**Section 1 Total System and Implementation Steps**

**Section 2 Subsystems**

**Chapter 4 Supplier Kanban and the Sequence Schedule Used by Suppliers**

This chapter talks about how Kanban is implemented for the suppliers of Toyota which is termed as ‘Supplier Kanban’. The author has written this chapter by interviewing and observing Aisin Seiki Company Ltd. Aisin Seiki Company Ltd. is one of the largest suppliers of Toyota.

Author highlights about how Toyota communicates to its suppliers/vendors monthly or daily information about parts requirements, replenishment system by Kanban and several other related topics.

**Flow\_of\_supplier\_kanban.png on page 62**

The above figure illustrates about the flow of a supplier Kanban. In short, the flow starts with the empty boxes along with Kanban taken to the suppliers and ends with supplier sending back filled boxes with the parts required by Toyota plant. The author extends this topic and describes about customer Kanban and in-process Kanban.

The author concludes this chapter by discussing about practical examples of delivery systems and cycles, he explains about how vendors/suppliers tackle problems relating to weather or any other emergencies.

Timeline of Kanban at Toyota:

1. 1962: Introduction of Kanban at Toyota
2. 1982: 98% of vendors of Toyota had supplier Kanban

Note: By 1982, still 50% of Toyota vendors were using ‘in-process Kanban’ in their plants.

**Chapter 5 Smoothed Production Helps Toyota Adapt to Demand Changes and Reduce Inventory**

One of the principal goals of Toyota production systems is to increase profits by reducing cost and reducing inventories. The concept of smoothed production arises from implementing just-in-time(JIT).

The demands of end customers always change from time to time and production systems of Toyota should adapt and produce only the products which is in demand at that particular time, adapting and producing required products in required quantity is called as ‘Production Smoothing’. The author states the main concept of production smoothing as “to diminish as much as possible the quantity variance in a production line.”

The author discusses about two important phases of smoothed production.

1. Smoothing of the total production quantity: This phase deals with producing about same number of products every day. By utilizing the Master Production Plan and other techniques we can adapt to increased or decreased demand of products.
2. Smoothing each model’s production quantity: to level the production and consumption of all the required parts needed for a particular model each period so that there will no time gap to wait for any other parts of the same model to be prepared before constructing the complete model.

**FrameWork\_of\_Production\_Smoothing.png on page 100**

**Chapter 6 The Information System for Supply Chain Management between Toyota, Its Dealers, and Parts Manufacturers**

The author discusses about information system used by Toyota dealers and its manufactures, Toyota Network Systems (TNS) and information system as Nissan Motor Company in this chapter.

As discussed in the supplier Kanban chapter, Toyota prepares a monthly production plan which consists of master production schedule and a parts requirement forecast table. After deciding the daily production order, they decide about product delivery schedule and the sequenced schedule of production. Parts Requirement Forecast table consists of 3 month production system where details regarding the part requirement for this month and next 2 months are forecasted and given it the dealer.

The new Toyota Network Systems (TNS) was introduced in 1990 to communicate and exchange electronic data among its dealers. They used CALS (Computer-Aided Acquisition and Logistic Support)

and EDI (Electronic Data Interchange) formats to interact with its dealers. Toyota invented a net intranet which was actually inter-company extranet called D-cruise Net. The TNS system was used for faster transmission of data and could handle large documents and drawings.

**TNS.png on page 117**

**Chapter 7 How Toyota Shortened Production Lead Time**

This chapter discusses about the advantages of shortening lead time, components of lead time and how to shorten those components.

The major advantage of reducing the lead time is to adapt to the demand of the customers. The author discusses about other advantages such as ‘job-order oriented production’, where the production of a single model is produced for an order from a customer, the amount of dead stock is reduced, WIP (Work In Progress) can be reduced by minimizing unbalanced production.

**Components\_of\_Lead\_Time.png on page 125**

The figure is self-explanatory about different components of Lead time and author discusses further about decreasing/reducing each components reduce time.

**Chapter 8 Machine Layout, Multi-Functional Workers, and Job Rotation Help Realize Flexible Workshops**

This chapter discusses about various techniques of managing the workers when the demand increases or decreases. He explains different scenarios where the demand of a particular vehicle might decrease and another vehicle’s demand might increase and there should be effective management of workers by transferring workers from low demand line to high demand line. There can also be a scenario where there is an economic depression or impositions of import/export tariffs which decreases the demands of all vehicles, in such a situation there should be a decline in workforce in all the production lines.

The author discusses about Shojinka and defines it as “Attaining flexibility in the number of workers at a workshop to adapt to demand changes”. As discussed in the previous paragraph, there should be flexibility of transferring the workforce from one production line to another line when demands change for the lines. The author extends his discussion by talking about having a proper design of machinery, ‘multi-functional workers’ and continuous evaluations of standard operating procedures. The author gives us a very detailed explanation on how we can achieve Shojinka by employing multi-functional workers.

**U\_Layout.png on page 145**

There is a good description given about ‘U Layout’ which means that entrance and exit of the line should be located in the same position as shown in the figure above. By implementing U Layout we can achieve great flexibility of increasing or decreasing workforce. The author extends his discussion by talking of various good layouts and their advantages.

**Chapter 9 One-Piece Production in Practice**

This chapter discusses about can we achieve One-Piece Production in practice by employing right methods like working standup, multi-process handling by multi-skilled workers and automation.

The author defines one-piece production as “the concept of having things flow smoothly through the

factory one by one, like water, without any holdups”.

The author discusses about why standing and working is the best practice in case of Toyota production systems. He also highlights that not to implement the requirements of one-piece production all at once but improve continually, one step at a time. He discusses about the importance of workers being multi-skilled i.e. to know few skills of the before and after processes, this helps the workers to help each other and also provide greater flexibility of work force. Finally, he discusses about the advantages of autonomation which automation with human intelligence is.

**Chapter 10 Standard Operations Can Attain Balanced Production with Minimum Labor**

This chapter discusses about goals and elements of standard operations. It extends by determining the components of standard operations and explains in detail about how to compute the components of standard operations.

**Elements\_of\_Standard\_Operations.png on page 172.**

There are 3 primary goals of Standard Operations. Firstly, to achieve high productivity by working effectively and not wasting energy or any other company resources. Secondly, to achieve line balancing

among all processes in terms of production timing. Thirdly, minimum quantity of working-process will qualify as standard quantity of work-in-process as stated in the book.

There are different components of standard operations where each are determined by the supervisor and each of them are very important to achieve the 3 above goals. Few of those components are cycle time, competition time per unit, standard operations routine, standard quantity of work-in-process and standard operations sheet.

Finally, the author concludes by saying that training and follow up by the supervisor is very important in implementing this system. The supervisor should teach the workers with reason and then later see that everyone follows those procedures.

**Chapter 11 Reduction of Setup Time—Concepts and Techniques**

This chapter describes about advantages of having of having low setup time and how to achieve it. Having a low lot size is very important for Toyota as it will give them huge potential to adapt to frequently fluctuating consumer demands. There can also be a scenario where delivery dates of few car models can change frequently, to adjust to such changes having low setup time is very important.

Taiichi Ohno, former vice president of Toyota company is the main person who bought down the setup of time majority of tasks. He highlighted about the importance of having low setup time. A ‘single-setup’ is a task which has single digit setup up time i.e. less than 9 minutes 59 seconds. Several tasks like 800-ton punch press for the hood and fender were converted to a single-setup whereas earlier it used to take hours and a day in extreme cases to setup such tasks.

The chapter further extends by illustrating and applying 6 concepts/techniques used for shorteing setup time. The 6 techniques given by author are:

1. Separating the internal setup from the external setup
2. Converting as much as possible of the internal setup to the external setup
3. Eliminating the adjustment process
4. Abolishing the setup step itself

**Chapter 12 5S—Foundation for Improvements**

This chapter talks about how to manage slack or “muda” in Japanese language. Muda means “waste of manpower, outputs, money, space, time, information”. Usually several companies manage slack only in adverse situations like recession or depression, but Japanese companies try managing slack in prosperous as well as in adverse conditions.

The author talks about how to manage muda by employing 5S concept or Kaizen. 5S represents the Japanese words Seiri, Seiton, Seison, Seiketsu, and Shitsuke. 5S is used to clean up all the dirt in a company. Dirt in a company is defined by author as “unnecessary work-in-process (WIP) inventories; defective inventories; unnecessary jigs, tools, and measures; inferior oil; and unneeded carts, equipment, tables, and so on.”

**Seiri\_and\_Seiton.png on page 200**

5S or Kaizen conept (in short):

Seiri: to clearly separate necessary things from unnecessary ones and abandon the latter

Seiton: to neatly arrange and identify things for ease of use.

Seiso: to always clean up; to maintain tidiness and cleanliness.

Seiketsu: to constantly maintain the 3S mentioned above, Seiri, Seiton, and Seiso. Keeping a clean workplace without rubbish or oil leakage is the activity of Seiketsu.

Shitsuke: to have workers make a habit of always conforming to rules.

Note: The above given rules are strictly followed for a hardware company and cannot be attributed to another industry sector directly, but they can be modified and used by any other industry sector.

**Chapter 13 Autonomous Defect Control Ensures Product Quality**

This chapter discusses about how to achieve customer satisfaction by delivering quality products through low production costs. Toyota company maintains a very good system of quality control as maintaining quality products is very essential for continuous flow of production.   
  
The company started off by using inspectors who used statistical methods to sample all the finished products and then test those products later they employed autonomation and inspected every single product. They could reduce the inspectors to 5% of total workforce of the Toyota company.

**Evolution\_of\_quality\_control\_activities\_at\_Toyota. On page 220**

The chapter extends to discuss about quality control using statistics and what are the limits on number of defects. Later Toyota introduced autonomation and coined the new meaning to jidoka as “automatic control of defects “ and refers to it as “Ninben-no-aru” jidoka which means “automation with a human mind”. The below figure explains how autonomation attains its purpose.

**Autonomation\_And\_Its\_Purposes.png on page 224. (How autonomation attains its purposes)**

**Chapter 14 Cross-Functional Management to Promote Company-Wide Quality Assurance and Cost Management**

This chapter discuss about company-wide functional management and Toyota terms it as “Kinohbetsu Kanri” although literal meaning of Kinoh implies function, Toyota uses it as company-wide role. The chapter extend by talking about how quality assurances and cost management is achieved all over the company through “functional meeting”. Functional meeting consists of managers who can take any administrative or executive decision relating to quality assurance, production and cost management of any parts of the company and they full authority over any part of the company. So, functional meeting and the director of the department who is the part of the function meeting is very important to plan, check, and decide remedial actions required to achieve a functional goal. The achapter extends by talking about various roles and function of different members of the organization.

**Framework\_of\_Toyota\_Management\_Organization.png on page 249**

**Chapter 15 Kaizen Costing**

**Standard\_vs\_Kaizen\_Costing.png on page 258**

This chapter discusses about differences between standard costing and kaizen costing, types of kaizen costing, preparing annual budget and short-term profit plan. Kaizen cost includes cost reduction in such a way that require changes the way company manufactures existing products.

Kaizen costing activities are classified into 2 types

1. Kazien costing for a specific product where the cost of the product should be drastically reduced for market changes.
2. Kazien costing activities implemented regularly to achieve allowable costs i.e. to reduce difference between target and estimated profit.

**Chapter 16 Material Handling in an Assembly Plant**

This chapter deals with models how to find and move required parts effectively from the vehicles onto the line. Since Toyota is a huge company and it has lot of dealers and suppliers supplying the different materials in vehicles, it would be very difficult to select the required parts and place in the correct line.

A system named as Set Parts System (SPS) is introduced in this chapter for moving parts onto the production lines in set. The following steps make up SPS:

Step 1: Sets of all the parts are placed in the upper level of the assembly shop in “Set Boxes” in the SPS area (a dedicated area for SPS) and then these boxes are moved onto wagons that move along the assembly line.

Step 2: Finally, the assembly operators takes parts one after another and installs them on appropriate vehicle.

**Set\_Parts\_System.png on page 272**

The author introduces another concept termed “Empty-handed” transportation which can be observed in the figure below.

**Empty\_Handed\_Transportation.png on page 276**

**Chapter 17 Further Practical Study of the Kanban System**

This chapter deals with a practical study of the Kanban system to attain one-piece conveyance which is also called as “Ikko-Nagashi” in Japanese. Ikko-Nagashi means that every process in a line will produce a single unit of product. So, we can understand that number of Kanban required for production of huge lots and large inventories.

**Production\_Ordering\_Kanban\_Post.png on page 281**

Practical systems use different Kanbans like production ordering Kanban, triangular Kanban and material requisition Kanban for different function. The author explains about advantages and implementation of each Kanban and how to control tools and jigs using existing Kanban systems in this chapter.

**Chapter 18 Smoothing Kanban Collection**

This chapter deals with why smoothed numbers of Kanban is important, obstacles of collecting smoothed numbers of Kanban, relationship between smoothed collection of Kanban and parts delivery, inventions of Kanban posts at the production site and finally about the post office mechanism for outgoing supplier Kanban.

Scenarios like lack of synchronization between collection of Kanban card during supply of parts, delay of collection of any Kanban cards and advanced delivery of parts by supplier and not collecting Kanban can lead to mismatch between number of Kanbans to the total parts delivered. So smoothing of number of Kanbans is very essential.

**Frequency\_of\_Kanban\_Collection.png on page 292 titled Frequency of collecting kanban can smooth delivered quantities of parts.**

Author describes few methodologies like setting a rule so that operator to move the Kanban from the supplier Kanban to the designated Kanban post as soon as he picks up a part from the parts pallet or box. The figure above gives a similar technique of smoothing number of kanbans according to the delivery schedule of the pickup trucks whenevery they deliver parts. Another technique is to allocate equal time intervals for collecting Kanban. The author extends his discussion by discussing about Kanban posts at production site and also about “post office mechanism” for outgoing supplier Kanban.

**Chapter 19 Applying the Toyota Production System Overseas**

The chapter discusses about Japanese production systems and about the transfer of technology occurring through joint venture between Toyota and GM.

The author comes up with few suggestions such as (in his own words):

“1. The Japanese management system can be adapted to include American or European concepts such as reducing the workweek.

2. The Japanese management system could be implemented exactly as it operates in Japan.

3. A new management system could be created that would combine the technology of both countries. For example, the Japanese kanban system has been connected to the American MRP concept; also, robotics and a computer network system developed in the United States have been applied to the Japanese system.

4. A new cultural environment, conducive to implementing the Toyota Production System, could be initiated in the other country. Once achieved, the Japanese management system would be applied and

adjusted to the new environment.”

**Section 3 Quantitative Techniques**

**Chapter 20 Sequencing Method for the Mixed-Model Assembly Line to Realize Smoothed Production**

One of the important step for designing mixed model assembly lines is to determine the sequence schedule of introducing different products on the same line. The author explains the main goals of introducing mixed model assembly, firstly, to level the total assembly time on each of the lines, secondly, to keep constant rate of consumption of parts on each line.

He discusses about both goals work load streamlining and sequencing model for parts usage streamlining mathematically. He further explain the formulas derived using a numerical example terming it as “Goal Chasing Method”. The author further gives another simplified algorithm to decrease computational time known as “Goal Chasing Method II” and then extends it by explaining the algorithm using an example.

**Chapter 21 New Sequence Scheduling Method for Smoothing**

In this chapter, the author talks about his own method termed “goals-coordinating method” for sequence scheduling of models to a mixed-model assembly line.

The author says that “the appearance ratio control” and “the continuation and interval controls” are the two main logical components for sequence scheduling. The author defines the logic components and says that these logical components are important for smoothing the assembly workload. Further, the author discusses about sequence scheduling using artificial intelligence and using it at painted body storage area between a painting process and an assembly process.

**Smoothed\_Sequences\_of\_Vehicles.png on page 339 titled Smoothed sequence of vehicles by AI and FA system.**

**Chapter 22 Computation of the Number of Kanban**

This chapter deals with computations of number of Kanban in constant quantity withdrawal system and a constant-cycle withdrawal system. The author describes about the system and give an example to explain it in detail. The author talks about computation of number of production ordering Kanban, computing and determining re-order point and lot size and finally about maintain the necessary number of Kanban.

The framework given for computing number of Kanban is the following:  
Constant-Cycle withdrawal System.

1. Number of withdrawal Kanbans.
   1. Inter-process withdrawal Kanban
   2. Supplier Kanban

Constant-Quantity Withdrawal System.

1. Number of withdrawal Kanbans
   1. Inter-process withdrawal Kanban

Number of production-ordering kanbans

1. Constant-cycle withdrawal system
2. Constant-quantity withdrawal system.

**Chapter 23 New Developments in e-Kanban**

**PAGE 369**

1 The Two Types of e-Kanban

2 Sequenced Withdrawal Method e-Kanban: Sequenced Withdrawal of Parts Matched to the Vehicle Loading Sequence Schedule

3 e-Kanban in the Later-Replenishment System: e-Kanban for the Parts Needed on Engine Assembly Lines, and So On

4 Sequence Information for Main, Unit, and Sub-Lines

5 e-Kanban Passing through a Collection Center (an Intermediate Warehouse)

Chapter 24 Kanban Supporting Information Systems

1 Toyota Production System Is Supported by Many Information Systems

2 Material Requirement Planning Subsystem

3 Kanban Master Planning Subsystem

4 Process-Load Planning Subsystem

5 Accounts Payable and Accounts Receivable Subsystem via Electronic Kanban

6 Actual Performance Measurement Subsystem

**Section 4 Humanized Production Systems**

Chapter 25 Cultivating the Spontaneous Kaizen Mind

1 Developing the Spontaneous Kaizen Mindset: Toward Embedding TPS

2 How Taiichi Ohno Came to Be Daihatsu’s Consultant

3 Create a Difficult Situation and Give People a Problem to Solve

4 Conclusions

Chapter 26 Improvement Activities Help Reduce the Workforce and Increase Worker Morale

1 Resolving the Conflict between Productivity and Human Factors

2 Improvements in Manual Operations

3 Reduction of the Workforce

4 Improvements in Machinery

5 Job Improvements and Respect for Humanity

6 The Suggestion System

7 Kanban and Improvement Activities

8 QC Circles

9 New Technical Personnel System

Chapter 27 Respect-for-Humanity Subsystem in the JIT Production System

1 Toward Respect for Humanity Based on Ergonomics

2 Conventional JIT Systems for Respect-for-Humanity Realization

3 Process Improvements

4 Need for Objective Evaluation of Workload

5 Conclusion

6 Appendix: TVAL Model for Measuring Workload

Chapter 28 Motivational and Productivity Effects of Autonomous Split-Lines in the Assembly Plant

1 Why Can Split-Lines Enhance Morale and Productivity?

2 Problem with the Conventional Assembly Line

3 Structure of the Functionally Diversified Autonomous Line

4 The Merits of Autonomous Split-Lines

Chapter 29 Mini Profit Centers and the JIT System

1 Why Do MPC and JIT Systems Fit Each Other Well?

2 Comparison and Mutual Extension of Merits between JIT and MPC Systems

3 Computation Formula for MPC Profit

4 Another Type of Mini Profit Center

5 Local Optimization and Global Optimization

6 JIT Production System as a Prerequisite for MPC Accounting

7 MPC Accounting Will Provide Motivation to Reduce Excess Inventory

8 Conclusion