

Preface

The term “life cycle” is used in various fields, including both the natural and the social sciences. Even in business alone, life cycle has a variety of meanings. One may consider the life cycle of an individual product, a category of products, or a whole industry. From the marketing perspective there also is the life cycle of consumers. This book focuses on the life cycle of an industry. This industrial life cycle concept is very close to that of the category life cycle but they have key differences. One key difference lies in the transition of sales. The target of this book is to go further into the industrial life cycle, which may be considered the central mechanism of the category life cycle. The size of the potential market is dependent on the advancement of the product and process innovations. The consumers at different stages are quite different in what they want and how much they are willing to pay. Companies should offer the right products at the right time, and at the appropriate service level. The industrial life cycle incorporates a wide variety of aspects, such as the innovation stage, the market, and facility location decisions. We integrate these into a meaningful whole that can be called the *industrial life cycle*.

In modern manufacturing, a supply chain, not a single company, is the basic business unit for competing in an industry. Although the supply chain is a relatively new concept, all products and materials have been delivered to customers from its origin. Substantially, the supply chains have sourced

materials, manufactured the products, and delivered them to consumers. To offer a variety of products at competitive prices, the member companies and the structure of the supply chain play very important roles. These roles differ at each stage of the life cycle, because the mission of the supply chain changes with the stages. At the beginning of an industry, some original members of the supply chain quickly boost the R&D activity collaboratively to launch the market. After the demand grows, they must establish a system suitable for the mass production. As the competition becomes more severe in the market, supply chains next should concentrate on pursuing efficiency and cost reduction while offering a wide variety of products. At the end of the life cycle, supply chains must withdraw from the market smoothly. The life cycle stages, therefore, have a great impact on appropriate supply chain management. This book is designed to uniquely combine supply chain management and the life cycle.

This book is composed of four main parts and a concluding chapter. In the first part (Chapters I-IV), we discuss the fundamentals of supply chain management and the life cycle, along with the quantitative analysis related to life cycles. The latter is very ambitious because, although industry life cycles are pervasive in modern business reality, very few research efforts have been conducted in the field. This part summarizes the book and discusses supply chain management and life cycle theories. Supply chains have become the basic unit for competition in the market (Bradley, 1986). Effective and efficient supply chain management is very difficult because supply chains have contradictory requirements and are multi-echelon systems composed of a patchwork network of participants, stages and players (Bowersox & Closs, 1996; Bowersox, Closs, & Helferich, 1986). Supply chains also may suffer from information distortions of various kinds.

In Chapter I, SCM Models, we discuss the basis of supply chain management. A key concern for SCM is the control of the dynamic interactions among the supply chain partners (Chan & Lee, 2005; Higuchi & Troutt, 2004). Supply chains are composed of multi-echelon layers to offer the products to the customers efficiently. However, they incorporate various partners whose purposes and interests do not always harmonize. In addition, supply chain processes are so long and complex that unexpected results very often can happen. Information distortion effects can cause supply chains to be inefficient and ineffective. The bullwhip effect and the boom and bust phenomena are good examples. To highlight these characteristics of SCM, we made a comparison with the similar but less comprehensive concepts of business logistics, physical distribution, and *Keiretsu*.

In Chapter II, Review of Life Cycle Theories, we explain the major life cycle theories related to business (Abernathy, 1978; Abernathy, Clark, & Kantrow, 1983; Doyle, 1976; Kotler, 1999; Moore, 1991, 2005; Rogers, 1995; Rosenbloom & Abernathy, 1982; Utterback, 1994; Vernon, 1966, 1977, 1998). The life cycle concept has been adopted widely in marketing. The Product Life Cycle (PLC) is the most well-known one. It typically divides the life-time sales of a particular product into four stages based on the transition of the sales. PLC can be expanded by combining it with the study of the consumer types, the extreme innovators, the innovators, the early adopters, the early majority, the late majority, and the laggards. The life cycle concepts have been developed from the other views such as innovation and manufacturing facility location. Technology is a powerful driver for the diffusion of a new product. The location of manufacturing facilities has a close relationship with manufacturability and cost, which is subject to changes according to the market and technology conditions as Product Cycle Theory demonstrates.

Chapter III, Analytic Research and Quantitative Models, presents a survey of research involving life cycles and modeling. This chapter provides two kinds of background information. First, we reviewed the supply chain management, operations management, and management science literatures for those works contacting life-cycle issues and at the same time that use quantitative or modeling approaches. We also developed synoptic summaries of these publications and provide some analysis of their central topics, trends, and themes. The results will be a helpful reference guide to the related literature to date for both practicing managers and researchers. We also introduce the standard quantitative methods and models used for mathematical life-cycle models. Most of them have been developed under the label of diffusion models and most of this work has been carried out by marketing scientists. Coverage of this material was deemed necessary for completeness. Also, we hope this treatment will provide an easy reference for those supply chain students with technical and forecasting interests. Because it was developed in the marketing literature under the name of “diffusion models,” it was somewhat harder to find within the supply chain management literature proper. Those readers not having related technical and mathematical interests may omit this material with no loss of continuity.

Chapter IV, Supply Chain Dynamics and Dynamic Simulation, examines the intrinsic dynamics of supply chains and the dynamic simulation modeling. In the first part of this chapter, the intrinsic dynamical interactions with supply chains are discussed. These theoretically are interesting and informative for understanding and managing supply chains. Next, the chapter explores the

power of dynamic simulations for managing and understanding the workings and complex interactions in supply chains. As revealed by the literature survey in Chapter III, the short life cycle case increasingly is important in practice. The intrinsic dynamics of supply chains can especially be problematic and potentially catastrophic in the short life-cycle case. The history of the well-known *Tamagotchi*TM toy is used to provide an illustration. The *Tamagotchi* case history, simulation experiments, and analysis illustrate the disastrous consequences that can occur if information distortion is not taken into appropriate account in capacity expansion decision making.

In the second part (Chapters V-VIII), product development including performance and quality is discussed from the viewpoint of product and process innovations. Product innovation must ordinarily precede process innovation. The discussion is based on the case of the VCR industry. The industry life span of the VCR is complete and well documented and provides excellent illustrations of the various life cycle and supply chain interrelationships.

Chapter V, Prerequisite Conditions for Commercializing, discusses the road to satisfying the prerequisite conditions for commercialization and the launching of the dominant design. This chapter deals with the period before the commercialization stage occurs and uses the VCR case study for illustration. Multiple companies attempt to launch a dominant design, namely a widely adopted, initially excellent product. However, only one can succeed. A dominant design is generally created after many failed attempts. The time until the emergence of the dominant design is periodized into three, the embryo period, the fetus period, and the birth. Then, the basic requirements for commercial success are discussed. It is necessary for any new category of products to satisfy all the minimum requirements. Otherwise it could not diffuse widely. In the VCR, Sony and JVC were in a severe struggle for the de facto standard because both of them launched an excellent product in the middle of 1970's, and both of their product versions satisfied the minimum requirements for commercialization.

Chapter VI, Struggle for De Facto Standard, explains how the VHS group of companies caught up with the Betamax group in the late 1970's. In the middle of the 1970's, Sony and JVC introduced the Betamax and VHS VCRs, respectively. Both of these products had enough potential to become the de facto standard. Sony had a first mover advantage in the market. On the other hand, JVC formed the VHS group and pulled ahead by 1980. Although the capabilities for the first Betamax and VHS, SL-6300 and HR-3300, were almost equal, the consumers preferred HR-3300 because of the longer maximum recording time to videotape movies, baseball games, and

football games. Most videotaped programs by any VHS machine could be played back, while Sony made a disconnection to the first Betamax when they launched the Beta II in 1977.

Chapter VII, Development of Products, illustrates the product development after the dominant design has emerged. The advancement and the price decline of products are illustrated based on the VCR case. After the dominant design emerges, the product advances incrementally or cumulatively. This is because the dominant design sets a standard design for the product and a framework for the competitors to follow. Many new generation products with new functions will have appeared in the market. Not all of them became popular. In the VCR case, typical consumers bought a monaural VHS machine first and then a HiFi VHS machine. However, most consumers did not purchase S-VHS, D-VHS and other advanced but too expensive machines. The alternation of generations of the VCR occurred only once, from the monaural to the HiFi machine.

Chapter VIII, Emergence of Destructive New Technologies, discusses the situation known as the productivity dilemma. The emergence of alternative products also is discussed. Companies launch alternative products to gain the initiative and to increase sales promotion, although the R&D and manufacturing cause dramatic cost increases. In the VCR case, there were many alternative products, such as EVR, TED, and the laser disk, especially during the 1960's. They continued to be improved many times in attempts to surpass the VHS. However, VHS (a magnetic recording system) remained the de facto standard until the DVD and HDD recorders finally replaced VHS. We also contact some recent research on destructive technologies and related phenomena from the strategy literature. This recent work also promises to be informative in better understanding cases in which a de facto standard may not completely replace one or more competitors.

In the third part (Chapter IX-XI), the development of the industry is analyzed from the perspective of the consumer roles at the differing life-cycle stages. Consumers are divided into five categories, the extreme innovators, the innovators, the early adopters, the early majority, the late majority, and the laggards. The innovators and the early adopters lead the early market and the early majority and late majority play a major role because of their size. Laggards are almost out of the picture in the model.

Chapter IX, Extreme Innovators and Innovators, discusses the two classes of customers called the extreme innovators and the innovators, respectively. Both of these groups purchased an incomplete or immature product at a high price. The characteristics and behaviors of these types of consumers are very

important in the infant market. The extreme innovators dare to purchase an incomplete product at high price and contribute to its product development. The innovators adopt the new product later than extreme innovators and purchase an immature product while still at a relatively high price. Their reviews have very influential effects on the future diffusion of the product. Their second and later repeat purchases are critical factors for the alternation of product generations.

Chapter X, Early Adopters and Early Majority, discusses the characteristics and roles of these customer classes. The early adopters and early majority customer groups are reviewed from the life cycle viewpoint according to the VCR case study. Both of these classes decide to purchase when a product becomes sufficiently mature, stable in features, and the price becomes reasonable. Their adoption also signals that the product performance has attractive future possibilities. On the other hand, manufacturers should expand their manufacturing facilities quickly to cope with the growing demand. The spread is very rapid in the first phased because the early adopters (13.6 npercent) amount to almost six times as many as the innovators (2.3 percent) and the early majority (34.1 percent) account for about 2.5 times as many as early adopters.

Chapter XI, Late Majority and Laggards, explains the characteristics and the roles of the late majority and laggards classes of buyers. Both of them adopt the product sufficiently late enough that the product has become both practical and inexpensive. Their impact on the market is not very great because various types of other customers co-exist in the market by that time. Also, manufacturers will have begun to offer a wide selection of products for all customers. The late majority and the laggards therefore are only a small fraction of the total customers. In addition, these buyers will have entered the market at a time when most manufacturers will have attained adequate manufacturing ability.

In the last part (Chapters XII-XV), physical facility location aspects and decisions are discussed. Facility location decisions at the life-cycle stages can be better informed by considering the manufacturability (feasibility), sales promotion opportunities, and the cost-reduction possibilities. The appropriate allocation of facilities and the design of the supply chain network are among the most effective means for fulfilling strategy in a manufacturing supply chain.

Chapter XII, Physical Location, introduces Vernon's Product Cycle Theory. This first is used to explain the transition of facilities locations. Then, reasons are discussed to show why location factors are important at the inception

of the industry life cycle. Vernon's product cycle theory is reexamined and further expanded because it was not originally able to address the recent environmental changes, the global economy, supply chain management, and the rise of developing countries. The relevance of geographic location of manufacturing facilities is demonstrated from the viewpoint of innovations. At the beginning of the VCR industry, nearly all manufacturing facilities were located in Japan. Even though a substantial global demand existed for the VCR from the beginning, Japanese companies exclusively manufactured them in Japan and exported products to the rest of the world.

Chapter XIII, Partial Dispersion, discusses the beginning of the overseas or local production, that is, production in the vicinity of the overseas customer. The strategy of locating all supply chain members in close proximity is better for most suppliers and manufacturers at the beginning of the life cycle. However, as time passes, companies start locating assembly facilities in the other advanced countries to increase the sales or to reduce costs. Overseas production is an effective and rapid way for the manufacturers to avoid trade friction and to penetrate foreign markets. Product and component standardization makes it possible to do so. The partial dispersion at the beginning of the standardized stage in the VCR Industry is demonstrated.

Chapter XIV, Total Dispersion, demonstrates the importance of global logistics or global sourcing during the standardized product stage of the industrial life cycle. In the middle of the standardized stage, companies promote total geographic dispersion of the manufacturing facilities because of the intensity of competition in the market. Leading companies, followers, and cost cutters, can all exist in the same market because the advancement of the product design and production processes invites newcomers and enables them to compete with others. The appropriate strategy differs based on the company type. The various consumer types, namely, the extreme innovators, the innovators, the early adopters, the early majority, the late majority, and the laggards, all co-exist in the market at this stage.

Chapter XV, Convergence of Facilities in Low Cost Operation Areas, discusses the convergence process of facilities under the situation that the demand for the product decline sharply. In the late standardized stage, very little room is left for the differentiation of products. The saturation in the market or the emergence of the alternative products decreases the demand for a product sharply at the end of the life cycle. For the further cost cutting under the declining demand, companies should make most of the economy of scale globally. As a result, companies start convergence of their manufacturing facilities in a low cost area or withdraw from the market.

In a concluding chapter, Chapter XVI, Application of Industrial Life Cycle Concept, we try to summarize the previous chapters from the viewpoint of the *Industrial Life Cycle* concept. The industrial life cycle concept integrates the innovation, location, and marketing aspects and is a very holistic concept in two respects, a whole category of products including their multi-generational forms, and a whole supply chain from the consumers to suppliers. We developed the industrial life cycle concept through a thorough study of the home-use VCR case history. The time frame is divided into five stages: *introduction* (before 1980); *early growth* (1980-1984); *late growth* (1985-1989); *maturity* (1990-2001); and *decline* (after 2002).

We hope this book will be of interest to a wide variety of executives; business strategists; international business managers; production, operations, and logistics experts; and marketing specialists who seek to further understand and apply supply chain management techniques. Life cycle techniques are very useful for foreseeing the future. The framework in this book, which includes the typical pattern of the innovation, the consumer behavior, the physical location, and the SCDM concept, is applicable widely in real life. The structure of the supply chain should be changed according to the mission of the supply chain which differs by stages, such as R&D oriented, the mass-production oriented, and the cost oriented. The book also should be useful for graduate students and advanced undergraduate students in business, particularly in international business and business strategy. We also hope the book will provide impetus for further research in these and related fields. A general undergraduate business education would be ideal as background for this book. However, experienced managers and advanced undergraduate students will hopefully find it quite readable.

We also hope this work achieves our aim of a comprehensive and in-depth coverage of the intimate connections between the industry life cycle and supply chain management issues. The industry life cycle of the VCR has recently come to its conclusion and provides the essential principles and illustrations for this new theory. We believe this new field will be of interest and use for both practitioners and researchers, and will contribute to both strategy and international business.

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