MODELING STRATEGIC OPPORTUNITIES IN PRODUCT-MIX STRATEGY: A CUSTOMER- VERSUS PRODUCT-ORIENTED PERSPECTIVE

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ABSTRACT

There has been significant research appearing in the marketing literature regarding the importance of measuring customer lifetime value (CLV) and its consequence, customer equity (CE). One of the implications of taking a CE approach is an increased emphasis on product mix. Once marketers establish CE as a metric of success, they create incentives for managers to increase it by selling more products to the same customers. While the literature has addressed how these incentives might be incorporated into simulation games, it has not addressed how games should be structured to confront participants with strategic alternatives where the incentives are relevant. This paper addresses this situation, outlining critical product-mix conditions developers might incorporate into a game to provide players with meaningful strategic choices related to Rust, Zeithaml, and Lemon's (2000) "profitable product death spiral" paradigm.

INTRODUCTION

Recent developments in the areas of customer lifetime value (CLV) and customer equity (CE) have provided motivation for modeling product-mix decisions. On the surface, orienting oneself to the concept of CLV is simply a logical extension of conventional marketing. If marketing efforts are able to win customers for a company, what could be more logical than examining the value of these customers? However, conventional marketing measures success in terms of profit, generally breaking profit down by product and division. This is a legacy of the manufacturers' dominance of marketing. When companies begin breaking profit down by customer, including the discounted value of future sales, the conception of a product changes. They begin to think much more like retailers, where the "product" is the assortment of products and services that customers expect to find when they go shopping.

Perhaps the best way to illustrate the difference between the traditional profit-driven metric and CLV, or its composite effect, customer equity (CE), is through what Rust, Zeithaml, and Lemon (2000) characterize as the "profitable-product death spiral." It states that conventional companies often seek to measure profitability by product, using this as an index of benefit to both the company and the customer. As companies seek to be more and more profitable within increasingly-stringent budgetary constraints, they become more and more demanding of their product managers to deliver profitability. Managers drop the less profitable products, ignoring the fact that customers typically want an assortment of products, and that the deletion may weaken assortments that customers want. The resulting loss of sales weakens demand for previously profitable products, subsequently causing them to be dropped. This weakens the assortments even further, and so forth in a downward death spiral. By focusing on customer rather than product profitability, marketers look at the portfolios of products their customers want rather than disrupting portfolios for the sake of individual product profitability.

This paper will address the criteria for modeling those customer product-mix profiles and product cost conditions that lend themselves to strategic analysis of the profitable-product death spiral, and subsequently, to customer profitability as an ideal product mix decision criterion. Section 2 outlines the product-mix decision and conditions pertaining to the effectiveness of customer profitability as a criterion for product-mix decisions. Section 3 will provide a detailed discussion regarding customer loyalty and its relationship with product mix. Section 4 will provide a detailed discussion of the simulation input variables, alternative product-mix decision criteria, and demand and budget equations that underlie the strategic alternatives available from the game. Section 5 concludes with a summary of how the different conditions discussed in the paper will affect results for alternative decision strategies used by simulation game players.

SIMULATION MODEL – PRODUCT-MIX DECISION PROCESS (FIGURE 1)

The product-mix simulation model compares the long-term profitability of two different product-mix decision criteria given different levels of product co-dependence and different levels of fixed-cost leverage in the product cost structure. To illustrate, we will discuss a simulation, where the initial inputs include three customer segments, each with a primary product and secondary products in their desired portfolio (I_j). An initial level of demand is set based on the portfolios desired by each segment.

Co-dependence refers to product-mix interactions, where consumers desire assortments of products rather than individual items, thus causing demand for one item to enhance demand for another. Fixed-cost leverage refers to the shifting of variable to fixed costs, thus enabling a company to enjoy economies of scale by increasing volume with a relatively smaller increase in cost.

To illustrate our approach, imagine a simulated business management institute. The simulation provides players with six potentially complementary products (course modules). The demand for each of these will vary by the needs of the three segments (people from three different functional business areas). Each module has a cost structure comprised of contribution margin (CM_i) and fixed cost (FC_i), determined by the extent to which faculty are paid according to enrollment versus the number of modules taught. If faculty are paid according to enrollment, the school will have relatively low fixed-cost leverage, yielding lower CMs in return for a lower risk of losing money if the courses have low enrollment. Conversely, if faculty are paid

by the number of courses taught, the school will have relatively high fixed-cost leverage, yielding higher CMs, but a higher risk of losing money in the case of low enrollments.

As program managers, game players will be required to decide which of the modules (potential products) they will include in their curriculum (product mix) and whether to hire faculty based on enrollment of the number of modules taught. The product-mix decision is budget constrained, so players are limited in the number of fixed-cost-leveraged modules they can offer.

Overall demand for each of the courses is fixed by the needs of the market segments. However, customers can go to another supplier if they do not like the courses the players choose to offer. Sales, then, depend on customer satisfaction. In our simplified example, satisfaction is simply a function of whether the simulated institute offers the courses customers want to take. Again, because course module offerings are budget constrained, players may choose to limit offerings in hopes of exploiting fixed-cost leverage. Offering fewer, high-CM modules might prove more profitable than offering a larger number of low-CM modules.

From a managerial accounting perspective, the actual determination of profitability depends on the performance criterion the simulation participant chooses to use. The simulation will provide two different metrics to use as potential decision criteria – product versus customer profitability, as suggested in Figure 1.

The product-profitability metric calculates the profit contribution of each individual product, after subtracting any costs that can be uniquely attributed to the product being evaluated. By contrast, customer-based profit incorporates profit contribution across products attributable
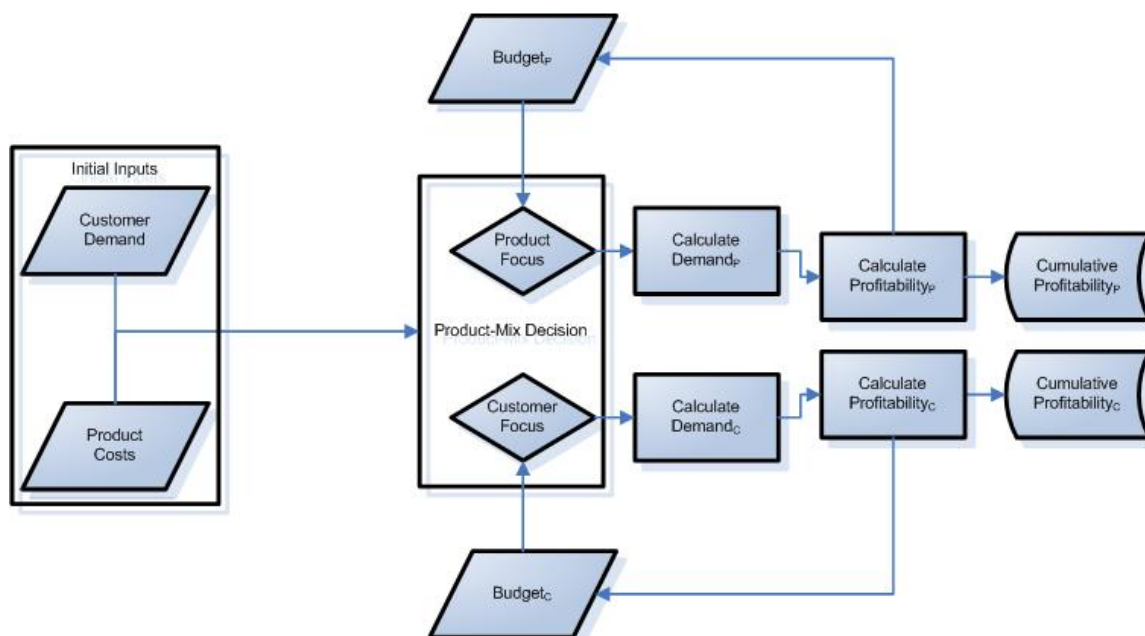
Figure 1
Simulation Model

Table 1
Simulation Conditions

Scenario	Product Codependence	Product Fixed Cost Leverage	Results
1	High	Low	R_1
2	High	High	R_2
3	Low	Low	R_5
4	Low	High	R_6

to individual customer segments, including changes in the estimated present value of future transactions (customer lifetime value). In the end, both of these measures are accumulated and adjusted for any unaccounted-for costs to provide an overall measure of profitability – the ultimate criterion for success in the simulation. The two metrics provide intermediate measures to help players manage their product mix to maximize overall profit.

As suggested in the above discussion, the purpose of this paper is to demonstrate how one might incorporate strategic scenarios into a simulated marketing environment where the participant's ability to select an appropriate product-mix strategy depends on the type of profitability metric he or she uses when making product-mix decisions. In order to maintain relative simplicity, the simulation will manipulate only a few levels of critical product-mix variables. Specifically, the simulation design varies two levels of product codependence and a decision between two levels of fixed cost leverage (fixed versus variable cost) in individual product cost conditions (see Table 1). This yields four possible combinations of product codependence/leverage conditions for each product. We will divide the products evenly between high and low product co-dependence, thus providing a full range of alternative conditions with which players may experiment. We will discuss the results in section 5.

QUANTITY DEMANDED AND PRODUCT-MIX

Earlier, we noted that demand is determined by the attractiveness of the products (course modules) available in the simulation to each of the three segments (functional business areas). This is divided among competing suppliers, depending on the attractiveness of the product mixes they offer. Assuming that there are no differences in other elements of the marketing mix among competitors, we can represent market share ($MS_{j,t}$) as a function of product-market fit, or, in our example, the attractiveness of the supplier's selection of courses to the various market segments. Using an adaptation of Cannon, Cannon, and Schwaiger (2005)'s approach to customer loyalty, this can be represented by equation (1).

$$MS_{j,t} = a\left[MS_{\min} + (MS_{\max} - MS_{\min}) \cdot \left(\frac{(\tilde{D}_j)^b}{c + (\tilde{D}_j)^b}\right)\right] + (1-a) \cdot MS_{j,t-1} \quad (1)$$

$$\tilde{D}_j = \left(\frac{D_j}{\overline{D}_j}\right) \quad (2)$$

Where

$MS_{j,t}$	=	the market share for segment j at time t
$MS_{\min}$	=	the minimum market share the company can be expected to achieve
$MS_{\max}$	=	the maximum market share the company can be expected to achieve
$\tilde{D}_j$	=	an index of relative product-mix fit in segment j
$\overline{D}_j$	=	a reference product-mix fit, against which the relative performance of the company would be compared in segment j (generally that of the next closest competitor)
D_j	=	the company's product-mix fit in segment j (a value between "0" and "1", where "1" represents a perfect fit)
A	=	a smoothing factor to account for customer "inertia" in withdrawing loyalty
B	=	a parameter determining the slope of the response curve (suggested $b=10$)
C	=	a parameter determining the shape of the response curve (suggested $c=1$)

The measure of the product-market fit variable (D_j) follows Teach's (1984, 1990) multi-attribute demand model. Following this logic, the relative attractiveness of the product/service portfolio a company offers can be expressed as a function of the Euclidean distance between the company's offering and the ideal established for a particular segment. In this context, a customer's desired portfolio becomes a kind of meta-product, where the desired products/services are analogous to the desired product attributes customers would look for in a conventional product. Again, following Teach's (1984, 1990) logic, the relative attractiveness of the company's product/service mix can be expressed as the distance between the company's offering and the ideal established for a particular segment. In the simplest conception, all competing products are assumed equal in quality. The model would include a dummy variable indicating whether a product or service is offered by the company. A meta-product would typically contain a core product (defining the product category and customer segment) with a value of "1" and ancillary

products/services having values of "0" or "1". In this conception, the use of nominal variables suggests that the more commonly used Euclidean distance measure would be replaced with a city block distance (see Anderberg 1973; Jobson 1992). Teach (1984) notes that the city-block is an acceptable method for measuring fit.

We must recognize that not all products will have equal value in the "ideal" portfolio. This reality can be incorporated into the calculation of fit by assigning an importance value, w_i, to weight each ideal-actual evaluation.

Equation (3) incorporates these concepts to create a distance measure whose value varies between "0" and "1," approaching "1" as the product-market fit gets better:

$$D_j = \frac{n_j - \sum_{i=1}^{n_j} w_{i,j}\left|I_{i,j} - d_i\right|}{n_j} \quad ; \sum_{i=1}^{n_j} w_{i,j} = 1 \quad (3)$$

Where

$I_{i,j}$ = the components of the ideal product portfolio for segment j, with "1" indicating that product i was included in the portfolio.

d_i = the components of the actual product portfolio, with "1" indicating that product i was included in the portfolio and "0" indicating that it was not

$w_{i,j}$ = A weighting factor (between "0" and "1") representing the importance of product i in segment j's ideal product portfolio

n_j = the total number of products included in the ideal portfolio for segment j.

Note that the calculation of D_j only considers those (n_j) products that are included in segment j's product portfolio.

Table 2
Input Parameters

Variable	Symbol	Simulation Criteria	Description
Ideal Product Portfolio	$I_{i,j}$	Vary across customers	This is the criteria which defines a customer (equation 3)
Product Weights	$w_{i,j}$	Vary across products and segments to for scenarios (3 levels)	This manipulation represents product codependence (equation 3)
# of products in Ideal Product Portfolio	n_j	Held constant ($n_j = 6$) for all customers	All customers are assumed to have some demand for all products (equations 3 and 7)
# of customer segments available	J	Held constant ($J = 3$)	Segments represent customer groups who are assumed to have the same ideal product portfolio (equations 5 and 6)
Product offering	d_i	A function of the product-mix decision	This is the output of the product-mix decision (equation 3)
Reference Product-mix fit	$\overline{D}_j$	Held constant (=1) across all levels	Not of interest as a variant in demand (equations 1 and 2)
Inertia Smoothing factor	a	Held constant (=0.9) across all levels	Not of interest as a variant in demand (equation 1)
Descriptor of customer response curve slope	b	Held constant (=10) across all levels	Not of interest as a variant in demand (equation 1)
Descriptor of customer response curve shape	c	Held constant (=1) across all levels	Not of interest as a variant in demand (equation 1)
Minimum Market Share	MS_{min}	Held constant (=0.2) across all levels	Not of interest as a variant in demand (equation 1)
Maximum Market Share	MS_{maz}	Held constant (=0.9) across all levels	Not of interest as a variant in demand (equation 1)
Budget in time t-1	B_{t-1}	Carried forward from t-1 to help determine budget in time t	Provides baseline budget from which new budgets are determined (equation 7)

This is a subset of a larger number (*n*) of products a company might include in its product mix. By considering only "ideal" products in equation (3), we are not penalizing a company for offering products that segment members do not want. Customers rarely object to a company offering too many products, but only to omitting products they want. The penalty for offering unwanted products comes from the costs associated with maintaining these products in the company's product mix. Indeed, it is the desire to avoid these costs that causes companies to fall prey to the profitable-product death spiral.

To summarize, equation (3) models the customer segment's desired product portfolio. The value of product-market fit (D_j) always falls between "0" and "1", where "1" is a perfect market fit. As the value of D_j falls, customers defect to other suppliers. The equations discussed in this section address the demand side of the firm's economic equation.

Cost functions will be described in the next section. Decreased demand due to poor product-mix fit combined with cost constraints motivates managers to trim unprofitable products, thus setting the stage for the "death-spiral" phenomenon if managers do not consider product-mix interactions.

INPUT VARIABLES, DEMAND CALCULATION, PRODUCT-MIX DECISION CRITERIA AND BUDGET CALCULATION

MARKET SHARE AND CUSTOMER LOYALTY INPUT VARIABLES

Section 3 discussed the parameters that influence market share, and by extension, the loyalty. that drives lifetime customer value. Table 2 describes the simulation input parameters that condition customer market share/loyalty. Note that only one parameter is varied across strategic scenarios -- the product weights within a customer's ideal product portfolio.

DEMAND

Equation (4) develops a demand equation, drawing on basic market demand, adjusted b market share/loyalty from equation (1). Again, the quantity demanded is equal to basic underlying demand, adjusted by market share.

$$Q_{j,t} = Q_{j,t-1}MS_{j,t-1} \qquad (4)$$

where

$Q_{j,t}$ = represents the unit quantity demanded per customer *j* at time *t*,

$MS_{j,t}$ = represents customer loyalty as described in equation 1 above,

PRODUCT-MIX DECISION CRITERIA

As discussed above, the objective of the simulation is to expose players to the strategic consequences of using two different product-mix decision criterion across different market conditions. The first criterion selects products by ranking each product by its individual product profitability (illustrated by π_i in equation 5). The second selects products by ranking each customer segment by its profitability (illustrated by equation 6) and then selecting the primary products desired by the most profitable segments.

Product Profitability: $\pi_i = \sum_{j=1}^{J} Q_{i,j}CM_i - FC_i \qquad (5)$

where

π_i = profits associated with product *i*

J = index representing each of *J* customers

I = index representing each of *I* products

$Q_{i,j}$ = unit quantity of product *i* demanded by customer *j*

CM_i = represents the unit contribution margin for product *i*

FC_i = fixed costs for product *i*

Customer Profitability:

$$\pi_j = \sum_{i=1}^{n_t} Q_{i,j}\left(CM_i - FC_i \bigg/ \sum_{j=1}^{J} Q_{i,j} \right) \qquad (6)$$

where

π_j = profits associated with customer *j*

J = index representing each of *J* customer segments

I = index representing each of *I* products

$Q_{i,j}$ = unit quantity of product *i* demanded by customer *j*

CM_i = represents the unit contribution margin for product *i*

FC_i = fixed costs for product *i*

In order to address the budget constraint, products associated with the ranked profitability measures for each of the two product criteria are included until the budget is depleted. Equation (7) illustrates a method for calculating the budget constraint. It matches actual profit performance ($\pi_{i,t}$) for each of *I* products (in our case, six course modules) in time *t* against target profit (π^*). Subsequent period budgets increase (decrease) when profits exceed (are less than) target expectations (π^*). This budget calculation process provides incentives to maximize profit in the present period in order to have greater budget allotments in future periods (maximizing cumulative profit over the life of the simulation).

Budget: $B_t = B_{t-1} \dfrac{\sum\limits_{i=1}^{n_t} \pi_{i,t-1}}{n_{t-1}\pi^*} \qquad (7)$

Where

B_t = Budget in time t,

$\pi_{i,t}$ = profits associated with product i in time t,

Π^* = represents a target level of profit expected of each product,

n_t = the number of products selected in time t,

The budget must cover all fixed product costs. The game players must decide the level of fixed-cost leverage – either primarily fixed cost or primarily variable cost. Fixed costs remain constant throughout the simulation life. For simplicity, we assume that variable costs are covered by current revenue (implying a fast enough turnover to provide the working capital needed to maintain production).

DISCUSSION OF CONCEPTS LEARNED

The consequences of players' decisions are easy to see in extreme cases, as suggested in Figure 2. If they choose a variable-cost strategy (cells 2 and 4), profit will be relatively low because of the low margins, even though they are able to provide a full range of products to their clients. The fact that they are able to provide a full range of products means that their strategy will meet the demands of co-dependence in every case, and there will be no difference between

product and customer profitability. This is apparent in equations (5) and (6). When a company offers a full line of products, it addresses the requirements of every segment's ideal product portfolio, offering a perfect product-market fit. This maximizes quantity demanded, and, assuming that the company was able to forecast capacity needs accurately, it enables the company to allocate all of its fixed costs across customer segments, causing them to drop out of the equation.

Of course, in the real world, life is seldom so easy. We can simulate this by establishing the target profit (π^*) high enough that it cannot be achieved without fixed-cost leverage. Fixed costs quickly eat into the budget constraint, forcing players to drop the least profitable products. If these are products with low levels of co-dependence (cell 3), there will still be no difference between product- and customer-profitability measures. While products carry high fixed costs, these will be fully allocated across segments, because the lack of co-dependence means customers will buy then on their individual merits, regardless of whatever other products the company does or does not carry.

Again, life is seldom easy enough to give marketers such a comfortable situation, especially in an era of relationship marketing, where company profits depend on effective "cross-selling". This leads to cell 1. Here product- and customer-profitability measures do differ. For instance, returning to our example of a business management

Figure 2
Consequences of Four Prototypical Market/Cost-Structure Conditions

Fixed-Cost Leverage

		High	**Low**
Product Co-Dependence	**High**	High margins, low volume. Product-profitability and customer-profitability measures differ because less profitable products may be co-dependent with more profitable ones. (1)	Low margins, high volume. No difference between product-profitability and customer-profitability measures because company is able to provide a full range of desired products. (2)
	Low	High margins, low volume. No difference between product-profitability and customer-profitability measures because customers evaluate products independently of each other. (3)	Low margins, high volume. No difference between product-profitability and customer-profitability measures because customers evaluate products independently of each other. (4)

institute, suppose the most profitable course module were "Effective Organizational Leadership" and one of the least profitable were "Managing Diversity". However, many people who enrolled in "Effective Organizational Leadership" also want "Managing Diversity". According to the product-profitability criterion, players would invest in "Effective Organizational Leadership" and drop "Managing Diversity" from the curriculum. According to the customer-profitability criterion, players would include "Managing Diversity" in the curriculum, because dropping it would decrease the product-market fit (D_j) for many of the customers. According to equation (1), this would decrease market share, thus reducing demand for "Effective Organizational Leadership", making it less attractive by the product-profitability criterion. If it is dropped, this would reduce demand for other co-dependent products. And so forth.

The sequence we have just described is what Rust, Zeithaml, and Lemon (2000) call the "profitable product death spiral". Figure 3 illustrates the traditional product-profitability criterion applied to "cell 1" conditions. Players delete the least profitable products in order to meet their budget constraints and maximize return on investment. Figure 4 illustrates the death spiral. By eliminating unprofitable products that are co-dependent with popular ones, demand falls for the popular products, until they too are dropped in order to maximize return on investment. This weakens other profitable products until they all die for lack of demand.

The consequence of the "profitable product death spiral" is that using the product-profitability criterion actually decreases profitability in the long run. Given that the ultimate criterion for success is total profit, measured across all products and customer segments, the death spiral means death for players' success as well.

Figure 5 illustrates the decision-making approach players would take if they were to apply a customer-profitability criterion. Instead of dropping the least profitable products, they would look for the most profitable segments and select the products they demand.

From the perspective of simulation game design, we would like to expose players to the "profitable product death spiral" phenomenon. This suggests that we should not only establish target profits that force students to invest in fixed-cost-leveraged products, but also include a large enough number of co-dependent products to force students to grapple with the need to look at the customer equity as a product-mix decision tool.

Figure 3
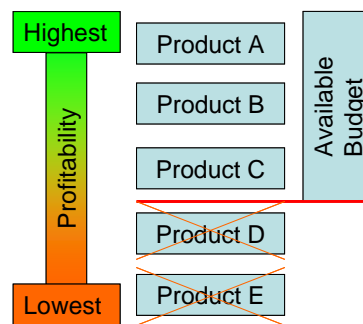**Application of the Product-Profitability Criterion to "Cell 1" Situations**

Figure 4
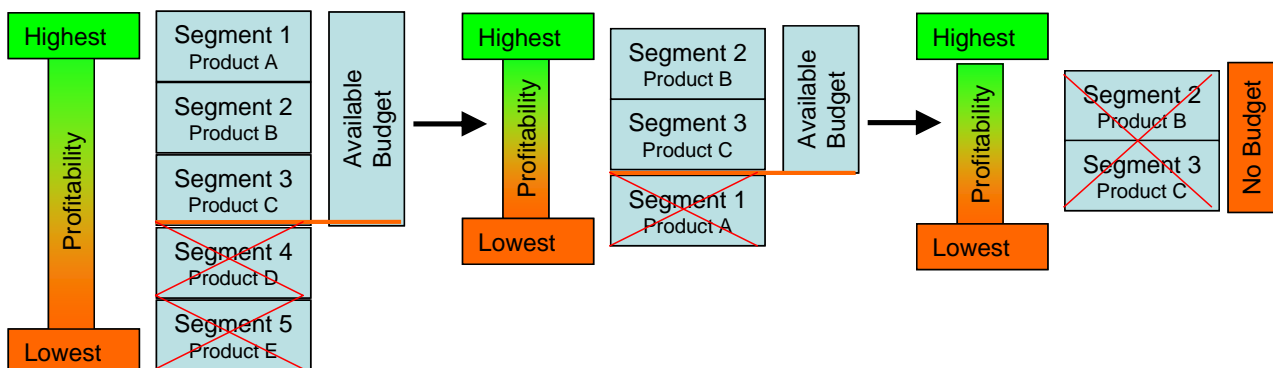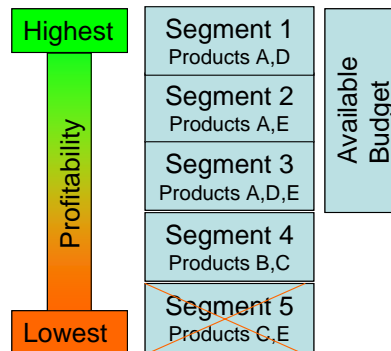**The "Profitable Product Death Spiral" Sequence**

Figure 5
Application of the Customer-Profitability Criterion to "Cell 1" Situations

REFERENCES

Anderberg, Mr. R. (1973). *Cluster Analysis for Applications.* Academic Press: New York.

Cannon, H. M., J. N. Cannon, and M. Schwaiger. "Simulating Customer lifetime value: Implications for Game Design and Student Performance," *Developments in Business Simulation and Experiential Learning,* vol. 32 (March 2005), (Reprinted in *The Bernie Keys Library*, available at http://www.absel.org).

Jobson, J. D. (1992). *Applied Multivariate Data Analysis, Volume 2: Categorical and Multivariate Methods.* Springer: Berlin.

Rust, Roland T., Valarie A Zeithaml, Katherine N Lemon (2000). *Driving customer equity: How customer lifetime value is reshaping corporate strategy.* New York: The Free Press.

Teach, Richard D. (1984). "Using Spacial Relationships to Estimate Demand in Business Simulations." *Developments in Simulation and Experience Learning*, 11, 244-246. Reprinted in The Bernie Keys Library, 5th edition [Available from http://ABSEL.org]

Teach, Richard D. (1990). "Demand Equations which Include Product Attributes." *Developments in Simulation and Experience Learning*, 17, 161-166. Reprinted in The Bernie Keys Library, 5th edition [Available from http://ABSEL.org]