An Evolutionary Approach to Product Growth Theory

Article *in* Journal of Marketing · October 1981

DOI: 10.2307/1251480 · Source: OAI

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Journal of Marketing, Vol. 45, No. 4 (Autumn, 1981), 125-132.

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Journal of Marketing is currently published by American Marketing Association.

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The continuing controversy about the product life cycle (PLC) concept may indicate that the concept, while useful, is inadequate to explain the entire phenomenon of product growth and proliferation. An alternative 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.

AN EVOLUTIONARY APPROACH TO PRODUCT GROWTH THEORY

Introduction

OVER the past two decades the product life cycle (PLC) concept has been increasingly used by business firms, as shown 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, Michael 1977, Staudt et al. 1976, Wasson 1974, to cite 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 1979a, 1979b). 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).

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The PLC Controversy

This proliferation has proceeded in spite of inconclusive evidence in support of the model and considerable doubt about its validity. Several authors have severely criticized the model, and these charges have not been fully addressed and answered. The controversy involves problems associated with the theoretical, practical, specification, and empirical aspects of the PLC, which are discussed below.

The Theoretical Issue of Modeling

The PLC is modeled 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 modeling system. The PLC omits the more relevant independent variables of competition, marketing effort, and other environmental factors that are

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more intelligible to practicing managers and are somewhat more within their control (Wind and Claycamp 1976).

The Practical Issue of Applicability

Many investigators agree that there is no faultless method of finding out where and when the PLC may be relevant. Dhalla and Yuspeh (1976) go a step further and claim that it is a dangerous tool in the hands of managers who, faced with an unsatisfactory sales picture, may commit a product to premature death or abort a promising innovation. The PLC in such cases becomes a self-fulfilling prophecy. 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; Patton 1959; 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 that fulfill the same want and are close substitutes for one another (e.g., cars, cigarettes). A review of the literature shows that authors generally feel that product forms bear the closest approximation to the PLC, individual brands are difficult to model, and patterns at the level of product class are less apparent because of the longer sales trends involved.

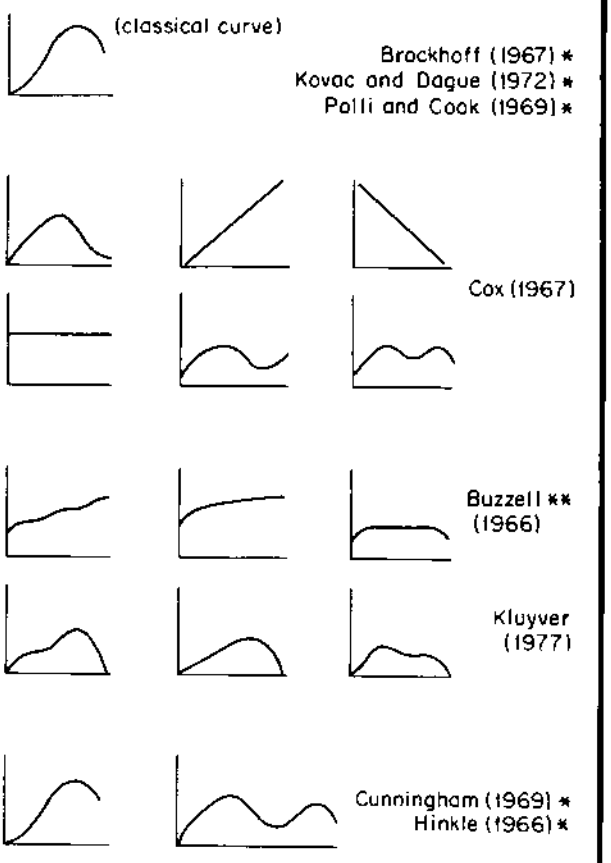
The Empirical Issue of Validation

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 12 published reports we reviewed, seven find evidence in support of the classical bell-shaped curve, but their results are by no means conclusive (Brockhoff 1967, Buzzell 1966, Cox 1967, Cunningham 1969, Hinkle 1966, Kovac and Dague 1972, Polli and Cook 1969). The remaining five studies found PLC curves of other shapes to be applicable (see Figure 1). In contrast, the analysis of Dhalla and Yuspeh (1976) indicated no PLC pattern to be significantly different from chance.

Summary

This discussion of the theoretical, practical, specification, and empirical problems highlights the weaknesses in the PLC as it is currently analyzed and used. Its limitations suggest that 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. Due to the incompleteness or partial truth of the concept in explaining the phenomenon of product proliferation, one will arrive at a different conclusion concerning the validity of the PLC, depending on which data one works with. Such a situation suggested the need for a broader framework that could explain more of the available data and provide a more stimulating framework for analysis. A return to the science that inspired the PLC—biology—was found to offer this alternative.

FIGURE 1
Empirically Tested PLC Curves



* Adapted
** Maturity stage only
Note: Vertical axis represents sales, horizontal axis represents time.

The Concept of Evolution

The PLC concept is based on the pattern of birth-growth-maturity-death, which is intrinsic to all bio-

logical specimens. But in biology the evolutionary cycle is used to explain the phenomenon of the growth and proliferation of species, groups of biological specimens that can breed within but not outside each group. Indeed, while the life-death cycle is a rigid, highly predictable one telling the story of each biological specimen (the individual horse, dog, etc.), the evolutionary cycle is a dynamic, open-ended one telling an even more exciting story of the origin, growth, and proliferation of entire species.

The term evolution has been used in marketing for many years, but only in a general sense of gradual, continuous change. Evolution is developed here as a scientifically rigorous construct. It designates gradual, continuous change that 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*, proceeding with greater complexity, efficiency, and diversity; and
- *patterned*, evidenced by five well-defined patterns.

Such a 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. It will, therefore, be useful to examine the application of these four attributes of evolution in biology and its relevance to marketing.

The Phenomenon of Cumulative Change

Though amazed at the wonderful adaptation of species to their environment, before the turn of the century biologists 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 no longer saw 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 that 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, we can trace a continuous line of history of the clothes washing machine 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 were cumulative, each building on the previous one to produce an improved version, much like that of species in nature.

The Phenomenon of Directed Change

The term directed is used here to mean a linear sequence of changes, not guidance or providence. In biological evolution this directed change is characterized by increasing diversity (e.g., see Leigh 1971), increasing efficiency or progress (Dobzhansky et al. 1977), and increasing complexity (e.g., see Ehrlich, Holm, and Parnell 1974).

The variety of living forms, all having evolved from a common ancestor, is illustrative 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, who was in turn faster than his three-, four-, and five-toed ancestors. The human nervous system is an example par excellence of the tendency toward increasing complexity that characterizes successful species in nature.

This three-dimensional direction change is applicable to product innovation as well. Product improvements, and especially new products that replace older ones, seem to be 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 an outstanding example of this trend, but so is the 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? Since the mid-twentieth century biologists have generally identified two primary forces at work. Today a third force 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*,

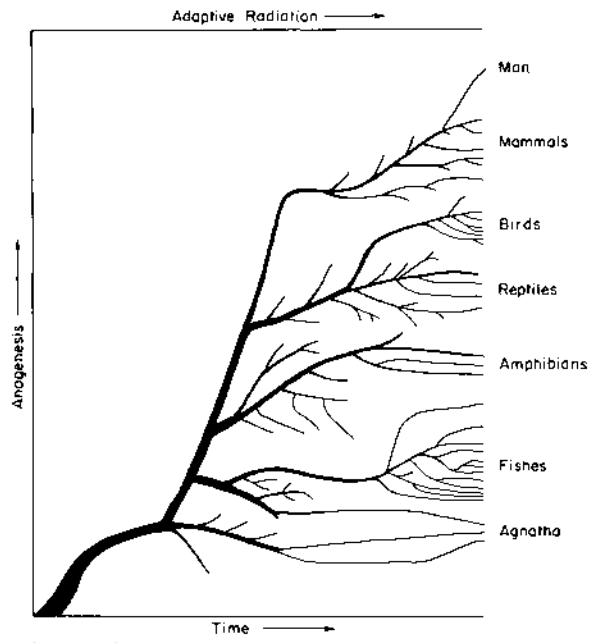
favoring those variations better suited for survival and eliminating all others. These two forces working together over the millenia have accounted for the origin, growth, and extinction of species.

- 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 has altered both natural selection and genetic mutation to eliminate unwanted species (e.g., disease carrying pests), to develop useful ones (e.g., corn, cattle), and to control or freeze the 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 consisting of consumers and competitors serves as the selective factor, determining what will and will not sell; and government and other agencies are increasingly playing the role of mediators.

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 motivate the process of product evolution in time.

FIGURE 2
Evolution as a Patterned Process



The Phenomenon of Patterned Change

The process of biological evolution as described here can be identified by five fairly distinct patterns, shown in Figure 2 (*Encyclopedia Brittanica* 1979):

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 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 increasing variations among members of a particular species, leading 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 number 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, most mammals and reptiles today are representative of this pattern of evolution.
5. Extinction is the dying out of a species that can no longer cope with environmental change.

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 not predetermined but are the result of evolution, which as stated before is driven by the combination of genetic variation and environmental selection (Dobzhansky et al. 1977, Futuyma 1979, Stansfield 1977).

These five 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 management's ability to cope with market dynamics and mediative agencies, then we can suggest a typology based on the biological model.

1. *Divergence* (like cladogenesis) is the start of a new product type (e.g., TV). This term is suggested because most often a product is not an entirely new concept but a modification or combination of existing products and technologies. It is a divergence from a line of product evolution. Thus TV may be considered an evolutionary divergence from the radio and the motion picture.
2. *Development* (like anagenesis) is the pattern where a new product's sales increase rapidly and the product is increasingly adapted to suit consumer needs best. Thus in the 50s, TV sales increased rapidly accompanied by frequent product improvements.
3. *Differentiation* (like adaptive radiation) is the pattern that occurs when a highly sucessful product is differentiated to suit varying consumer interests. More recently TVs are available as black and white, color, portable, and console sets, and variation has extended to CRTs, rear-projection screens, home computers, and videodiscs.
4. *Stabilization* (like stasigenesis) is a pattern characterized by few and minor changes in the product category, but numerous changes in packaging, service deals, product accessories, and stable or fluctuating sales. Black and white television was in stabilization for years prior to differentiation into portable sets and the other uses mentioned above.
5. *Demise* occurs when a product fails to meet consumer expectations or can no longer satisfy changes in consumer demand. Sales decline and the product is ultimately discontinued.

Some of the patterns of change may appear similar to stages of the PLC, but the similarity masks some differences that are crucial to this analogy.

PLC and PEC Contrasted

There are four essential differences between the PLC and the PEC that need to be highlighted here: determinism, time dependence, role of management, and place of strategy.

Determinism

The PLC is a deterministic model in that 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 the last ones. It is thus indeterminate in shape but well-defined in terms of the three motivating forces.

Time Dependence

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

Role of Management

The PLC considers product growth to be a self-limiting activity, which will at some time cease. In contrast, because the PEC assumes that managerial creativity is one of the three motivating forces of change, 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

Based on the PLC, most marketing authors propose that strategies be tailored to fit the particular stage of the PLC (for example, Luck 1972, Smallwood 1973, Wasson 1974). But the PEC holds 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, to pursue the analogy, there are four types of adaptation by species in nature: change of habitat, change of appearance, change of organ use, and development of new organs. These adaptations have their counterparts in marketing strategy: change of market segment, change of promotion-theme or product image, change of product use, and change in product form or technology. We should note, however, that while strategy in marketing is the result of conscious choice, patterns and typologies identified in biology are retrospective deductions made by man.

The Issues Resolved

Having developed the evolutionary concept of product growth and contrasted it with the PLC, we can investigate how the PEC helps resolve the four problems associated with the PLC discussed at the outset of this paper (level of aggregation, modeling, validity, and applicability).

Level of Aggregation

While the life-death phenomenon relates to individual specimens in nature, it is the evolutionary cycle that captures the phenomenon of growth and proliferation of species, genus, family, and class; this concept is suggested here as a complementary explanation of product growth at the levels of brand, form, and class. There may be some product histories where sales happen to follow the normal curve or PLC (e.g., fad and fashion products); these are special cases. Indeed, insofar as the PEC has been developed as a coherent construct to explain all cases of product growth, the PLC retains value only as a special case of the PEC.

Modeling

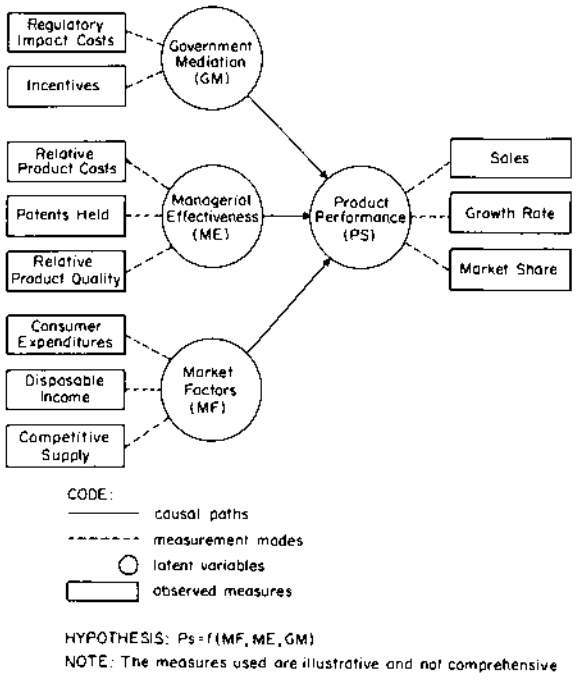
As a theoretical model, the PLC represents an oversimplification of the product growth process (Wind and Claycamp 1976). As a mathematical model it amounts to a tautology (Hunt 1976). In contrast the PEC models product evolution as a function of market dynamics, managerial creativity, and government mediation. Each of these factors can be quantified in specific terms, using suitable measures to develop a more sophisticated and plausible model for analyzing product growth (see Figure 3). Since these factors are more meaningful variables and some of them are management-controlled, the model is also more relevant for planning strategy. In addition, this approach to model building in marketing reinforces the importance of including competitive analysis, a factor that has gained more recognition recently (Hanssens 1980). The competitive dimension is incorporated partly by using relative measures of managerial effectiveness and partly by incorporating competitive supply into the demand construct. Finally, the inclusion of government influence in modeling is very relevant in the current business environment.

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 stage of the microwave oven. Neither of these creates a problem for the PEC because, as discussed earlier, the PEC patterns are neither rigidly sequential nor 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 frustrating 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 resulting from it. Indeed, the model drawn in Figure 3 is empirically testable, subject to further conceptual developments, especially regarding interrelationships among the independent variables. One such test is possible by the development of causal models with latent variables and multiple measures (Bagozzi 1980). The latter approach enables a rigorous

FIGURE 3
Hypothesized PEC Model



empirical test of a model, while retaining its theoretical meaningfulness and interpretability.

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. An in-depth analysis and model building along these lines is more likely to lead to useful guidelines for reform and rejuvenation than to unprofitable prescriptions for "death and burial." It would prevent product management from degenerating into management of self-fulfilling prophecies. 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 as in the special case of fad and fashion products.

Implications

The evolutionary approach holds important implications for many aspects of marketing strategy, three of which are discussed here: brand perpetuation, strategic planning, and technological cross-fertilization.

Brand Perpetuation

"Tide" has changed considerably since it was introduced. As a matter of fact, it is precisely those changes or adaptations to evolving consumer needs and ecological considerations that are responsible for the product's survival and growth, consistent with Proctor & Gamble's policy of never letting a brand die—insofar as possible. A brand name today is often a firm's most valuable asset, and the evolutionary concept is consistent with the perpetration of these asset values.

Strategic Planning

The PEC analysis lends itself to a comprehensive picture of product evolution, forcing one to identify product origins and future trends. A car is not merely an Escort 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 fuel and are ultimately substitutable by communications. What answer does a firm have to such a scenario, and what plans for the future? The PEC appears to be 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 is becoming an important source of product innovation in an increasingly complex technological era. 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 AT&T is knocking at the door of the data processing industry.

Conclusion

The PLC concept is 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 modeled primarily as a function of time and are expected to produce curves that display growth, levelling, and decline.

In this paper, an evolutionary approach to product growth is adopted to help resolve the controversy and to provide an encompassing 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 efficiency, greater complexity, and greater diversity. The evolutionary process consists of five well-defined patterns: product divergence, development, standardization, differentiation, and demise. On the basis of this approach, a testable model for analyzing product growth and planning strategies is proposed.

A major premise of the PEC is that product growth is partly the result of the strategy adopted and not the reverse. A key implication of this premise is that a brand is not predestined to mature and die but can be kept profitable by proper adaptation to the evolving market environment. Indeed, the PEC analysis presents a construct of product evolution that is consistent with integrated, strategic marketing planning.

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