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Manufacturing Excellence: A Case Study on the Improvement Journey of Operations Management

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Abstract

This case illustrates the operations management improvement journey of LP Semiconductor Co. Ltd. What the teaching case describes includes strategic thrusts and priorities of improvement, design of operations, managing of operations, and adaptation of operations. With the information provided by the case, participants could discuss the current situation and action for continued improvement from all dimensions of operations management. From the teaching case, participants could learn how to use the theories and methods of operations management in actual business practice in order to achieve the ultimate goal of manufacturing excellence.

Key words: Case study; Operations management; Joint venture; Performance

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1. INTRODUCTION

1.1 Introduction of LP Semiconductor Co. Ltd

LP was found on March 1st 1995. It is a joint venture invested by ON Semiconductor and Ls Radio Company. As one of the most excellent semiconductor centers in China, the company has been invested by more than 500 million dollars. There are two Final Assembly-Test plants and one wafer fab in the company. Till now, there are more than 2000 employees are working in LP. It produces miniature standard surface mount semiconductor consisting of transistors and diodes. The products are used in electronic equipment, automotive industry, communication systems, broad band data technology, computer and consumer electronic products, etc. Operation management is the management of all the resources and activities necessary to provide the market with tangible goods and services (Chase, 2004). This includes the systems and operations which creates and delivers the firm's or the supply chain's primary product of services. It also includes the activities of planning, organizing, and controlling as well as the system design, operation and improvements in order to maximize the relationship between demand and supply. This case will analyze the current situation and improvement areas of LP Semiconductor Co. Ltd from all dimensions of operations management.

1.2 Value Creating System of Industry

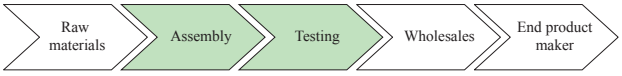

Figure 1
The Value Creating System in Semiconductor Industry

Regarding to LP, it is in Assembly and Testing, and the internal value creating system is:

Figure 2
The Internal Value Creating System of LP

1.3 Transformation Systems

LP is a manufacturing plant in semiconductor industry, which can be categorized as material processor, not as an information processor or service processor. The plant produces semiconductor products, such as audion, diode and IC for manufactory of automobile and electronic product. In the process of producing, the WIP physical goods are transferred from assembly to testing, then to

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QA, shipping warehouse, finally deliver to customers, who are composed of companies of automobile (Delphi), electronic equipment (Motorola, Nokia) and computer appliance (Haier, Changhong), all of them are physical properties.

1.4 Products & Services

LP's products are semiconductor components with the following characters: tangible, can be stored, production precedes consumption, low customer contact, can be transported, quality is evidence. So we can think it produces "pure" goods, the operation output from process is product. It also provides the service according to demand by customer, such as quality issue analysis, production line control system audit, etc.

1.5 Topology in Terms of 4Vs'

Regarding to the 4Vs (Volume, Variety, Variation and Visibility), all dimensions have implications for the cost of creating our products and services. The 4Vs analysis of LP is shown below, and the graphical analysis method is according to Slack (2001).

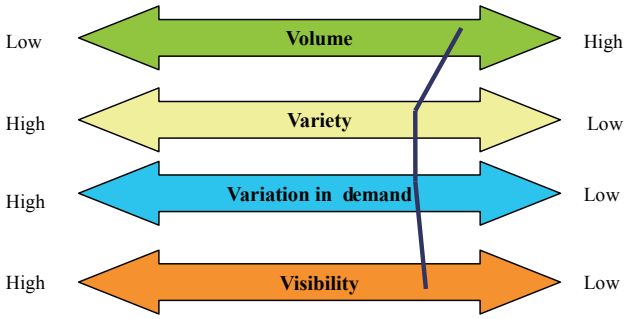

Figure 3
The 4Vs Analysis of LP

From the figure above, currently, it has high volume, low variety, low variation and low visibility to keep processing cost down. Volume is high because of its high repeatability and systemization; variety is low because it is routine and standardized; variation in demand is low because it is stable and high utilization; visibility is low for the standardized manufacturing.

1.6 External Environment of the Organization

1.6.1 Complexity

More and more customer in automobile, electronic/ communication equipment and computer focus on environment-friendly product, small volume, and small power consumptive products, not merely quality. It requires that this type of products to meet the requirement of customer should be introduced by strong R&D support.

Before, the primary competitor is outside of China, the advantage is lower cost comparing with the competitor; but right now, some semiconductor plant were established to produce the same products in China with better engineer recourses and better geographical positions to attract technical talents. At the same time, they also have lower transport cost. The entry of local competitor triggers more fierce competition than before. Many competitors continue to develop new products and introduce new technology on their products, such as using copper wire instead of gold wire, producing in large amount on lead-free components and provide total solution with lower cost and high quality and reliability. It will be difficult to attract new customers and retain current customers without new technology. Finally, it is hard to recruit qualified talents with high skills and retain them.

1.6.2 Dynamics

It is highly recommended to develop products with better reliability and environmental protection to improve competition ability, which will challenge the internal ability of R&D. It is hard for the competitors to enter the threshold of semiconductor, so the quantities of companies participating in competition do not impact uncertainty a lot.

From the technological perspective, inventions are developing fast. Some competitors rapidly put into a large amount of manpower and materials and strengthen new development of products in order to introduce their new technology on production line.

More and more international semiconductor entered Chengdu, which is the capital of the Sichuan province. Leshan is just a small city, so some skilled talents leave it and search for more job opportunities in Chengdu. It has already brought high level management's attention to find a way to reduce brain drain and retain the talents.

1.6.3 Uncertainty

Since China joins WTO, local companies have more choices to select the suppliers from domestic and international market with fair price. International companies can choose Chinese companies as their supplier as well, so the chance and risk coexist together.

More and more multinational semiconductor companies are successful in China now, and the other international companies which do not enter Chinese market may start to establish their local factories. In the meantime, the companies which already had production lines in the developed regions of China may setup new plants in the southwest of China due to low production cost.

The current customers may lose and it will be difficult to develop new customers if the competitors release new high-tech products, because new technology introduction is under high uncertainty.

Since China's reform and opening-up in 1978, people change their jobs more frequently than before, especially after the reform of state-owned enterprises. The primary reason is that they continue to look for job opportunities with higher salary, which will be in conflict with cost reduction of manufacturing plants.

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Table 1
Characterization of External Environment

Item	Customers	Competitors	Technology	Labor	Communities and other stakeholders
Complexity	Moderate	High	High	High	Moderate
Dynamics	Moderate	High	High	High	Moderate
Uncertainty	High	High	High	Moderate	Moderate

2. STRATEGIC THRUSTS AND PRIORITIES OF IMPROVEMENT

2.1 Business Unit Strategic Thrusts

The strategic leadership field is rooted on Hambrick and Mason's (1984) article. To achieve a long term competitive advantage, LP lists the following addressed primary action-oriented issues to be resolved: people development and commitment towards excellence; excellence towards perfection in manufacturing; develop next level of leadership via people development; develop technical competent engineers/technicians to drive productivity via TPM (Lean 6 sigma); industrial Engineering BB and GB, benchmarking activities and engineering excellence; provide timely feedback to better manage manufacturing operations; ensure at all times safety/health/environment is in total compliance.

2.2 Strategic Operation Unit

2.2.1 Polar Representation of Operations Performance Objectives

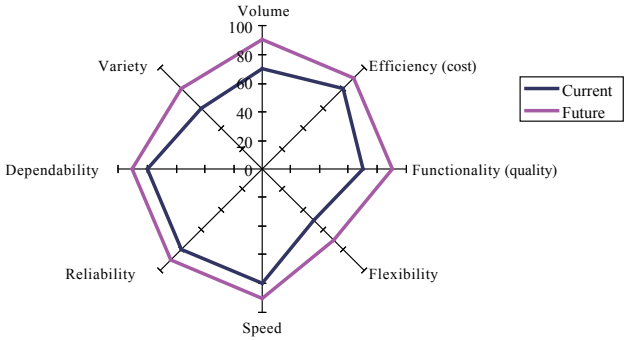

Figure 4
Polar Representation of Operations Performance Objectives

2.2.2 Performance & Important Matrix

Before we identify the priority of performance objects, we should know what the competitive factors are, what the competitor influences are, and then we can determine the priorities to improve.

Competitive factors are basically is what our customer's requirement is or what their concern are. Generally, customer focuses on the following seven factors, which are also its performance objectives:

1) Quality: it requires to do things right.
2)Speed: it requires to do things fast
3)Dependability: it requires to do things on time
4)Flexibility: it requires to be able to change what we do
5)Cost: it requires to do things cheaply
6)Quantity: it requires to have a necessary capacity
7)Innovation: it require to meet the potential requirement

We can use the following matrix to scale how the above factors are important to LP by score. The graphical analysis method is according to Slack (2004).

Table 2
Importance/Performance Rating on the Nine-Point Scale

Performance objectives	1	2	3	4	5	6	7	8	9
Quality	I	P							
Speed		P	I						
Dependability			P	I					
Flexibility							P	I	
Cost		I,P							
Quantity			I	P					
Innovation						I		P	

Remark: I—Important rating; P—Performance rating

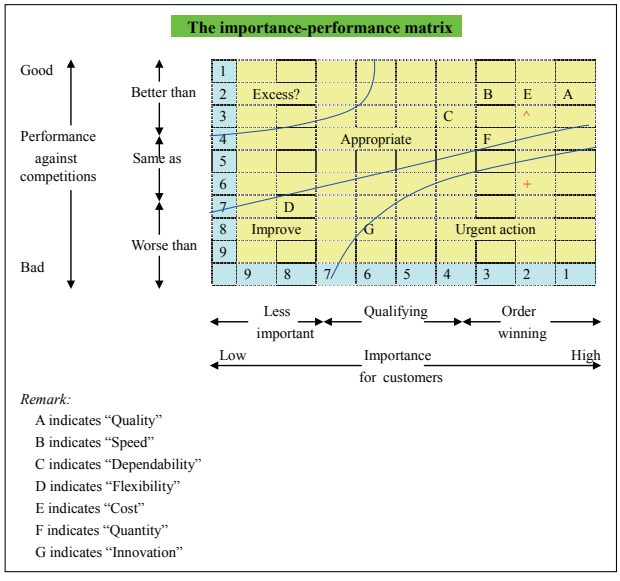

Figure 5
The Important-Performance Matrix

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From the above, we can see that quality, speed, dependability, quantity and cost fall into "Appropriate" area, flexibility falls into "Improve" area and innovation falls into "Urgent Action" area. So "innovation" should get the highest priority, especially when compared with others.

3. DESIGN OF OPERATIONS

3.1 Design of Products/Services

Current Situation

It currently focuses on producing common semiconductor components based on different requirements from customers.

A. Concept generation stage

At this stage, the ideas are basically from research and development (R&D) engineers. R&D is responsible for developing new knowledge and ideas in order to solve particular problems or to grasp an opportunity.

B. Concept screening stage

At this stage, it will detect whether the idea could be deployed based on the local resources, including both hardware and engineer capacity. Then it will do necessary evaluation on acceptability, feasibility and risk.

C. Preliminary design

At this stage, engineering department will define the standard procedures and processes exactly, such as the specification, what BOM (Bill of Material) will be used and how to adjust machines to produce the new package.

D. Evaluation and Improvement

At this stage, the engineers from R&D department will analyze the new package together to determine whether it is possible to improve something or it could be run according to the current equipment capacity.

E. Prototyping and final design

At this stage, the EBR lots for new package will be put into production to produce engineer prototyping, and then the devices of the EBR lots will be sent to a special lab for professional parameters testing. Finally, the formal procedure for new package will be developed.

Issues to improve

According to the importance-performance matrix, it should take action to improve flexibility and innovation ability immediately. Machines could be improved to produce different devices/ packages with small adjustment in a short time. More training could be provided for employees from NPD (New Product Development) department, and the engineers could be sent to other plants to study new knowledge and technology.

3.2 Selection of Process Type

LP is in manufacturing process type with high volume and relatively narrow variety, so it could be considered as mass production. The reasons are described below:

A. High volume/ low variety: LP produces semiconductor components of over 100 million one week, and different varieties of products do not affect the basic production process, so the variety is low.

B. Repetitive: It produces one type of package on a production line.

C. Large predictability: The output is based on the capacity of production line.

3.3 Design of Operations Network

3.3.1 Forward/Backward Integration

Current situation:

The following figure shows the current direction, extent and balance of vertical integration for LP.

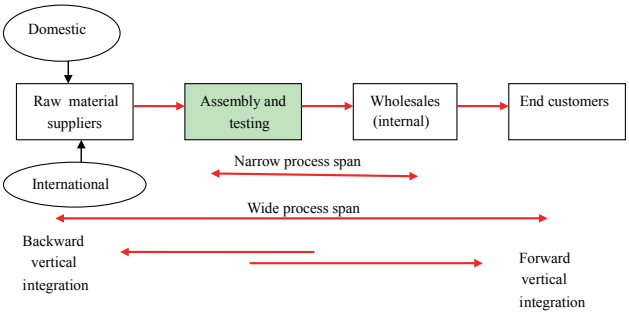

Figure 6
The Current Direction, Extent and Balance of Vertical Integration for LP

Currently, most of the key raw material suppliers are from outside of China, and it can not be changed in a short term. It only has one supplier for some raw materials, so it is out of control on the cost and risk. For the shipping, since all finish goods are delivered to internal distribution center in Singapore, it is easy to handle this direction.

Issue and actions:

Refer to the position in BEG and current situation, the major thing should be considered is how to control wide raw material suppliers with good indicators on cost, quality and timing. Many multinational companies invest manufacturing plants in China and the local factories are growing fast, so it should plan to seek qualified local suppliers for raw materials and it will be helpful to improve business performance.

3.3.2 Location Decisions

Current Situation

A. Land Cost: Leshan is a small city, and the land cost is cheaper than that of Chengdu (capital of Sichuan Province).

B. Labor Cost: The life cost in Leshan is much cheaper than that of Chengdu, therefore, the labor cost is lower to employ the same skilled people.

C. Energy Cost: There is a big power station in Leshan, and the lower price for energy promised by the local government supports the development of LP.

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D. Transportation Cost: Both raw materials and finish goods must be transported from or to Chengdu airport, and the cost is high.

E. Community Factors: Since LP gets strong support from the local government, some preferential policies are published for LP specially, such as low tax rates.

Table 3
The Comparison Table with Chengdu

	Land Cost	Labor Cost	Energy Cost	Transportation Cost	Community Factors
Leshan	low	low	low	high	normal
Chengdu	high	high	normal	low	good

Issues and Action

The current issue is that the high skilled talents are not enough. There is only one university in Leshan, so it is difficult to recruit qualified electronic engineers from local market. To solve the problem, we should keep good relationship with related universities located in Chengdu, create student sources focusing on those students whose family is in Leshan, and encourage them to find jobs in Leshan after their graduation from universities.

3.3.3 Balance of Capacity

Current Situation

Its capacity strategy can be considered as capacity cushion strategy, it is "Lead demand". Local managers review the capacity vs total output and the trend of demand in every monthly operation review. Recently, the utilization is near 100%, which means there is no more time to do machine PM.

Issue and Action

As recently the run rate is near 100%, it is a risk that machine may be out of service. The above discussion is about the current phase in BEG, and the current immediate action is to make innovative products for performance improvement.

Improved capacity management drives cost efficiency in operations and enhances asset utilization (Hahn & Kuhn, 2012).

In order to avoid the conflict, LP should manage an appropriate inventory to free some machines; PM can be done, and EBR could also be run for new testing lots to improve performance.

3.4 Process Technology

Current Situation

It covers materials-process and information-process, but does not cover customer process.

A. Materials-process: It has implemented Computer Numerically Controlled machines to control a machine instead of by hand, and all actions of equipments are controlled by programs integrated in machines. Assembly robots do accurate position operation for components and complete products. This technology reduces incorrect operation by operators. Computer-integrated manufacturing is deployed in the whole plant since 1996, which helps to monitor and control all aspects of the manufacturing process.

B. Information-process: It has established infrastructure on both data and voice communication, such as LAN (local area network), WAN (wide area network), VPN (virtual private network), internet connections and internal PABX.

Issues

Although it is doing well on both material-process and information-process, some independent and old systems make it difficult to integrate data to e-commerce application, which is managed by the corporation in the US. Many interface programs are hard for maintenance and should be developed.

Action to Improvement

Currently the business relies heavily on internet technologies, those old systems which cannot or are difficult to exchange information with new systems should be eliminated, and the old database with SQL database should be replaced. It will strongly support decision making system and serve customers better.

4. MANAGING OF OPERATIONS

4.1 Work Organization & Job Design

Current Situation

Currently the corporation is in the stage of "Empowerment", and expected future positions are located at "Flexible Working" and "Self-Organization".

The following addressed how LP applies the key elements of job design currently:

A. Combining task

LP provides necessary skill trainings to help people meet the basic job requirements. But some trained skills may not apply to their working areas. When people are assigned to different jobs that they have been trained, they still do not like it and just do their job, so there is still a lack of motivation.

B. Establishing client relationship

Top management teams think that it is important to keep good communication with employees, and it sets up management dialogues with operators, apply "open door" culture and issue company newspaper to report major events and publish company's policy, communicate with all employees once a quarter. All these create a good communication environment.

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C. Opening feedback channels

It established feedback channels mainly through HR department.

Expectation in Future

In the future, it will strive toward to be empowerment stage. Employees must have enough knowledge or skills to establish the stage of empowerment, flexible and self-organization in the corporation. For example, IT engineers just focus on the IT system deployment and maintenance now. But in the future, they must understand how to link the advantage of IT to business, and create IT basis application to help business unit to improve productivity. This requires people to have enough knowledge and strong team spirit. To achieve the goal, more training will be provided to employees to improve their technical knowledge and skills. The job description will be designed with more clear statement, and everybody knows the responsibility clearly.

4.2 Nature of Planning and Control

The planning and control of LP is the process of reconciling demand with supply, so the nature of planning and control depends on both the nature of demand and supply.

Current Situation

Since the total outputs of products are based on the order distribution by ONSemi global marketing planning department, the demand of LP is dependent. Global planning will allocate the orders from customers or are forecasted by the marketing department based on total planning and operation capacity. For example, when global planner gets an order from the customer, as ONSemi owns another assembly/testing plant in Malaysia, the planner will log into the system to evaluate and decide which plant to finish the order. Sometimes, the planner should balance it between LP and the Malaysia's plant. When the planner finishes the order distribution, the amount of related raw materials will be generated automatically in the planning system, a notification message will be sent to the local planner, and the LP local planner will release the purchasing request to the purchasing department.

For the order sequencing, LP follows the sequence below:

A. Customer Priority: The order from the important customers will be considered first regardless of its volume.

B. Due Date: The objective is to deliver products to the customers on time.

C. FIFO (First In First Out): LP follows this for normal orders.

Expectation in Future

Currently LP's planner just follow the notification by email from ONSemi to do planning, the information is not enough to help them to generate deep report for local management. So it is expected to setup a planning system to track more information needed to control the orders better.

4.3 Supply Chain Management

4.3.1 Push Control & Pull Control

Current Situation

The current situation of LP is pull control. LP is a joint venture, most of the systems are independent in local, and are not integrated into ONSemi's system. But it is important to follow ONSemi's process to produce according to orders. ONSemi has deployed ERP globally, the inventory of wafer is in ONSemi, but other BOM is in local system, so the local system has to meet the requirement of ONSemi. Cachon (2004) shows that: with a push contract there is a single wholesale price and the retailer, by ordering his entire supply before the selling season, bears all of the supply chain's inventory risk; a pull contract also has a single wholesale price, but the supplier bears the supply chain's inventory risk. At the same time, the operation process is based on the standard procedure on the production line. The internal customers just accept the products from form-end, they accept what the form-end provide to them.

Expectation in Future

With the BB (Black Belt) and GB (Green Belt) projects start, the pace and specification of what is done will be set by the "customer" workstation. "Pull" work is from the preceding workstation, which is in opposite direction comparing with "push" (Wikner et al., 2007). demonstrate that it is possible to mix push and pull inventory systems to satisfy customer demand at various levels of production variability. It is important to compare the two outsourcing structures under a push contract (whereby orders are placed before demand is realized) and a pull contract (whereby orders are placed after demand is realized).

4.3.2 Integration Trend in Supply Chain

The supply chain integration is becoming the trend according to the current marketing requirement. The reasons are:

A.Information share: Both the customer and supplier share necessary information together to benefit both. If information is available and is shared throughout the chain, all the operations can monitor the true demand.

B.Vendor-managed inventory: Even when using the same information, differences in forecast methods or purchasing practices can lead to fluctuations in orders between operations in the chain. In order to avoid it, one way is to allow upstream supplier to manage the inventories of its downstream customer.

4.3.3 MRP & JIT

Current Situation

Currently, LP does not have MRP system. The traditional control method used in Western countries has been material requirements planning (MRP) (Anderson et al., 1982). In the 1970s, just-in-time (JIT) technology was successfully developed in the Toyota Motor Company of Japan (Sugimori et al., 1977; Kimura & Terada, 1981).

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JIT is a pull system basically. LP has deployed LSS (Lean Six Sigma) in the whole plant, and there are over twenty project teams to focus on lean production in order to improve productivity and reduce cost. Managers simply process with lean tools to make internal and external satisfaction. It not only makes effective process, but also has a good inventory control. At the same time, activities of CI teams help to improve the productivity in the production lines.

Expectation in Future

JIT activities could not be limited to the manufacturing department, but be deployed in other departments as well, especially in supplier chain. Poor inventory will cause unpredictability in an operation, and unpredictability causes waste.

5. ADAPTATION OF OPERATIONS

5.1 Knowledge Management

Current Situation

LP pays more attention on knowledge management. A committee named T&E (teaching and education) is responsible for knowledge introduction, which is directly managed by HR manager. Some technique courses related to product are introduced for production engineers and technicians, such as technical ladder, TPM introduction, and technical paper forum. Special training lab is established for the operators, such as general electronic knowledge training, and some excellent operators could design the training courses to share their experience. Basic management skill training courses are designed to train managers, such as how to do a presentation, how to manage a meeting, how to manage a project and how to communicate with their team and boss. Knowledge sharing and introduction of the company about culture and the industry standard is designed for all employees. For example, when an audit is started, the trainings about the requirements and procedures are provided to employees to know the details.

Expectation in Future

In the post-industrial era, the success of a corporation lies more in its social assets—its corporate IQ and learning capacity—than in its physical assets (Zohar, 1997). It should pay more attention on the feedback to improve knowledge introduction. T&E committee should help introducer to update knowledge to the team level and the organization level.

5.2 Motivate Learning & Sharing of Information

Current Situation

Currently, most of the training courses force employees to participate, and it is difficult to achieve the objective of the training. On the other hand, in order to develop good training courses, LP awards good trainers every year.

Expectation in Future

Trainers could learn new ways to make the class interesting and fun, and more on-job training could be provided.

CONCLUSION

The teaching case uses the theory and methodology regarding to operations management to analyze the current situation, and then come up with the corresponding solutions to the existed problems for improvement. Future discussions could focus on the areas of managerial coherence (leadership, decision making) and formulation of operations strategy.

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