ADVERTISING DECISIONS*

David B. Montgomery** and Glen L. Urban**

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David Bruce Montgomery

Glen Lee Urban

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by

David B. Montgomery

and

Glen L. Urban

Sloan School of Management

Massachusetts Institute of Technology

CHAPTER 4

ADVERTISING DECISIONS

Advertising and promotional expenditures have become significant in
the marketing of many products. In 1966 about 16 billion dollars was
spend on advertising alone. This expenditure is made because advertising
has a vital communication function to play in marketing as part of the
overall communication mix the firm utilizes to inform and convince
customers of the desirability of its products. The discussion in this
chapter will be largely restricted to advertising decisions, but the
management science techniques discussed are also relevant to other
promotion and communication decisions.

The marketing manager faces many decisions in advertising. Some
of these decisions are shared with his advertising agency, but he and
his technical advisors should have an understanding of each decision
area in order to insure the quality of the decisions. In advertising,
decisions must be made regarding the goals of the advertising expenditure,
the appeals to be used, the size of the overall budget, the media to be
used, and the copy to be employed. These decisions are interrelated.
For example, the media schedule cannot be determined until the budget is
specified, but the effectiveness of the schedule may affect the budget
necessary to achieve the specified goals. It would be desirable to specify
all these decision solutions simultaneously, but this is an extremely
complex problem. To relieve this complexity, advertising decisions may
be placed in a hierarchy. In Figure 4-1, an order of decision making is

outlined. In given decision situations, this hierarchy may be varied.
For example, the budget may be determined before the specific appeals are
identified, but the budget decision must be made with some estimate of
the probable effectiveness of the appeals that will be created. Likewise,
media decisions will reflect copy considerations, since the size of the
ad will be a factor in determining media schedules. For purposes of
exposition this hierarchy will be utilized in this chapter. As decisions
are discussed, the interrelations between them will be developed.
In Figure 4-1 certain of the important interactions which are exceptions
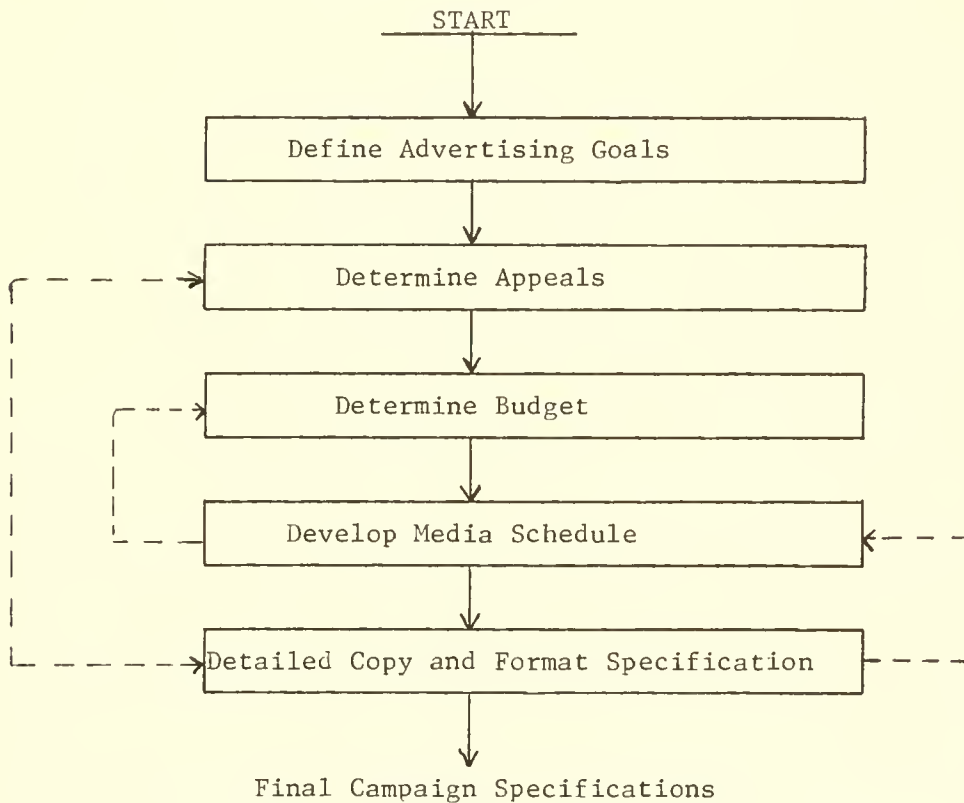to the hierarchy are denoted by dashed lines.

FIGURE 4-1

HIERARCHY FOR ADVERTISING DECISIONS

4.1 Determination of Advertising Goals

In its widest context advertising should be viewed as an investment,
so the goal of advertising should be to maximize the returns on the
investment. This implies a measurement of the profit implications of
advertising expenditures. This is the most desirable goal, but the
problems in identifying profit effects are considerable. In an effort
to express the goal of advertising in measurable terms, several alter-
native criteria have been suggested. In Table 4-1 a list of possible
advertising goal criteria is given. The criteria are listed in order
of increasing relevance to the investment decision, but this listing also
is one of increasing measurement difficulty.

I.   Exposure

   A.   Total Exposure

   B.   Frequency (Impact)

   C.   Reach (Coverage)

II.   Awareness

III.   Attitudes

IV.   Sales

V.   Profits

TABLE 4-1

ADVERTISING GOAL CRITERIA

Exposure

The first criteria possibilities pertain to the exposure to advertising.
The exposure criteria refer to a relevant segment of the total population.

The relevant segment is a target group of people who are potential and desired customers. For example, a target group may be all men between 25 and 35 with incomes above $8000. The exposure criteria attempt to measure various levels of exposure to advertisements within given target groups. The definition of target groups is necessary before meaningful advertising goals can be established. This relates to overall marketing strategy decisions. In the remainder of this chapter it will be assumed that the target group (or groups) is known.

The three principal exposure criteria which have been proposed are total exposures, frequency (impact), and reach (coverage). While these have been termed exposure criteria, a more descriptive term might be "potential" exposure. This more descriptive label reflects the fact that exposure measures generally reflect exposure to the medium which contains the advertisement. This is something different than actual exposure to the ad. For example, a subscriber to a particular issue of _Time_ magazine will have had potential exposure to all ads in that issue, yet he may, in fact, only have been actually exposed to a few of those ads - those in the pages which he happens to glance at or read. Special studies may be used to estimate the extent of this audience shrinkage. Data from these studies may then be used to adjust exposures. In the remainder of this discussion the term exposure will be used to denote either potential or adjusted exposures. Time, cost, and feasibility constraints will dictate which is used in any practical situation.

The total exposure is the sum total of the number of times any

advertisement relating to the product is seen or heard by target group

members in a given period. Letting

A_i = number of target group members in the audience of

medium i (i=1,...,I)

N_i = number of advertisements in medium i during the time

period of interest,

the total exposure to the $N_1,...,N_I$ insertions in the respective media

is given by

$$T_e = \sum_{i=1}^{I} A_i N_i,$$

where T_e denotes total exposures.

The frequency or impact is the average number of advertisements for

the product seen by each member of the target group during the given

period. If there are M individuals in the target group, the frequency

is just

$$F = T_e/M$$

where F denotes frequency. Frequency is an important criterion measure

whenever the response to the product's advertising is thought to have an

"S-shaped" relationship to cumulative exposures or whenever there is

a threshold number of exposures required in order to trigger the desired

response (purchase) on the part of target group members.

The reach or coverage of advertising is defined as the total number

of people exposed to at least one advertisement relating to the product

in a given time period. The two subcategories of reach are cumulative

audience and net coverage. They are defined as :

Cumulative audience = the reach of two or more issues of a given medium,

Net coverage = the reach of a combination of single issues of two or

more media

For example, cumulative audience would refer to the total number of target

group members who will be exposed at least once when successive weekly

insertions are made in <u>Life</u> magazine. Net coverage would refer to the total

number exposed at least once when insertions are made in single issues

of <u>Life</u> and <u>Time</u>. In order to encompass both cumulative audience and net

coverage in the discussion below, a medium will be defined as a single

insertion.[1] For example, two successive insertions in Life could be

considered as two separate media in this discussion.

Reach measures the number of <u>different</u> people in the target group who

are exposed one or more times to a given campaign in a set of media.

For the case of two media, say media 1 and 2, the reach of a single

insertion in each medium will be

$$R = A_1 + A_2 - A_{12}$$

where $\quad$ R = the reach or number of persons exposed to one or

more of the two insertions

A_{12} = the duplication between medium 1 and medium 2

and A_1 and A_2 are as previously defined. Note that A_{12} measures the extent

of overlap in exposures within the target group between the two insertions.

That is, A_{12} represents the number of target group members who will be

exposed to both ads. For insertions in three media, the reach will be

$$R = A_1 + A_2 + A_3 - A_{12} - A_{13} - A_{23} + A_{123}$$

where A_{123} = the triplications among media 1,2, and 3

(i.e. the number of target group members who

will be exposed to the ads in each of the

three media).

In general, for I media the expression for reach will be

$$R = \sum_{i=1}^{I} (-1)^{i-1} A$$

where $A^1 = \sum_{i=1}^{I} A_i$ = total target group members in the audiences

of media 1,...,I

$A^2 = \sum_{i=1}^{I} \sum_{j=1}^{I} A_{ij}$ = the total of all pair wise duplications

of the I media

$A^3 = \sum_{i=1}^{I} \sum_{j=1}^{I} \sum_{k=j}^{I} A_{ijk}$ = the total of all triplications

$A^I = \sum_{i=1}^{I} \sum_{j=1}^{I} ... \sum_{q=p}^{I} A_{ij...pq}$

These results follow from set theoretic considerations.

The equation for the reach of I media requires a great deal of data. For example, for I=5, it will be necessary to know (or have estimates of) the target audience overlap between each pair of media, each triplet of media, each group of four media in addition to the overlap among all five media and their individual total audiences in order to determine the reach of simultaneous insertions in each of these five media. The measurement problem involved is tremendous. Fortunately, it appears that short cut estimation procedures are useful. Agostini[2], utilizing an extensive French study of audience duplication, triplication, and up to 15-tuplication,

found that the total reach for magazine insertions may be estimated by

$$R = \frac{1}{k(A^2/A^1)+1} \quad A^1$$

This formula was found to be an excellent approximation to total reach for French magazines when K=1.125. The relation is also approximately true for American and Canadian magazines.[3] For a theoretical discussion see Claycamp and McClelland.[4] The Agostini formula is particularly useful in estimating reach for media where data for higher than second order replications among the media audiences is not available.

The criteria relating to exposure are relatively simple to measure since they depend only on readerships of various media, the number of insertions, and the total number in the target group. Making advertising decisions on the basis of exposure, however, assumes a direct relationship between the ultimate advertising returns -- profits -- and exposures to advertising.

Awareness

Exposure merely relates to the potential for having seen and noticed a particular ad. Awareness, on the other hand, implies some ability to recall an advertising message. Measures of ad awareness are available commercially through such services as Starch and Gallop-Robinson. These services use recall and aided recall techniques in surveys of potential readers of ads in order to determine the extent to which particular ads are noticed and remembered. Since awareness is somewhat closer to the ultimate sales and profit goals of advertising, it would seem that it might be a better prediction of the sales and profit effects of advertising

than exposure measures.

Attitude

Attitude changes may be used as the criterion by which advertising performance is judged. The firm may monitor attitudes related to specific product attributes or to overall attitudes such as brand, total product, and corporate images. Advertising may then be designed and evaluated in terms of attitude changes which the firm believes will ultimately enhance sales and profitability.

An interesting conceptual model of the progress of a consumer from unawareness through attitude change to ultimate purchase has been given by Lavidge and Steiner[5]. They postulate the hierarchy of effects illustrated in Figure 4-2 . The consumer is seen as passing from a lack of awareness about the firm's products to a state of awareness of the firm's offerings. Awareness is followed by knowledge of the product's characteristics. Advertising plays an informative role in both of these steps. In terms of liking, preference and conviction, advertising plays the role of persuader. It is at these steps that attitude change would seem to be an appropriate measure of advertising effectiveness. The final step, purchase, relates to the sales criterion discussed below.

While considerable progress has been made in attitude measurement[6], there are limitations in its use as a criterion of advertising performance. It is a relatively costly and time consuming procedure and the representativeness of the sample from which attitudes are obtained is often open to question in terms of generalization to the population of potential customers.

Purchase

```
┌─────────────────────────┐
│                         │
│      Conviction         │
│                         │
│      Preference         │
│                         │
│       Liking            │
│                         │
│      Knowledge          │
│                         │
│      Awareness          │
│                         │
└─────────────────────────┘
```
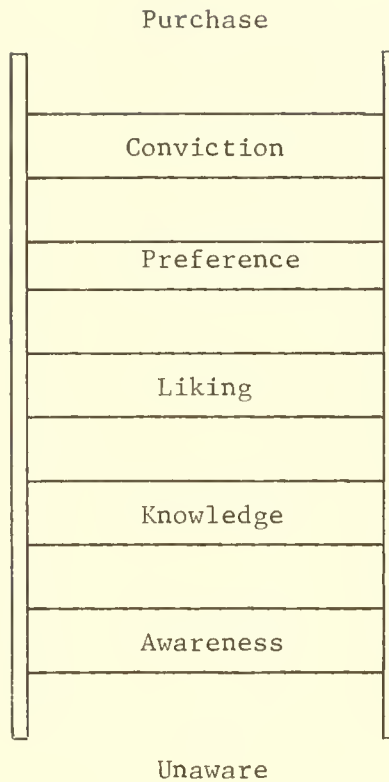
Unaware

FIGURE 4-2

HIERARCHY OF EFFECTS LEADING TO PURCHASE

In addition, the link between attitude change and sales is not direct in
that it is known that attitude change may follow a purchase rather than
precede it.[7]

Sales

Several researchers have used sales as a criterion to
evaluate advertising expenditures. For example, Benjamin and Maitland[8]
analyzed four different models of sales response to advertising using data
from five separate advertising campaigns. Although none of the models

provided a uniformly good fit to the data[9], the best sales response to

advertising relation was given by a logarithmic equation of the form

$$R = a \ln A + b$$

where $\quad\quad\quad\quad$ R = sales response to A

$\quad\quad\quad\quad\quad\quad\quad\quad$ A = advertising expenditure

$\quad\quad\quad\quad\quad\quad\quad\quad$ a,b = constants.

This relation was initially proposed on the basis of a priori reasoning

which suggested that advertising might be considered analogous to a

psychological stimulus and hence might be expected to have a logarithmic

relation to sales response, a relation which is common in psychophysical

research[10]. The empirical results which they obtained suggested that

    a. there is a threshold value of advertising expenditures

        (A) below which there is no appreciable response

        to advertising

    b. saturation (diminishing returns to advertising) eventually

        sets in

With reference to item a recall the discussion of the potential importance

of frequency as an exposure criterion when there is likely to be such a

threshold effect.

    Banjamin and Maitland have gone on to link the sales response to

profit. If

                r = profit margin per unit of product sold

                x = a proposed percentage increase in advertising,

then the increment in R,(ΔR), resulting from an increment in A,(ΔA), will be

$$\Delta R = a \, \ln \frac{A+\Delta A}{A}$$

and the criterion for increasing advertising by x per cent is

$$r \, a \, \ln(1-\frac{x}{100}) - \frac{Ax}{100} \geq K$$

where A is expressed in terms of cost and K is a prescribed minimum

increase in revenue.

In a later paper Banjamin, Jolly and Maitland[11] proposed a time response

function to an advertising pulse based upon an equation of the form

$$R = a \, e^{-bt} \, (1+ct)^d$$

where
                     R = weekly sales response following a single

                            advertising pulse,

                     t = time in weeks measured from the time of the

                            advertising pulse,

                     a,b,c, and d are constants which must be estimated.

The model was again posited on a priori grounds, this time by analogy to

epidemiological phenomena such as infection, incubation, and immunity.

The appeal of this epidemic analogy to advertising response is based upon

the intuitively appealing notions that:

1.   Advertising is concerned with the spread or diffusion of an idea,

2.   Some people may not be susceptible to the idea,

3.   It takes time for an idea to take root, and

4.   The ideas in an ad need not be simultaneously communicated to all

     persons in the community - i.e. there may be word of mouth trans-

     mission of the initial message.

While the fit of this model to their data was not especially good[12], they

concluded that "the data suggest a response distribution over time with a

very sharp rise to a maximum and a subsequent gradual decline."[13]

A significant problem in the measurement of sales response to adver-
tising is the likelihood that the sales response to an advertisement may
continue over many periods, perhaps even years. Palda[14] in an analysis
of the cumulative effects of advertising for Lydia Pynkham's found that
there indeed is such a carryover effect[15]. Behavioral mechanisms which
may generate such carryover effects / the fact that consumers may learn
to buy the advertised brand or product or the ad may convert them to
hard core loyal customers for the firm[16].

The attempts to establish sales-advertising relationships have been
plagued by statistical problems related to isolating the effects of
advertising. The problems involved in using historical data have been
lucidly discussed by Quandt[17]. After reviewing the pitfalls in using
cross-sectional models, single equation time series models, and simul-
taneous equation time series models, Quandt concludes that there is a
need to return to classical experimentation in order to measure the sales
effects of advertising. Buzzell[18] reported such an approach at du Pont.

In spite of the measurement problems involved, sales and profit
represent the best criteria for advertising goals if their dependency on
advertising can be established.

Summary on Advertising Goals

In selecting the criteria to be used in setting goals for advertising
a compromise is necessary between the accuracy of measurement and relevance
of the criteria in achieving the overall objective of maximizing the profit

produced by the advertising investment. If results and decisions are not to be judged on the basis of profits, then one must explicitly or implicitly assume a relationship between the response measured (e.g. exposure, aware-ness, attitudes) and profits. Given a relationship between profits and the criteria listed in Table 4-1, the overall goal of maximizing profits can be translated into more measurable criteria such as reach, frequency, awareness, attitudes, or sales. For example, the goal for advertising in a target group may be to create a specified level of awareness. This is meaningful if level of awareness was determined by a consideration of the relationship of advertising to awareness and awareness to attitudes and attitudes to sales so as to maximize the return on the advertising investment. The use of the more easily measured criteria will become more practical as lower levels of the decision goal hierarchy (see Figure 4-1) are reached.

Assuming that the overall goal of advertising is to maximize profits, this section has discussed how this overall goal could be expressed in terms of criteria that are more measureable. The price paid for the ease of measurement of the criteria is a difficulty in tracing the explicit effect of the criteria on advertising profits. Ignoring the problem of linking lower level criteria to profits is not satisfactory. A better approach is to attempt to make the relationships explicit rather than treating the relationships as implicit assumptions.

4.2 Creating Advertising Appeals

With a satisfactory set of overall goals and subgoal criteria in mind,

the next problem is to generate an appeal that will be most effective in achieving these goals. The creation of appeals to be used in advertising is based upon a sound understanding of the firm's consumer market. In particular the behavioral characteristics of the firm's target group for this campaign must be clearly identified and understood. These characteristics will include the psychological, sociological, and social-psychological factors affecting their behavior. Theories of consumer behavior based on notions of perceived risk, cognitive dissonance, images, social norms, economic utility, and personality will be relevant to this decision. It is not within the scope of this book to discuss these topics. Management science applications have largely been outside this area. This is perhaps because the factors do not lend themselves to quantification and because the problem is largely an exercise of behavioral science knowledge and creative intuition. Management science can be useful in evaluating alternate campaigns, but the creation of viable alternate appeals has largely remained outside the scope of management science efforts up to this time.[19] There is no conflict between the creative and research or management science aspects of this problem. Both functions are compatable; research and evaluation techniques will help place appeals in relative positions of effectiveness as well as suggest new appeals. The management scientist and the behavioral scientist must both display creativity in the generation and evaluation of the appeals.

4.3   Determination of the Advertising Budget

Once the appropriate appeals for a potential campaign have been

determined, the overall level of commitment to the campaign must be estab-
lished. While the selection of appropriate appeals may have required
preliminary judgment as to the approximate size of the campaign, the
optimal advertising budget must be determined at this stage.

The advertising budget will be optimized with respect to the goals
which have been established for the campaign. While several goal criteria
are available (as discussed in Section 4.1), budget determination generally
has a sales or profit goal as the optimization criterion. It should be
emphasized once again that long run profit maximization is the ultimate
goal even though a more measureable subgoal may be used as the explicit
criterion.

A Simple Model

In the simplest case current advertising is the only variable
affecting current period sales. That is,

$$q = f(A)$$

or quantity (q) sold in the current period is a function of current period
advertising (A). Letting p denote unit price, Pr denote total profit,
and C(q) denote the total cost of producing and marketing (exclusive of
advertising) q units during the current period, the total profit may be
expressed as

$$Pr = pq - A - C(q)$$

$$= p\, f(A) - A - C(f(A))$$

If q=f(A) and C(q) - C(f(A)) are differentiable functions and if there are
decreasing returns to advertising at some level of A, then classical

optimization procedures may be used to solve (4.3-1) for the profit max-
imizing budget level of advertising[20]. If variables other than advertising
affect demand, a multivariate version of this simple model may be developed[21].

Dynamic Models

If the advertising decision made in the present period will have
impact on sales and profits in future periods, the budget problem becomes
more complex in that it takes on dynamic aspects.[22] A simple model for
determining an advertising budget in the presence of carryover effects
is given by Julian Simon.[23] He assumes that revenues realized in future
periods due to an advertising expenditure in the present period will
decrease by a constant rate per period into the indefinite future. In
addition, there will be sales revenue realized in the present period even
if the present advertising budget is zero. This is due to the carryover
effects in the present period of previous advertising. If b denotes the
retention rate of sales revenue per period (i.e. b = 1-{constant rate of
revenue decline per future period}) and i denotes the firm's cost of
capital, the discounted present value in period t of all present and future
revenues generated by an advertising expenditure of A_t in period t is given by

$$PV(A_t) = \frac{1}{1-b(\frac{1}{1+i})} [\Delta R(A_t)]$$

where $\Delta R(A_t)$ represents the incremental net sales revenue generated in the
present period (period t) by the expenditure of A_t for advertising. The

sales revenue is the net of incremental gross revenue and production
costs. Profit from advertising in the present period is given by

$$Pr = PV(A_t) - A_t$$

The profit maximizing rule is to continue advertising in period t until the
increase in $PV(A_t)$ due to ΔA_t is just equal to ΔA_t. It should be noted
that this model concentrates upon a single period budget decision.

A more general formulation would look at the effect of advertising
decisions in each of a number of future periods and determine the optimum
on the basis of the dynamic effects of the series of decisions. The
reading following this chapter by Nerlove and Arrow attacks this problem
by allowing dynamic advertising effects to accumulate in a storage variable
called "goodwill". This goodwill is assumed to depreciate at a fixed
rate and advertising plays the role of replenishing it to the desired
level. Sales are assumed to be a function of the level of goodwill, so
the problem is to determine the optimum level of goodwill over time.
Then the optimum yearly advertising rate is equal to the depreciation of the
goodwill or the amount of advertising necessary to build the goodwill to
the desired level. To determine the optimum level of goodwill the classical
calculus model is applied with enough assumptions to assure that the
necessary conditions of the optimum are also sufficient. An interesting
finding that results from the study is that in the special case of

1. constant marginal costs of production,

2. a demand function which is linear in its logarithm,

3. a stationary environment, and

4. exogenous competition

the optimal advertising budget is a constant percent of sales. This is
a rule of thumb which has often been used by business and which has been
accused of "putting the cart before the horse" in the sense that advertising
is supposed to be a determinant of sales, not visa versa. It is interesting
that it proves to be optimal in this special case.

The Arrow and Nerlove formulation of incorporating inter-period
effects into a store of goodwill is one of a number of alternative dynamic
formulations. Forrester[24] has investigated some dynamic advertising
effects by considering advertising as a mechanism to borrow sales from
future periods. He gives particular attention to the amplified production
fluctuations and the related costs which may result from this borrowing
effect. However, his analysis does not lead to an optimum advertising
budget.

Vidale and Wolfe[25] have considered dynamic advertising effects in a
model which is based upon experimental evidence. In their studies for
several major industrial concerns they found that the rate of change in
sales may be related to advertising expenditures in terms of the following
differential equation:

(4.3-2)
$$\frac{dS}{dt} = [r\ A\ (M-S)/M] - \lambda S$$

where
S = rate of sales at time t

r = response constant (sales gnerated per dollar of
advertising expenditure when S=0)

A = rate of advertising expenditure at time t

M = saturation level (the maximum sales which can be
practically achieved via a given campaign)

$$\lambda = \text{sales decay constant (the proportion of sales}$$

$$\text{lost per time interval when A=0)}$$

Strictly speaking S and A should have a time subscript. The parameters
r, M, and λ are taken as constant for a given product and campaign. It
might be noted that λ is measured by observing sales declines in areas
where A has been set at zero for measurement purposes.

Equation (4.3-2) may be solved to yield the rate of advertising necessary
to maintain sales at a constant level $(\frac{dS}{dt} = 0)$ or at a specified growth
rate $(\frac{dS}{dt} = k)$. For example, to increase sales by k units per period,
the advertising for this period would have to be

$$A = \frac{(k+\lambda S)M}{(M-S)r} \qquad .$$

Vidale and Wolfe also present sales results for a constant advertising
expenditure for a period of length T and for a pulse campaign. (A pulse
is a short, intense advertising campaign.) For the constant campaign
of length T, integration of (4.3-2) yields

(4.3-3)
$$S(t) = [M/(1+\lambda M/rA)] \ (1-e^{-[(rA/M)+\lambda]t})$$

$$+S_o e^{-[(rA/M)+\lambda]t} \qquad \text{for } t < T$$

$$\overline{S}(t) = S(T)e^{-\lambda(t-T)} \qquad \text{for } t > T$$

where S_o is the rate of sales at t=0, the start of the campaign. The total
additional sales generated by this campaign may be obtained from

(4.3-4)
$$\int_o^T S(t)dt + \int_T^\infty S(t) \ dt$$

where the integrands in (4.3-4) correspond to the appropriate functions

in (4.3-3). For a pulse campaign, assuming no saturation, the total add-

itional sales generated are

$$(4.3-5) \qquad \frac{M-S_o}{\lambda} \; (1-e^{-ra/M})$$

where S_o now denotes the sales rate just prior to the pulse campaign.

If (4.3-2) can be integrated for a particular campaign, a pulse or continuous

campaign, the resulting sales equation may then be optimized. Vidale and

Holfe then present an investment approach to advertising for the case of

a pulse campaign. For many potential campaigns the integration of (4.3-2)

may be analytically intractable. Numerical integration may be of help in

these instances. Numeric methods may also be necessary when optimizing the

resulting equation relating sales to advertising.[26]

Competitive Models

The models describe above are rather powerful if the relationship

between sales and advertising can be estimated, if the equation for

optimality can be solved, and if a sufficiency check is feasible.[27]

Even if these conditions are satisfied they suffer another limitation.

They treat competitive effects as exogeneous variables. This is not

justified in most marketing situations. Competitive promotional effects

are not as important when:

1. the firm is a monopoly (competition does not exist),

2. there is pure competition (no advertising exists),

3. the firm is the industry leader with respect to advertising in the

    sense that other firms copy its promotional leads.

In the latter case the firm could set a promotional level such that the industry level would be the equal to the monopoly level. In most cases competitive response[6] are important because the markets are characterized by imperfect competition.

The simplest advertising model which incorporates competitive effects is the one in which advertising does not affect total industry demand but does affect a firm's market share. In this model relative advertising expenditures are assumed to determine the share of market gained by each of the N firms in the industry. Thus market share for firm i may be expressed as

(4.3-6)
$$MS_i = \frac{A_i}{\sum\limits_{j=1}^{N} A_j}$$

where $\quad MS_i$ = market share of firm i

A_j = advertising expenditures of firm j.

This simple model may be extended to account for differential sales effectiveness per dollar of advertising between the firms by raising each advertising term to a constant exponent. This yields

(4.3-7)
$$MS_i = \frac{A_i^{\varepsilon_i}}{\sum\limits_{j=1}^{N} A_j^{\varepsilon_j}}$$

where ε_i represents the sensitivity of the firm's market share to changes in the level of advertising expenditures. It is similar to the economist's concept of elasticity.[28] The ε_j exponents also reflect the fact that for each firm a given change in the level of advertising may have a different

effect on market share at different levels of firm and industry advertising. To determine a firm's sales simply multiply the total industry sales by the appropriate MS_i. Thus a firm's sales are a function of its own and its competitors' advertising budgets.

The problem of determining an optimum budget level is now complicated by the fact that the payoff for advertising expenditure is not only dependent upon how the market responds to advertising increases, but also upon how competitive firms will react. To analyze this problem, the first step is to construct a table describing your return to advertising for each of the competitors' possible reactions. The market share equation can be used to determine the net profits for various advertising levels. For example, if two competitors were present, the table might appear as in Table 4-2. To specify the best advertising level some decision rule must be specified. If one firm knew what its competitor was to do, then the firm could choose its best alternative. This is usually not the case. Rather, the firm is faced with a budget decision under conditions of uncertainty.

		Firm Two: Level of Advertising ($ in 000's)					
Net Payoff Table		100	200	300	400	500	600
	100	500	400	300	200	100	50
Firm One:	200	800	700	600	400	300	200
Level of	300	1000	900	800	700	600	500
Advertising ($ in 000's)	400	1200	1100	1000	850	700	600
	500	1300	1200	1100	900	800	750
	600	1300	1200	1100	900	750	700

TABLE 4-2

PAYOFF TABLE FOR FIRM ONE

Game Theory can be useful in selecting a strategy under uncertainty.[29]
Lawrence Friedman developed the first game theory models to deal with
advertising expenditure.[30] The models are based on dividing a fixed
market with various geographic areas between two firms. Games with two
players and a fixed total reward are called two person zero-sum games.
Friedman explored various plays--advertising levels -- either firm could
utilize if he knew what his competitor would do. For example, in Table 4-2,
if firm one knew firm two was going to spend $600,000, its best strategy
would be to spend $500,000 since it would receive $750,000 of profit at
this level.[31] That is the best he can do against this competitor's play
of $600,000. Mills extended Freidman's models by considering zero sum
games with more than two firms and by considering more realistic market
share terms (see equation 4.3-2).[32] In the game in Table 4-2 the strategy
that would guarantee the highest reward to firm one (the maximum strategy)
would be an expenditure of $500,000. The competitor must also make a decision
about his strategy. If his payoff matrix is identical to firm one's, he
would also choose $500,000, and since neither firm would see an alternative
that would increase their rewards given that the competitor holds his
strategy, an equilibrium would exist. The effects of various
decisions and the existence of stable equilibriums can be investigated by
the aid of a computer. Refer to Shakum's paper following this chapter
for an example of a game analysis of an advertising situation, the deter-
mination of optimal level of advertising, and considerations of stability
and the rate of convergence to equilibrium.

Adaptive Models

Little has developed a model for the adaptive control of advertising expenditures. His paper is included at the end of this chapter. The adaptive model uses continuous market experimentation to sense changes in market response to advertising. The term "continuous market experimentation" indicates that experiments are designed and performed in each period in order to detect market changes. The model provides for an optimal experimental design in each period.

On the basis of these experiments and past parameter values new estimates of advertising response characteristics are made. These characteristics are used to optimize the next period's advertising expenditure. Then new experiments are optimally designed for the next period so that a continuing experimental program is carried out. At the end of each period experimental results are integrated with past estimates, new response parameters are established, a new advertising budget is determined, and new experiments are designed for the next period.

Adaptive models are particularly useful in that they will sense and react in an optimal manner to changes in market response to advertising. They are also useful in sharpening the determination of the optimum budget even if the market parameters do not change. If the market is stable, the adaptive model will improve the estimates of the response parameters.

In its present state the adaptive model has certain limitations. For example, it ignores the possibility of carryover effects. In addition, competitive effects are only partially and implicitly encompassed. Current period competitive effects are not incorporated at all. For planning

periods of several months duration (which will be necessary in order to carry out the experimental measurements) this may be a serious shortcoming. However, competitive reactions which are lagged by one period are implicitly incorporated in parameter changes.

Stochastic Models

Stochastic models of consumer behavior can also be useful in advertising budget determination. A model using the concepts developed in the linear learning model of consumer behavior has been proposed by Alfred A. Kuehn.[33] He conceptualized sales as made up of three segments: sales due to habit, sales due to product characteristics, and sales due to advertising interacting with the product characteristics. Only the third segment is affected by the advertising expenditure. This advertising dependent section of the total sales function is dependent upon the industry growth rate, the lags between placing the advertising and achieving results, and the relative advertising market share effects. The cumulative profit function resulting from this sales function is quadratic with respect to the firm's advertising and may be optimized by classical methods. The model can be used to construct a competitive payoff matrix and the game theory concepts previously indicated can be utilized to find the best advertising budget.

Kuehn's model incorporated a parameter which represents sales decay just as the Vidale and Wolfe approach did. However, the brand shifting analysis incorporated in Kuehn's model provides procedures for estimating this decay constant without eliminating advertising. This is in contrast to the Vidale and Wolfe approach which require experiments using no

advertising in order to estimate the decay constant. In a competitive
advertising situation this is a clear advantage for the Kuehn model.

The potential to utilize consumer models in aiding the budget deter-
mination decision is great. Research should be directed at linking the
parameters for the consumer models to controllable marketing variables.
For an example see the Haines article reproduced at the end of Chatper 3
and discussed in the text. Linking the effects of the advertising
budget to the models would be helpful in the optimum determination of
the advertising expenditure.

Decision Theory

Statistical decision theory offers an alternative method of formulating
the budget decision problem. The probabilistic nature of both competitive
and market response can be encompassed within this framework[34]. Assuming
constant marginal utility for money (at least in the relevant range of
operation), the Bayesian criterion dictates choice of that level of adver-
tising which generates the greatest expected value of profits. The states
of nature in this case represent the joint occurrence of some particular
market and competitive responses. In order to compute the expected value
of some level of advertising, A, the conditional probability for each state
of nature given the level of advertising A is needed. In the Bayesian
framework these probabilities may be objectively based upon past data or
upon subjective estimates of the likelihood of various outcomes (i.e.
joint occurrences of particular market and competitive responses). In
addition to the probability of each outcome given the level of advertising A,

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the value (profits net of advertising A) of each outcome for the level A
must also be estimated by objective or subjective procedures. These
values are then multiplied by their respective probabilities and summed
over all outcomes to yield the expected payoff to the level of advertising
A. This procedure is repeated for each budget level under consideration,
and the one generating the greatest expected value is chosen. This
procedure develops the best budget level (in terms of expected profits)
among the budget levels being considered. A global optimum (the best
possible) budget will be chosen whenever the global optimum lies in the set
of candidate budgets. Whenever it does not, the procedure yields a
suboptimum budget level.

The Advertising Budget as Part of the Marketing Mix

Most of the models indicated above make budget determination recom-
mendations based on the assumption that advertising is the only variable.
This is an assumption that is usually not true. Price, channels of
distribution, and personal selling effort are a few of the other variables
important in the overall marketing program. Advertising is part of a
marketing mix and should be determined simultaneously with other elements
of the mix. For example, if price were changed the optimal advertising
level might change and vice versa. These marketing mix considerations and
efforts to obtain the optimum mix will be discussed in the chapter to
follow on pricing and new products.

Advertising may also be linked to the total marketing program when a
product line is offered by the firm. Shakum in the reading concerning

game theory discusses the coupled market effects of advertising. A full

consideration of these product interdependency effects will be deferred

to the new product chapter.

4.4 Specification of the Media Schedule

After the optimum budget has been determined, the next problem in

the advertising decision hierarchy is the selection of the media to be

utilized in the campaign.

Decisions must be made concerning the allocation of the budget between

radio, TV, magazine, newspapers, and outdoor advertising. In each of these

media, decisions must be made concerning the number of inserations in each

media, the timing of the insertions, and some preliminary designation of

the kind of insertion (e.g. full page color or half page black and white

magazine insertions). The output of the media decision is a schedule of

number, frequency, and kind of inserations in the media to be utilized.

The problem is to determine a media schedule which will optimize the effect

of the advertising budget allocation.

The first question to be resolved is what is the "effect" of the

advertising. What criteria will be used to measure the effects? Earlier

in this chapter several criteria were listed (see Table 4-1) and it was

stressed that the use of each of them required assumptions concerning how

it was linked to the overall goal of profit maximization. The choice of

criteria for the media selection problem is the same. The exposure criteria

are relatively easy to measure, but are removed from sales and profit

results. Reach and frequency are possible exposure criteria, but each has

different market implications. They cannot be maximized simultaneously

by one campaign.[35] Reach tends to assure that everyone receives at least

one message, while frequency is concerned with generating the greatest

number of exposures for each person in the target group. Reach may be more

appropriate during early stages of the campaign when a minimal awareness

in all segments of audience is desired. Frequency may be more appropriate

in later stages of the campaign when repeated exposures are needed to

move people closer to the purchase state.

Instead of being concerned with reach or frequency, media could be

selected to maximize total exposure. In this case the reach and frequency

are replaced by an overall criteria which reflects the total exposure

potential in the target market. The most desirable criterion would be

sales results of the media schedule. If the media can be selected to

maximize sales, a more direct link to profits is possible.

Using the profit criterion, the media problem is to find that media

schedule which maximizes profit. The schedule specifies the media to be

used, the number of insertions in each media in each time period, and a

preliminary guide to the copy to be used for each insertion (e.g. full page

color or black and white).

The problem is very complex. First, the media insertions must be

linked to sales results. With this linkage and with unit production cost

functions (perhaps non-linear), the profit results of the media schedule

can be calculated. The sales results of the campaign will be the result

of a number of factors. The sales response to each medium will probably

change as the number of insertions increases. This non-linearity will be compounded by the carryover effects of past insertions. In addition to replication over time, duplication between media in a given time period will affect the response relationships, as will the tendency for target group members to forget insertions with the passage of time. The sales response to media insertions may also be different for subsegments of the target group (e.g. geographic areas, income class, etc.). Even further complexity is introduced by the fact that sales responses may also depend upon competitor's choice of media.

The complexity of the sales response relationship is not the only barrier to simple solution of the media problem. The nature of insertions and media cost structures pose additional problems. For example, media insertions are necessarily integer values. One cannot purchase a fraction of a billboard facing or part of a full page ad without changing the nature of the/sales response. Furthermore, media discount policies are such that media costs, even over a restricted range, are not constant. In fact, the cost per insertion is usually a discontinuous function of the number of insertions which reflect the media's discount policy. The costs may be further complicated if the firm is placing ads for a number of its products in the same media. Then the cost per insertion is interdependent with media selections of other products in the firm's line.

If all the factors and complexities noted above were considered in resolving the media problem, a comprehensive solution would be produced. If this general problem were then solved, the output would be an optimum media schedule.

Using this general formulation as a reference, the past efforts to solve the media selection problem can be analyzed and placed in perspective. Three basic approaches have been made to the media problem: simulation, heuristic programming, and mathematical programming.

Simulation

The most comprehensive and detailed approach to analyzing the media selection problem is to utilize simulation. A micro-analytic simulation approach has been proposed by the Simulmatics Corporation[36]. In their model a given media proposal is analyzed in great detail. Each micro unit (individual) is sequentially exposed to each insertion in the media schedule over a time period. The simulated micro units have media habits and socio-economic and demographic characteristics which are representative of the national market. The output of the simulation is a summation of the effects experienced by each of the 2,944 micro units. The large number of micro units and the detail used in specifying each micro unit allows the generation of a comprehensive specification of the effects of a given media combination. The results of the campaign can be measured by the cumulative reach over time, the frequency of exposure over time, the total exposure, and the costs for each of these results. The results encompass the factors of replication, forgetting, media interaction, duplication, cost discounts, and non-linear response to integer media insertions.

Although a richness of output is obtained and all the desireable features of a media schedule are encompassed, there are two problems with this micro-analytic simulation approach. First, the results of the

campaign are in terms of exposure (e.g. reach, frequency, total exposure) so the relation to profit must be assumed. The second limitation of the Simulmatics model is that it does not solve the media problem. It only evaluates given media schedules. If enough schedules are tested information relevant to selecting the near optimum schedule would be generated, but the number of trials would be tremendous. To test a small problem of ten media over four time periods with ten insertion/periods, four hundred trials would be needed. The costs of the simulation approach expand very rapidly if it is used as a tool to search for the best media schedule. However, with a reasonable set of alternative media schedules, microanalytic simulation can be used to generate comprehensive data concerning the outcome of each campaign. Hence it is an evaluative procedure which may assist the decision maker in determining a satisfactory, but perhaps not optimum, media schedule.

Heuristic Programming

A number of attempts to specify the best media schedule have been based on heuristic procedures. A heuristic procedure is one that is useful in determining better solutions to a problem. Heuristic programming leads to good solutions, but it cannot guarantee that the optimal solution has been found.

Heuristic programming is the application of a heuristic rule to a mathematical model in an ordered fashion. In media selection three British authors have done substantive work in building models of the problem and developing heuristic rules to generate good solutions. Lee and Burkart

were the first authors to formulate mathematically the media problem in a meaningful fashion[37]. They clearly differentiated between the exposure criteria of impact (what we have called frequency) and coverage (what we have called reach) and developed mathematical relationships for them. In Lee and Burkart's first paper the maximization of the impact (frequency) of the campaign was attempted by a heuristic rule of purchasing advertisements in an inverse proportion of the square of the cost per thousand. The maximization of coverage (reach) was attempted under the assumption that the square of the proportion of the target group readership for a media divided by the cost for an insertion were equal for all media:

$$\frac{A_1^2}{C_1} = \cdots \frac{A_1^2}{C_i} \cdots = \frac{A_n^2}{C_n}$$

A_i = proportion of target group reading media i

C_i = cost of one insertion in media i (all media assumed to have a common insertion unit - e.g. full page ad)

They showed that there is an equilvalence between impact and coverage maximization under this assumption. The conditions for this equilvalence are not usually fulfilled, however. Later in the research and in the next paper Lee showed that in general it is impossible to maximize both the coverage (reach) and impact (frequency) simultaneously[38]. His analysis further stressed the differences between the two criteria and explored the implications of maximizing them separately. Lee suggested that a meaningful alternative would be to maximize one criteria subject to a restriction on the other. Taylor proposed a graphical heuristic procedure to derive

solutions to the problems Lee and Burkart formulated[39]. The procedure was
based on first determining the optimum size of ads for each media and
then specifying the number of insertions. The criterion function is a
combination of coverage and impact and represents a compromise between the
two criteria. The magnitude of the compromise is specified by a managerial
decision regarding the relative weights to be given to coverage and impact.
The number of insertions is determined by a graphical procedure which
attempts to determine the point where the marginal returns to the last
insertion is equal to the cost of the insertion for each media. The output
of the procedure is the number of ads to place in each media and the size
of each insertion. The last of the British papers was written by Lee and
considers the dynamics of media problems.[40] The criterion for this
formulation is awareness. Awareness is characterized by recall of the
advertisement. Lee postulates a mathematical rule of forgetting the
proportion of people who saw an insertion on day r and remeber it on day d
is hypothesized to be:

$$mq^{d-r}$$ where q<2 and m and q are memory parameters.

The total awaremenss is defined to be proportional to the total exposure.
The total proportion of the readership of media i who are aware of the
insertion during d is:

$$AU_i(d) = \sum_{r=1}^{d} A_i mq^{d-r}(1-P_i) \, P_i^{r-1} Z_i$$

A_i = proportion of target group reading media i

P_i = probability of not reading insertion

A_i = size of insertions

$AU_i(d)$ = awareness units associated with media i on day d

The criterion function is the total awareness on each day:

$$TAU(d) = \sum_{i=1}^{n} AU_i(d)$$

Lee formulated the problem as one of determining the schedule which will maintain at least a specified TAU for each day of the campaign at a minimum cost. This minimization may be done subject to constraints on the level of coverage and impact. Although Lee does not solve the problem he suggests approaches that could be used to derive solutions.

This series of four papers was a comprehensive mathematical exploration of the problems surrounding media selection. They explicitly defined the criteria and the relationships between them[41]. Although they did not explicitly link the criteria to profit, they indicated response relationships that could be used to do this. Their procedures were heuristic and lead to good solutions, but in general they could not be termed optimal.

During the time of the British work, an American advertising agency developed a heuristic model for media selection. Young and Rubicam developed a model they called the "High Assay Media Model"[42]. This model develops a media schedule based on purchasing media one unit at a time in each period. The first media insertion purchase is the one with the lowest cost per prospect reached. The criterion appears to be related to reach (coverage). After the first purchase the media exposure values are revised for duplication and the costs for the next insertion are changed if there is a media discount schedule. This cycle is then repeated. Marginal insertions are placed until a target exposure value has been reached for that period. This marginal approach is repeated for each time period so that the output

is a media schedule which meets target exposure requirements which have been set for each period. The determination of the target exposure values is presumably the result of demand considerations which incorporate the effects of the number of potential customers in the population, purchase cycles for the product, and brand switching rates. The media schedule is specified so as to meet the target exposure criteria at the least cost.

A similar heuristic for a media schedule has been indicated by Alfred A. Kuehn[43]. He suggests placing insertions one at a time based on the heuristic of adding the media with the highest incremental consumer impact per dollar.

The heuristic procedures outlined here allow considerable flexibility in comprehending the complexities of the media selection problem. They can consider the factors of inter and intra media replication, forgetting, cost discounts, non-linear response, and the integer nature of the problem, but they cannot guarantee an optimum solution to the media problem. They will, however, generate reasonable and usually good solutions.

Mathematical Programming

A number of attempts have been made to derive optimal media schedules by the use of mathematical programming. Rather than describe the some-what inconsistent chronological development of mathematical programming in media selection, the models will be presented in order of increasing sophistication and relevance.

The application of the simple linear programming model to the media problem requires a number of very restrictive conditions. Suppose, first,

that the problem is reduced from one of determining a schedule of placement

of insertions to one of specifying only the number of insertions to be placed

in each media in a given time period. Then a series of assumptions can

make the linear programming model applicable. If it is assumed:

1. The measure of effectiveness will be total exposure,

2. Responses to media insertions are constant,

3. Costs of media insertions are constant,

4. There are no inter-media interaction effects,

5. The number of insertions is a continuous variable, (i.e. it may

    take on fractional values).

With this set of assumptions and the problem reduction, the media problem[44]

is to

$$\text{Maximize: Total Exposure} = \sum_{i=1}^{I} R_i X_i$$

$$\text{Subject to} \quad \sum_{i=1}^{I} C_i X_i \leq B$$

$$X_i \leq L_i$$

$$X_i \leq 0 \qquad \text{for } i-1,\ldots,I$$

where X_i is the number of insertions in medium i,

C_i is the cost per insertion in medium i,

B is the total advertising budget available,

L_i is the physical limit of insertions in medium i,

R_i is the rated exposure value of a single insertion in medium i.

This formulation can be solved by linear programming computational

routines. In fact, this simple model can be solved without them or a

computer. The solution is simply to select the medium with greatest

rated exposure value (R_i) and purchase as much as possible in that media.

The limit being B or L_i. If the budget is not expended, purchase L_i in

the medium and then purchase as much as possible of the media with the next

highest rated exposure value (R_i). The result is optimal, but it represents

concentration of the budget in one or a few media. This is intuitively

implausible so users of the model were led to specify lower limits for the

number of insertions in each media (X_i). These artificial constraints

were added on the basis of judgment. The problem still could be solved

without a computer or linear programming. The procedure outlined above

would be followed except the lower limits would be satisfied first. After
                                        remaining
buying the lower limits, the/budget would be expended on the media with

the highest R_i. This would be carried to the upper limit of this medium

(L_i) or until the budget is expended. If the budget is not expended,

insertions are purchased up to the limit of the remaining budget in the

medium with next highest R_i.

The counter intuitive nature of the solution to the simple model is

largely due to the assumption that the rated exposure values are constant

(R_i). If the R_i are non-linear this conflict need not appear. The case

of non-linear R_i can be solved by linear programming. The procedure is

termed piecewise-linear programming and is based upon splitting the non-

linear problem into an equivalent linear problem[45].

Suppose that the total exposures relate to X_i as shown in Figure 4-2 .

The rated exposure value, R_i, is the slope of this function. A piecewise

linear approximation to this non=linear function may be obtained by taking

$$R_i X_i = R_i' X_i' + R_i''(X_i'' - X_{i1}) + R_i'''(X_i''' - X_{i2})$$

where the following constraints must be met:

$$0 \leq X_i' \leq X_{i1}$$

$$X_{i1} < X_i'' \leq X_{i2}$$

$$X_{i2} < X_i'''$$

The ability to form these piecewise approximations to the non-linear response function allows the problem to be solved by linear programming routines[46].
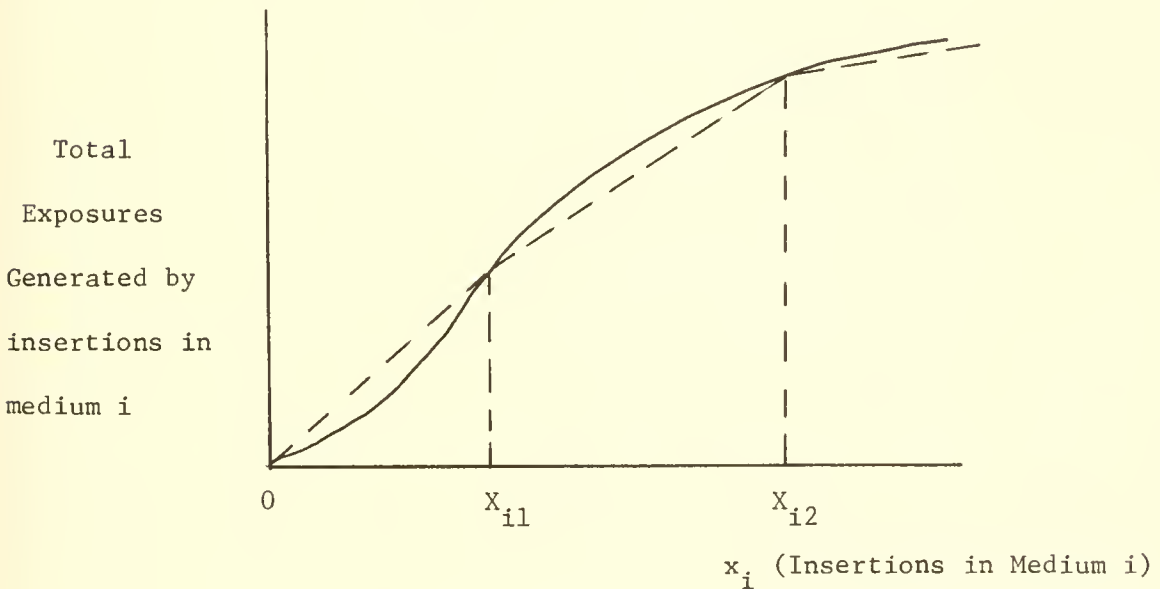

FIGURE 4-2

PIECEWISE LINEAR APPROXIMATION

A similar approach may be taken to media discount schedules of the form illustrated in Figure 4- . If the discount structure is of the form shown in Figure 4- , the piecewise approach won't work in that the discount

$$x_i^j = z(x_i^j) + \sum_{k} \lambda_{ik}(z_k) + \sum_{k} z_{ik}$$

where the following constraints must be met:

$$0 \leq z_i \leq z_i^{max}$$

$$\sum_i z_i = z_i$$

$$z_{ij} \geq 0$$

The ability to have local linearity approximations to the non-linear response function allows us to utilize an efficient linear programming routine.

applies to all previously incorporated insertions, thus changing the cost
coefficients for variables already in the solution.

Total

Cost

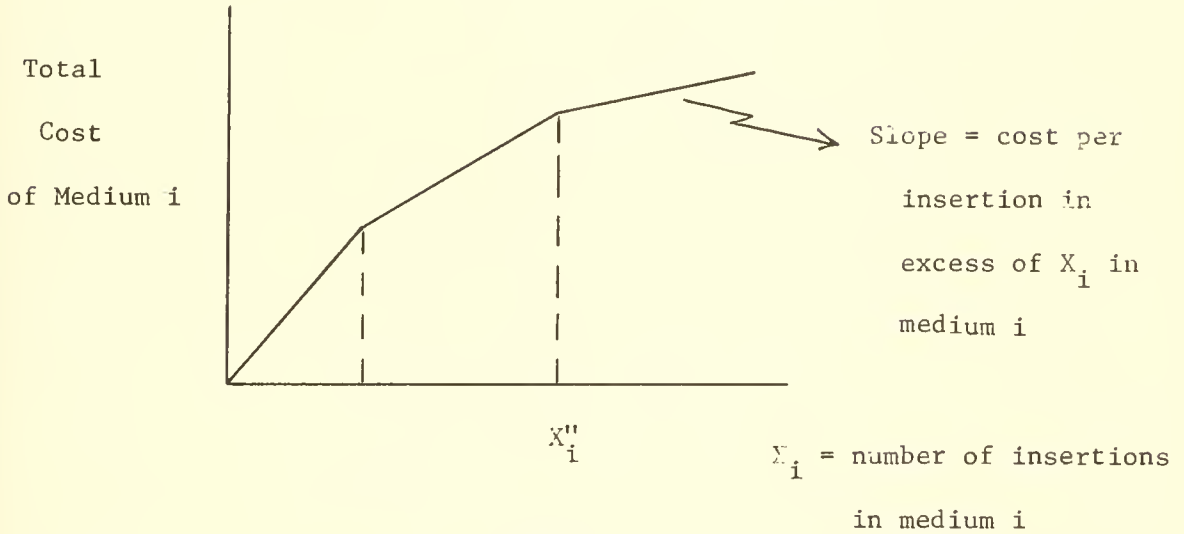of Medium i

Slope = cost per
insertion in
excess of X_i in
medium i

X_i''

X_i = number of insertions
in medium i

FIGURE 4-3

PIECEWISE LINEAR MEDIA DISCOUNTS

Total
Cost
of Medium i

Slope = cost per insertion in
medium i for $X_i \leq X_i''$.

X_i''
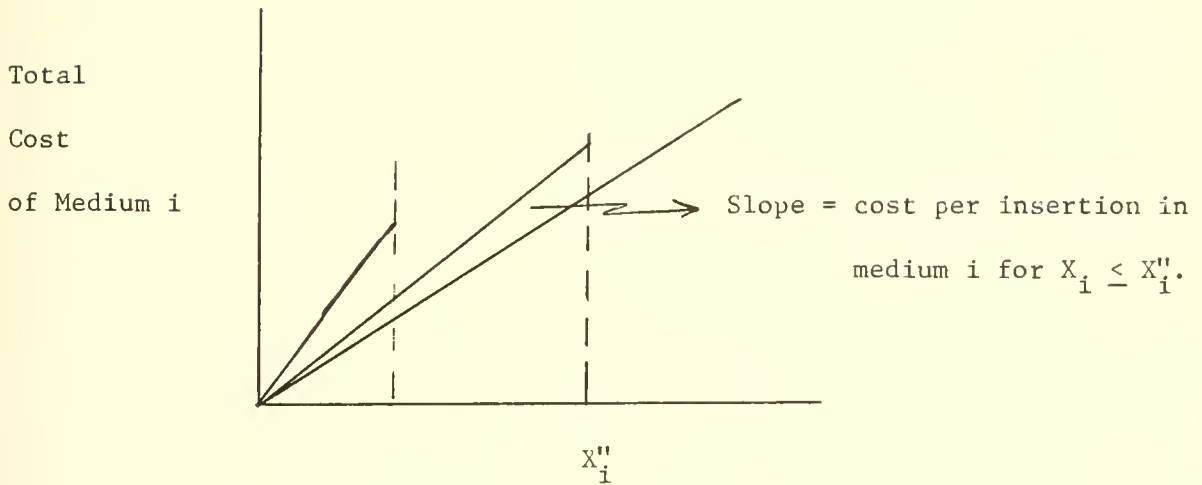
FIGURE 4-4

DIFFICULT MEDIA DISCOUNT STRUCTURE

The scheduling aspects of the problem can be added to the simple model by adding a time subscript to each X_i and defining the total exposure as the sum of $R_{it}X_{it}$ over each media (i) and over time (t).[47] This does not however, include the dynamic carryover effects of replication and forgetting.

A similar procedure can be used to add preliminary copy considerations to the model. X_{it} could be subscripted by a "j" to reflect size of color characteristics of the insertions. Alternatively, each i could index a particular medium, copy choice combination. For example, X_{1t} might be a four color, full page ad in _Life_ during time t, while X_{2t} might be a black and white full page ad in the same magazine.

The choice of criterion for the linear programming model is generally fixed as total exposure. This can be softened by adding constraints on reach. This follows the suggestion of Alec Lee cited earlier in the media selection discussion.

The nature of the LP model that allows the number of insertions to be fractional can be theoretically overcome by integer programming[48]. However, the computational effectiveness of these algorithms is generally poor. It is not feasible to consider this technique for most media problems, so unless new algorithms can be developed, the integer nature of the media problem remains beyond the comprehension of the linear programming model.

The linear programming model in its extended (piecewise linear) form is basically reasonable and yields optimal media schedules. The greatest disadvantages are: (1) the inability to deal with the integer nature of instertions; (2) the restrictive nature of the criteria of total exposure; and (3) the inability to comprehend the dynamic and cumulative effects

of forgetting and inter-media replication.

These three limitations can be overcome by the use of another mathe-
matical programming technique--dynamic programming.[49] Little and Lodish
have developed a dynamic programming model that uses sales as a criterion
for the media schedule. The model includes considerations of accumulation
of insertions and forgetting over time, as well as inter-media replications.
This is done by making sales functional upon the cumulative exposure level
of a market segment. The number of media, the timing of the insertions, and
the retention rate determine the cumulative exposure level. This model is
described in the readings that follow this chapter.

Although the dynamic programming formulation may face computational
limitations, it comes the closest to solving the general media problem
discussed earlier.[50] The only factor that has not been considered in any
of the work is the effect of competitors' media selections. If a competitor
uses a media heavily it may affect the response to the firm's insertions
in the media. Would it be wise to place insertions to counter your
competitor's insertions, to avoid media he uses, or to ignore his media
selection?

Summary

The problem of media selection has probably received more management
science research effort than any other single marketing problem. The
development followed several paths but it can be concluded that four
techniques are relevant:

1. Simulation models to evaluate the details of a given plan.

2. Heuristic procedures to develope a good media schedule.

3. Extended linear programming models to specify optimal plans when
    the criterion of total exposure is appropriate and dynamic carry-
    over effects are not important.

4. Dynamic programming models to specify optimal solutions when the
    computation problems are not overburdening.

The best model will depend upon the particular firm utilizing it. Having

all of the techniques available on an interactive time sharing system may

provide the ideal system. The manager could then use his intuition and

combinations of the models to solve the media selection problem.

4.5 Copy Specification

     The solution to the media problem is a schedule of insertions in various

media. The copy to be used in these insertions must be determined. Copy

is made up of two parts -- content and format. The content refers to what

the insertion communicates to the viewer. Content includes the design of

the photographic, artistic, and written sections of the insertion. This

will be directly related to the appeals selected earlier in the decision

hierarchy. In fact, the appeals decision probably was made with some

preliminary copy content in mind. The problem is now to design the final

copy content. While statistical techniques can be useful in testing

alternate copy content, the essential problem of design is a creative one.

Buzzell has reported that the quality of the message content and presenta-

tion (as measured by Schwein) are important factors in explaining changes

in market share.[51]

With the content in mind the detailed format decision must be made.
The format is concerned with the physical details of the insertion such as
size, color, bleed (white page margins), and exact positioning in media
(e.g. time of day for TV insertion). When the media problem is solved as
outlined in the last section, a preliminary specification of copy has been
determined. This is necessary because the number of insertions (X_{ijt})
referred not only to a particular media (i) and time (t) but also to a
copy parameter (j). This parameter could be page size or use of color
in the case of magazine media. These parameters refer to the preliminary
format of the copy. A number of other format characteristics must be
specified. In magazines for instance, the number of colors to be used,
position in the magazine, the use of the left or right page, headline
layout, and use of bleed must be determined.

The format variables should be determined so as to present the content
or appeal in the most effective way. The overall copy effectiveness will
be related to the effect it has on the consumer's attitudes and predis-
position to purchase the brand. The effect can be maximized by developing
the best copy possible and making sure it is seen. This second function is
partially dependent upon the format of the insertion. The format should
be designed to attract the attention of the reader so that full impact of
the copy appeal will be felt. The attracting power of the insertion could
be measured by the number of times an ad is seen. If the parameters of
format can be linked to the attention generating power of the ad, decisions
concerning the best format may be made. This linking has been attempted
by regressions of the attention gathering power of an ad to format parameters.

Twedt used the parameters of size of insertion, size of illustration, and number of colors in a regression of readership results of 137 advertisements in The American Builder.[52] These three variables accounted for about fifty percent of the variation in the criterion variable of ad readership. Yamanaka did a similar study for Japanese newspapers and explained eighty percent of the variance in readership.[53] The most comprehensive format regression study has been carried out by Diamond. His research is reported in detail in a reading following this chapter. The regression is based on Starch readership data and about one thousand Life magazine advertisements. The regression model was tested on an additional forty-three ads and it was found to explain about seventy percent of the variance in the number of people seeing (noting) the ad. The author then place the model on an on-line time sharing computer system. The interactive model called CAPMAF (Computer Aided Preparation of Magazine Advertisement Formats) can be used to estimate Starch scores for a particular advertisement or design a format for a given ad. In the design mode CAPMAF considers the readership and cost aspects in selecting the best format.[54]

These regression approaches are based upon an available store of past readership data. For media where this data is available the regression model can help design formats which will be most effective in calling attention to the insertion's appeal.

A word is in order on the interaction between advertisement format decision aids such as CAPMAF and the media models discussed in Section 4.4. Procedures such as CAPMAF and the other regression studies are capable of supplying necessary market response input to the media models. For

example, the effectiveness coefficients for black and white and for color ads may be estimated, as well as the effectiveness of various sizes (half page, full page, three page gate fold, etc.). These coefficients then enter the media model as input data. Thus the decision hierarchy is not an inviolable sequence, but rather is a useful framework in which to discuss advertising decisions.

4.6 A Note on Other Promotions

This chapter has directed itself exclusively to the subject of advertising, but advertising is only one of the elements in the total promotional mix. Personal selling is an element of the mix and is considered in Chapter 5. Price-deal promotions are considered in Chapter 6 on pricing. Promotions such as service, credit, and guarantee are considered as product variables and discussed in Chapter 8 on product decisions.

Packaging is not considered elsewhere, but the tools outlined in this chapter are directly applicable to the packaging decision. The total allocation of funds to packaging must be determined in a manner similar to the advertising budget. It could be considered as a separate budget or as one media channel in the allocation of the combined advertising and packaging budget. Package design is similar to selection of advertising appeals and copy specification. The design is constrained, however, by the physical package characteristics necessary for product protection.

Point of purchase displays are another promotional technique. They may also be analyzed by considering them as media in the advertising decision. Similarily, the distribution of free samples could be considered a

media channel with a particular copy. The copy is the sample physical good. The relative effectiveness of these promotions will be reflected in the funds allocated to them in the media selection decision.

4.7 Summary

In this chapter advertising decisions have been analyzed within a hierarchical framework. The first decision was to identify advertising goals, objectives, and measurement criteria. The profit generated by advertising was suggested as the ultimate goal, but the necessity of trans- forming this goal into measurable criteria was recognized. The measurable criteria of reach, frequency, awareness, or attitudes are suitable sub- goals, if they are determined by linking them to sales and the ultimate goal of long run profit maximization. With the profit goal in mind the next step is to create the best appeals for the advertising. Creativity is essential at this step. Management science procedures can help evaluate the relative effectiveness of appeals, but the creative nature of the process is the dominant factor. With the best appeal in mind the next decision is to determine the best advertising budget.

After specifying the advertising budget, it / must be allocated between the possible media. The determination of the best media schedule can be approached by simulation, heuristic programming, extended linear programming, and dynamic programming models. The criteria used for allocation may be related to exposure, awareness, or sales. In each case the criteria must be implicitly or explicitly related to the overall goal of profit maximization.

After the media schedule has been specified the detailed copy decision must

be made. Regression models and interactive computer aided format models

were discussed as decision aids at this stage.

The role of management science in advertising is to help structure

and utilize management's judgement and data to improve advertising decisions.

After the media schedule has been specified and adjusted your decisions must
be made. Regression models and interactive computer aided format models
were discussed as decision aids at this stage.

The role of management science in advertising is to help structure
and utilize managerial judgement and data in formulating advertising decisions.

Footnotes

[1] This procedure obviates the need to discuss each of the subcategories separately in the discussion below.

[2] J.M. Agostini"How to Estimate Unduplicated Audiences," Journal of Advertising Research 1, No. 3, (March 1961), pp. 11-14.

[3] John Bower, "Net Audiences of U.S. and Canadian Magazines: Seven Tests of Agostine's Formula," Journal of Advertising Research 3, No. 1 (March 1963), pp. 13-21.

[4] Claycamp, H.J. and McClelland, C.W., "Estimating Reach and the Magic of K," Working Paper No. 117, Graduate School of Business, Stanford University, December 1966.

[5] Robert C. Lavidge and Gary A. Steiner, "A Model for Prediction Measurements of Advertising Effectiveness," Journal of Marketing XXV (October 1961), pp. 59-62.

[6] See, for example, Torgerson, W.C., Theory and Methods of Scaling, (New York: Wiley), 1958 and Green, P. and Tull, D., Research for Marketing Decisions, (Englewood Cliffs, N.J.: Prentice-Hall), 1966.

[7] Raymond, C.K., "Must Advertising Communicate to Sell?", Harvard Business Review, (Sept.-Oct. 1965), pp. 148-159.

[8] B. Benjamin and J. Maitland, "Operational Research and Advertising: Some Experiments in the Use of Analogies," Operational Research Quarterly IX (September 1958), pp. 207-217.

[9] This best fitting form yielded a "goodness of fit" chi square value of 57.09. With seven degrees fo freedom, a chi square this large means that the null hypothesis that the model predictions and the data are not different from each other may be rejected at a very high level of significance (far in excess of the 0.01 level for which the chi square is 18.475).

[10] For a discussion of psychophysical laws and their relation to measurement and scaling see S.S. Stevens " Measurement, Psychophysics and Utility: in Churchman and Ratoosh (Ed.) Measurement: Definitions and Theories, (New York: Wiley), 1962. It might be noted that such a logarithmic relations has been found to be a good fit for message diffusion in sociological research.

[11] B. Benjamin, W.P. Jolly, and J. Maitland, "Operational Research and Advertising: Theories of Response," Operational Research Quarterly. pp. 205-218.

[12] This lack of fit occurred even though there were only three degrees of freedom for error. (The three degrees of freedom are the result of their starting with seven data points and estimating the four parameters, a, b, c, and d.)

[13] Op. Cit. pg. 213.

[14] Palda, K., The Measurement of Cumulative Advertising Effects, (Englewood Cliffs, N.J.: Prentice-Hall), 1964.

[15] For a review of research on the carry-over effects of advertising see Palda, K., "Op Cit."
and Tull, D. "The Carry-Over Effect of Advertising", J. of Marketing, Vol. 29 (April 1965), pp. 46-53.

[16] For example, see Kuehn, A.A., "How Advertising Performance Depends on Other Marketing Factors, "J. of Advertising Research, Vol. II (March 1962), pp. 2-10 and Harary, F. and Lipstein, B. "The Dynamics of Brand Loyalty: A Markovian Approach, " Operations Research, (Jan-Feb 1962). pp. 19-40 reprinted at the end of Chapter 3.

[17] Quandt, R.E., "Estimating Advertising Effectiveness: Some Pitfalls in Econometric Methods," J. of Marketing Research, May 1964, pp. 60-   .

[18] Buzzell, R.D., Mathematical Models and Marketing Management, (Boston: Harvard University Press), 1964.

[19] See E. Emmanuel, L.H. Klassen, and H. Theil, "On the Interaction of Purchasing Motives and Optimal Programming of Their Activation," Management Science
for an evaluation approach based on probability model of appeal combinations.

[20] See the appendix on Classical Optimization. Second order optimality conditions should also be checked.

[21] For prices as a co-determinant of demand see Chapter 6. For the multivariate model see the Classical Optimization Appendix.

[22] For empirical evidence of the carryover or future effects of advertising
see Kristian S. Palda, The Measurement of Cumulative Advertising Effects
(Englewood Cliffs, N.J.: Prentice-Hall, Inc.). Palda uses an econometric
model (distributed lag) to measure these carryover effects. For
experimental procedures and applications see R.J. Jessen, "A Switch-
Over Experimental Design to Measure Advertising Effect", J. of Advertising
Research, Vol. I, No. 3 (March 1961) pp. 15-22 and P.L. Henderson, J.F.
Hind, and S.E. Brown, "Sales Effects of Two Campaign Themes", J. of
Advertising Research, Vol. 1, No. 6 (December 1961), pp. 2-11. These
two articles are reprinted in R.E. Frank, A.A. Kuehn, and W.F. Massy,
Quantitative Techniques in Marketing Analysis (Homewood, Ill: R.D.
Irwin, Inc.)

[23] Julian Simon, "A Simple Model for Determining Advertising Appropriations,"
Journal of Marketing Research (August 1965), pp. 285.

[24] Jay W. Forrester, "Advertising: A Problem in Industrial Dynamics,"
Harvard Business Review XXVII, (March-April 1959), pp. 100-111.

[25] M.L. Vidale and H.B. Wolfe, "An Operations-Research Study of Sales
Response to Advertising," Operations Research (June 1957), pp. 370-381.

[26] The equation describing the necessary conditions for optimality may
have to be solved by numeric methods. This is true for all classical
models which are not directly solvable in the form $\frac{d(Profit)}{dA} = 0$.

[27] See appendix on Classical Optimization for a discussion of the problem
of multiple solutions to $\frac{dPR}{dA} = 0$.

[28] The advertising elasticity of market share is the percent change in
market share divided by the percent change in advertising.

[29] See appendix on Game Theory for a discussion of various decision rules.

[30] Lawrence Freidman,"Game Theory Models in the Allocation of Advertising
Expenditures," Operations Research VI (Sept-Oct 1958), pp. 699-709.

[31] Note the game in Table 4-2 is not a zero sum game. The sum of the
rewards to the players is not constant.

32 Harland D. Mills, "A Study in Promotional Competition," in Bass et. all. (eds.) Mathematical Models and Methods in Marketing (Irwin, 1961), pp. 271-288.

33 Alfred A. Kuehn, "A Model for Budgeting Advertising," in Frank M. Bass, et. all. (eds.) Mathematical Models and Methods in Marketing (Irwin, 1961), pp. 315-348.

34 See Paul E. Green, "Bayesian Decision Theory in Advertising," Journal of Advertising Research II (December 1962), pp. 33-42, for additional Bayesian concepts related to advertising.

35 Alec M. Lee, "Decision Rules for Media Scheduling: Static Campaigns," Operational Research Quarterly, XIII, No. 3,

36 Simulmatus Media-Mix: General Description and Technical Description (New York: The Simulmatus Corporation), October, 1962).

37 A.M. Lee and A.J. Burkart, "Some Optimization Problems in Advertising Media," Operation Research Quarterly XI (September 1960), pp. 113-122.

38 Alec M. Lee, "Decision Rules for Media Scheduling: Static Campaigns," Operational Research Quarterly XIII (September 1962), pp. 229-241.

39 C.J. Taylor, "Some Developments in the Theory and Application of Media Scheduling Methods," Operational Research Quarterly, XIV (September 1963), pp. 291-305.

40 Alec M. Lee, "Decision Rules for Media Scheduling: Dynamic Campaigns," Operational Research Quarterly XIV (December 1963), pp. 365-372.

41 These differences are apparently not clearly understood. Oddvar Bie Mevik and Niels Vining in "Two Dimensions of Media Selection: Coverage and Frequency," Journal of Advertising Research VI (March 1966), pp. 29-35, propose a "principle of concentration through dilution." This is no principle at all, but rather the expected effect of changing from a basic criteria of coverage (reach) to one of total exposure.

42 This description is adapted from William T. Moran, "Practical Media Models - What Must They Look Like," Proceedings of the Eighth Annual Conference of the Advertising Research Foundation (New York: Advertising Research Foundation, 1963, pp. 578-594.)

[43] Alfred A. Kuehn, "Models for Budgeting Advertising" in Peter Langhoff (ed.) Models, Measurement, and Marketing (Englewood Cliffs, N.J.: Prentice-Hall), 1955, pp. 135-136.

[44] The following references discuss the simple LP model: Frank M. Bass and Ronald T. Lansdale, "An Exploration of Linear Programming in Media Selection," Journal of Marketing Research III (May 1966), pp. 179-187; R.D. Buzzell, Chapter 5 in Mathematical Models and marketing Management, Graduate School of Business Administration, Harvard University, Boston 1964; C.L. Wilson, "Use of Linear Programming to Optimize Media Schedules in Advertising", Proceedings of the 46th National Conference of the American Marketing Association, Henry Gomez, ed., 1963, pp. 178-191; R.L. Day, "Linear Programming in Media Selection" Journal of Advertising Research II (June 1962), pp. 40-44; J.F. Engel and M.R. Warshaw, "Allocating Advertising Dollars by Linear Programming," Journal of Advertising Research IV (September 1964), pp. 42-48.

[45] The following references discuss the piecewise extension: D.B. Brown and M.R. Warshaw, "Media Selection by Linear Programming," Journal of Marketing Research II (February 1965), pp. 83-88; M.L. Godfrey, "Media Selection by Mathematical Programming," Talk before the Metropolitan New York Chapter of the Institute of Management Sciences, October 10, 1962.

[46] See the appendix on Mathematical Programming for additional information about piecewise procedures.

[47] See Stasch, "Linear Programming and Space-Time Considerations", Journal Of Advertising Research, Vol. 4 (December 1965), pp. 40-47.

[48] W.I. Zangwill, "Media Selection by Decision Programming," Journal of Advertising Research V (September 1965), pp. 30-36.

[49] See Richard B. Maffei, "Planning Advertising Expenditures by Dynamic Programming Methods," Management Technology I (December 1960), pp. 94-100 for the underlying concepts of dynamic programming and this decision.

[50] The computational problems are produced when more than one target group subsegment is included in the optimization. See Little and Lodish's paper that follows this chapter.

[51] Robert D. Buzzell, "Predicting Short-Term Changes in Market Strategy as a Function of Advertising Strategy," Journal of Marketing Research I (August 1964), pp. 27-31. This article stimulated considerable controversy which is contained in the following comments and replies:

[52] Dick Warren Twedt, "A Multiple Factor Analysis of Advertising Readership", *Journal of Applied Psychology* XXXVI (June 1952), pp. 207-215.

[53] Jiro Yamanaka, "A Method of Prediction of Readership Score," *Journal of Advertising Research* II (March 1962), pp. 18-23.

[54] See Diamond's paper at the end of this chapter for details.