

# **Brand Management Facilitation: A System Dynamics Approach for Decision Makers**

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## **ABSTRACT**

A well-managed brand represents a major asset for many consumer product companies. Whether it is Coke® or Kleenex®, consumers are willing to pay a premium price for established brands because of the perception of quality and the life style that the brand conveys. Building and sustaining a brand is an expensive, complex, and challenging task for a brand manager. While there are existing models and processes for this purpose, most are based on mental models, as well as the tacit knowledge that successful brand managers have acquired through experience and practice. While tacit knowledge is extremely difficult to elicit, making it explicit in a system dynamics model could dramatically improve the brand management decision-making process. It would permit the testing of the complex mix of assumptions that underlie brand strategy and provide decision makers with the ability to explore various scenarios, policies, and decisions. The paper presents a system dynamics model of the brand management process for fast-moving consumer goods. It makes explicit the normal mental models of brand managers and combines the dynamic forces of markets into the decision-making process. The paper concludes with a demonstration of a brand policy implementation and its effects on a brand.

## **KEYWORDS**

Marketing, Brands, Brand Management, Brand Equity, Brand Awareness, Brand Loyalty, Product Quality, Decision Making

## **INTRODUCTION**

To the average consumer on Main Street, the term “product” and “brand” are often used interchangeably. However, on Wall Street and Madison Avenue, the terms are used quite differently. A product is something that offers a functional benefit, it is produced in a factory. A brand, on the other hand, is a name, symbol, design, or mark that enhances the value of the product beyond its functional value (Farquhar, 1989). David Ogilvy, the founder of the advertising agency Ogilvy & Mather, defines a brand as:

“A complex symbol. It is the intangible sum of a product’s attributes, its name, packaging, and price. Its history, reputation, and the way it’s advertised. A brand is also defined by consumers’ impressions of the people who use it, as well as their own experience.”

The purpose of this paper is to produce a conceptual model of the brand equity process from the management perspective. It is suggested that with proper analysis of such a model, a brand manager will be able to make better judgments and decisions. Currently, brand managers work through the complexities of brand equity only with mental models. It is suggested that the development of a system dynamics model will enhance the decision-making process of brand managers.

## **PROBLEM FOCUS: BRAND MANAGEMENT**

A brand represents a major benefit for many service or consumer companies. However, the process of building and sustaining a brand is highly complex and unstructured. While there are existing models and processes for building brands, most of them are based upon mental models and tacit knowledge, which are not easily elicited and as a result difficult to understand and communicate.

A brand consists of a set of assets and liabilities linked to a brand’s name and symbol. These assets are summarized as brand equity. Thus, the management of brand equity involves investments to create and enhance those assets. Each brand equity asset creates value in a variety of ways. For example, brand equity creates value for the customer as well as for a firm. The intrinsic value of a brand for a firm can be quantified not only in dollars, but also as part of the firm’s intangible asset value.

The problem for decision makers is to decide upon advertising objectives and programs, within the context of the total marketing and communication scheme. Their main tasks include the selection and definition of the target audience, setting of the advertising objectives, determining budget priorities, and assessing the composition of the different communication tools, needed to achieve the best possible positive impact in terms of effectiveness and efficiency. The decisions that are made by the brand manager may be more or less rational; depending upon a number of factors, including the organizational setting, the decision-maker’s insight into brand management, the information at hand, and the resources available.

To make rational decisions, the brand manager needs a lot of information, which is required to reduce the uncertainty concerning the outcome of the brand strategy. However, in real life, there are numerous examples of limited and insufficient information searches in connection with brand decisions – even when possible failures may have serious consequences. An insufficient information search can lead to the use of mental models, which employs operating procedures that have evolved out of experience. The findings of a recent study (Lynch & Hooley, 1990) demonstrate that advertising decisions are impeded with great loads of uncertainty.

Decisions concerning brands and brand building are affected by three factors: 1) the role of the decision maker, 2) the availability of information, and 3) time. Therefore, mental models play an important role, and they have certain advantages over more explicit approaches. One such advantage is that they take into account a wide range of qualitative and quantitative information (Stermann, 1991). On the other hand, these models also have drawbacks. First, they are not easily understood because the interpretation of the model is based on the experience and role of the decision maker. Second, the assumptions, on which the mental models are based, are usually difficult to examine, so ambiguities and contradictions within them often go undetected, unchallenged, and unresolved (Stermann, 1991). Managing brands in today's competitive environment is a complex and challenging task for a decision maker – time pressure, incomplete information, organizational context, and selfish motivation can strongly influence a decision. As a result, many decisions are made incorrectly. Additionally, the implications of a desired brand strategy cannot be known with any degree of certainty at the time a decision is made.

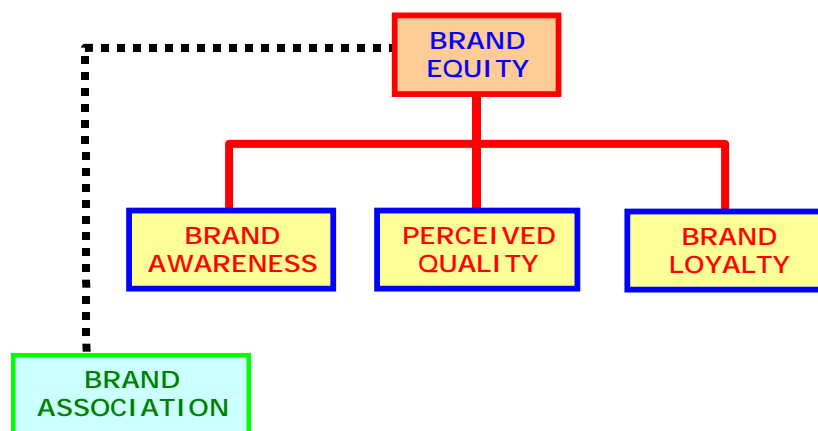
Making the mental models of successful decision makers explicit would improve the decision-making processes associated with brand management. It would permit the testing of a mixture of assumptions combined with the ability to explore the consequences of various scenarios and decisions. In order to do this, there needs to be a means of modeling the complex heuristic mental models as well as a way of explaining the interaction among decision variables – in other words, computer based modeling techniques need to be considered.

Simulation methods are believed to improve management education by virtue of their ability to enhance learning through experience (Stermann, 2000). Simulation modeling involves testing ideas by conducting “what-if” analyses. In each scenario, inputs are altered and output parameters are observed at the end of the simulation run. Having the ability to predict the impacts of different strategies, it is suggested that simulation modeling provides more transparency and comfort in decision making. This paper proposes that the integration and use of simulation models in brand management can have a profound positive impact on the effectiveness of strategic decision making.

## PROBLEM DYNAMICS IN BRAND EQUITY

Managing brand equity involves decision making in various dimensions in order to create or sustain an active presence of a brand in a given market. Figure 1 illustrates brand equity and its components.

*Figure 1 – Components of Brand Equity*



**Brand awareness.** Aaker (1991) suggests that brand awareness is important because people will often select a recognized brand over an unknown brand. High brand awareness can be a signal of quality and commitment to help a buyer consider the brand at the point of purchase, which leads to favorable behavior for the brand.

**Brand loyalty.** Oliver (1997) defines brand loyalty as "a deeply held commitment to rebuy or repatronize a preferred product or service consistently in the future, despite situational influences and marketing efforts having the potential to cause switching behavior" (p. 392). Loyal consumers show more favorable responses to a brand than nonloyal or switching consumers do (Grover, 1992). Brand loyalty makes consumers purchase a brand routinely and resist switching to another brand. Hence, to the extent that consumers are loyal to the brand, brand equity will increase.

**Perceived quality.** Zeithaml (1988) defines perceived quality as "the consumer's [subjective] judgment about a product's overall excellence or superiority" (p. 3). Personal product experiences, unique needs, and consumption situations may influence the consumer's subjective judgement of quality. High perceived quality means that, through the long-term experience related to the brand, consumers recognize the difference and superiority of the brand. Zeithaml identifies perceived quality as a component of brand value; therefore, high perceived quality would drive a consumer to choose the brand rather than a competing brand. Therefore, to the degree that brand quality is perceived by consumers, brand equity will increase. While brand management is a complex and unstructured process, the underlying assumption is that most decisions are related to the previously discussed brand equity dimensions.

**Brand association.** Brand association, although not a direct component of brand equity, is important to understand. In an advertising campaign, brand associations might include: Product attributes, a celebrity spokesperson, or a particular symbol. Brand associations are driven by the brand identity – what the brand should stand for in the consumer's mind.

## CONTEXT

The proposed simulation model will be designed in the context of fast-moving consumer goods corporations, as well as from the standpoint of a marketing or advertising agency. Companies regard a brand to be an intangible asset thus creating an identifiable economic earnings stream. Firms that are good at developing strong brands usually have a strong brand-building culture; they have defined values, norms, and organizational symbols. Brand building is accepted in firms where top management visibly supports the brands, and better yet, they take evasive actions when brands are at risk. It is suggested that in such a context, the inclination to use a simulation model will be high.

## AUDIENCE

The model is aimed at managers who have responsibilities for a brand. These managers work in marketing departments, or in advertising or consulting companies. Brand managers have strategic and tactical responsibilities for their brand that include identity and position, maintaining that identity by securing needed investments, and making sure that all media efforts are consistent with the identity. A broader target audience would include general management, where the model will be used to support managers when presenting brand specific strategic recommendations.

## MODEL PURPOSE

The purpose of the model is to simulate generic brand dynamics, which can be found in fast-moving consumer markets. Simulating the dynamics of service brands, or investment goods, would certainly look and behave differently than the model described in this paper. It is suggested however, that the integration of simulation models in brand management can have a profound impact on the effectiveness of strategic decisions.

## MODELING STRUCTURE

**Problem definition.** Key questions that are addressed in this paper are:

- I. How does brand awareness, perceived quality, brand loyalty, and the desire to buy a brand change, with respect to various strategy implementations?
- II. What insights does the model provide?

With regard to the first question, the proposed model, should be able to predict changes in the different brand sectors. For example, a change in the amount of money available for brand communication, or a change in the communication strategy, (e.g. using a different communication mix of direct marketing versus classical advertising TV commercials, magazine ads, or billboards).

With regard to the second question, the model should provide the brand manager with insights concerning the effect of different strategies that he or she would not be able to see.

**Model objective.** The proposed model will simulate brand dynamics for a sector of the generic fast-moving consumer goods that are in their early stages of development. It is proposed that the model will help improve decision making and reduce the size and scope of complexity in managing a given brand.

## CONCEPTUAL DESCRIPTION

**Identifying Key Variables.** The following description suggests several key variables, conceptualizing the basic feedback structure of the model:

***Investment rate:*** The capital a company is investing to manage its brand.

***Investment in “Above-the-line”:*** A percentage of total investment a brand manager would invest in traditional advertising media, e.g. TV commercials, billboard, and magazine or newspaper ads.

***Investment in “Below-the line”:*** A percentage of total investment, which is used for direct marketing activities (direct mails, telephone marketing, banner ads).

***Investment in “Price Promotion”:*** A percentage of total investment for promoting price reductions, through coupons, in-store promotions, and give-aways.

***Investment in “Public Relations”:*** A percentage of total investment for public relation activities, e.g. press conference, news releases, and internal or external newsletters.

***Competitive pressure:*** Measures how much a direct competitor is investing in its marketing campaign.

***Effectiveness:*** Measures the performance of the brand campaign against total spending of the category.

***Brand awareness:*** The awareness that reflects the presence of the brand in the mind of customers (0 – 100 scale). Initial values will be taken from market research.

***Perceived quality:*** A rate that involves a product frame of reference, reflecting the actual quality of product (0 – 1 scale).

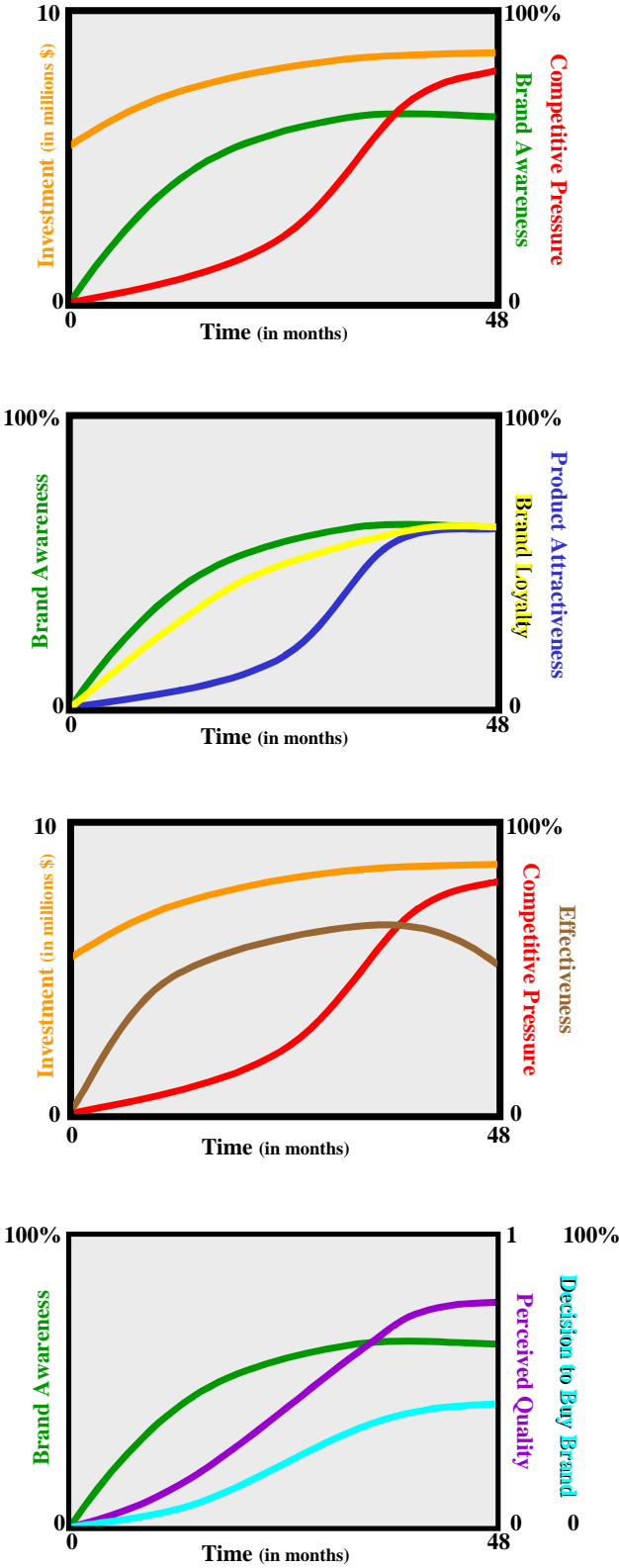
***Product attractiveness:*** Measure the price-value (quality) relation of a product (0 – 1 scale). The product attractiveness sector is taken from Vensim Molecule, and represents Jim Hines conceptual model of product attractiveness.

***Brand loyalty:*** A measure that reflects the level of loyalty from a consumer to a particular brand (0 – 100 scale). Initial values will be taken from market research.

***Desire to buy brand:*** A value which reflects the desire of consumers to buy the particular brand (0 – 100 scale).

The reference modes for key variables are shown below in Figure 2.

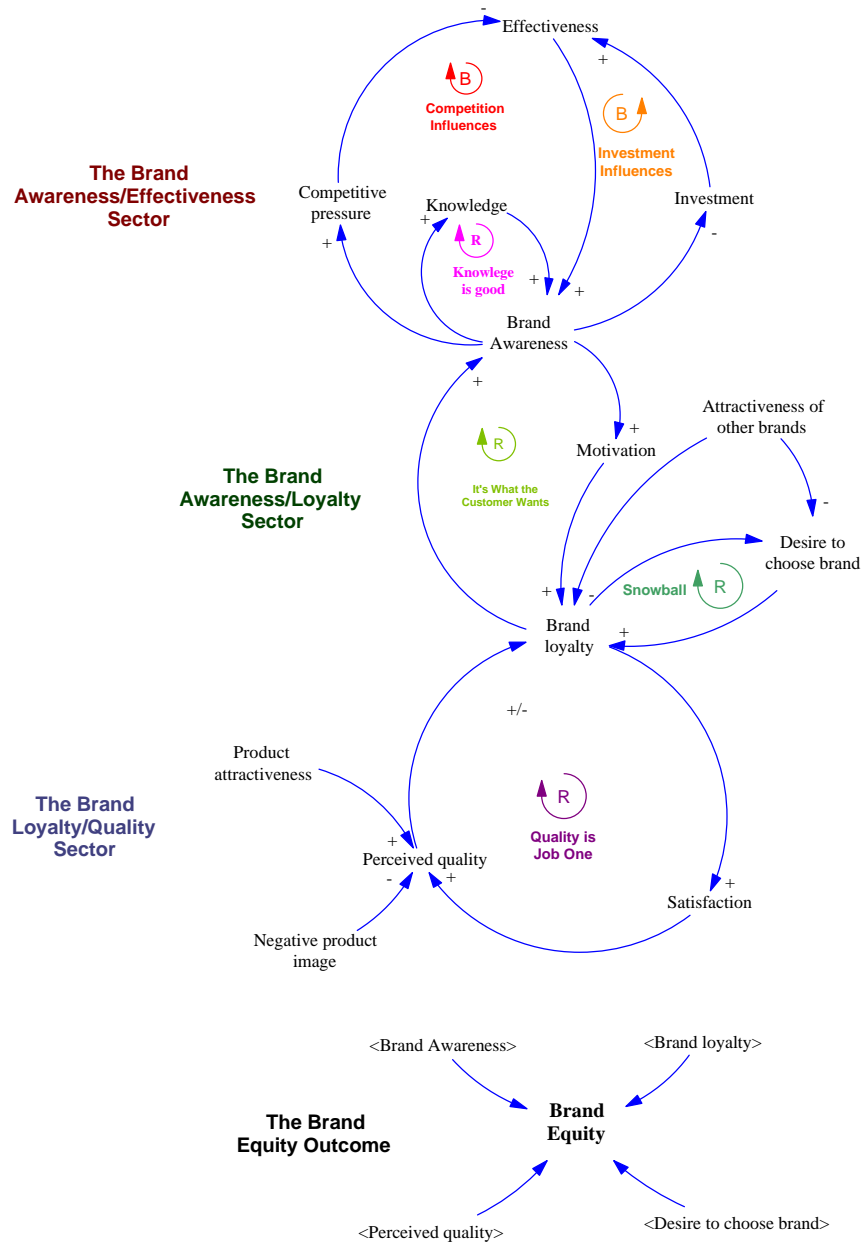
Figure 2 – Reference Modes for Brand Management



# CAUSAL DIAGRAM

The following diagram represents the three sectors of basic causal feedback structure of the model.

*Figure 3 – Facilitating Brand Management: A Sector Overview*

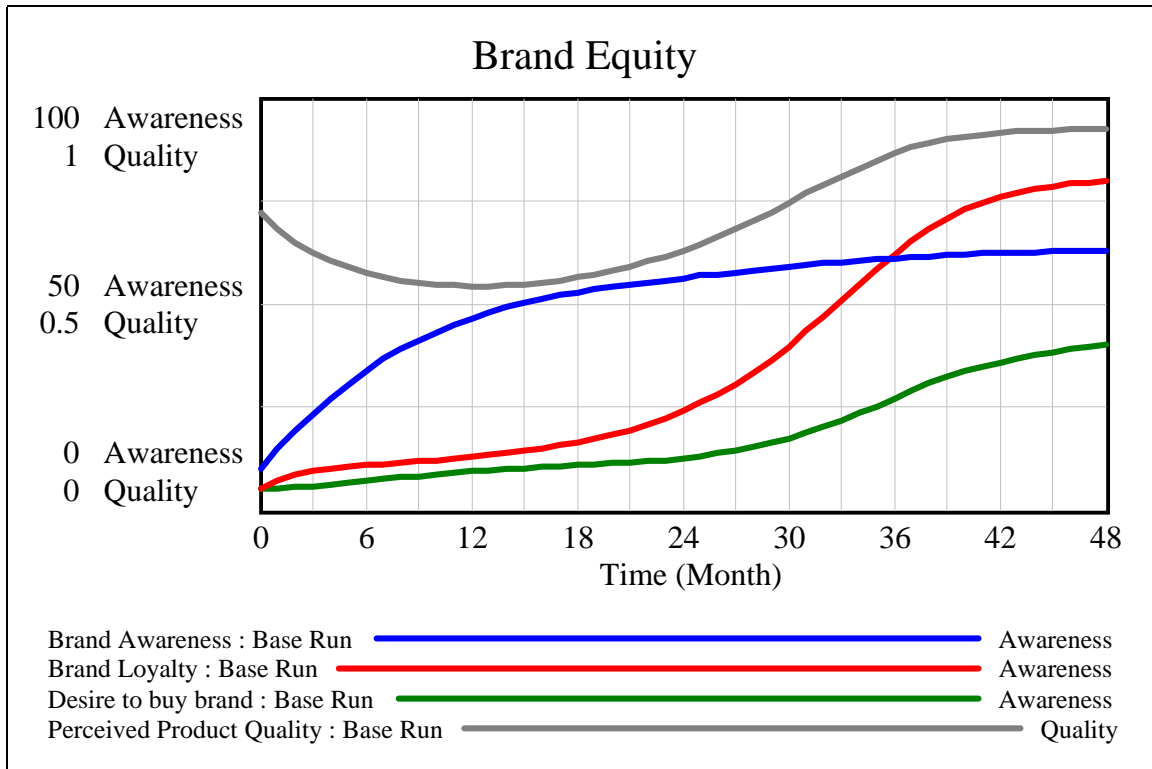




## MODEL BEHAVIOR

The first policy simulation is based on the following input: A launch of a new consumer good with an initial investment of \$50,000 per time step (i.e. total spending for 48 months is \$2.4 million). In the model this value is captured with 50 units of dollars. The strategy is to assign 65 percent for “Above-the-Line” (indirect marketing), 15 percent for “Below-the-line” (direct marketing), 10 percent for “Price Promotion,” and another 10 percent for “Public Relations.” Figure 4 displays the results of this base run.

*Figure 4 – Base Run*

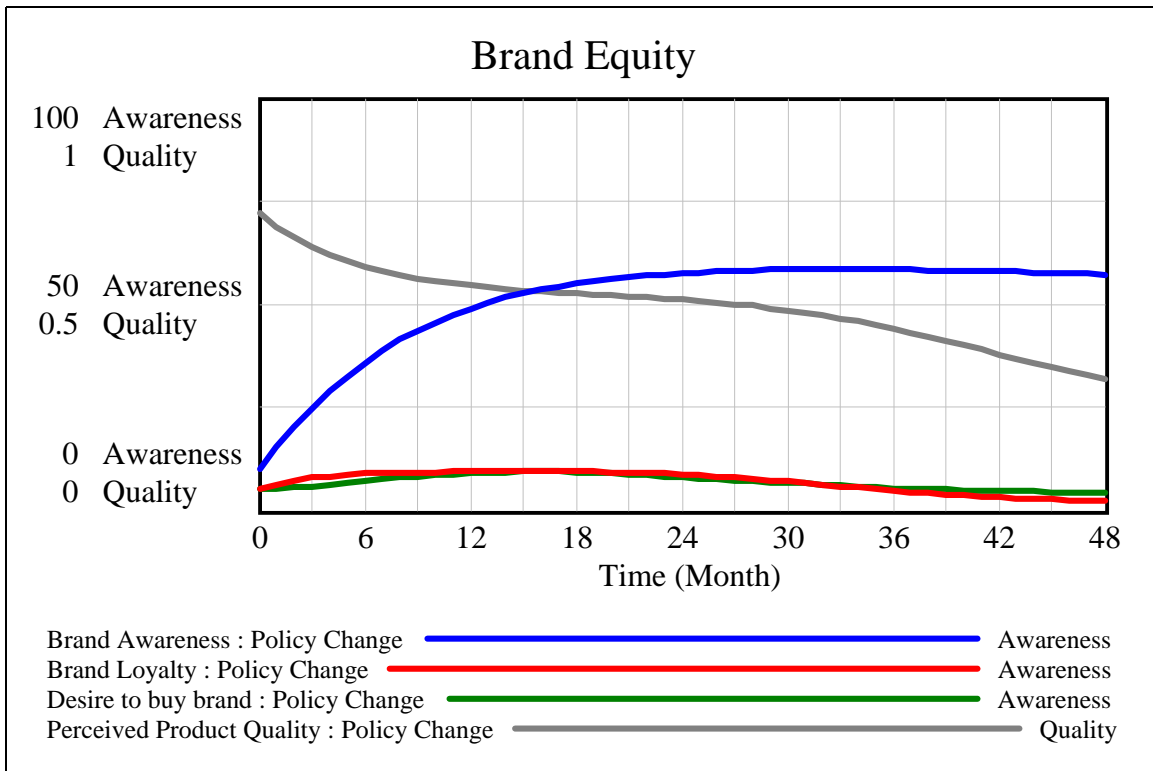


## Observation

An initial investment of 50 enables the brand manager to build up brand awareness over a period of approximately 18 months – by splitting the investment into the previously mentioned communication tools. This is a realistic timeframe for the launch of a new brand in a fast-moving consumer market – particularly since 65 percent of the total budget was directed toward “Above-the-line” advertising. Brand loyalty and desire to buy the brand take longer to build up, because consumers need to be aware of a brand before they begin buying it. If product attractiveness (determined by price-value relation and initial product quality) is high enough, consumers stay loyal and develop brand loyalty over time.

The second policy simulation captures the effect of overspending in the brand awareness sector and low investment for price promotions. Initial investment remains at 50 (\$50,000), investment in brand awareness is increased to 75 percent, “price promotion” 5 percent, investment in “below-the-line”, and “public relation” is now 10 percent each. Figure 5 shows the results of these changed policy inputs.

Figure 5 – Policy Change



### Observation

Brand awareness is marginally increased over the base run. However, desire to buy brand and brand loyalty are decreasing after an initial increase when the product was launched. The consumer's perception of quality declines throughout the entire timeframe and produces the poor activity in loyalty and desire. The results of this simulation suggests that fast-moving consumer goods need to stimulate demand and brand loyalty, using a certain level of price promotion activities, together with other marketing activities.

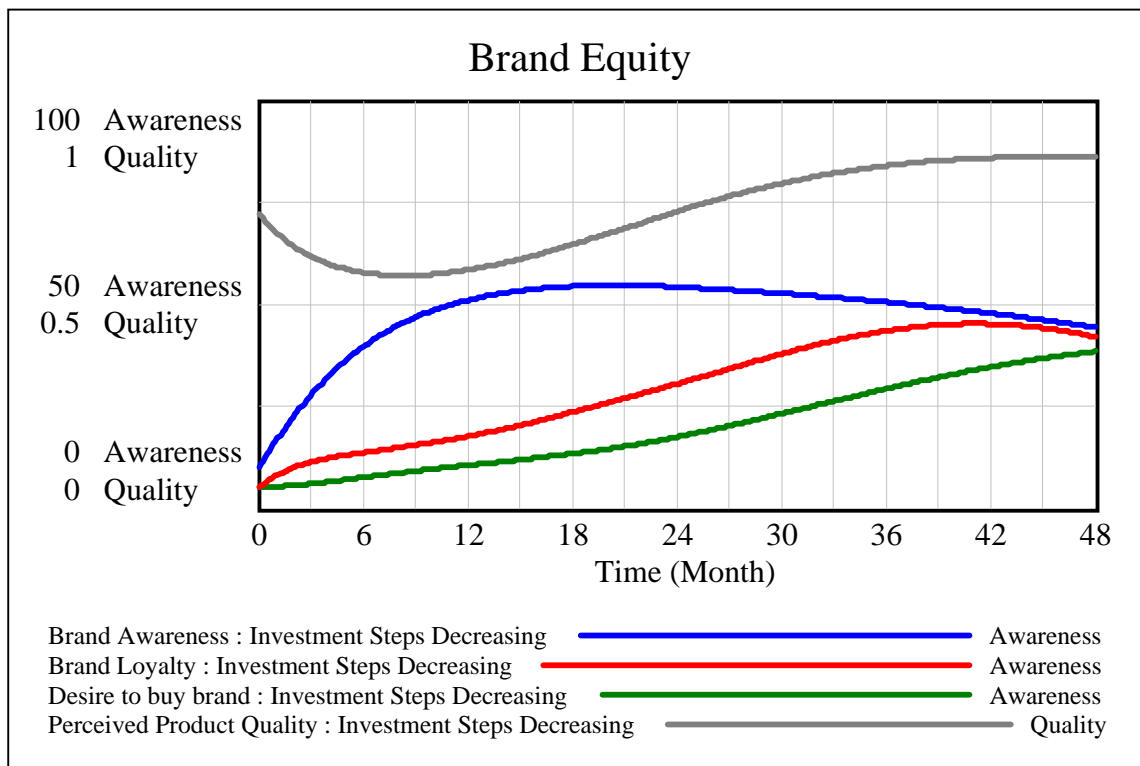
For the third policy implementation, a time series of different investments was used to simulate the effect of changing spending levels. An initial investment of 70 or \$70,000, was used and then decreased by 10 units (\$10,000) for each of the remaining six-month periods. Base run policy decisions remained the same for “Above-the-Line” advertising, “Below-the-Line” advertising, price promotion, and public relations. Figures shown in Table 1 show investments that are changed each six months of the model run.

*Table 1 – Investment levels over time*

<b>Time</b>	0	6	12	18	24	36	48
<b>Investment (in 000\$)</b>	70	60	50	40	30	20	10

Figure 6 demonstrates the various time-stepped decisions shown in Table 1. What is interesting to note is the gradual decline in brand awareness.

*Figure 6 – Time Series with Changes in Investment*



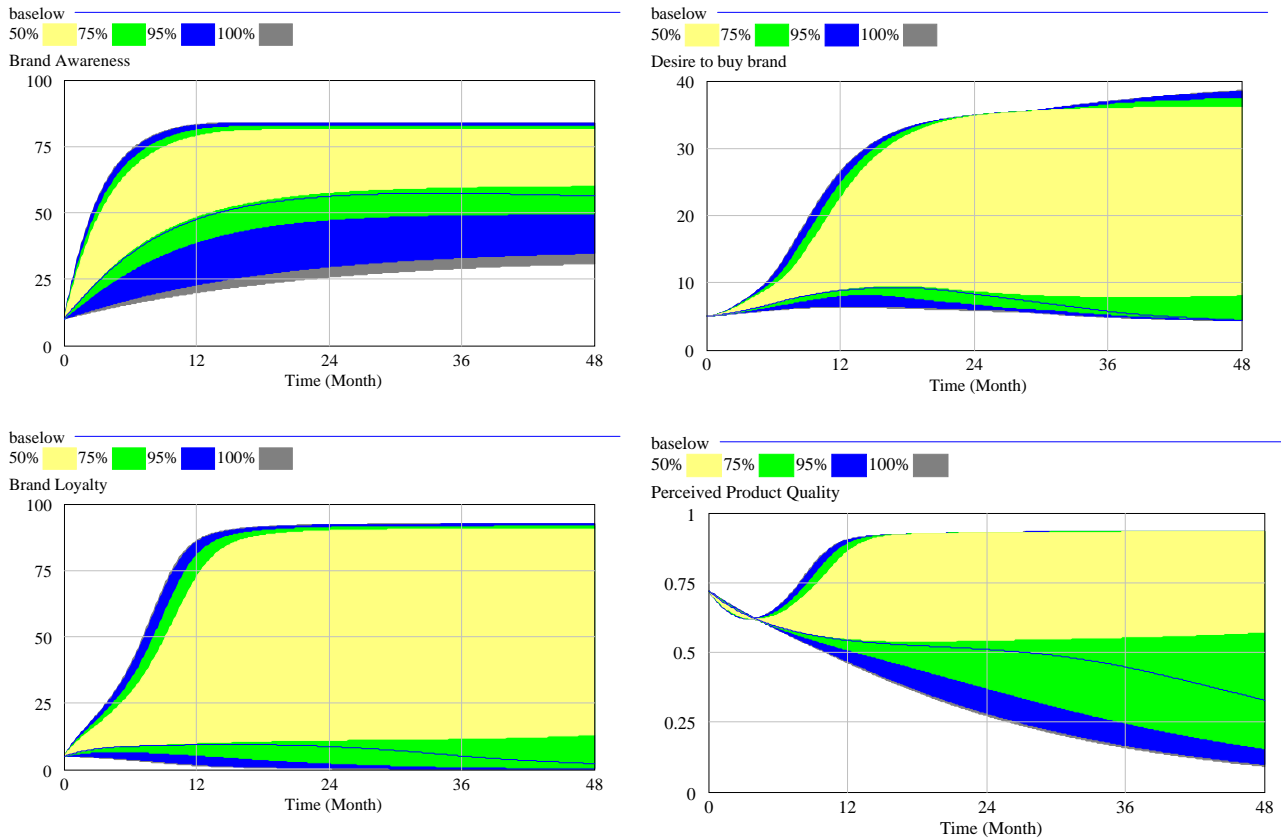
### Observation

In this run, the initial investment was set at 70 and then decreased by 10 units over each of the 6-month intervals. What was observed was that brand awareness had a very healthy increase for the first 18 months and then it began to decay. Brand loyalty also showed an increasing trend until about the 40<sup>th</sup> month, and then a reversal began to be displayed. Brand loyalty, on the other hand, showed a very slow, but ever increasing increase. Perceived product quality seemed to achieve a state of equilibrium. This run suggests that the brand manager must find a certain level of investment that will keep his overall brand equity from going into decay.

## INTERNAL VALIDATION

To understand the model behavior and sensitivity, a number of sensitivity runs were performed in Vensim DSS. The following graphs in Figure 7 vary in “Initial investment” from 0 to 200 units, in 000\$ (uniformly distributed):

*Figure 7 – Sensitivity Analysis Runs*



The behavior of the model is changing based on different levels of investments in the early stages, however, it converges to the same equilibrium. “Brand awareness” stays between the initial value and equilibrium and never goes below the initial value, suggesting that there is always a certain level of brand awareness, even with minimal investment. “Brand loyalty” and “desire to buy brand” can vary from their initial value, or even decline to zero, suggesting that if brand awareness declines to a certain level of investment, loyalty and desire to buy brand could be zero. Behavior for “perceived product quality” varies from reaching equilibrium to a low value, but never reaches zero.

## POLICY ANALYSIS

**Results of commonly suggested policies:** Any brand-building program comprises a number of interrelated decisions about the level of investment, target group, and use of different communication tools. To the extent that these decisions are arbitrarily made, or based on insufficient information, the rationality will suffer, because a high degree of inconsistency and uncertainty must be expected, increasing the risk of failures in the marketplace. Brand managers tend to make decisions based on intuition, habits, or subjective experience. In other words, a

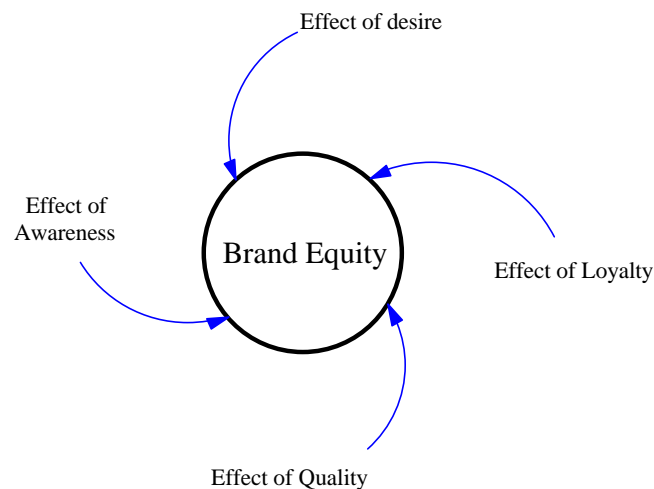
brand manager might have an insufficient understanding of the decision problem, possibly combined with an overestimation of his or her own level of competence. Limited information, or lack of interest to search for information about advertising effects and effectiveness, often leads to generic, one-dimensional brand strategies – the proverbial “putting all eggs in one basket.”

**Results of policies form the modeling process:** As opposed to a generic, one-dimensional approach to build brands (i.e. investing too much money for “above-the-line” activities), the modeling process suggests that a multi-dimensional approach can improve the quality of a brand strategy in several ways. First, investing in different areas at the same time can result in a better sustainability of brand equity and desire to buy brand over time. Secondly, too much investment in “above-the-line activities” does not always improve the overall result of a brand strategy. The modeling process provides a brand manager with more information and insights about the implications of different brand policies, thus, reducing the risk for failures in the marketplace.

## CONCLUSION

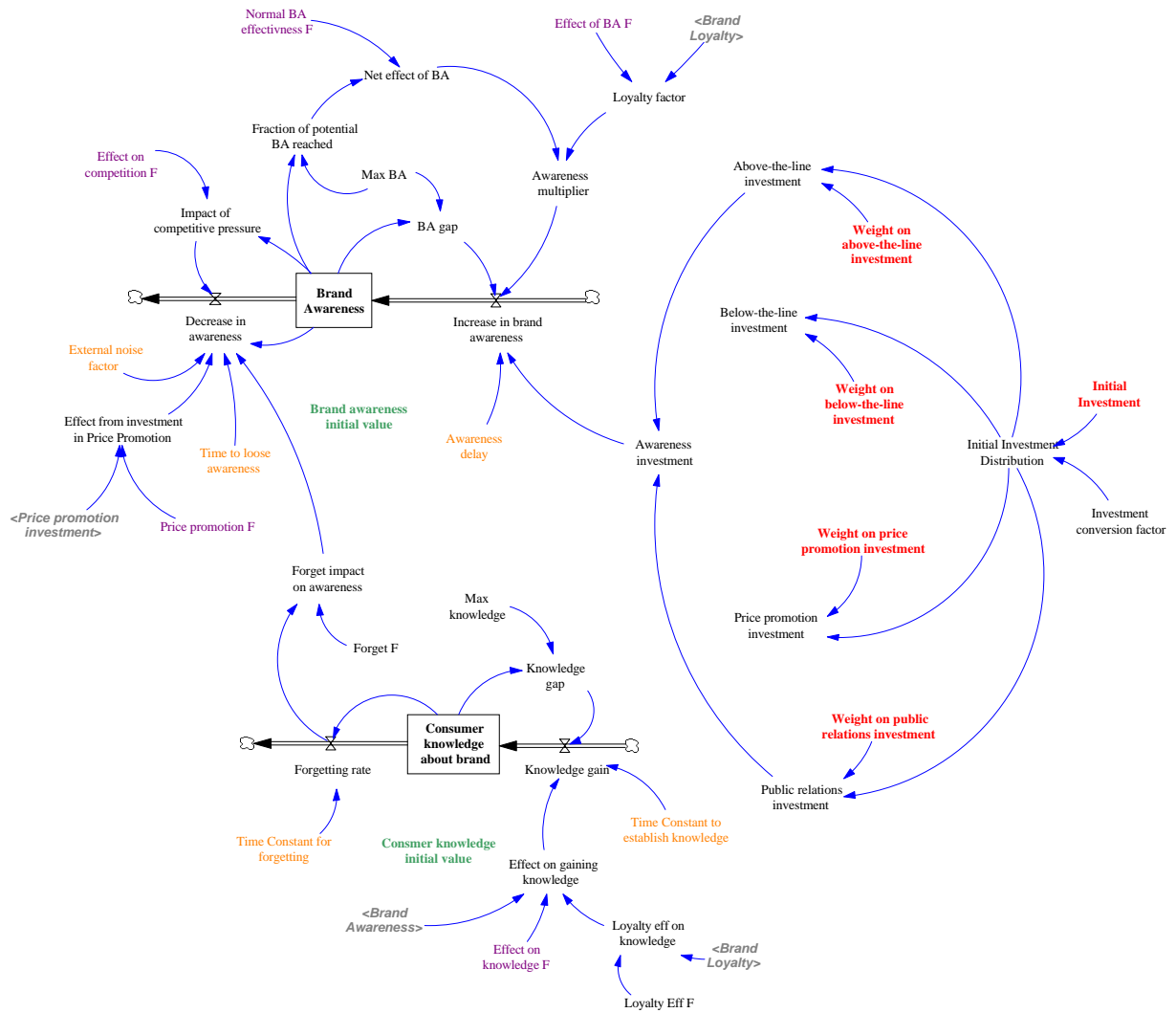
This paper set the groundwork for establishing a system dynamics model concerning the management of brand equity for a generic sector of fast-moving consumer goods. The authors are attempting to produce a working model of brand management processes that could be used to supplant current “mental model” practices among brand managers. It is agreed by the authors that the current work is incomplete. There is a need to test the behavior of the model with real market data and validate the outcome against real brand strategies. However, this paper has attempted to capture the “big picture” of the overall process and it is hoped that future refinement of the model will produce workable, and usable, results.

## MODEL SECTORS – BRAND EQUITY

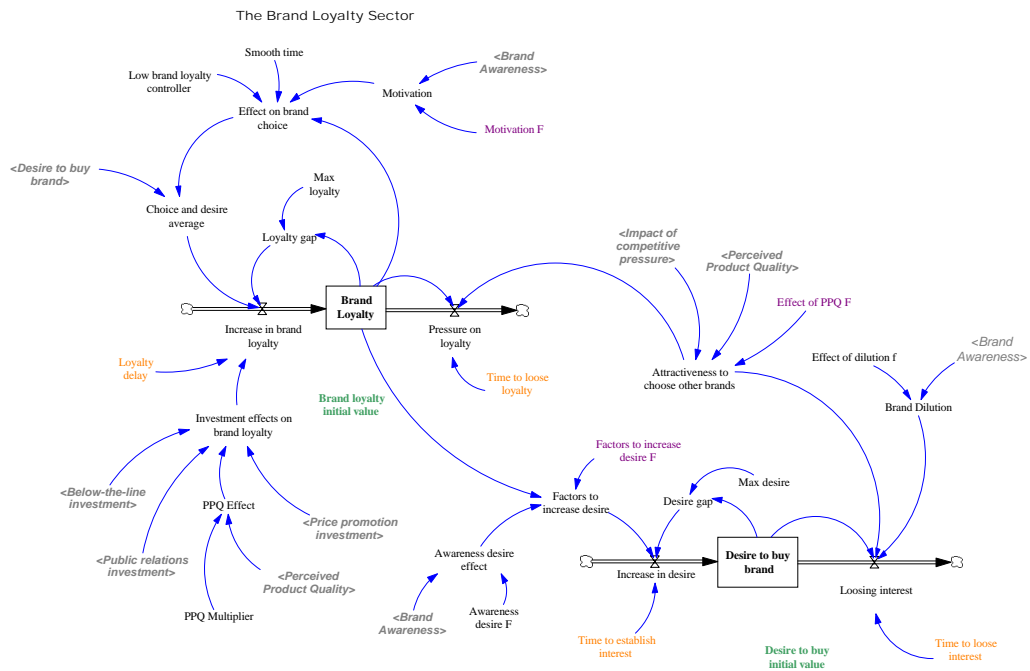


# MODEL SECTORS – BRAND AWARENESS

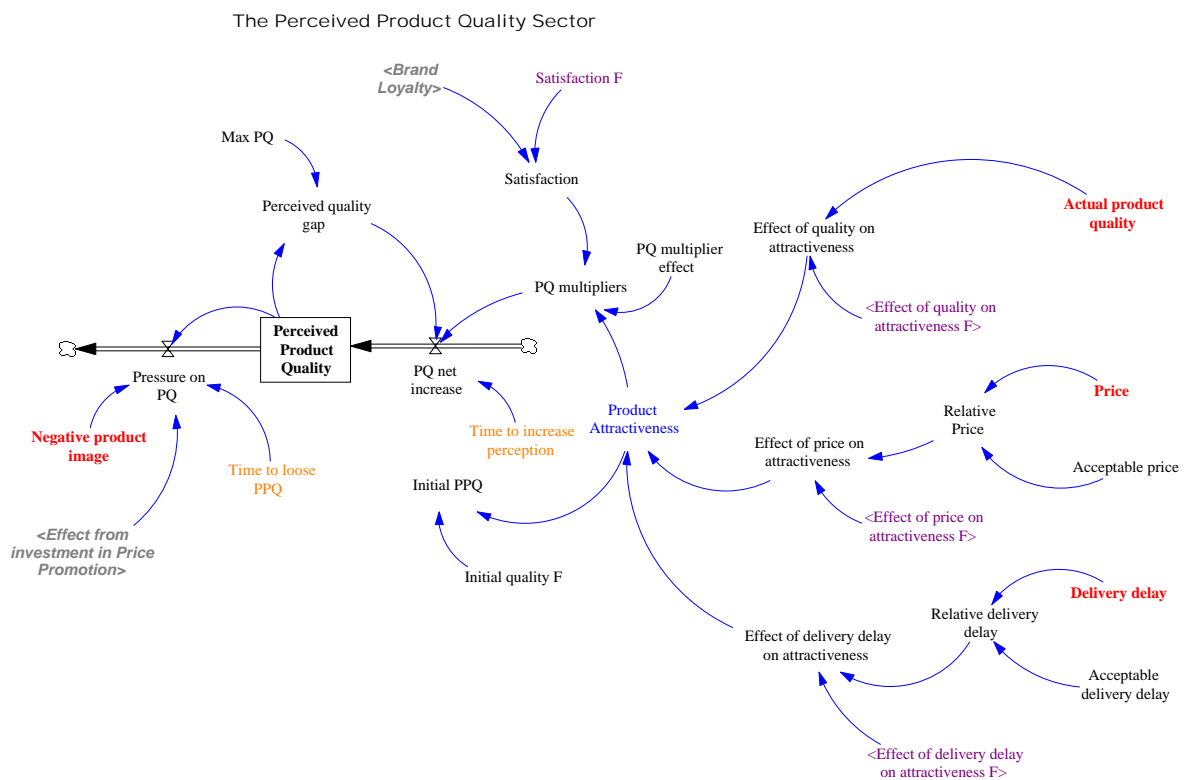
The Brand Awareness/Effectiveness Sector



## MODEL SECTORS – BRAND LOYALTY



## MODEL SECTORS – PERCEIVED PRODUCT QUALITY



## MODEL FORMULAS

\*\*\*\*\*  
 "Brand Awareness/Effectiveness Sector"  
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"Above-the-line investment" = Initial Investment  
 Distribution\*Weight on above-the-line investment"  
 Units: Dollar/Month

Awareness delay = 8  
 Units: Month

Awareness investment = "Above-the-line investment"+Public  
 relations investment  
 Units: Dollar/Month

Awareness multiplier = Loyalty factor+Net effect of BA  
 Units: Month/Dollar

BA gap = Max BA-Brand Awareness  
 Units: Awareness

Brand awareness initial value = 10  
 Units: Awareness

Consumer knowledge initial value = 5  
 Units: Knowledge

Consumer knowledge about brand = INTEG (-Forgetting  
 rate+Knowledge gain,Consumer knowledge initial value)  
 Units: Knowledge

Decrease in awareness = External noise factor\*(Brand  
 Awareness\*(Impact of competitive pressure+Effect from  
 investment in Price Promotion +Forget impact on  
 awareness))/Time to loose awareness  
 Units: Awareness/Month

Effect of BA F([(0,0)-  
 (100,1)],(0,0.01),(4.58716,0.149123),(11.0092,0.311404),(24.4648,  
 0.526316),(37.3089,0.657895),(50.1529,0.741228),(62.3853,0.811  
 404),(75.2294,0.872807),(87.4618,0.916667),(100,0.9167))  
 Units: Month/Dollar

Effect on competition F([(0,0)-  
 (101,0.3)],(0,0.01),(14.3119,0.0407895),(24.9541,0.0697368),(35.5  
 963,0.106579),(45.5046,0.138158),(55.4128,0.164474),(66.789,0.1  
 81579),(77.7982,0.193421),(90.2141,0.197368),(100,0.2),(101,0.2)  
 )  
 Units: dmnl

Effect on gaining knowledge = Effect on knowledge F(Brand  
 Awareness+Loyalty eff on knowledge)  
 Units: dmnl

Effect on knowledge F([(0,0)-  
 (200,100)],(0,0),(21.4067,16.6667),(42.2018,28.5088),(59.9388,38.  
 1579),(83.792,42.5439),(105.199,45.614),(130.275,48.6842),(153.  
 517,53.0702),(172.477,62.7193),(187.156,74.5614),(200,95))  
 Units: dmnl  
 External noise factor = 0.15  
 Units: dmnl

Forget F([(0,0)-  
 (50,1)],(0,0),(9.48012,0.0570175),(17,0.157895),(21.4067,0.25),(2  
 5.6881,0.350877),(28.2875,0.421053),(31.4985,0.54386),(35,0.728  
 07),(39.2966,0.868421),(44.4954,0.964912),(50,0.99))  
 Units: dmnl

Forget impact on awareness = Forget F(Forgetting rate)  
 Units: dmnl

Forgetting rate = Consumer knowledge about brand/Time Constant  
 for forgetting  
 Units: Knowledge/Month

Fraction of potential BA reached = Brand Awareness/Max BA  
 Units: dmnl

Increase in brand awareness = ((Awareness investment\*Awareness  
 multiplier)\*(BA gap))/Awareness delay  
 Units: Awareness/Month

Initial Investment = 50  
 Units: Dollar/Month

Initial Investment Distribution = Initial Investment/Investment  
 conversion factor  
 Units: Dollar/Month

Investment conversion factor = 100  
 Units: dmnl

Knowledge gain = (Effect on gaining knowledge/Time Constant to  
 establish knowledge)\*(Knowledge gap)  
 Units: Knowledge/Month

Knowledge gap = (Max knowledge-Consumer knowledge about  
 brand)/100  
 Units: Knowledge

Loyalty Eff F([(0,0)-(100,100)],(0,0),(100,100))  
 Units: Awareness

Loyalty eff on knowledge = Loyalty Eff F(Brand Loyalty)  
 Units: Awareness

Loyalty factor = Effect of BA F(Brand Loyalty)  
 Units: Month/Dollar

Max BA = 100  
 Units: Awareness

Max knowledge = 100  
 Units: Knowledge

Net effect of BA = Normal BA effectiveness F(Fraction of potential  
 BA reached)  
 Units: Month/Dollar

Normal BA effectiveness F([(0,0)-  
 (1.1,1)],(0,0.969298),(0.107645,0.969298),(0.259021,0.951754),(0.  
 407034,0.899123),(0.590214,0.807018),(0.740061,0.679825),(0.87  
 4618,0.5),(0.957187,0.377193),(1.01927,0.25),(1.1,0.0001))  
 Units: Month/Dollar

Price promotion F([(0,0)-(1,0.5)],(0,0),(1,0.5))  
 Units: dmnl

Time Constant for forgetting = 2  
 Units: Month

Time Constant to establish knowledge = 3  
 Units: Month



Time to loose awareness = 1  
Units: Month

"Weight on above-the-line investment" = 0.65  
Units: dmnl

"Weight on below-the-line investment" = 0.15  
Units: dmnl

Weight on price promotion investment = 0.1  
Units: dmnl

Weight on public relations investment = 0.1  
Units: dmnl

\*\*\*\*\*  
.Brand Loyalty Sector  
\*\*\*\*\*

Attractiveness to choose other brands = (Effect of PPQ F(Perceived Product Quality))+Impact of competitive pressure  
Units: dmnl

Awareness desire effect = Awareness desire F(Brand Awareness)  
Units: Loyalty

Awareness desire F(  
[(0,0)-(100,100)],(0,0),(100,100))  
Units: Loyalty

"Below-the-line investment" = Initial Investment  
Distribution\*"Weight on below-the-line investment"  
Units: Dollar/Month

Brand Awareness = INTEG ( Increase in brand awareness-Decrease in awareness, Brand awareness initial value)  
Units: Awareness

Brand Dilution = Effect of dilution f(Brand Awareness)  
Units: dmnl

Brand loyalty initial value = 5  
Units: Loyalty

Choice and desire average = (Desire to buy brand+Effect on brand choice)/2  
Units: desire

Desire gap = (Max desire-Desire to buy brand)/100  
Units: desire

Desire to buy brand = INTEG (Increase in desire-Loosing interest,Desire to buy initial value)  
Units: desire

Desire to buy initial value = 5  
Units: desire

Effect of dilution f([(0,0)-(100,5)],(0.30581,0.350877),(19.2661,0.460526),(38.2263,0.723684),(53.5168,1.55702),(62.6911,3.00439),(77.9817,3.9693),(99.3884,4.36404))  
Units: dmnl  
Effect of PPQ F([(0,0)-(1,0.8)],(0,0.8),(0.149847,0.764912),(0.259939,0.715789),(0.342508,0.670175),(0.449541,0.57193),(0.492355,0.459649),(0.553517,0.322807),(0.626911,0.203509),(0.718654,0.115789),(0.850153,0.0491228),(1,0.0001))  
Units: dmnl

Effect on brand choice = (SMOOTH((Brand Loyalty\*Motivation),Smooth time))+Low brand loyalty controller  
Units: desire

Factors to increase desire = Factors to increase desire F(Brand Loyalty+Awareness desire effect)  
Units: dmnl

Factors to increase desire F([(0,0)-(200,100)],(0,0.01),(29.3578,3.94737),(50.7645,8.33333),(76.4526,17.9825),(99.6942,34.2105),(123.547,57.0175),(149.847,69.7368),(171.865,73.6842),(199.388,75))  
Units: dmnl

Impact of competitive pressure = Effect on competition F(Brand Awareness)  
Units: dmnl

Increase in brand loyalty = (Investment effects on brand loyalty\*Choice and desire average)\*(Loyalty gap/Loyalty delay)  
Units: Loyalty/Month

Increase in desire = (Factors to increase desire/Time to establish interest)\*Desire gap  
Units: desire/Month

Investment effects on brand loyalty = (Public relations investment+"Below-the-line investment"+Price promotion investment)\*PPQ Effect  
Units: 1/desire

Loosing interest = (Attractiveness to choose other brands\*Desire to buy brand\*Brand Dilution)/Time to loose interest  
Units: desire/Month

Low brand loyalty controller = 1  
Units: desire

Loyalty delay = 14  
Units: Month

Loyalty gap = Max loyalty-Brand Loyalty  
Units: Loyalty

Max desire = 100  
Units: desire

Max loyalty = 100  
Units: Loyalty

Motivation = Motivation F(Brand Awareness)  
Units: desire/Loyalty

Motivation F([(0,0)-(110,1)],(0,0),(13.1498,0.0482456),(22.3242,0.127193),(28.4404,0.29386),(37.0031,0.5),(49.8471,0.649123),(61.4679,0.72807),(74.9235,0.780702),(87.7676,0.798246),(100,0.8),(110,0.8))  
Units: desire/Loyalty

PPQ Effect = Perceived Product Quality\*PPQ Multiplier  
Units: Month/(Dollar\*desire)  
PPQ Multiplier = 1  
Units: Month/(Dollar\*desire\*Quality)

Pressure on loyalty = (Brand Loyalty\*Attractiveness to choose other brands)/Time to loose loyalty  
Units: Loyalty/Month

Price promotion investment = Initial Investment  
Distribution\*Weight on price promotion investment  
Units: Dollar/Month

Public relations investment = Initial Investment  
Distribution\*Weight on public relations investment  
Units: Dollar/Month

Smooth time = 5  
Units: Month

Time to establish interest = 9  
Units: Month

Time to loose interest = 6  
Units: Month

Time to loose loyalty = 1.5  
Units: Month

\*\*\*\*\*  
.Perceived Product Quality Sector  
\*\*\*\*\*

Acceptable delivery delay = 1  
Units: Month

Acceptable price = 65  
Units: \$/widget

Actual product quality = 0.8  
Units: fraction

Brand Loyalty = INTEG (  
Increase in brand loyalty-Pressure on loyalty,  
Brand loyalty initial value)  
Units: Loyalty

Delivery delay = 1  
Units: Month

Effect from investment in Price Promotion = Price promotion  
F(Price promotion investment)  
Units: dmn

Effect of delivery delay on attractiveness = Effect of delivery  
delay on attractiveness F(Relative delivery delay)  
Units: dmn

Effect of delivery delay on attractiveness F([(0,0)-  
(4,1.1)],(0,1),(1,1),(1.54124,0.924342),(1.92784,0.792763),(2.2989  
7,0.476974),(2.91753,0.197368),(3.30412,0.101974),(4,0.05))  
Units: dmn

Effect of price on attractiveness = Effect of price on attractiveness  
F(RelativePrice)  
Units: dmn

Effect of price on attractiveness F([(0,0)-  
(2,1.1)],(0,1),(1,1),(1.20103,0.911184),(1.33505,0.769737),(1.4484  
5,0.430921),(1.63402,0.141447),(1.78608,0.0690789),(2,0.05))  
Units: dmn

Effect of quality on attractiveness = Effect of quality on  
attractiveness F(Actual product quality)  
Units: dmn

Effect of quality on attractiveness F([(0,-0.1)-  
(1,1.1)],(0,0.01),(0.5,0.0842105),(0.568807,0.110526),(0.631443,0.  
173684),(0.681701,0.284211),(0.733945,0.415789),(0.776758,0.62  
1053),(0.824742,0.828947),(0.880155,0.934211),(0.944954,0.9947  
37),(1,1))  
Units: dmn

Initial PPQ = Initial quality F(ProductAttractiveness)  
Units: Quality

Initial quality F(  
[(0,0)-(1,1)],(0,0),(1,1))  
Units: Quality

Max PQ = 1  
Units: Quality

Negative product image = 0.05  
Units: dmn

Perceived Product Quality = INTEG (  
PQ net increase-Pressure on PQ,  
Initial PPQ)  
Units: Quality

Perceived quality gap = Max PQ-Perceived Product Quality  
Units: Quality

PQ multiplier effect = 10  
Units: dmn

PQ multipliers = ProductAttractiveness\*Satisfaction\*PQ multiplier  
effect  
Units: dmn

PQ net increase = (Perceived quality gap\*PQ multipliers)/Time to  
increase perception  
Units: Quality/Month

Pressure on PQ = (Negative product image+Effect from investment  
in Price Promotion)\*Perceived Product Quality/Time to loose PPQ  
Units: Quality/Month

Price = 65  
Units: \$/widget

ProductAttractiveness = Effect of delivery delay on attractiveness \*  
Effect of price on attractiveness\* Effect of quality on attractiveness  
Units: dmn

Relative delivery delay = Delivery delay/Acceptable delivery  
delay  
Units: dmn

RelativePrice = Price/Acceptable price  
Units: fraction

Satisfaction = Satisfaction F(Brand Loyalty)  
Units: dmn

Satisfaction F([(0,0)-  
(200,1.1)],(0,0),(12.844,0.0614035),(25.3823,0.122807),(37.3089,0.  
.197368),(50.1529,0.285088),(60.8563,0.403509),(74.9235,0.5745  
61),(87.7676,0.763158),(100,1),(200,1))  
Units: dmn

Time to increase perception = 5  
Units: Month

Time to loose PPQ = 1  
Units: Month

\*\*\*\*\*  
.Brand Equity Sector  
\*\*\*\*\*

Awareness equity F([(0,0)-(100,100)],(0,0),(100,100))  
Units: Equity

Brand Equity = (Effect of Awareness+Effect of Loyalty+Effect of  
Quality+Effect of desire)/4  
Units: Equity

Desire F([(0,0)-(100,100)],(0,0),(100,100))  
Units: Equity

Effect of Awareness = Awareness equity F(Brand Awareness)  
Units: Equity

Effect of desire = Desire F(Desire to buy brand)  
Units: Equity

Effect of Loyalty = Loyalty Equity F(Brand Loyalty)  
Units: Equity

Effect of Quality = PPQ equity F(Perceived Product Quality)  
Units: Equity

Loyalty Equity F([(0,0)-(100,100)],(0,0),(100,100))  
Units: Equity

PPQ equity F([(0,0)-(1,100)],(0,0),(1,100))  
Units: Equity

\*\*\*\*\*  
.Control  
\*\*\*\*\*

Simulation Control Parameters

FINAL TIME = 48  
Units: Month

INITIAL TIME = 0  
Units: Month

SAVEPER =  
TIME STEP  
Units: Month

TIME STEP = 1  
Units: Month

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