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AN EVOLUTIONARY APPROACH TO PRODUCT GROWTH THEORY

Working Paper No. 232

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Abstract

The continuing controversy about the product life cycle (PLC) concept probably indicates that the concept, while useful, is inadequate to explain the entire phenomenon of product growth and proliferation. A complementary concept, the "product evolutionary cycle" (PEC), is hereby proposed to help resolve this controversy and to provide a better framework for explaining and managing product growth.

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Introduction

Over the past two decades the product life cycle (PLC) concept has been increasingly used by business firms, as evidenced by its mention in news reports, speeches, annual statements, and brochures. The concept has been used extensively in academia as a framework for product management (Buzzell 1966, Catry and Chevalier 1974, Dodge and Rink 1978, Doyle 1976, Kotler 1980, Luck 1972, Wasson 1974, Staudt et al. 1976, to cite just some of the more recent authors), strategic planning (Smallwood 1973), cost and financial aspects (Fox 1973, Savich and Thompson 1978, Simon 1979, White and Ostwald 1976), retailing (Davidson, Bates, and Bass 1976), purchasing (Berenson 1967, Rink 1976), international trade (Wells 1969), and as a framework for linking manufacturing to marketing (Hayes and Wheelright 1979). In all these instances the concept has been used more as a means of communication and a framework for analysis than as a mathematical model for prediction, but its use as a model for forecasting has also been explored (Balachandran and Jain 1972, Cooke and Edmondson 1973, Kovac and Dague 1972, Parsons 1975).

The PLC Controversy

It is important to note that this proliferation has proceeded in spite of inconclusive evidence in support of the model and considerable doubt about its validity. In addition, several authors have severely criticized the model, and these charges have not been fully addressed and answered. To summarize, the controversy involves problems associated with the theoretical, practical, specification, and empirical aspects of the PLC.

The Theoretical Issue of Modelling

The PLC is modelled on the fixed cycle of birth-growth-maturity-death which higher living organisms pass through. Applications of and commentaries

on the PLC generally hypothesize the "classical" bell-shaped curve of product introduction-growth-maturity-decline. Hunt (1976), however, argues that from a methodological platform, the PLC is not a model in the strict sense of the term but a tautology. He points out that the PLC uses sales to define the stages of the life cycle which in turn are used to predict sales, thus amounting to a vacuous modelling system. In his words, the PLC is "impotent and void of explanatory power unless and until it can be refined to the point where the stages can be identified independent of the sales variable." p. 55.

Using sales to predict sales is not inherently incorrect, but such a statistical simplification assumes that sales are a function only of time. The PLC omits the more relevant independent variables of competition, marketing effort, and other environmental factors which are more intelligible to practicing managers and which are somewhat more within their control. In the words of Wind and Claycamp (1976), "traditional (PLC) analysis...ignores the competitive setting of the product, the relevant profit considerations and the fact that product sales are a function of the marketing effort of the firm and other environmental forces." p. 8.

The Practical Issue of Applicability

Many authors writing on the PLC agree that it is not universally applicable and that there is no faultless method of finding out where and when it may be relevant. Dhalla and Yuspeh (1976) go a step further and claim that the PLC is a dangerous tool in the hands of managers who, faced with an unsatisfactory sales picture, might commit a product to premature death or abort a promising innovation. The PLC in such cases becomes a self-fulfilling prophecy. Based on their experience and analysis, Dhalla and Yuspeh prescribe a total rejection of the concept. Other authors who recognize this danger suggest exploiting or extending the PLC to transcend the

limitations of the model (Enis, La Garce, and Prell 1977, Field 1971, Levitt 1965, Smith 1980).

The Specification Issue of Level of Aggregation

While there has not been much controversy about the level of aggregation at which the PLC applies, neither has there been much unanimity about it. Authors generally distinguish between product class, form, and brand, where class is the broadest level of aggregation, consisting of products which fulfill the same want and are close substitutes for one another (e.g., cars, cigarettes). The problem here is not so much to arrive at clear-cut distinctions of class, form, and brand across all product categories (itself no simple task), but to determine how applicable the PLC is at each of these levels. A review of much of the PLC literature leads us to conclude that authors generally consider that:

- Of the three levels of aggregation, product forms bear the closest approximation to the PLC.
- Brands are difficult to model because of their strong individuality and erratic sales pattern.
- Patterns at the level of product class are less apparent because of the longer sales trends involved.
- Commodity products (e.g., sugar, cotton, and grain) probably fall outside the explanatory power of the PLC.

The Empirical Issue of Validation

A few studies designed to validate empirically the PLC have been reported. Most of these involve narrow product categories, and many are now more than a decade old. Of the eleven published reports we reviewed, only six find evidence in support of the classical bell-shaped curve, but their results are by no means conclusive (Buzzell 1966, Cox 1967, Cunningham 1969, Hinkle 1966, Kovac and Dague 1972, Polli and Cook 1969). The most

elaborate of these studies (Polli and Cook 1969) found that the classical PLC performs better than chance in 44 percent of the 140 products tested, at the 0.05 percent confidence level. The remaining five studies found PLC curves of other shapes to be applicable. Thus Cox (1967), in analyzing 258 ethical drug products, discovered six different PLC curves; Buzzell (1966) found three typical curves during the maturity stage; Kluyver's (1977) analysis also led to three types of PLC curves; and Cunningham (1969) and Hinkle (1966) found two each (see Fig. 1). In contrast, the analysis of Dhalla and Yuspeh (1976) indicated no PLC pattern to be significantly different from chance.

This discussion of the theoretical, practical, specification, and empirical problems highlights the weaknesses in the PLC as it is currently analyzed and used. However, it would be premature to conclude on the basis of these problems and conflicting viewpoints that the PLC concept is in its own maturity or decline phase! If the concept is still being widely used, there must be some value in it. If these curves have been found to be significant by researchers, then some of them might be widely relevant. The question is which one, and when. As will be argued in this paper, this is not merely a logical question but a crucial one, because there may be more than one phenomenon at work in product growth and proliferation, only one of which has been described and studied at length--the classical PLC. Hence the crucial question: which curve is the relevant one?

The crystallization of multiple approaches to the PLC and the hardening of contradictory opinions about its validity is probably due to the incompleteness or partial truth of the concept in explaining the phenomenon of product proliferation--it can explain some but not all of the available data. Hence, depending on which data one works with, one will arrive at a different

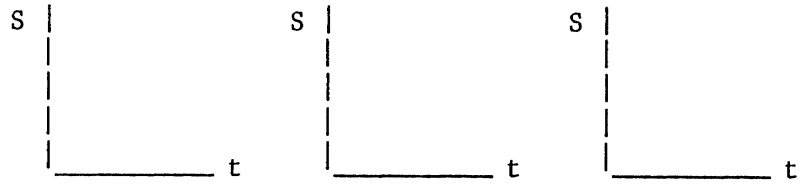
Figure 1

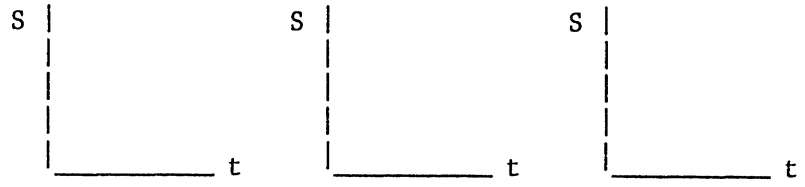
Empirically Determined PLC Curves

(classical curve)

Kovac and Dague (1972)
Polli and Cook (1969)

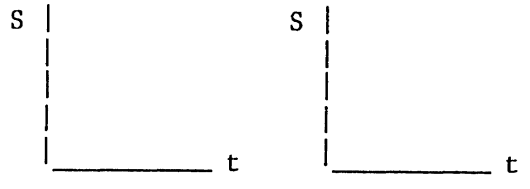
Cox (1967)





Buzzell
(1966)

Kluyver (1977)



Cunningham (1969)
Hinkle (1966)

conclusion concerning the validity of the PLC. Such a situation suggests the need for an alternate or broader framework which can explain more of the available data and provide a more stimulating framework for analysis. Perhaps if we go back to the science which inspired the PLC--biology--we may have some clues.

The Concept of Evolution

The PLC is based on the pattern of birth-growth-maturity-death which is intrinsic to all biological specimens. But a close look at nature will reveal that there is another "cycle" besides this one of life and death which is used to explain the whole phenomenon of the growth and proliferation of species in nature, and that is the evolutionary cycle. Indeed, while the life-death cycle is a rigid, highly predictable one which tells the story of each biological specimen (the individual horse, dog, etc.), the evolutionary cycle is a dynamic, open-ended one which tells an even more exciting story of the origin, growth, and proliferation of species. (A species is a group of biological specimens which can breed within but not outside the group.)

Researchers in marketing patterned the PLC on the life-death cycle of nature. This was surely a practical and handy concept, but it captured only half the truth. The research problem for the present paper was to study the evolutionary cycle, to determine whether it might not capture the other half.

The term "evolution" has been around in marketing for a long time, but it has been used loosely and often linked loosely with the PLC (Kotler 1980, Cox 1967, Luck 1972, to cite just some examples). Kotler in particular describes at some length a "theory of market evolution." However, in general the term has been used by these authors to mean gradual, continuous change.

Evolution as used in biology is a powerful concept. It designates gradual, continuous change which is also:

- cumulative, each change building on the previous one;
- motivated by well-defined forces, primarily a generative and a selective one and now increasingly a mediative one;
- directional, moving in a well-defined direction of greater complexity, greater efficiency, and greater diversity; and
- patterned, evidenced by five well-defined patterns.

This powerful concept of evolution was applied to biology only as late as the turn of the century, but it proved to be a watershed in the progress of that science. Its use in astronomy to explain the development of the universe and in social psychology to explain the development of human consciousness has resulted in some promising theories. The rest of this paper will examine the applicability of this concept to the phenomenon of product growth and proliferation, vis-à-vis that of the PLC.

The Phenomenon of Cumulative Change

Biologists before the turn of the century, though amazed at the wonderful adaptation of species to their environment, were unable to offer a natural explanation. Evolutionary theorists, however, took a macroscopic view of all biological forms; classified them systematically; considered the time dimension, with the continuous, cumulative changes that took place over the ages; and saw no longer a static taxonomy, but a dynamic evolving scenario. The multitudinous species, many of them extinct, were no longer seen as isolated entities but as evolving patterns connected by vital, though often missing, links--the small changes over generations which cumulated to give new species.

Viewed macroscopically, products too cease to be individual, isolated entities and merge into evolving patterns. This requires that changes be

cumulative as well as successive. For example, consider the clothes washing machine. We can trace a continous line of history as it evolved from the first crude hand- and foot-driven models to the present sophisticated versions with variable speeds, temperatures, and timing facilities. The changes undergone are cumulative, each building on the previous one to produce an improved version, much like that of species in nature. The same is true of most other products. But there remains one important difference. In nature, evolutionary gains of one species can never be adopted by another one--there is no possibility of cross-fertilization across species! In marketing, however, it is possible to apply a form or technological innovation from one product category to another--e.g., the application of electronics to watches. Similarly, two products can be merged into a superior new product--e.g., the blender.

The Phenomenon of Directed Change

Superficially, it may appear that evolution in nature proceeds randomly at a blind pace, and the same may be believed about product proliferation. But it is not so. Paths once crossed need not be traced again, victories once won need never be repeated. Thus, once the early land forms developed rudimentary limbs, successful successor species continued to improve upon them. The same can be said of wings, eyes, or any other biological features. The question is, in what direction is this progress?

Biologists specify that evolution invariably proceeds in the direction of greater complexity, greater efficiency, and greater diversity. The variety of living forms, all having evolved from a common ancestor, is proof of diversity. The speedy horse is a good example of increasing efficiency--the present-day horse is a more efficient runner than his two-toed ancestor, and he in turn was faster than his three-, four-, and five-toed ancestors.

Finally, the human nervous system is an example par excellence of the tendency toward increasing complexity which characterizes successful species in nature.

This three-dimensional directional change is perfectly true of product innovation as well. Product improvements, and especially new products which replace older ones, are invariably characterized by greater sophistication in their form and manufacturing, greater efficiency in their performance, and greater diversity in their total offering to consumers. The car is just one example of this trend. But it is equally true for the simple ball-point pen or shaving blade, where simplicity may mask an increasingly sophisticated technology, greater convenience, and seemingly limitless variety.

The Phenomenon of Motivated Change

What keeps this exciting process ticking? Biologists identify two primary forces at work in nature. In the course of developing this evolutionary construct, we identified a third force which is playing an increasingly important role. We will call the first two the generative and selective forces and the third, the mediative force.

- The generative force is the genetic system, a fascinating development in nature which serves as a code for excellent copies of the parent, as well as a means of endless variety through crossing and a source of promising variations through genetic mutation--all of which are essential to provide ample opportunity for good selection.

- The environment serves as a selective force, favoring those variations better suited for survival and eliminating all others. These two forces working together over the millenia have accounted for the origin, growth, and extinction of species.

. But in the last thousand years or so, and especially in the last hundred years, a third factor, a mediative one, has entered the scene--Man. Human intervention is capable of engineering both natural selection and genetic mutation in order to eliminate unwanted species (e.g., disease-carrying pests), develop useful ones (e.g., corn, cattle), and control or "freeze" evolution of rare ones (e.g., zoo and park animals).

The application of the evolutionary concept to marketing reveals three similar forces at work. Managerial and entrepreneurial creativity serves as the generative factor; the market serves as the selective factor, determining what will and will not sell; and government and other agencies are increasingly playing the role of mediators.

The identification of these three factors as the motivating forces of product growth is central to the whole evolutionary approach. While many authors have stressed the importance of one or more of these factors as prime marketing variables, this essay considers these three factors not only as well-defined forces, each with a unique role, but as interdependent parts of a system. We suggest that this system is both necessary and sufficient to explain the entire process of product evolution in time. This point needs to be elaborated.

As a process, product growth must be generated. This role is played by managerial creativity, evidenced by the development of new products, product modifications, new product uses, and new promotion strategies. But growth itself would be chaotic and cancerous if it were not subjected to some limiting or selective influence. This is the role of market dynamics, personified by consumers who buy only what meets their needs and competitors who offer alternative choices. Managerial creativity and market dynamics are two forces in direct opposition, a situation which can easily turn into

unproductive conflict if there is not a third, or mediative, force to write the rules of the game and maintain order--the role of government and other mediative agencies.

The discussion so far has served to describe the what, whither, and how of the evolutionary process that products go through. An important question still remains. What are the characteristic patterns of evolution, or how might one distinguish its progress? What are the "stages" of the evolutionary process, if one might use the term? Such a discussion will also help us show how the PEC complements the PLC and helps solve some of the controversy about the latter. Let us revert to biology for a typology.

The Phenomenon of Patterned Change

In spite of the variety of evolutionary forces in nature and the extensive time during which it has been going on, it is possible to identify five distinct patterns of evolution (see Fig. 2):

1) Cladogenesis is the divergence of a new clad or species from an evolutionary line, triggered by some environmental stimulus; e.g., the evolution of the first land forms from sea forms.

2) Anagenesis is a pattern of adaptation by a species to its environment, characterized by increasing complexity and numbers of members of the species; e.g., the rapid increase in the numbers of early land forms and the development of better limbs for land movement.

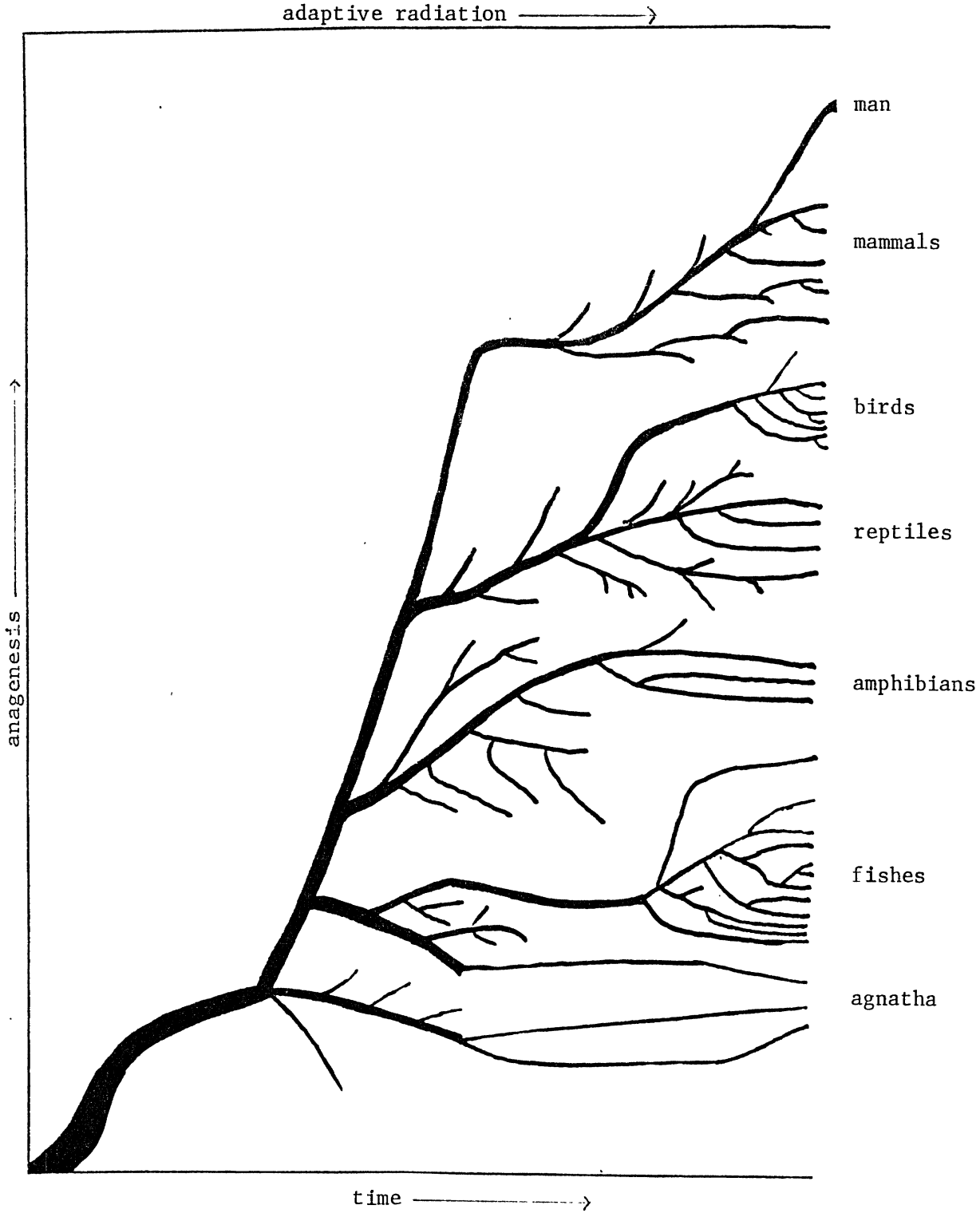
3) Adaptive Radiation refers to a period of abundant increase in numbers and variations among members of a particular species caused by a favorable environmental change. These variations lead to the formation of subspecies, each adapted to a particular niche in the environment. For example, once the early land forms developed wings and began to inhabit the skies, there was a rapid increase in the numbers and variations of these winged forms.

4) Stasigenesis is a term used to describe a period of stability or stagnation when there is not much change in the numbers or variation of a species; e.g., most mammals and reptiles today are representative of this pattern of evolution.

5) Extinction is the decrease in numbers and ultimate dying out of a species which can no longer cope with environmental change.

Figure 2

Evolution as a Patterned Process



Interpretation

- nodal points ≡ cladogenesis
- verticle branching ≡ anagenesis
- horizontal radial branching ≡ adaptive radiation
- unbranched horizontal lines ≡ stasigenesis
- branches which fall short of right vertical axis } ≡ extinction

It is important to note that, except for the first pattern which must precede all others and the last one which ends an evolutionary line, none of the patterns need occur in a fixed sequence or last for a fixed period of time. Thus anagenesis may follow adaptive radiation or cladogenesis and may last for a few decades or for a thousand years. The patterns are independent of each other and dependent only on environmental changes and the capacity of a species to adapt to these changes.

These patterns of evolutionary growth in biology provide us with an excellent typology with which to understand product diversification and growth, as well as a clue to solving some of the controversy about the PLC. If we think in terms of patterns of product growth instead of the PLC's stages, each of indeterminate length, each capable of preceding or following another, and each dependent not so much on the preceding one as on managements' ability to cope with market dynamics and mediative agencies, then we can suggest a typology based on the biological model (see Fig. 3):

1) Divergence (like cladogenesis) is the start of a new product. This term is suggested because most often a product is not an entirely new concept, divorced from all others in the marketplace, but a modification of existing products or a new combination of existing products and technologies. It is a divergence from a line of product evolution.

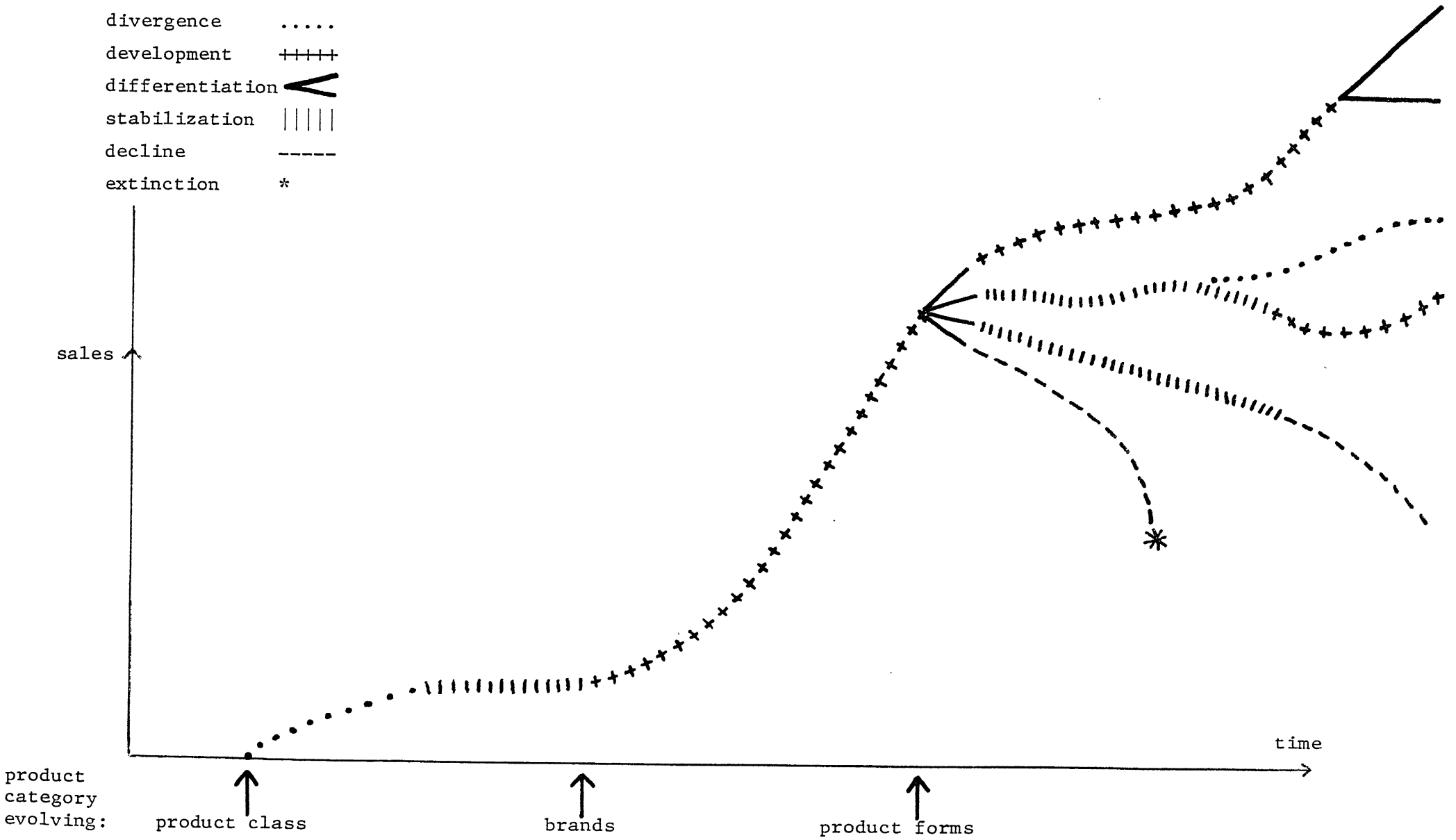
2) Development (like anagenesis) is that pattern of a new product's ascent where sales increase rapidly and the product is increasingly adapted to best suit consumer needs.

3) Differentiation (like adaptive radiation) is the growth pattern that occurs when a highly successful product in the marketplace results in very rapid sales increase and abundant product variation to suit newly emerging consumer interests. An example is calculators.

4) Stabilization (like stasigenesis) is a pattern characterized by few and minor changes in the basic product, but numerous changes in packaging, service deals, and product accessories, and stable or fluctuating sales. Most products exhibit this pattern of evolutionary growth, e.g., cars.

Figure 3

Representation of Hypothetical Product Growth Patterns



5) Decline occurs when a product decreasingly meets consumer expectations or can no longer satisfy changes in consumer demand. Sales decline and the product is ultimately discontinued.

These five patterns of change may appear similar to the stages of the PLC, but the similarity masks some differences which are crucial to this analogy and constitute the very heart of this essay.

PLC and PEC Contrasted

There are four essential differences between these two conceptualizations of product growth which need to be highlighted here: determinism, time dependence, role of management, and place of strategy.

Determinism

The PLC is a rigid deterministic model where the stages follow each other in a predetermined sequence. The PEC is a dynamic, basically open-ended phenomenon in which the patterns do not follow any fixed sequence, except for the first and last patterns which commence and conclude the process. It is thus indeterminate in shape but well-defined in terms of direction, motivation, and distinguishable patterns.

Time Dependence

The PLC assumes that each stage lasts for a certain predictable length of time, or, to put it differently, that sales are a function of time only. The PEC, on the other hand, assumes that sales are a function of three motivating forces and are not primarily time-dependent. The PEC makes the crucial distinction that while evolution proceeds within the dimension of time it is not a time-dependent process.

Role of Management

Because of the above assumptions, the PLC considers product growth to be a self-limiting process that must at some time result in decline and

death. In contrast, because the PEC assumes that managerial creativity is one of the three motivating forces of growth, the process is conceived to occur well within the realm of managerial influence. In effect, growth is limited only by management's ability to harness market dynamics and the efforts of mediative agencies.

The Place of Strategy

Most marketing authors use the PLC to elaborate various marketing strategies and generally propose that strategies should be tailored to fit the particular stage of the PLC (for example, Kotler 1980, Luck 1972, Smallwood 1973, Wasson 1974). By contrast, it is a basic premise of the PEC that strategic changes in response to market dynamics determine the pattern of growth, just as it is the response of a species to environmental change that will determine whether it will grow, proliferate, stagnate, or die.

Indeed, if one may pursue the analogy, there are four strategies of change adopted by species in nature: change of habitat, change of appearance, change of organ use and development of new organs. These strategies have their counterparts in marketing: change of market segment, change of promotion-theme or product image, change of product use, and change in product form or technology (see Fig. 4). The analogy illustrates the point that it is strategy that influences growth pattern or "stages," and not the other way around.

The Issues Resolved

Having developed the evolutionary concept of product growth and contrasted it with the PLC, we will now examine points of complementarity between the two concepts. In particular, we will investigate how the PEC helps resolve the four problems associated with the PLC and discussed at the outset of this paper (modelling, level of aggregation, validity, and applicability).

Figure 4

Strategic Alternatives: Biology and Marketing

TYPE	BIOLOGICAL VARIANT	MARKETING VARIANT
change of location	change of habitat (e.g. migration)	change of market segment
change of image	change of color, design (e.g. bright colors to attract mates)	change of promotion theme, image
change of function	adaptation of an organ for alternate purpose (e.g. elephant's trunk)	change of product use
change of form	development of new organs for new environments (e.g. limbs, lungs, wings)	development of new product form and technology

Level of Aggregation

The PLC is based on the life-death phenomenon as it relates to individual specimens in nature; in marketing, however, it has been applied at a higher level of aggregagation--that is, forms and classes of products. Strictly speaking, it would apply best at the corresponding level of product aggregation, i.e., the individual unit, which has a birth (manufacture), life (use), and death (discard) of its own (see Fig. 5A). This universal application of the PLC across varying and ill-defined levels of aggregation has contributed to the misunderstanding regarding the concept.

In nature, it is the evolutionary cycle which captures the phenomenon of growth and proliferation of species, genus, family, and class, and it is this concept which is suggested here as a complementary explanation of product growth at the levels of brand, form, and class (see Fig. 5B). The PLC would retain value as a framework for analysis in those cases where products follow a fairly predictable pattern of rapid rise followed by stagnation, eventual decline, and death. Fad and fashion products (e.g., the hula hoop) are examples of this phenomenon, but even here the application of the PLC would be most appropriate at the level of product form, rather than for any particular brand.

Modelling

As a theoretical model, the PLC represents an oversimplification of the product growth process. As a mathematical model it amounts to a tautology, as pointed out by Hunt (1976). In contrast, the PEC models product evolution as a function of market dynamics, managerial contribution, and government mediation. Each of these factors can be quantified in specific terms, using suitable surrogates (see Fig. 6), to develop a more sophisticated and plausible model for projecting product growth trends. As

Figure 5A

Comparative Models Used in Marketing and Biology

Marketing	Level of Aggregation	Individual Unit	Brand	Form	Class
	Model Used	None	PLC	PLC	PLC
Biology	Level of Aggregation	Individual Organism	Species	Genus	Family, Class
	Model Used	Life-Death	PEC	PEC	PEC

Figure 5B

Suggested Model for Marketing

Level of Aggregation	Individual Unit	Brand	Form	Class
Model Suggested	None	PEC	PEC,PLC	PEC

these factors are also more meaningful variables, and some of them are management-controlled, the whole model is more relevant for planning strategy. It thus overcomes Wind and Claycamp's (1976) criticism of the PLC as an oversimplification of the product-marketing process.

Validity and Applicability

Much of the controversy regarding the validity of the PLC revolves around the discrepancy between actual and theoretical sales curves, which is due to either:

--an unexpected sequence of stages, such as the successive growth spurts of nylon (Levitt 1965); or

--an unexpected time scale, such as the prolonged introductory or maturity stage of the microwave oven.

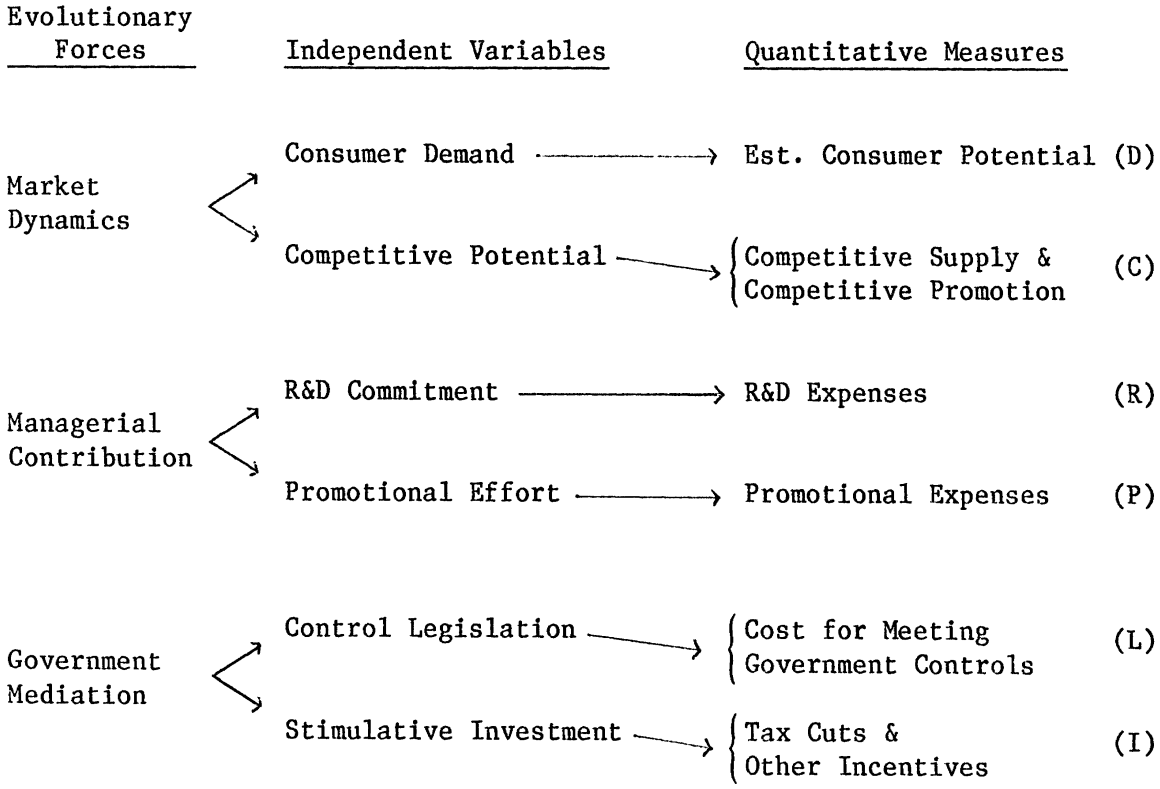
Neither of these creates a problem for the PEC because, as discussed earlier, the PEC patterns are not rigidly sequential and are not primarily time-dependent, but are the result of the interaction of the evolutionary forces of market dynamics, managerial creativity, and government mediation. Thus, the story of nylon is a good example of managerial creativity exploiting market potential, while the microwave is an example of a market situation stalling managerial efforts. The decline in new product introductions by the drug industry is an example of government controls stalling management's innovative efforts.

By shifting the emphasis from the identification of proper curves to the analysis of underlying forces and trends, the evolutionary concept resolves the controversy about the validity of the PLC as well as the distortion in managerial attention which results from it. Indeed, the testable model drawn up in Figure 5 not only appears logical but should not be difficult to validate empirically.

Figure 6

Testable Model Based on PEC

Assumption: product evolution is the result of an interplay of market dynamics, managerial contribution and government mediation.



Testable Hypothesis: Product sales is a function of D, C, R, P, L, I.

Any of the independent variables may be simplified or made more elaborate depending on their applicability.

The essential management task therefore boils down to determining what forces currently define the PEC pattern and how these might be influenced to alter that pattern to advantage. In the face of a sales decline or slowdown, certain key questions need to be addressed:

Is managerial conservatism causing lost opportunities?

Are demand swings responsible for lost sales?

Is government control leading to sluggish sales?

Addressing questions such as these would lead to an in-depth analysis, with subsequent guidelines for reform and rejuvenation. It would prevent product management from degenerating into management of "self-fulfilling prophecies," as the PLC is accused of inducing (Dhalla and Yuspeh 1976). The underlying premise in the PEC approach, of course, is that the product is not predetermined to obsolescence. Indeed, the death stage of the PLC need never be accepted as certain except when all other innovative modifications fail to provide a profitable alternative or in the special case of fad and fashion products.

Implications

The evolutionary approach holds important implications for three aspects of marketing strategy: brand perpetuation, holistic planning, and technological cross-fertilization.

Brand Perpetuation. The product which goes under the brand name of "Tide" has changed considerably since its first introduction. As a matter of fact, it is precisely those changes or adaptations to evolving consumer needs which are responsible for the product's survival and growth all these years. It is this realization which has prompted Proctor & Gamble to pursue a policy of never letting a brand die--so far as possible. It makes sense, especially since the brand name is often a valuable investment.

Holistic Planning. The PEC analysis lends itself to a comprehensive picture of product evolution which forces one to identify product origins and future trends. A car is not merely a Plymouth or a Honda, but a means of transportation--a means that has evolved from foot- and animal-drawn vehicles and will continue to evolve into winged, jet-powered, or other sophisticated forms. Further, all means of transportation are ultimately dependent on oil and ultimately substitutable by communications. What answer does a firm have to such a scenario, and what plans for the future? The PEC is undoubtedly a valuable backdrop for planning at the macro level and for longer horizons.

Technological Cross-Fertilization. A biological species is incapable of copying an adaptive breakthrough made by another species, but this is no limitation in business. Indeed, technological cross-fertilization, or the adoption of an outside technology to the redesign of an old product, is becoming an important source of product innovation in an increasingly complex technological era. The example of the watch industry is a case in point. By adapting electronics to watches, firms in Japan and Hong Kong were able to more than double their combined international market share in the four years after 1975, at the expense of the older and well-entrenched Swiss firms. In much the same spirit G.E. is getting ready to challenge the three auto giants, while AT&T is knocking at the door of the data processing industry.

Conclusion

The PLC is a handy tool for preliminary product and market analysis, widely used among practitioners and academicians. However, as a scientific model for in-depth analysis, the PLC has stirred up considerable controversy because of the theoretical, practical, empirical, and specification problems associated with the model. The root of the problem is that sales are modelled

merely as a function of time and are supposed to produce curves which are bell-shaped or some variation on bell-shaped.

In this paper, an evolutionary approach to product growth (PEC) is adopted to help resolve the controversy and to provide a complementary analytical framework. This approach assumes that products are in a state of constant evolution motivated by market dynamics, managerial creativity, and government intervention, and that the evolution proceeds in a direction of greater complexity, greater efficiency, and greater diversity. The evolutionary process consists of five well-defined patterns: product divergence, development, standardization, differentiation, and decline. On the basis of this approach, a testable model for analyzing and forecasting product growth is developed. The model assumes that sales are a function of market dynamics, managerial contribution, and government control and incentives.

Against the PEC framework, the PLC will continue to be a convenient framework for conducting and communicating certain market analyses, especially at the level of product form. It is particularly appropriate for product executives involved in the dayto-day management of products.

A major premise of the PEC is that the pattern of product growth is partly the result of the strategy adopted, and not the other way around. A key implication of this premise is that a brand is not necessarily predestined to mature and decline, but can be kept constantly in a growth phase by proper adaptation to the evolving market environment. Indeed, the PEC analysis presents a scenario of product growth in the context of competitive products and long-term trends which leads to integrated and holistic marketing planning.

References

Balachandran, V. and Subbash Jain (1972), "A Predictive Model for Monitoring Product Life Cycle," in Relevance in Marketing/Marketing in Motion, Fred Allvine, ed., Chicago: American Marketing Association.

Berenson, Conrad (1967), "The Purchasing Executive's Adaptation to the Product Life Cycle," Journal of Purchasing, 3 (May), 52-68.

Brockhoff, Klaus (1967), "A Test for the Product Life Cycle," Econometrica, 35 (July-October), 472-484.

Buzzell, Robert (1966), "Competitive Behavior and Product Life Cycles, in New Ideas for Successful Marketing, John Wright and Jac Goldstucker, eds., Chicago: American Marketing Association.

Catry, Bernard and Michel Chevalier (1974), "Market Share Strategy and the Product Life Cycle," Journal of Marketing, 38 (October), 29-34.

Cooke, Ernest F. and Ben C. Edmondson (1973), "Computer Aided Product Life Cycle Forecasts for New Product Investment Decisions," in Increasing Marketing Productivity and Conceptual and Methological Foundations of Marketing, Thomas Greer, ed., Chicago: American Marketing Association.

Cox, William E., Jr. (1967), "Product Life Cycles as Marketing Models," The Journal of Business, 40 (October), 375-384.

Cunningham, M. T. (1969), "The Application of Product Life Cycles to Corporate Strategy: Some Research Findings," British Journal of Marketing, 33 (Spring), 32-44.

Davidson, William R., Albert D. Bates and Stephen J. Bass (1976), "The Retail Life Cycle," Harvard Business Review, 54 (Nov.-Dec.), 89-96.

Dhalla, Nariman K. and Sonia Yuspeh (1976), "Forget the Product Life Cycle Concept!," Harvard Business Review, 54 (Jan.-Feb.), 102-112.

Dodge, H. Robert and David R. Rink (1978), "Phasing Sales Strategies and Tactics in Accordance With the Product Life Cycle Dimension Rather Than Calendar Periods," in Research Frontiers in Marketing: Dialogues and Directions, Subhash Jain, ed., Chicago: American Marketing Association.

Doyle, Peter (1976), "The Realities of the Product Life Cycle," Quarterly Review of Marketing, (Summer), 1-6.

Enis, Ben M., Raymond La Garce and Arthur E. Prell (1977), "Extending the Product Life Cycle," Business Horizons, 20 (June), 46-56.

Field, George A. (1971), "Do Products Really Have Life Cycles?," California Management Review, 14 (Fall), 92-95.

Fox, Harold (1973), "Product Life Cycle--An Aid to Financial Administration," Financial Executive, 41 (April), 28-34.

Hayes, Robert H. and Steven C. Wheelwright (1979a), "Link Manufacturing Process and Product Life Cycles," Harvard Business Review, 57 (Jan.-Feb.), 133-140.

_____ (1979b), "The Dynamics of Process-Product Life Cycles," Harvard Business Review, 57 (Mar.-Apr.), 127-136.

Hinkle, Joel (1966), Life Cycles, New York: Nielsen.

Hunt, Shelby D. (1976), Marketing Theory: Conceptual Foundations of Research in Marketing, Columbus, Ohio: Grid Inc.

Kluyver, Cornelis A. (1977), "Innovation and Industrial Product Life Cycles," California Management Review, 20 (Fall), 21-33.

Kotler, Phillip (1980), Marketing Management: Analysis Planning and Control, 4th ed., Englewood Cliffs, NJ: Prentice-Hall Inc.

Kovac, F. J. and M. F. Dague (1972), "Forecasting by Product Life Cycle Analysis," Research Management, 15 (July), 66-72.

Levitt, Theodore (1965), "Exploit the Product Life Cycle," Harvard Business Review, 43 (Nov.-Dec.), 81-94.

Luck, David J. (1972), Product Policy and Strategy, Englewood Cliffs, NJ: Prentice-Hall Inc.

Michael, George C. (1971), "Product Petrification: A New Stage in the Life Cycle Theory," California Management Review, 14 (Fall), 88-91.

Parsons, Leonard J. (1975), "The Product Life Cycle and Time Varying Advertising Elasticities," Journal of Marketing Research, 12 (Nov.), 476-80.

Patton, Arch (1959), "Stretch Your Product's Earning Years: Top Management's Stake in the Product Life Cycle," Management Review, 48 (June), 9-14, 67-79.

Polli, Rolando and Victor Cook (1969), "Validity of the Product Life Cycle," The Journal of Business, 42 (Oct.), 385-400.

Rink, David (1976), "The Product Life Cycle in Formulating Purchasing Strategy," Industrial Marketing Management, 5 (August), 231-242.

Savich, Richard S. and Laurence A. Thompson (1978), "Resource Allocation Within the Product Life Cycle," MSU Business Topics, 26 (Fall), 35-44.

Simon, Hermann (1979), "Dynamics of Price Elasticity and Brand Life Cycles: An Empirical Study," Journal of Marketing Research, 16 (Nov.), 439-52.

Smallwood, John E. (1973), "The Product Life Cycle: A Key to Strategic Marketing Planning, MSU Business Topics, 21 (Winter), 29-35.

Smith, Ward C. (1980), "Product Life Cycle Strategy: How to Stay on the Growth Curve," Management Review, 69 (Jan.), 8-13.

Staudt, Thomas et al. (1976), A Managerial Introduction to Marketing, Englewood Cliffs, N.J.: Prentice-Hall, Inc.

Wasson, Chester R. (1974), Dynamic Competitive Strategy and Product Life Cycles, St. Charles, Illinois: Challenge Books.

Wells, Louis T., Jr. (1969), "Test of Product Cycle Model of International Trade: M. D. Exports of Consumer Durables," Quarterly Journal of Economics, 83 (February), 152-62.

White, G. E. and P. F. Ostwald (1976), "Life Cycle Costing," Management Accounting, 54 (January), 39-40.

Wind, Yoram and Henry Claycamp (1976), "Planning Product Line Strategy: A Matrix Approach," Journal of Marketing, 40 (Jan.), 2-9.