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Home Shopping Programs: How Long Should a Product Be on the Air?

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Introduction

"This is a tremendous buy!" asserts the sales personality on the Cable Value Network (CVN). "Just whip out your credit card—any card—and dial the toll-free number. You'll receive your merchandise within ten days in the comfort of your home!" In the meantime, the TV screen displays the product from every angle and the features are demonstrated in detail.

Sound interesting? Apparently a lot of people think so, because home shopping programs have recently taken the TV airwaves by storm. Some even compare it with the intensity and hypnotic power of MTV. Although some may consider it another fad that will quickly disappear, its potential for growth cannot be disputed. Media consultants Paul Kagan Associates (Carmel, California) estimate that the sales for this medium will grow from $450 million in 1986 to $2 billion by the end of 1987 and to $7.2 billion by 1991. Furthermore, *BusinessWeek* predicts that by late 1988 50 million Americans—representing more than 50% of all homes with TV—will be able to shop by video. An electronic marketing consultant goes so far as to say that "it has the potential to change marketing the way airplanes changed the travel industry." According to Jones Intercable, Castro Valley, California, about 6% of cable TV subscribers buy from home shopping services, of which 64% purchase once a month or more.

One of the most well-known and succesful shows is the Home Shopping Network Inc., Clearwater, Florida (HSN). After starting in 1985, HSN made profits of $30 million in its first year of national distribution (by end of August 1986) on sales of $160 million. Furthermore, its stock rose a whopping 800% in 1986. Although it is difficult to estimate how many actually watched the programs, more than 500,000 viewers bought goods from the company in the year ending August 1986. HSN states that its average club member places 15 orders a year at an average price of $32.

The success of HSN has spawned a host of other shows such as CVN (Minneapolis), QVC (Philadelphia), and VTV (New York). Also, retail giants such as Sears, Roebuck and J. C. Penney are scrambling to either enter into exclusive contracts with existing shows to carry their products or to start their own programs. All in all, there seems to be no arguing that this newly born and highly successful industry is making inroads into traditional retailing.

As the competition between similar programs increases, however, such programs must think about several factors that will give them the competitive advantage. These might be the offering of brand name items, competitive pricing, promotion, specialization of the product line in order to target a specific market segment, and convenient distribution. Along with the marketing mix strategies such as those mentioned above, another key factor for success is the efficient use of air time. That is, an important question to be addressed by the producers is how long each product should be presented on the air. In other words, what is the optimal number of products to be presented in a given period of time that will maximize the amount of incoming orders?

If the viewers of such programs are able to comprehend the nature of the product in a very short time and if there is no diminishing of the comprehension rate due to the cluttering of the presentations, the optimal strategy would be to cram as many products as possible within a given period of time. On the other hand, if it requires a long time for viewers to comprehend the nature of the products and if they do not become bored with the long presentation of the same product, it would be optimal to present one product for a long period of time. Obviously, the optimal presentation time must be somewhere in the middle.

This problem is a good example of the classic "newsboy problem." The newsboy problem concerns the decision facing a newspaper boy regarding how many copies of a newspaper he must purchase for stock every morning. He can minimize the risk of having unsold newspapers left at the end of the day—the cost of which he cannot salvage (of course this assumes that the publisher does not refund the leftovers)—by buying only a few newspapers each morning. However, by doing so, he might run out of stock and lose the opportunity to sell more. On the other hand, he can minimize the opportunity loss due to stock-outs by buying a lot of newspapers in the morning. However, this would also increase the chances of losing money on the unsold papers. Thus in making a decision, the newsboy must carefully balance between the risk of losing money due to overstocking and the risk of opportunity loss due to stock-out. In the present case, the producers of home shopping programs must balance between the need to let the viewers comprehend the product versus the need to minimize the chances of viewers becoming bored with the program.

In this chapter, we will attempt to statistically derive an optimal length of presentation time for each product based on a reasonable stochastic model of viewing behavior. Specifically, the model will consider two types of cognitive processes involved in viewing such a program, as well as the time required to achieve each. First, it will consider the time necessary for a given viewer to comprehend the product. Here, "comprehension" would mean not only having sufficient knowledge about the product but also having thought about the necessity, usage occasions, fit with one's lifestyle, etc., to initiate the process of deciding whether to buy the product. Second, it will consider the time it takes for a viewer to become bored from watching the same product being presented for a long time and thus become disenchanted with the program itself.

These two processes in conjunction with one another are closely related to the literature on the effects of message repetition on attitudes and purchase intentions (Sawyer, 1974; Belch, 1982). Most studies in this area show that messages gain in impact for a few exposures but that further exposures—beyond the point of "overlearning"—begin to have a negative effect.

For example, Ray and Sawyer (1971) conducted a laboratory experiment in which a sequence of advertisements were shown on television. The number of exposures to advertisements for different products were varied. Dependent measures were recall, attitude toward brand, and purchase intention. The results showed that exposure to advertising had diminishing returns such that the response curve of recall resembled the "modified exponential curve." Also, Miller (1976) studied the attitudinal and behavioral responses to various numbers of exposures to a poster on a social issue. Subjects were assigned to four exposure groups varying in the number of posters they were exposed to. The results also showed diminishing returns to exposure. This line of research takes the process view that while increasing exposure initially enhances learning (comprehending) and favorable attitudinal affect, subsequent exposures create tedium and negative affect (Berlyne, 1970; Stang, 1975). This leads to an inverted-U curve for repetition impact.

The implication of the results from this line of research is that the optimal presentation time of each product must be long enough to allow the maximum proportion of viewers to comprehend the product, while it must be short enough so that the minimum proportion will become bored and disenchanted.

The chapter will discuss the implications of the basic model and also discuss the factors that can be incorporated into the basic model in order to make it more realistic.

A Stochastic Model of Viewing Behavior

As described above, it is envisioned here that there are two basic events involved in the viewing of shopping programs. One is comprehension of the product and the other is becoming bored with the presentation. These two events can be modeled using a probabilistic modeling framework based on the following assumptions.

First of all, assume that the time until the comprehension event occurs (i.e., a viewer comprehends) is a random variable with a probability distribution function (p.d.f.) f(t) and a cumulative distribution function (C.D.F.) F(t). Also, assume that the time until a viewer becomes bored is also a random variable with a p.d.f. g(t) and a C.D.F. G(t).

Here, some general discussion about probability distributions is in order. The random variable of interest time (t) is obviously a continuous variable ranging from zero to infinity and thus the corresponding distribution functions are continuous functions. A probability distribution function (p.d.f.) is a function that assigns probabilities to values of a random variable where the probabilities are given by the area under the curve. For example, the probability of comprehending by the time $t=10$ is given by the area under the f(t) curve between $t=0$ and $t=10$. A cumulative distribution function represents the probability of the random variable taking on a value less than t. For example, the probability that boredom occurs at or before time $t=20$ is given by $G(t=20)$. So $G(t=20)$ is the area under the g(t) curve between $t=0$ and $t=20$.

Second, in our context it is assumed that the time until each event occurs followsexponential distributions with parameters θ for comprehension and μ for getting bored. An example of what exponential distributions look like in general is presented in figure 10.1.

As can be seen from figure 10.1, the parameter determines the shape of the curve. Thus, the two events can be represented by the following equations:

COMPREHENSION:

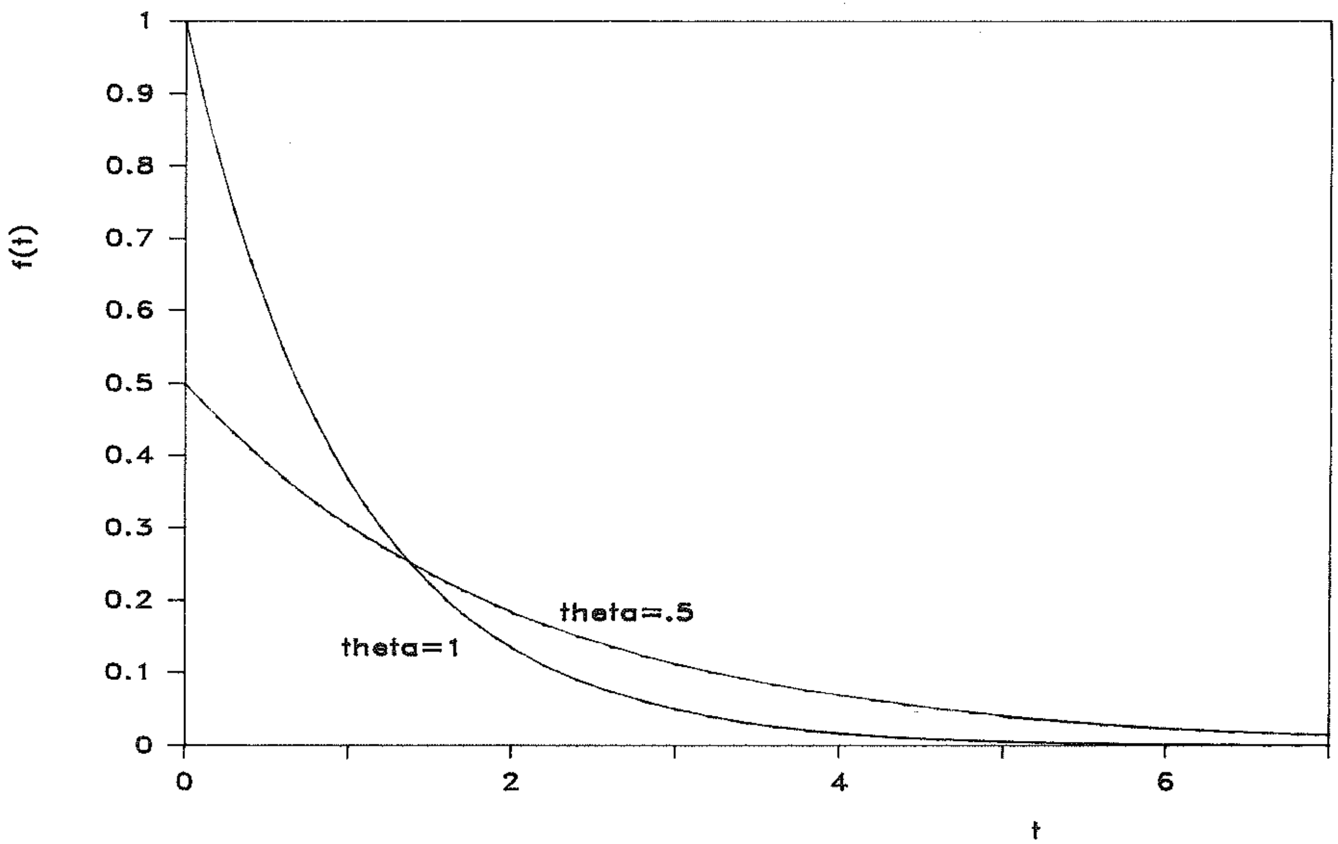
p.d.f.:	$f(t) = \theta^{-\theta t}$	$t>0$
C.D.F.:	$F(t) = 1 - e^{-\theta t}$	$t>0$

BOREDOM:

p.d.f.:	$g(t) = \mu e^{-\mu t}$	$t>0$
C.D.F.:	$G(t) = 1 - e^{-\mu t}$	$t>0$

Following the characteristics of exponential distributions, the mean times till comprehension and boredom are $1/\theta$ and $1/\mu$ respectively. Furthermore, the nature of the exponential distribution implies that events of compre-

Figure 10.1
Exponential Distributions
$f(t) = \Theta e^{-\Theta t}$



hension and boredom are random with constant likelihoods of occurring at each increment of time.

The third assumption that needs to be made is that these two random variables are independent of each other such that the occurrence of one event (e.g., comprehension) has no bearing on the occurrence of the other (e.g., boredom). This independence assumption leaves open the possibility that a person can get bored before he/she comprehends the nature of the product. This assumption is not unreasonable in that it is possible for a person who has never learned about or used a computer could become bored immediately when presented with a computer.

Fourth, assume that comprehension rates are the same for all products and, similarly, the boredom rates are also the same for all products. This last assumption implies that the optimal length of presentation time for one product will also be optimal for all other products. Thus, each product will be on the air for the same length of time.

Given this model of viewing behavior, the desirable event from the perspective of the producer is that the viewer comprehends the product but that he/she has not become bored in the process. The probability of this event is represented by the joint probability P(C, ~B) where C denotes the event of comprehension and ~B denotes the event of not becoming bored. Thus we are attempting to find the optimal length of presentation time that maximizes this probability. Let τ denote the length of the presentation of each product. Then, the probability $P^c(\tau)$ that a viewer comprehends the nature of the product by the end of the interval τ is given by:

$$P^c(\tau) = \int_0^\tau f(t)dt = \int_0^\tau \theta e^{-\theta t}\, dt = 1 - e^{-\theta\tau}$$

Furthermore, the probability $P^{\sim B}(\tau)$ that a viewer does not become bored by the end of the interval τ is given by:

$$P^{\sim B}(\tau) = 1 - \int_0^\tau g(t)dt = 1 - \int_0^\tau \mu e^{-\mu t}\, dt = e^{-\mu\tau}$$

Then, with the independence assumption, the joint probability P(C, ~B) can be represented by the product of the two individual probabilities:

$$H(\tau) = P^c(\tau)\, P^{\sim B}(\tau) = [1 - e^{-\theta\tau}]\, e^{-\mu\tau} \tag{1}$$

Figure 10.2 presents the graph of $H(\tau)$ when θ (comprehension rate) = 1 and μ (boredom rate) = 0.5. The inverted-U shaped curve indicates that as the length of the presentation time τ increases from 0, the desired probability P(C, ~B) increases but as τ becomes greater, it starts to decrease. So in the first range, as the length of presentation is increased, the increasing risk of boredom is more than offset by the increasing benefit of comprehension. Beyond a certain magnitude of τ (i.e., greater than the

Figure 10.2
The Graph of P(C, ~B) When Theta = 1 and Mu = 0.5

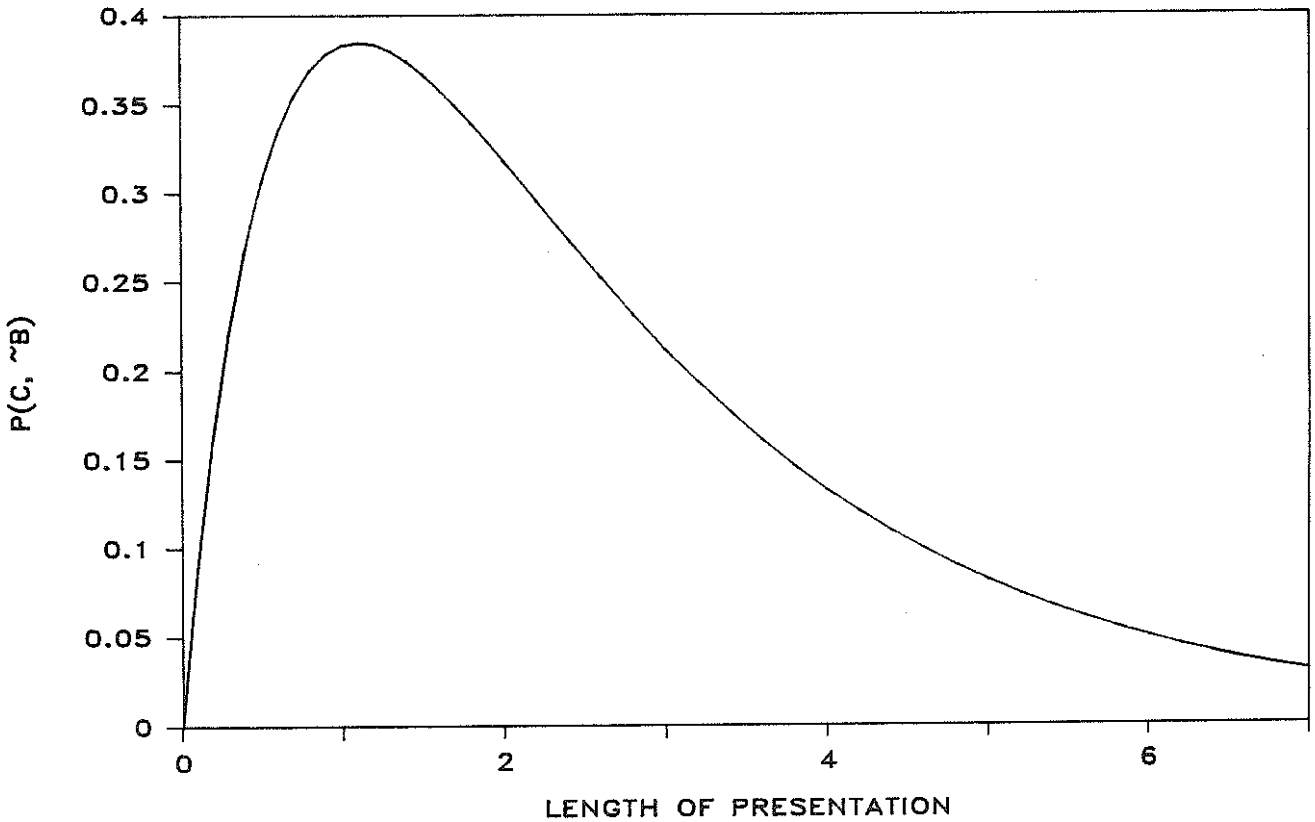


Table 10.1
Optimal τ and P(C, ~B)

	z							
	50	20	10	5	2	1	.5	.2
τ*	.079	.152	.240	.358	.550	.692	.810	.910
P(C,~B)	.907	.817	.715	.582	.385	.250	.148	.067

point at which the curve is the maximum) the opposite is true—further increases in τ will push up the risk of boredom much faster than the benefit of comprehension. The objective is to find the optimal length τ that will maximize equation (1) above. By differentiating (1) with respect to τ and setting it equal to zero, we can derive the optimal length of presentation τ^* (the derivation is given in the appendix):

$$\tau^* = -\ [\ 1/\theta\ ]\ \mathrm{Log}_e\ [\mu/(\mu + \theta)] \tag{2}$$

That is, finding the value of τ^* that satisfies equation (2) maximizes the probability of the desirable event of comprehension and no boredom.

Here, let's define z where z equals mean time until becoming bored ($1/\mu$) divided by mean time till comprehension ($1/\theta$). Thus, in our model, z is equal to θ/μ. This is a useful measure in tracking the properties of τ^* under various magnitudes of θ and μ. In a different context, Morrison (1981) has extensively shown the properties of τ^* under various magnitudes of z. Applying Morrison's findings to the problem at hand, we can make several interesting observations. Table 10.1 gives the values for τ^* and P(C, ~B) under various values of z. Note that τ^* here represents the optimal length of presentation as a proportion of mean time till boredom event.

When the comprehension rate is equal to the boredom rate (i.e., $\Theta = \mu$; z=1), the optimal length of presentation τ^* is equal to .692 (the unit of measurement depends on how the rates θ and μ were measured) and the probability of the desirable event (C, ~B) is .25. This means that the event (C, ~B) occurs only one-quarter of the time even when the product is presented for the optimal length of time. As z becomes larger (i.e., comprehension rate becomes larger relative to the boredom rate), the optimal length as a proportion of mean time until comprehension becomes smaller and the probability of the desired event (C, ~B) becomes larger. This says that as viewers take shorter and shorter times to comprehend, compared to the length of time needed to become bored, the program should devote less and less time to presenting each product, because doing so will increase the probability of the desired event. This is intuitively correct.

Possible Extensions of the Basic Model

Although the model above captures the essence of the problem, several factors can be incorporated into the model to make it even more realistic.

First, in all likelihood, the producers of such shopping programs are not out to maximize the probability given above. Rather, they are probably trying to maximize revenues or profits. If we denote the total length of the program as T, then for a given value of τ (length of each presentation), the number of products that will appear during the entire program is T/τ. So the longer the presentation length of each product, the fewer the number of products that will be presented during the program. Assuming that (i) once viewers achieve the event (C, $\sim$B) (i.e., comprehend the nature of the product and do not become bored in the process), they have a constant probability p of ordering the product, and (ii) all products have equal margins of m, the expected earning per product can be represented as:

$$P[C, \sim B|\tau] * m * p$$

and the total earnings during the program can be represented as:

$$[T/\tau] * P[C, \sim B|\tau] * m * p$$

Here, since m and p are assumed to be constants, they can be omitted from the model without affecting the derived optimal length τ^*. Thus, the total profit from a program lasting T time periods is proportional to:

$$H_1(\tau) = [T/\tau] * P[C, \sim B|\tau]$$

Since the revenue factor T/τ is greater when τ is smaller, it will probably drive the optimal length of presentation down so that it might pay in terms of greater total revenue to shorten the optimal τ^* and pack more products into the program.

A second factor that can be incorporated into the model is related to the stream of research conducted by Ray and Webb (Ray and Webb, 1976, 1978, 1986; Webb and Ray, 1984) concerning the effect of clutter on advertising effectiveness. This line of research, through a series of laboratory experiments, has shown that increasing clutter of advertisements embedded in a TV program (both by shortening each commercial presented within a given period of time and by increasing the total time devoted to commercial presentation) significantly reduces their effectiveness. Specifically, they found that increasing the clutter of non-program material (e.g., commercials, promotional announcements, public-service messages, etc.) resulted in decreased attention, recall, and positive cognitive responses (Webb and Ray, 1984).

The implication of these findings in the present context is that, although the term T/τ will drive the optimal time spent presenting each product τ^* to be smaller such that more products will be introduced within a given period of time, an increase in the number of products presented will probably hinder the comprehension of the viewers. This is because as the viewers are exposed to more and more products in a short period of time, their attention will be adversely affected, and their average comprehension rate will decrease. Specifically, viewers' overall comprehension rate will be greater when each product is on the air for a long period of time, as opposed to when each product is on the air for a short period of time. In the context of the model, the comprehension parameter θ is inversely related to the number of products presented during the program (T/τ) or directly related to length of presentation (τ).

A third extension is related to individual differences. Currently, the implicit assumption is that all viewers have the same rates of comprehension and boredom. This can be relaxed by capturing the heterogeneity through specifying distributions on the parameters themselves. So the rate parameters can be distributed across the population according to some probability distribution.

Whatever the extensions may be, researchers obviously have to make a trade-off between the parsimony of the model and the amount of reality it captures. At present, the model seems to capture the essence of the problem and provide reasonably intuitive results.

Conclusion

This chapter is an attempt to suggest a model describing the viewing behaviors for TV shopping programs, as well as to derive an optimal length of presentation of a product on such programs. Although the model is a quantitative one, the results derived from the model are qualitative in nature. This is because the unobservable processes of comprehension and boredom are very difficult if not impossible to estimate. Nevertheless, extensive behavioral research does exist in this area, and further work will make it more feasible to empirically estimate θ and μ. Meanwhile, practitioners and other experts can probably make educated guesses on at least the proportion $z = \theta/\mu$ if not the parameters themselves. With such guesses, the model can provide insights into the viewing patterns, as well as directional guidance in formulating strategies for production of TV shopping programs.

Although the model was developed in the context of TV shopping programs, it can also be applied to the issue of advertising length. There has been a major debate on the advantages and disadvantages of currently popular 15-second spot commercials. This model can address the issues involved in the debate, and possibly help in deciding under what conditions short commercials will be more effective than traditional-length commercials.