A STRATEGIC APPROACH TO THE PRINCIPLES OF TOYOTA'S RENOWNED SYSTEM

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New York Chicago San Francisco Lisbon London Madrid Mexico City
Milan New Delhi San Juan Seoul Singapore Sydney Toronto

The McGraw-Hill Companies

1 2 3 4 5 6 7 8 9 0 DOC/DOC 0 1 5 4 3 2 1 0 9

ISBN 978-0-07-161549-5

MHID 0-07-161549-0

To my wife Vidhya and daughters Apsara and Rani,
and in memory of my parents
Thank you

Ananth

To my wife Shubha, daughters Padmavati and Sharada,
and all my family
Thank you

Sridhar

To my wife Audrey; daughters Jody and Neely; my mother Emma,
who at the time of this writing is 105; and all my family
All my love

Roy

Foreword

For decades, Toyota's success in the marketplace has been admired by business practitioners and executives alike. The automaker is the envy of others within the automobile industry, but the company is also considered to be the symbol of excellence in business in general. The firm has been the focus of research in academia.

The power of Toyota has been attributed to its two distinct core values: the Toyota Way and the Toyota Production System (TPS). The Toyota Way has created a culture of respect for individuals, promoting innovation and fostering cooperation. TPS has been the engine under which lean manufacturing, kanbans, quality systems, just-in-time, and continuous improvement practices have been developed. Together, they have been the pillars for the foundation upon which Toyota has become so successful.

But the Toyota Way and TPS are just foundational pillars. There is another concrete secret to the success of Toyota: the way the company runs its supply chain. The Toyota Way and TPS of course have been part of how Toyota has developed its supply chain principles and how the company has applied such principles to work with its suppliers, dealers, and manufacturers. Based on these principles, Toyota has coordinated the plans across the supply chain—and it has executed them well. Supply chain management excellence is the ultimate way in which Toyota has built its superior efficiency in operations.

I am delighted to see this book about Toyota's supply chain management written by two leading academics and an experienced Toyota executive. This book reveals the powerful way that Toyota runs its supply chain, and it shows vividly how the Toyota Way and TPS have been ingrained in the processes used by Toyota to run its supply chain. I submit that reading about Toyota Way and TPS is only a starting point for really learning the innovativeness and effectiveness of Toyota's operations. The current book completes the picture.

While TPS is the central theme of how Toyota runs its factories, the scope of supply chain management is much greater. It spans suppliers to Toyota as well as possibly the suppliers' suppliers, the distribution channel, the dealers, and ultimately, the consumers. The coordination, planning, and control of this extensive network are a daunting task. The current book well describes how Toyota has been very smart in examining three dimensions of supply chain management: geography, product, and time. This book gives us a treatment on how Toyota has designed and operated supply chains to adapt to these three dimensions. For example, the needs for the Japanese and U.S. markets, the Camry versus the Lexus, and at different points in time of the product life cycle, are different, and so different supply chain processes are needed.

I would urge the reader going through this book to keep two perspectives in mind. First, it describes in great details how Toyota runs its supply chain. As a result, there are many innovative ideas that Toyota uses, and many best practices described. So the reader can pick up a lot of useful tips and revelations. Second, the structure of the book is extremely helpful to organize your thoughts and evaluations of your own supply chain. The chapters that follow cover the whole spectrum of what constitutes comprehensive supply chain management. So, going through the chapters gives you a framework to follow. In that sense, even if you extract the Toyota content out of the chapters, the book is a good guideline to develop sound supply chain management practices.

One of the most useful conceptual frameworks in this book is the v4L construct. We see how Toyota manages its supply chain to ensure that the 4v's—variety, velocity, variability, and visibility—can be controlled. In every chapter, for every supply chain operation, the authors describe how this can be done. Again, seeing how Toyota has done it is valuable and informative. But I also think that the reader can benefit from seeing how the authors developed the thought process behind what Toyota did to accomplish the objectives of gaining control of the 4v's. That knowledge by itself is highly educational.

For anyone who wants to learn the true secret of Toyota's operational excellence, this book is a must-read. In addition, while learning about Toyota's supply chain management, we also are given a journey of sound supply chain management in general.

In my personal research, I have come across Toyota's supply chain management practices and have been very impressed by how thorough and innovative the company has been since its inception in the 1930s. I must congratulate the authors of this book, as they have done the most comprehensive, insightful, and penetrating treatment of this subject.

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Acknowledgments

The authors express their appreciation to the management of Toyota Motor Engineering & Manufacturing North America, Inc., for providing access to their executives for interviews as well as for the tour of the Georgetown manufacturing facility. Nancy Banks, manager external affairs, was extremely helpful in coordinating the interviews and arranging for the plant tour. Nancy also spent countless hours reviewing drafts of the book and providing excellent feedback.

The interviews with Toyota executives provided deep insights into Toyota's management of the supply chain. We would like to thank all of the interviewees for taking precious time out of their busy schedules to speak with us. Gene Tabor and Jamey Lykins, general managers in Toyota's Purchasing Division, discussed how Toyota's purchasing relationship with suppliers plays an important role to ensure a strong partnership with suppliers at all levels. David Burbidge, vice president of Production Control, provided an excellent overview of Production Control's role in managing the supply chain. Mike Botkin, general manager of Logistics, shared with us his expertise of Toyota's Logistics operation.

In addition, the interviews with executives from Toyota's partners enlightened us on how the extended supply chain supports Toyota's management philosophy. Jeffrey Smith, vice president and general manager for Toyota Business Unit Johnson Controls, Inc., has several years of working with Toyota around the world and was able to provide the supplier perspective. Gary Dodd, former president of Tire & Wheel Assembly, also discussed the supplier's role and explained the process of becoming a new Toyota supplier. To round out the supply chain we spoke with Steve Gates, dealer principal, Toyota South in Richmond, Kentucky, to obtain an understanding of the dealer operations in the Toyota environment. Steve is also a member of Toyota's dealer council, so he

was able to provide a comprehensive view not only of the dealer's operation but also the Toyota dealer network. Achim Paechtner, former senior manager of Toyota of Europe, provided a framework of how Toyota and other automobile companies operate in Europe. Achim's understanding of the European markets was extremely helpful.

We thank the Toyota Motor Corporation for endowing the Term Professorship at the Stern School of Business without which Sridhar Seshadri, the first Toyota Motor Term professor, would never have met Roy Vasher and this joint project would never have been undertaken. Ananth Iyer acknowledges the support of the Krannert School of Management at Purdue University whose Fall DCMME Manufacturing Conference, where Roy was a speaker in 2007, provided a forum for the authors to meet face-to-face for the first time.

We thank Mayank Agarwal, MBA student at the Stern School of Business for his extensive research into the automobile business. The research was used in this book to confirm the benefits of Toyota's supply chain management. The final manuscript would not be complete without the assistance of Leslie Culpepper, who helped copyedit this manuscript.

Introduction

Toyota uses unique processes to effectively manage and operate the supply chain. These processes span the supply chain and have enabled Toyota to deliver remarkably consistent performance over decades. The authors, a retired Toyota senior executive with hands-on experience and two senior academics, have pooled their combined experience to both describe existing processes as well as understand why they work. By combining the insights of a practitioner with almost 20 years of Toyota's execution and management experience and two academics with decades of research experience, we hope to provide a unique presentation of the topic that can influence supply chain practices at auto and nonmanufacturing companies.

The fundamental thesis of this book is that understanding process details, as well as the logic associated with their success, will enable adoption of these ideas in both manufacturing and service contexts. The material in the pages that follow provides insights into how Toyota uses learning (L) processes to implement practices and principles, both within Toyota's cross-functional organizations as well as with Toyota's partners (including suppliers and dealers)—in short, across the extended supply chain. *We show how integrated and synchronized processes enable careful balancing of variety, velocity, variability, and visibility (4v's) across the supply chain.* Learning is linked to the 4v's to form the v4L framework. We will describe the v4L framework in more detail in Chapter 1.

In keeping with the "how-to" approach to these complex topics, most chapters provide illustrative examples that both explain details as well as illuminate the logic behind the processes. The choice of topics is meant to focus on essential tactical and operational differences in the way Toyota manages its supply chain. Chapter 1 describes the v4L framework and the Toyota learning principles. Chapter 2 provides a comprehensive overview of processes that are part of the

overall supply chain. That, in turn, is followed by topics in the sequence of activities in a supply chain. First, there's "Mix Planning" (Chapter 3) to support production stability and how this is translated into "Sales and Operations Planning" (Chapter 4). We then cover how sales requests are supported by "Production Scheduling and Operations" (Chapter 5), "Parts Ordering" (Chapter 6), and "Managing Suppliers" (Chapter 7). The inbound and outbound "Logistics" processes are described next (Chapter 8), followed by "Dealer and Demand Fulfillment" (Chapter 9) and dealer-related processes, which will complete the supply chain coverage. Finally, Chapter 10 covers how Toyota handles "Crisis Management."

The detailed discussion of Toyota's supply chain processes will be followed by chapters on "The Toyota Way of Managing Supply Chains" (Chapter 11) and how that has been used to design and improve each of these steps, and "How to Apply Toyota Way Principles to Nonautomotive Supply Chains" (Chapter 12). We have also included a chapter titled "The Beer Game and the Toyota Supply Chain" (Chapter 13), which describes the well-known bullwhip effect in supply chains and examines how following Toyota's integration of processes across the supply chain enables reduction of the bullwhip effect. Two "Reflections" chapters conclude the book: Chapter 14 examines the reflections of supply chain participants; Chapter 15 reflects on the Toyota experience in general and considers potential future innovations in the automotive supply chain.

Although there are several excellent books that describe the Toyota production system, as well as a few that cover principles used in the Toyota supply chain, we believe there is a benefit to understanding process details in order to execute processes consistent with the principles. The sources of material for this book include firsthand experience with applying these processes at Toyota, direct interviews with Toyota-experienced managers and suppliers, existing books on Toyota's processes, academic research, surveys, and empirical case studies.

Contents

Chapter 1

Toyota Learning Principles and the v4L Framework

Toyota is well known for its approach to problem solving and continuous improvement. Articles by practitioners, researchers, and participants have made the tools and techniques of continuous improvement familiar to every business executive. For example, phrases such as *andon*, *heijunka*, and *kanban* have become part of the day-to-day vocabulary of managers. In an insightful commentary on these tools and techniques, Jeffrey Liker writes that Toyota's success goes beyond these tools and techniques to what he calls "The Toyota Way."[1]

Liker presents the Toyota Way as an all-encompassing method for designing and managing processes. Every student of Toyota also knows that the Toyota Way is unique, not only in its approach to problem solving but also in perpetuating its way of thinking across different types of operations, organizations (including suppliers, logistics providers, and dealers), and worldwide locations. Underlying the success of Toyota is the company's approach to scientifically examining problems, solving them, learning from the experience, and passing on that knowledge to others.

Toyota is a global auto company with many products and markets. The company encompasses markets across the globe with different characteristics (e.g., the United States, Europe, and Japan) that warrant different supply chain configurations. In addition, differences among the Toyota, Lexus, and Scion vehicles warrant different supply chain processes. Although common processes underpin these supply chains, variations across these supply chains provide additional insights. We believe that an understanding of how all these supply chains coexist in one company provides an excellent learning opportunity for a practicing supply chain manager to apply the v4L framework to his or her work.

v4L Framework

Performance at Toyota is evaluated with equal weight given to both the process used to derive performance and the results achieved. This process focus aims to generate a balance of key supply chain parameters—variety of products offered, velocity of product flow, variability of outcomes against forecast, and visibility of processes to enable learning. The learning follows a carefully documented process that promotes continuous improvement. At the end of every chapter a reflection section will be included that links the chapter to the v4L framework: balancing variety, velocity, variability, and visibility across the supply chain. One way for managers to understand Toyota's concepts is to first ask how their company's supply chain achieves this balance. Often, variety is chosen with a focus on marketing benefits with scant attention to supply chain implications, velocity, variability, and the like. This off-optimal choice of variety can have severe repercussions across the supply chain, which is often difficult to untangle. A careful choice of v4L parameters enables superior supply chain performance at Toyota.

Learning (L) Principles

Toyota has mastered the art of learning and believes that the principles to attain mastery are universal. Moreover, Toyota has spread these ideas throughout its supply chain in its leadership role. We shall review these ideas in later chapters and provide a summary of methods that makes learning a practical and ongoing process at every level and every task in Toyota. Toyota's way of making learning happen not only conforms to the theory of learning (as we mention in Chapter 11) but can be simply explained (as is often the case with things that are very hard to accomplish!). The following are the main principles:

- *Create awareness.* Unless problems are seen, they will not be solved. Systems need to be in place to report ideas, problems, deviations, and potential issues to a direct team leader with no delay.
- *Establish capability.* Unless someone is capable of solving a problem that might arise within the system boundaries set for him or her, that person will be unable to contribute to the problem-solving process and will be unable to recognize the need for specialized help.
- *Make action protocols.* Actions have to be taken within a set of constraints, and they must conform to certain standards. Doing so will help in the identification of the relation between action and results. It will aid in the codification of the knowledge for future use, with the same language and format used as well as similar content.
- *Generate system-level awareness.* As experience with solving problems is obtained, greater awareness of other areas that might be affected

by actions or that might impact one's own performance needs to be created.

- *Produce the ability to teach.* As system-level awareness and experience accumulate, the capability to teach others about these methods needs to be in place.

v4L Principles

The v4L learning principles are combined across all Toyota supply chain management processes to systematically focus on the v4L balance:

- *Variety* is carefully chosen to balance market demands and operational efficiency. Awareness of the impact of variety on the market demand and on manufacturing and supply chain costs enables all the entities across the supply chain to be considered when decisions regarding variety are being made. In one sense, variety represents a crucial supply chain design choice that has an impact across all supply chain participants. A key issue when variety is being chosen is the need to have feedback loops to ensure that the selected variety represents the best response to current market conditions. As we will discuss in each of the chapters, this is where the learning features of Toyota's process enable the constant loop of Plan, Do, Check, and Act (PDCA).
- *Velocity* of supply chain flows is the next key concept, and it manifests itself in all processes across the supply chain. A focus on maintaining a steady flow throughout the system enables capacity planning to be synchronized across the supply chain. The detailed process descriptions in the following chapters will highlight how a rate-based approach serves as a linchpin for the planning processes across the system.
- *Variability* of orders or deliveries across the supply chain is minimized by how the individual processes are executed. Reducing variability enables all of the supply chain flows to operate with low levels of inventory. It also enables quality improvement processes to operate without interruption, thus enabling continuous cost reductions and quality improvements. Notice that variety, velocity, and variability all interact to stabilize supply chain performance.
- *Visibility* of all processes is ensured with use of the right metrics and the requirement that a consensus be reached before plans are changed. At Toyota, performance metrics have a 50 percent weight for results and a 50 percent weight for process compliance. In other words, the goal is to reward not only short-term successes but also ensure that the correct processes are followed. Such an approach ensures that bottlenecks are visible and responses immediate, changes are deliberate, velocity is maintained,

variety is synchronized to demand, and variability is minimized. Visibility enables continuous learning and feedback, thus guaranteeing that execution of processes remains synchronized with market realities.

We suggest that v4L highlight the intricate balance of all supply chain processes. How each of them is balanced by vehicle type or geography is a business choice that reflects Toyota's competitiveness in that market. The choice of the v4L and the actions required to implement these choices are guided by the learning principles. All companies should be asking themselves how their current choices reflect the impact of the v4L. A way to remember this concept is to ask, is the supply chain's v4L engine at my company appropriately tuned for competitive performance?

Endnote

1. Jeffrey K. Liker, *The Toyota Way.* New York: McGraw-Hill, 2004.

Chapter 2

Comprehensive Overview of Supply Chain

The Toyota Production System (TPS) is the benchmark used throughout the world as the foundation for "lean" thinking. At Toyota, the TPS practices and principles extend well beyond the factory walls to include the extended supply chain and require some crucial choices to ensure supply chain efficiency. This chapter explains how Toyota plans and operates its supply chains globally. But first, a brief look at the extended global automobile supply chain is in order, which will enable you to understand the processes described in the following chapters.

The automotive supply chain is very complex and consists of many processes that, when linked together, form a supply chain from the customer back to the various tiers of suppliers. The physical processes consist of the production of parts at the suppliers, transportation of these parts to the assembly plant of the original equipment manufacturer (OEM), assembly of parts into a completed vehicle, distribution of completed vehicles to dealers, and finally delivery to a customer. In addition to the physical processes, there are both preproduction and day-to-day operational support processes. To fully understand these processes, some background on the auto industry is necessary. The following questions need to be answered:

- What is the product?
- Who are the customers?
- What are the distribution models?

What Is the Product?

A car or a truck can be described with its specifications. Each OEM uses a slightly different terminology to define a vehicle's specifications. Toyota uses a

Table 2-1. Vehicle Specifications Hierarchy

Make	Model	Body	Grade	Options	Accessories
Toyota	Camry	Sedan	LE	Sunroof	Spoiler
		Sedan	XLE	Navigation	Floor mats
	Tundra	Crew cab		XM Radio	Tow hitch
		Double cab		Sunroof	Bed liner
Lexus	ES350	Sedan		Navigation	Floor mats

hierarchical method of vehicle specifications. The typical hierarchy of the vehicle specifications is shown in Table 2-1. The following are some examples of vehicle specifications:

- *Make.* Toyota, Lexus
- *Models.* Camry, Avalon, Tundra, Sienna, etc.
- *Body style.* Four-door sedan, two-door coupe, convertible, crew cab, double cab, etc.
- *Grade.* XLE, LE, SE, etc. When a grade is selected, it usually includes several standard equipment items. Typically the higher-grade vehicles include many standard items. Sometimes when the grade is selected, the engine and transmission combination is included as standard equipment.
- *Engine.* Six-cylinder, four-cylinder, etc.
- *Transmission.* Automatic, five-speed, etc.
- *Factory options.* Engine, transmission, sunroof, air-conditioning, navigation, radio, power windows, etc.
- *Accessories.* These items are like options, but they can be installed in the factory or added after the vehicle is built. Examples are spoiler, tow hitch, roof rack, and pinstripes.

In addition to the above specifications, exterior and interior colors must be included to complete the vehicle build specifications:

- *Exterior color.* The outside color is usually one color; however, it could be two-toned.
- *Interior trim/color.* The interior colors (e.g., black leather and gray cloth) are usually coordinated with exterior ones, but not all interior colors always will be available with all exterior colors.

So each vehicle is built with a unique set of specifications called a "build combination." If all possible build combinations were produced, then the total build combinations for a model would be in the millions. This variety would make managing the supply chain an extremely complex and costly process; therefore, many automotive companies limit the number of build combinations