final TV assembly stage, brand power and cost performance determines the firm's competitive advantages.

Table 1 - Modularity and Comparison of LCD and PDP

	LCD	PDP	Focus
TV	Modularity	Modularity	Productivity/Cost competitiveness
module	Modularity	Intermediate integral (Panel-module integration)	Productivity/Cost competitiveness
panel	Intermediate integral		Process/Cost competitiveness
parts	High integral	High integral	Quality competitiveness

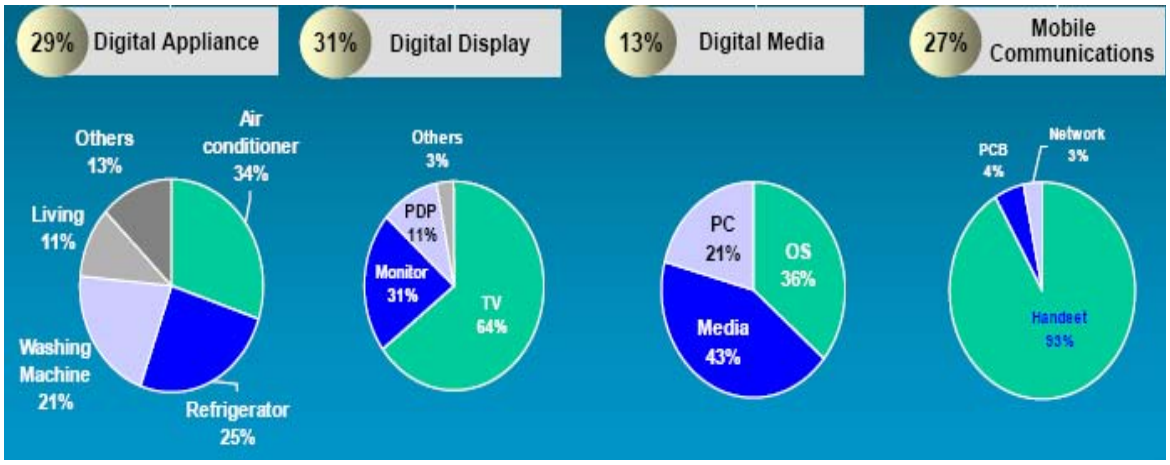
In this context, operations management is becoming more important in recent FPD TV manufacturing processes for the purpose of productivity enhancement and cost reduction. Most TV manufacturers show losses in their financial statements, it is critical to maximize the

production efficiencies and minimize assembly costs for profitable FPD TV production. This case study therefore focuses on changes in manufacturing processes in the final assembly line of LCD/PDP TV among FPD TV.

3. Case Study

3.1. Case Background

Korean FPD TV makers occupy the top positions in terms of global market share. In all TV global market, Samsung and LG maintain 1st and 3rd place respectively and accordingly, the global competitiveness of Korean firms is fairly high. LG Electronics, this particular case focus firm, has four business units—DA (Digital Appliance), DD (Digital Display), DM (Digital Media) and MC (Mobile Communication). Flat Panel TV belongs to DD (Digital Display) and it produces both LCD and PDP TV. Panel module that is the core TV module is produced by LGE's PDP Unit and its subsidiary LG Displays (changed from LG Philips LCD in 2008). As of 2008, DD (Digital Display) Business Unit is 31% of LG businesses and therefore its significance is well-noticed.



Source : IR document of LGE (2008.2)

Figure 5 - Business Area of LGE

In the global market, FPD market share of LGE is rapidly increasing. As of the end of 2007, its rank is 3rd in all TV market and 4th in FPD market. LGE sold 6.5 millions of LCD TVs and 2.5 millions of PDP TVs and maintained 9% of market share (4th) in the world. For PDP (with

its own manufacturing facilities) at the 4th quarter of 2007, LG surpassed Samsung's SDI and ranked 2nd in the world market (inews24, 2008. 2.1).

Table 2 - PDP Market Share (3rd and 4th Quarter, 2007) (Based on Market Volume)

Firms	'3rd Quarter	4th Quarter	Growth Rate (Compared to 4th quarter of 2006)
Matsushita	32.7%	36.8%	48%
LG Electronics	27.3%	28.4%	113%
Samsung SDI	28.8%	25.1%	95%
Hitachi	6.8%	6.4%	17%
Pioneer	4.2%	3.2%	-39%
Orion	0.2%	0.1%	80%
Total	100%	100%	62%

Source: DisplaySearch

In 2008, LGE's goal is to attain 10% market share and therefore is to catch up with Sharp by developing innovative strategic products and concentrating marketing capabilities (ETNEWS, 2008.1.8). In 2000s, with the drastic reduction in panel price, in addition to effective marketing and product development strategies, improvement in profit rate through productivity enhancement is becoming an important strategic priority.

3.2. Case Analysis

3.2.1. Integration of Panels and SCM system

This case examines integration details of supply chain with LG Displays, the producer of LCD panels of LG Electronics (LGE). Specifically, it is about integration of panel modules (i.e., the core of TV products) in view of their short product life cycle and long lead time from component parts suppliers to the finished products. With the continuous TV price decline (i.e., value-added reduction in supply chain) substantial production cost reduction requires integration of manufacturing processes of component parts and assembly processes of finished products. Since assembly costs of all products in Korea are relatively expensive, LGE established 17 manufacturing facilities worldwide for back-end manufacturing LCD/PDP module and other TV component parts. (Different from PDP panel that belongs to the family

of internal digital display) LCD requires final TV assembly of panels (which are manufactured by Philips LCD) in Gumi and Paju facilities in Korea, Nanjing in China and other facilities around the world. This is the background of how LGE has built global supply chain management by which integration of panel firms and SCM resulted in overall logistical cost reductions.

This SCM system of LGE is integrated with the ERP system of LG Group. LGE built an ERP system so that various management information (accounts, production, marketing, product development, customer service) to become business resources can be drifted to the post of group whole strategically from 1996. LGE introduced Oracle ERP system in seven sections (financial accounting process, production schedule and shipment process, business process, product development process, customer management process, and logistics process) during 3 years 6 months.

At first, in 2001 LGE and LG Philips (LG Displays as of 2008), LG Innotech, and LG Communications successively introduced ERP system (LG news, 2001.11.14). LGE and affiliation companies of LGE came to have GSCM (Global Supply Chain Management) and CRM (Customer Relationship Management) at the same time by integrated ERP construction. In particular, there are advancement business of SCM, BPM introduction of entire company, and SRM introduction in SCM introduction process of LGE. And advancement work was done in all fields of Supply Chain Planning (SCP), Supply Chain Execution (SCE) of SCM. The result of part number redesign work to standardize parts information of LGE was reflected in SRM system and this system was inaugurated in March of 2005. LGE built a global unified supply network planner for the unified production schedule establishment of whole world production and sales departments. Transport Management System (TMS) was completed in domestic division in 2005, and Warehouse Management System (WMS) which was already built, was spread in service and parts department of America.

On the other hand, the LGE carried out SCM unification with cooperation companies with inside system unification in 2001. LGE developed an electronic document system (XML-EDI) which could process all duties to occur at the time of business with business partners on internet and has begun to apply it to all areas of purchasing from August of 2001. LGE with Korea Trade NET (KT-NET) developed XML-EDI system investing 1,300,000,000 won from 2000 to improve inefficient procedures to secure global competitive advantage through reinforcement of subcontractors. More than 2,500 subcontractors of LGE were connected to an

XML - EDI system through internet network by such a system introduction and got possible to process all duties on online from order form dispatch, L/C establishment, an article receipt, tax calculation by the price settlement to occur at the time of materials deal. LGE expected cost cutting of higher than 5,000,000,000 won in a year not to mention what could go ahead around 30% of work productivity by handling all works on online (ETNEWS, 2001.8.2). The ERP system which LGE has built until 2001 was operated in web environment, and it was possible to analyze a market and management information in all business processes with real time, and LGE realized e business through collaboration with subcontractors in operation, marketing, and service.

In 2005, LGE began project to improve existing ERP system by 2010, and to build global unification systems (Oracle News). In first stage, LGE introduced unified GHRS (Global Human Resource System) for early decision making from June of 2005 to April of 2006. In second stage, Global standard ERP was built through introducing domestic production ERP unification and global standard system of marketing / accounts from October of 2005 to December of 2006. In third and fourth stage, LGE planned to integrate all of the 11 offshore production division using Oracle ERP now including in-house system of 65 abroad division through synchronization between domestic and overseas practice process by 2010 (ETNEWS, 2007.8.1). Through Global ERP unification project to unify overseas systems in entire company, LGE expect that global visibility and cooperation would be increased. In addition, LGE say that the ability in performing an entire company business plan improves by building Global SCP (Supply Chain Plan).

Ordering and supply of parts was enabled through SCM system which linked such Global ERP with a cooperation part company by real time, so that it make LGPS efficient. There are around 250 cooperation firms for TV part cooperation firms and LGE adopts electronic Kanban system applying Kanban system of Toyota. As mentioned, LGE introduced in all part companies SCM system connected with cooperation firms in 2001, and through G-ERP information exchange is possible through internet network at real time between LGE and subcontractors. LGE fixes quantity of ordering now before 15th day and notifies it to parts companies by real time. Part companies enter production of parts with established part delivery information before 3rd day finally. Parts companies complete delivery of each TV module to LGE factory before four hours of LGPS module injection after production on the appointed date of delivery of LGPS. Through such an integrated SCM system, LGE maintains

such a collaboration relationship in an overseas advance together.

3.2.2. Efficient mass production through implementation of LGPS (LG Production System)

One manufacturing facility of LGE produces more than 10,000 FPD TV daily (monthly production is about 200,000). In general, other firm's facility produces about 500 TVs per shift. Japanese Sharp produces 800 TVs in the same time. Besides its facilities in Gumi areas of LGE maintains both its assembly lines and manufacturing facilities that produces panel modules. LGE assembles them as final products in Gumi area and 17 other foreign factories including Mexico (2), Brazil (2), Poland (2), Karzarkstan (1), Russia (1), Thailand, Indonesia, Egypt and China (2), etc. Such mass global production system is possible through implementation of LGPS (LG Production System), which applied TPS (Toyota Production System) method in their TV manufacturing processes. Five TV assembly facilities adopted TPS from 2004. It is being implemented both in Korean facilities and other facilities located in Poland, Indonesia and China.

As shown in Table 3, Case factory which adopted TPS involves 7 lines that assemble PDP TV, LCD TV, and Monitor—1 stream conveyor line (with slat method), four pallet conveyor lines and two lines (mini lines that use cell methodologies). Conveyor plays role in pallet so that it does not have pallet in Stream line, unique line of LGE.

The specifics of Slat TV line configurations apply TPS in the following ways. First, PDP modules, the core of assembly processes, are completed in manufacturing facilities nearby. Second, LCD modules supplied from LG Displays and all other component parts also are delivered in modular forms.

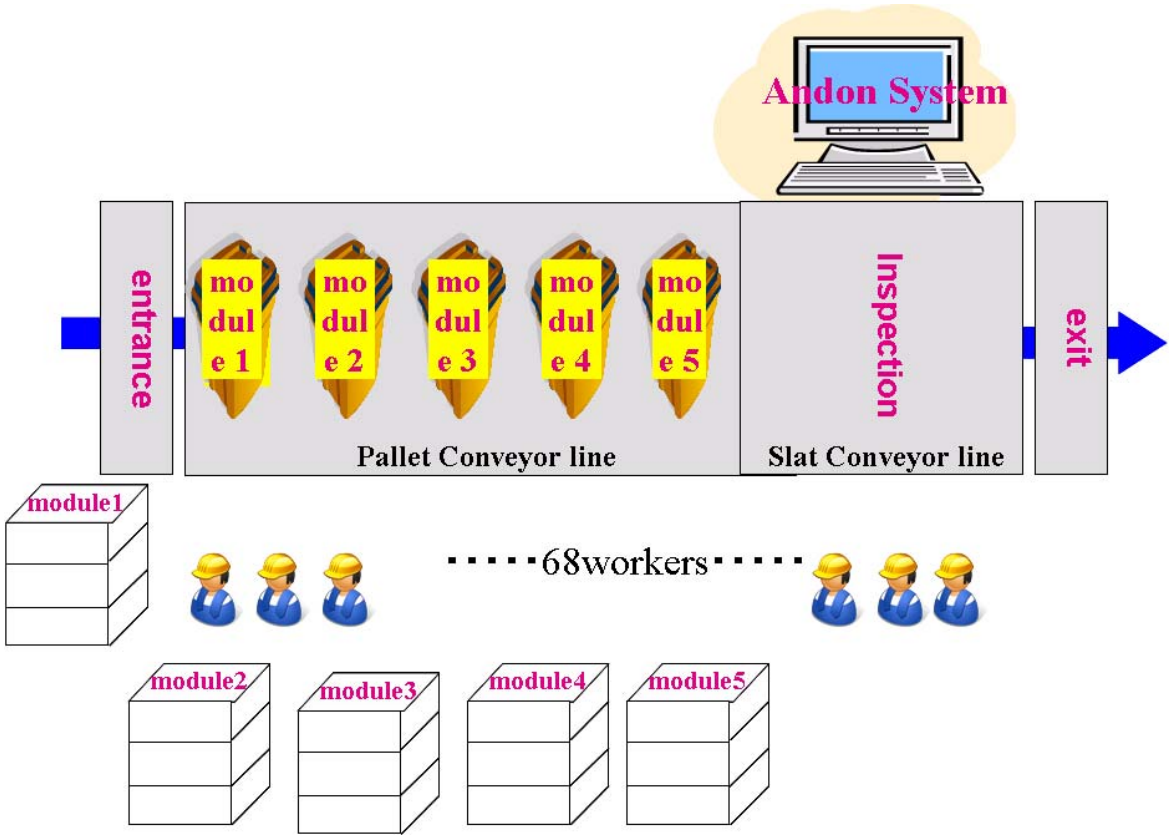
Table 3 - Case plant line organization

Slat method	Pallet method			Cell method
1st line	2st-3rd line	4th line	5th line	6th and 7th line
LCD TV, PDP TV	LCD TV, PDP TV	Monitor	Big Monitor, LCD TV	Small lot, Cell Assembly beyond 60 Inch

Source: Interview Results

Figure 6 shows modular assembly processes (i.e., Front modules → PDP/LCD modules →

Chassis modules (TV board) → back covers → Stand). Different from automobile assembly that includes pallets TV conveyors act the functions of pallets as well. Since Andon System is programmed, the entire work processes are available through video monitors in real time.



Source: Interview Results

Figure 6 - Conveyor Line Process

Sixty eight workers assigned to each line continue the assembly processes in seamless fashion. By streamlining the module assembly lines into five modules and conveying the pallet, the overall assembly time is substantially reduced. LGE's assembly rate per hour is maximum 400 so that the maximum Tact time is 7.8 seconds. Normally they operate production rate of 330 per hour (11 seconds Tact time). (Note: Tact time can be defined as the maximum time allowed to produce a product in order to meet demand. It is derived from the German word taktzeit which translates to clock cycle.).

Such LGE's operational performance is outstanding compared to that of other TV assembly

lines. This is primarily because the number of module processes is reduced to five. Besides, such level of performance requires solid collaborative relationship with external suppliers and strategic partners. Although core PDF and LCD panels are a part of this LGPS, the remaining four modules are all delivered as completely assembled parts and therefore, LGPS as a whole achieve a very high level of production efficiencies.

The defect rate of the entire manufacturing processes is reduced to 0.7%. The ratio of inspection among module assembly lines is relatively high. Twenty three workers are allocated to manage the sizable number of inspection items. The inspection processes are according to incoming materials related inspection standards (RF/ AV 1, 2,3/ Component 1, 2, 3 / HDMi 1,2,3,4 / DTV) and checking TV viewing quality. Pattern adjustments are not applied except the white balancing adjustment.

Table 4 - Comparison of TPS and LGPS

TPS	LGPS
●A Pull production system (production as to be sold) ●JIT, Kanban system	●Deciding production volume of each TV size setting TV standard time to make a TV (For example, set normal production time per one 32 inches in 10 minutes, decide production volume of one day, put it together with other TV size, and produce that amounts) ●Kanban system
TPS=Output fixed/ Input variable	LGPS=Output variable/ Input fixed

Source: Interview Results

One group leader is placed by line, and all distance of one line are 130m so that one TV is produced for every 11 minutes normally. By the way, productivity rises when its distance makes shorter because frequency pushing Andon button reduces. To make this effect maximized, LGE is going to let conveyer distance shortened. TV productivity target is 15,000,000 sets in 2008 and a ratio of Korean domestic production is 8-10% now. LGE has plan to raise Poland and Mexican production ratio.

Of course, though LGPS applies TPS of Toyota, it is fundamentally different from principle of TPS in a delivery method of a part. TPS is a production method to minimize stocks by

producing it as to be sold basically, but LGPS is the system which makes the change of output while fixing Input.

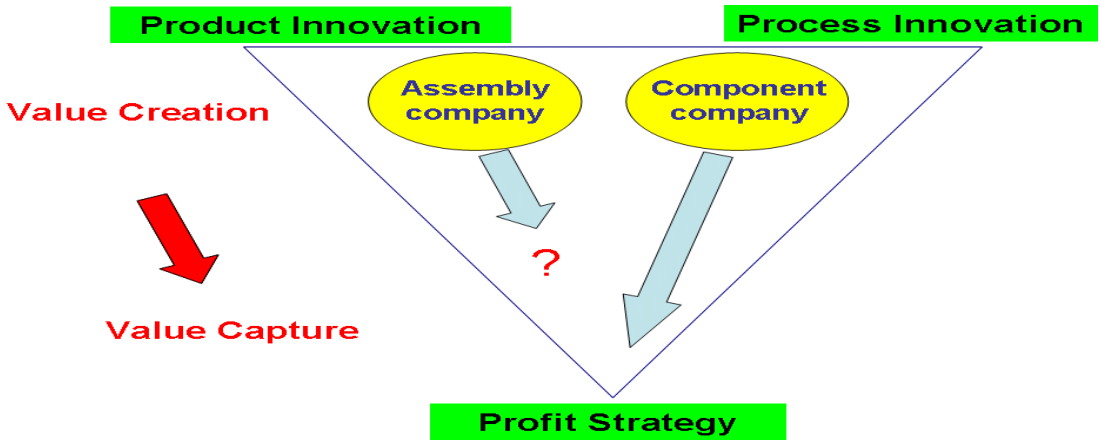
4. Discussion

This case study illustrates how LGE applied effective operations management practices in the context of product architecture characterized with intense modularity. As shown in LGE, FPD TV/panel manufacturing facilities (with the constant downward pressures of their product prices) are required to implement efficient operations management for cost reduction. Just like many other modularized electronic products, production facilities are moving into China, India and other nations that offer low labor costs. LGE has attained efficient cost reduction and productivity enhancement by implementing global supply chain strategy and adopting LGPS that applied TPS (Toyota Production System).

However, such operation management practices do not provide fundamental answers to the growing business challenges in view of the recent financial results of FPD TV firms. Although LGE is one of big global five TV makers, its profit rate is not very good. Long term struggles with the low profit-generating products exhaust both the senior management and the participating workers. Increasingly businesses look for new strategy model that create substantial value-added products that contribute to the high level profits.

Figure 7 shows that firms create values through product or process innovation. US firms are relatively strong in production innovation while Japanese firms (represented by Toyota) show their advantages in process innovation. The question is whether the value added is actually connected to the firm's profit performance.

Most of FPD TV assembly makers show deterioration of their profit level. In contrast, small and medium component suppliers show higher profit level. In a simple comparison of profit rate of component suppliers and the LCD panel firms, component suppliers do better. When we compare LCD panel firms with LCD TV assemblers, LCD panel and component firms show higher profit rate (Sakakibara, 2006). Among suppliers, Japanese component suppliers (that have original technology know-how) are doing better than non-Japanese component suppliers. In general, the profit level of all firms is becoming smaller and in fact, many firms reported losses in 2006-2007(LG Weekly Economy, Dec 13, 2006).



Source: Adapted from Nobeoka et al.(2006)

Figure 7 - Dillema of Value Creation

On the other hand, VIZIO (Note: this firm appeared a few years ago like a comet and occupied # 1 market position in LCD market in 2007) does not have any FPD TV/panel manufacturing facilities. VIZIO outsources almost all functions. It buys Korean-made panels and assembly is conducted in Taiwan. It also sells its products mostly through discount chains to take advantage of low distribution margin (Maeil Economy, Dec 15, 2007).

From 2nd quarter of 2008, LGE will supply 32 inch PDP module (which is close to integral than LCD module) to VIZIO (inews24, 2008.1.25). From August 2007 LGE started selling 81Cm (32 inch) TV when many asserted that minimized TV is regarded not so feasible. In a sense, VIZIO utilized better business model than better operations management. Even after achieving product innovation as the first in the world, if it is not related to the firm's profit level, it is not so meaningful from the firm's strategic standpoint.

From the second half of 2007 LGE is strengthening vertical integration and innovation activities. The leader of digital display business strives for innovative results through vertical integration among LGE (TV sets, PDP module, core chip), LG Displays (LCD module), LG Innotech (tuner), LG Micron (PDP back panel), LG Chemical (electronics components) and domestic supply of the component parts. Other value-adding efforts are the bold adoption of advanced business practices in the areas of purchasing and manufacturing technologies and utilization of integrative module design with LG Displays (inews24, 2007.9.2).

The first matter to be considered is profit strategy through product modularity. According to

the comparative data of prices by inch for the Japanese FPD TV product architecture, the prices drastically change depending on whether image engine is independently developed or routine chips are used. The highly priced 4 type develops image engine independently and their panel is produced within. By the end of 2005, Matsushita PDP TV (bigger than 32 inch) and Sharp (maximum size of 65 inch) are included as well (Sakakibara, 2006). For the large screen TV, the range of price reduction is relatively small; however, the development cost is also very high. However, with the purchase of panels, the final price of TV is set somewhat lower than when they are produced internally. In a sense, this shows commoditization of FPD TV and yet, it also demonstrates the price competitiveness of the small and medium size TV (smaller than 30 inch).

Table 5 - Price Comparison of FPD TV Products (Unit: Inch)

Engine / Panel		Image Engine(LSI)		Total
		Dependent	Independent	
Panel	Purchase	(1)4010.4Yen (n=64)	(3)6780.2Yen (n=95)	5665.3Yen (n=159)
	Internal Production	(2)4012.3Yen (n=32)	(4)8356.9Yen (n=82)	7137.4Yen (n=114)
Total		4011.0Yen (n=96)	7510.7Yen (n=177)	6280.0Yen (n=273)

Source: Sakakibara (2006)

In 2007 LGE made the outsourcing contracts with Taiwanese firms at the volume level of annual 500, 000 of LCD TV (30~40 inch)(Meil Economy, 2007.12.25). LGE is also strengthening marketing campaigns in North America, Latin America, Europe, China and Asia by regions with the budget of one billions dollars. Internal product development is restricted to premium TV larger than 40 inch and all other smaller TV distribution (less than 30 inch) will be handled by outsourcing (ETNEWS, Jan 18, 2008). With the careful consideration of value-added of each product, internal production and outsourcing decisions should be made beyond implementation of effective operations management practices.

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