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MARKETING As a Science

An approach showing how it is possible to apply scientific reasoning to a dynamic and competitive marketing situation.

By Harlan D. Mills

It is now clear that the same reasoning processes which have led to notable progress in the physical sciences can be applied to marketing, and that marketing "laws" can be derived in the same manner as the laws of physics. Therefore, the way is open for marketing to become, more and more, a science.

This does not mean that formulas will replace the purely creative functions of marketing. However, in many operations where trial-and-error efforts have hitherto been necessary, marketing men will have the benefit of generalized information and insights similar to those which guide the work of engineers.

Practical Science

Through modern mathematics, practical theories are being developed to guide and expedite decisions on complex questions. I will attempt to build one such theory here. But first we must set the stage by stating this basic principle:

Practical theory must begin with tangible marketing actions and end in visible marketing results. In short, practical theory must deal with marketing "observables."

The key word in this principle is "observables." In order for marketing theory to be practical, it has to *work* with things which marketing men can affect and see. But theory does not have to be *based* on observables! Consider this example from the natural sciences:

> Physics is certainly a practical science. Its theories have produced such practical results as atomic bombs and space satellites. Yet the things which physicists worry about — such as electrons, protons, gravitation, cosmic rays, and so forth — are not observable. No physicist has ever seen an electron, or a proton, or gravitation. They are figments of the physicists' imagination. Nevertheless, they play a vital part in theories which are used to produce practical results.

We would do well to investigate the distinction between observables and nonobservables a little more closely, because it is so important in understanding the nature of scientific theories. Imagine an atom smasher — a very large and complicated piece of apparatus. There are wires running in all directions, and magnets here and there. There is a switch with positions "on" and "off." At another place in the apparatus is a photographic plate.

The observables are the switch, the photographic plate, and the physical configuration of the equipment, wires, magnets, and the like. But associated with the apparatus are a host of nonobservables: we imagine electricity running up and down the wires, although we do not actually see it; we picture electrons jumping from one point to another in vacuum tubes; and so on. Through very complicated equations and reasoning, we hypothesize what would happen if the switch were turned on.

In other words, we reason through nonobservable activities until finally we are able to predict that something observable will occur.

What we predict is that a white line will appear on the photographic plate. Now we have connected an observable cause and an observable effect. The observable cause is the switch being turned on, and the observable effect is the white line appearing on the photographic plate.

Thus we see that in physics one can trace observable causes through nonobservable activities to observable effects. Every science has this same character. Perhaps it will be helpful to have it summarized:

> Physics is a practical theory dealing with physical observables. But its power is due to nonobservables, such as electrons (nonobservable objects) and gravitation (nonobservable mechanisms), which link observable causes and effects through physical theory.

Systems of Nonobservables

The need for nonobservables is even greater in marketing than in physics. If developing a theory were simply a matter of relating observables to each other, without any "submerged logic," then we would have had it long ago. The real task facing marketers is to develop theoretical systems of nonobservables which link observable causes and effects in marketing activities. Such theory must help the executive to ask proper questions and must prove out when tested on simple problems.

To illustrate what I mean by "proper questions," suppose that you are playing stud poker. On the third card, with no strength visible, the man on your right puts up a big bet. Then:

> ▼ You could ask yourself, "Is this guy bluffing?" That is *not* the proper question! Barring great psychological deficiencies or differences, the question will lead nowhere. It is not a matter of whether the guy is bluffing, but of what you should do. True, the answer to the bluffing question makes the behavior question obvious. But it is false reasoning to conclude that you *must* answer the bluffing question in order to answer the behavior question.
>
> ▲ Or you could ask, "How shall I play?" That *is* the proper question. The theory of games answers the question of how to behave in poker; and the problem of bluffing becomes an automatic by-product. On the surface, the distinction between the behavior and bluffing questions may seem small, but, in fact, this distinction is the difference between scientific progress and lack of it.

I also said that a theory must give correct answers when proved out on simple problems. A word of explanation may be helpful:

> In order to use gravitational theory, we first require that it predict simple things like "apples fall to the ground." Only then do we turn it loose on calculating satellite trajectories. This is another basic attribute of science: that sound scientific theory must account for known facts and relationships before it proceeds to the unknown.

In the theory we are about to develop, we will try to make sure that we have our apples falling to the ground before we venture off into satellite predictions.

Competitive Equilibrium

The most characteristic aspect of marketing is *competition*. To be sure, marketing deals with people, with motivation and communication, and with the organization of resources. But competition is the one dominant feature. Marketing people constantly battle other marketing people, who are free to use new strategies and ingenious tactics to try to achieve their own goals.

In our economy, a company of any size has, by definition, already passed many stiff hurdles simply to stay alive and grow. There is a natural selection as ruthless and comprehensive as any that Darwin ever envisioned in the natural world. It selects companies that compete best, and propagates the more effective marketing strategies through their survival.

Competitive equilibrium is the concept that most effectively characterizes a marketing situation in its over-all form. This is a state of a market (usually in dynamic movement) in which each competitor is acting to maximize his own profits against all competing strategies. It is recognized — and this is fundamental — that marketing people must think not only about what they would do if the world should hold still, but also about what their strategy should be in the event that competitors should react intelligently with counterstrategies.

Tactics in Competition

To illustrate this concept, let us proceed to a study of the competition between two brands in a certain market. In this example of competition we simplify matters for the sake of arithmetic; in actual cases, of course, the details can be as complicated as you want. Thus:

Exhibit I shows two brands in competition and their respective balance sheets. Each line of the balance sheet is derived from the preceding one.

Exhibit I. An initial position

	Brand	
	A	*B*
Marketing effort	$100	$ 300
Sales volume	500	1,500
Manufacturing costs	250	750
Profit	150	450

We assume, in this market, that a given share of the marketing effort leads to a like share of the market. (Notice that Brand A in this exhibit expends 25% of the marketing effort and gets back 25% of the market.) We also assume that the manufacturing costs in each case are 50% of the sales volume. Finally, the profit is simply the difference between the volume and the costs of marketing effort and manufacturing.

Further, just to keep the example easy to follow, suppose that total dollar sales in the market are fixed. As for marketing effort, it can take any form that is appropriate for getting additional business — advertising, extra salesmen, price cuts, or whatever.

Now put yourself in the position of Brand A and ask, "How can we improve our profit (which is currently $150)?" Brand A has the choice of raising or lowering its marketing effort of $100. One reasonable possibility is that profits will go up if marketing effort is increased. Let us try out that strategy and see what actually happens. Exhibit II shows the results when Brand A raises its marketing effort to $200.

Exhibit II. A competitive adjustment

	Brand	
	A	*B*
Marketing effort	$200	$ 300
Sales volume	800	1,200
Manufacturing costs	400	600
Profit	200	300

Notice that even though Brand B does not change its marketing effort, Brand A's shift causes a change in the rest of Brand B's balance sheet. Now Brand A has 40% of the marketing effort and hence 40% of the total market. The rest of the balance sheet is recomputed as before. We find that Brand A's profit does, indeed, go up — from $150 to $200.

Now what should Brand B do at this point to counter?

Offhand, it would seem that Brand B should raise its own marketing effort in response to Brand A's move. A trial case will show, however, that Brand B's best action is to *reduce* its marketing effort. We can calculate exactly how much it should be reduced, but let us consider the matter even a step further. Suppose we set up a sequence of steps in which Brand A, then Brand B, then Brand A, and so on, make moves and countermoves, each one continually improving its own profit position.

Where will this sequence ultimately lead? It will lead to our concept of competitive equilibrium. This competitive equilibrium can be calculated mathematically. For the case we are studying, it comes out as shown in Exhibit III. At this point, neither Brand A nor Brand B can improve its profit position by changing the marketing effort.

Exhibit III. Two brands in competitive equilibrium

	Brand	
	A	*B*
Marketing effort	$ 250	$ 250
Sales volume	1,000	1,000
Manufacturing costs	500	500
Profit	250	250

Practical Theory

Now that we have this concept of competitive equilibrium, what can we do with it? Let us look at one example of how the concept can be used to develop some practical marketing theory. *Specifically, we will use the concept of competitive equilibrium to develop a theory which shows how a company can translate a cost advantage into the greatest possible competitive advantage.* Thus:

> Let us suppose that the manufacturing department of Brand A suddenly learns to make the product more cheaply. As a result, manufacturing costs are now only 40% of sales volume instead of 50%. If the marketing effort remains the same, the new balance sheet found in Exhibit IV obtains.

At this point, the $100 saving in manufacturing costs has been transferred into profit. How-

Exhibit IV. Brand A achieves manufacturing cost reduction

	Brand	
	A	*B*
Marketing effort	$ 250	$ 250
Sales volume	1,000	1,000
Manufacturing costs	400	500
Profit	350	250

ever, this $100 represents a potential war chest for the marketing department. What would happen if it were reinvested in marketing effort, instead of pocketed as extra profit? Or, alternatively, what would happen if some fraction of the war chest were put into marketing effort, with the remainder going to profit? How do you decide what to do in this case? What is the *best* thing to do?

To answer this question, we need a practical rule. And, indeed, we can close in on one, as we proceed with our example.

Notice that Brand B has no cause to change on the balance sheet above, because it is maximizing its profit against Brand A's marketing effort of $250. It is Brand A that has failed to maximize its profit against Brand B's marketing effort of $250, for Brand A's manufacturing costs have gone down, and this destroys the previous conditions of maximization.

When Brand A does introduce a new strategy (by reinvesting some part of its cost saving in marketing effort), then Brand B's position is altered and it is forced to launch counterstrategy. Through a sequence of strategies and counterstrategies, Brands A and B will eventually arrive at a new competitive equilibrium. This new position will reflect the discrepancies in their manufacturing efficiency. Exhibit v shows the new competitive equilibrium.

Notice that Brand A has reinvested $48 of the possible $100 in extra marketing effort, and that Brand B's best response is to pull back slightly, by $2. Now Brand A has about 55% of the business instead of 50%.

Exhibit v. New state of competitive equilibrium

	Brand A	*Brand* B
Marketing effort	$ 298	$ 248
Sales volume	1,092	908
Manufacturing costs	436	454
Profit	358	206

Possibly more surprising, however, is what has happened to Brand A's profit. The reinvestment of $48 in marketing effort has returned only an additional $8 in profit. This seems to be mighty little for the money. But look what has happened to Brand B's profit. It has dropped from $250 to $206 as the result of Brand A's strategy. By contrast, the share of profit for Brand A has been increased considerably.

This points up a rather interesting phenomenon — that a cost advantage can and should be parlayed into additional advantages in share of market and share of profit. Our theory did not set out to prove this, but most marketing men will agree with the conclusion. It would appear (to refer back to our earlier analogy) that we have some apples falling to the ground.

Incidentally, in studying this problem — and following the sequence of a manufacturing improvement and a marketing improvement — one cannot help but note that manufacturing people are on the job to "make money" and marketing people are on the job to "clobber the competition." The major effect Brand A achieved by reinvesting part of its cost saving in added marketing effort was to cut down Brand B's profit; Brand A's own gain, as we saw, was relatively small.

Guesswork Gone

Why was it best for Brand A to reinvest $48? Why not $75, or $25, or $100? Why exactly $48? Without a guiding rule, Brand A's management would have to guess at the proper amount. But now we have a way to eliminate guesswork. When the mathematical basis for the increase is worked out, a simple rule emerges.

We can phrase this rule in the following terms:

> *At competitive equilibrium, a cost reduction should be reinvested in marketing effort in proportion to the increase of the unit manufacturing margin.*

This rule of thumb covers exactly what is relevant in the question and what the quantitative relationships are. (Because of the rule's importance, I have worked it out in some detail in the Appendix.) In addition, by omission, it points up all the irrelevant things which one might be tempted to consider in connection with the problem. This is an important virtue of the scientific approach: it makes it possible to stop worrying about elements of a problem which are really inconsequential.

In the example I have presented, it is completely unnecessary for Brand A managers to know Brand B's manufacturing or marketing costs. As a matter of fact, Brand A managers do not have to know *anything* about their competitor. The key matter is the increase of the unit manufacturing margin, and the required action is to reinvest a proportionate increase in the marketing effort.

This rule meets the requirements we originally set down; it depends only on marketing *observables*, and it connects possible marketing *actions* with visible marketing *results*.

Thus we have seen that it is possible to apply scientific reasoning to a dynamic and competitive marketing situation. For that reason, we can be confident that marketing can increasingly become a science.

APPENDIX

RULE FOR REINVESTING SAVINGS IN MANUFACTURING COSTS

In the example given earlier, we assume a fixed total market in sales of \$2,000, split between two brands, A and B. In addition, we assume that:

1. Share of marketing effort equals share of market.
2. Manufacturing costs are a constant percentage of sales for each brand, say a and b. Using the values in our example, a is equal to 50% or 0.5 at all times, and b is equal to 0.5 at the beginning and 0.4 later on.

Let x and y be the marketing effort (in dollars) expended by A and B, and let P and Q be their profits. Then P and Q can be built up as consequences of strategies x and y in the choice of levels of marketing efforts. The generalized balance sheets in TABLE A are developed as in the preceding exhibits (I–V).

TABLE A. GENERALIZED BALANCE SHEETS

	A	*B*
Marketing effort	x	y
Sales volume	$\frac{x(2{,}000)}{x+y}$	$\frac{y(2{,}000)}{x+y}$
Manufacturing costs	$\frac{x(2{,}000)a}{x+y}$	$\frac{y(2{,}000)b}{x+y}$
Profit	$\frac{x(2{,}000)(1-a)}{x+y} - x$	$\frac{y(2{,}000)(1-b)}{x+y} - y$

That is, we have expressions for the profits as:

$$\text{(1A)}\quad P = 2{,}000(1-a)\frac{x}{x+y} - x$$

$$\text{(1B)}\quad Q = 2{,}000(1-b)\frac{y}{x+y} - y$$

The problem of the marketers is now to pick x to maximize P and y to maximize Q. But B's choice of y affects A's profit P, and A's choice of x affects B's profit Q.

For any fixed value of y, the values of P, as they depend on x, describe a dome-shaped curve, as shown in CHART A. (We assume that B's marketing effort is fixed.) A's profit P has a maximum value at x^o.

It can be shown, by differentiating P with respect to x, that to get this maximum value of x^o, A must choose x to satisfy the following maximizing equation:

$$\text{(2A)}\quad 2{,}000(1-a)y = (x+y)^2$$

Similarly, it can also be shown, for any fixed value of x, that to maximize profits, B must choose y to satisfy the equation:

$$\text{(2B)}\quad 2{,}000(1-b)x = (x+y)^2$$

When equations 2A and 2B hold simultaneously, A and B are maximizing their profits against each other's strategies; they are at competitive equilibrium. By equating these expressions, we find:

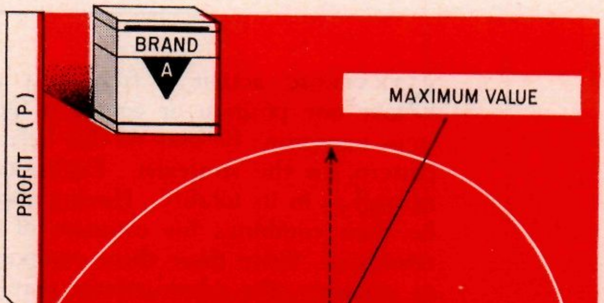
$$2{,}000(1-a)y = (x+y)^2 = 2{,}000(1-b)x$$

An immediate consequence of this is the following relationship:

$$\text{(3)}\quad \frac{x}{1-a} = \frac{y}{1-b}$$

This equation states that the marketing efforts at competitive equilibrium are proportional to the unit manufacturing margins (1–a and 1–b) of the two brands.

CHART A. RELATION OF PROFIT TO MARKETING EFFORT FOR BRAND A



By further substituting equation 3 into equations 2A and 2B we find, after some algebra, that:

$$\text{(4A)}\quad x = 2{,}000\frac{(1-a)^2(1-b)}{(2-a-b)^2}$$

$$\text{(4B)}\quad y = 2{,}000\frac{(1-a)(1-b)^2}{(2-a-b)^2}$$

These are the levels of marketing effort which achieve competitive equilibrium for the brands.

Finally, we substitute these marketing efforts into the profit equations 1A and 1B to find, after some simplification, that:

$$\text{(5A)} \quad P = 2{,}000 \frac{(1 - a)^3}{(2 - a - b)^2}$$

$$\text{(5B)} \quad Q = 2{,}000 \frac{(1 - b)^3}{(2 - a - b)^2}$$

Now let us apply these formulas to our case example. When $a = .5$ and $b = .5$, equations 4A and 4B become:

$$x = 2{,}000 \frac{(.5)^2(.5)}{(2 - .5 - .5)^2} = 250$$

$$y = 2{,}000 \frac{(.5)(.5)^2}{(2 - .5 - .5)^2} = 250$$

These are the marketing efforts used in Exhibit III. Similarly, when $a = .4$ and $b = .5$, equations 4A and 4B become:

$$x = 2{,}000 \frac{(.6)^2(.5)}{(2 - .4 - .5)^2} = 298$$

$$y = 2{,}000 \frac{(.6)(.5)^2}{(2 - .4 - .5)^2} = 248$$

Note that these are the figures for marketing effort used in Exhibit V. The remainders of the balance sheets at competitive equilibrium in the exhibit follow directly.

IMPLICATIONS FOR STRATEGY

In order to derive the rule of thumb, notice how the marketing effort x in equation 4A depends on the unit manufacturing margin (1–a). The derivative or rate of change of x with respect to the manufacturing margin is:

$$\frac{\partial x}{\partial (1 - a)} = \frac{4{,}000\,(1 - a)\,(1 - b)^2}{(2 - a - b)^3}$$

This equation can be rewritten, using equation 4A again, as:

$$\frac{\partial x}{\partial (1 - a)} = \frac{2(1 - b)}{(2 - a - b)(1 - a)}\, x$$

Now, when a and b approach equality (as one could expect in a competitive industry), notice that:

$$\text{(6)} \quad \frac{\partial x}{\partial (1 - a)} \rightarrow \frac{x}{1 - a}$$

In words, this equation states that the percentage change in marketing effort at competitive equilibrium approaches the percentage change in the unit manufacturing margin. This is the rule of thumb described earlier for determining the most profitable follow-up reinvestment of a manufacturing cost reduction in marketing effort. Note that this is a rule of thumb, not an exact relationship.

Other relations are also immediately available from equations 5A and 5B. For example, if the profits of Brand A are divided by the profits of Brand B, the following equation results:

$$\text{(7)} \quad \frac{P}{Q} = \left(\frac{1 - a}{1 - b}\right)^3$$

In words, this equation states that an advantage in the ratio of unit manufacturing margin can be cubed in profits. Such a parlaying of small edges into large advantages bears out general experience in marketing competition.

Strategic action is frequently *contradictory.* The administrator may take one position or course of action today and reverse his attitude or steps tomorrow; he may do this *here* and that *there.* Yet this is the "logical" pattern for the strategist. Each situation must be seen in all its specifics as well as in its totality. Having appraised it in this comprehensive manner, he then combines his estimate of the situation with his prejudices and resources. Since these three components can differ radically from situation to situation, the administrator may not often take the same action. Many opposites appear in nature such as night and day, love and hate, high and low. This is also true in administration. For example, the administrator is faced with expanding or contracting product lines, increasing or decreasing costs, and adding or dropping personnel. He analyzes and does what he thinks best with the resources available. There is no set of simple, rigid principles to follow except those of basic morality. Of course, one does not wish to paint strategy as the rule of disorder. On the contrary, it is a calculated plan to obtain optimum results by a synthesis of the available components. In this sense strategy means order but a different order, if necessary, in each situation. This basic truth should not be obscured by the essentially "zig-zagging" appearance of the strategist in operation. The administrator gives or withholds information; he attacks or retreats; he is aggressive or passive. The state of contradiction is inherent in strategy.

Clyde T. Hardwick and Bernard F. Landuyt, *Administrative Strategy*
New York, Simmons-Boardman Publishing Corporation, 1961, pp. 12–13.

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