

# Simulating A Crisis

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## Abstract

An influence diagramming approach is applied to modelling a typical large magazine publishing company. The assumptions built into the model are tested by an empirical study of the old Saturday Evening Post. Experiments with a DYNAMO simulation version of the model lead to an understanding of how the system reacts both in the short and long run to changes to the management control variables such as subscription and advertising 'rates.' The potentially self-destructive nature of the system is demonstrated together with a policy for survival based on a knowledge of the system's behavior.

## OVERVIEW OF THE MODEL

The basic structure of the model of a magazine publishing firm was assembled using an influence diagramming technique (5). It is illustrated in Figure 1. It consists of four interrelated sectors: 1) accounting information flows, 2) measures of performance, 3) managed variables, and 4) relationships of the firm with its environment.

The accounting information flows sector represents the accumulation of accounting information concerning total revenues and total expenses, the reporting of the end-of-year amounts, and the closing and clearing of the balances in the accounts so that the process may repeat itself in the following year.

The measures of performance sector represents the computation of three major performance indices for magazine publishing companies, namely, the profit margin on total revenue as reported at year-end and the relative growths of revenues and readers over the year in question.

The managed variables sector represents the major variables under the management's control; namely, the annual subscription 'rate' or price to be charged readers of the magazine, the advertising 'rate' or price per page to purchase advertising space in the magazine, the annual circula-

tion promotion expense for acquiring trial readers, the advertising selling expense and the magazine volume (pages per year). It is assumed that the management can, if it so desires, manipulate these variables by a conscious decision making process initiated, perhaps, by changes in the measures of performance. It was discovered, however, that both the advertising selling expense and the annual magazine volume were automatically adjusted by industry and company standard practices. Most magazines pay their advertising agents a standard commission on sales, so that the advertising selling expense varies directly with the advertising revenue earned. Similarly, magazines have editorial-advertising formulas which regulate the number of pages of text that the editor may publish for each page of advertising purchased in the magazine. The magazine volume, therefore, is related to the pages of advertising purchased. The other managed variables, that are subject to the management's fiat, are viewed as system states that remain unchanged over time unless the management makes a conscious decision to change them. For example, the subscription 'rate' can be increased or decreased only by a subscription 'rate' change decision. A similar representation is used to model changes to the advertising 'rate' and circulation promotion expense. Since one of the unknowns or missing links in corporate simulation modeling concerns the mechanism by which the management of an organization decides how to change prices and promotion expenditures in response to changes in its measures of performance, these modeled decision points are used as experimental inputs.<sup>1</sup> An arbitrary change, such as a twenty per cent change in the subscription 'rate', can be imparted to the model and its impact traced through the system to facilitate an understanding of how the system functions as a whole.

Finally, the relationships with the environment sector represents the firm's interaction with its principal marketing and technical environments, namely, the flow of advertising pages purchased (advertising pages selling rate), the rate of expenditure on editing, printing and

distributing the magazine to the readers, and the rate at which subscriptions are sold and expire together with their effect on the total readers of the magazine. The rate of selling advertising pages is posited to be related to the unit price for advertising established by the industry (advertising 'rate' per thousand readers). This in its turn is computed from the total readers reported at the year-end and the advertising 'rate' per page set by the management. The dollar expenditure rate on producing and distributing the magazine is assumed to be a function of the total number of pages delivered to the readers which, in its turn, is computed from the magazine volume and the current total readers. The sale of trial subscriptions is assumed to be influenced by both the expenditure on circulation promotion and the magazine volume. Subscriptions are modeled as expiring one year after purchase. The sale of regular subscriptions are posited to be a function of the regular and trial subscriptions that are expiring and therefore potentially renewable, the magazine volume (number of pages in the annual volume) and the annual subscription 'rate' charged. The total readers of the magazine is represented as a system state, the level of which changes in response to the flows of subscribers in and out of the system. The total number of readers is reported annually and provides the basis for computing the advertising 'rate' per thousand readers.

Figure 1 can be viewed as a system of inter-related parts. It represents a working hypothesis of how a magazine publishing system functions and it requires testing before inferences can be drawn concerning how it behaves as a whole.

#### AN EMPIRICAL STUDY

The assumptions built into the model were tested by an empirical study using data covering a twenty-year period of the operations of the old Saturday Evening Post. The gathering, treating and subjecting of the data to a Regression Analysis was, itself, a considerable undertaking and, due to the limitations of space, it is not reported here. The values of the summary statistics<sup>2</sup>, computed to assess the reliability of the estimates in the regression equations, lend credence to this model of a publishing firm as representing reality for the purpose in hand.

In particular, the analysis indicated that the major influence on trial subscription sales was the circulation promotion expenditure, that the fraction of regular subscribers who renewed their subscriptions was strongly related to the subscription 'rate' charged, and that the fraction of trial subscribers who convert to regular readership was markedly affected by the magazine's volume.

The model was programmed in the DYNAMO computer simulation language (6, 9), primed with the relationship uncovered in the empirical study and with the initial conditions pertaining to the old Saturday Evening Post in 1940, and let to run. The results of this experiment are shown in the three plots of Figure 2. The three major managed variables of subscription 'rate', advertising 'rate' and circulation promotion expense in this experimental run, are fixed throughout the twenty simulated years (top plot). However, since the circulation promotion expense is sufficient to acquire trial readers at a rate that more than offsets the natural loss of readers, the readership commences to grow slowly in the first few years. This growth reduces the price of advertising in the magazine (advertising 'rate' per thousand readers), stimulates the sale of advertising pages which, through the editorial-advertising formula, causes the magazine volume to grow. The increasing size of the magazine volume attracts a greater fraction of the trial readers to become regular readers and the regular subscription selling rate improves (middle plot). The consequent increase in total readers further reduces the price of advertising and the cycle repeats itself. This positive feed-back in the cause and effect chain built into the model creates exponential growth of the total readers of the magazine. The effect of producing a thicker magazine and delivering it to an ever increasing number of readers, drives up the total expense of operating the firm at a rate that is faster than the increase in total revenues from circulation and advertising. The net effect on the measures of performance (bottom plot) is that the profit margin declines very rapidly after the simulated year 1945. We might infer from this experiment that the system of publishing a magazine is potentially self destructive.

Since the Profit Margin is the only performance measure to go out of control, we might expect the management of the firm to take corrective action, such as increasing subscription and advertising 'rates' to increase revenues or decreasing the circulation promotion expenditure to decrease expenses. The results of experiments with these variables are shown in Figures 3, 4 and 5. These plots illustrate that there is an immediate improvement in the profit margin in response to a change in each of the managed variables. Unfortunately, this improvement lasts but for a few years before the performance deteriorates as before. Increasing the subscription 'rate' has an adverse effect on the relative growth of readers (Figure 3). It strikes at the company's most valuable asset, its regular subscribers. Fewer subscribers means less revenue from circulation and advertising, so that the long-run growth of revenue is affected adversely also. Perhaps the most unexpected relationship of all exists between

the advertising 'rate' and the relative growth of readers. An increase in the advertising 'rate' (Figure 4) reduces the volume of the magazine through the advertising demand and editorial-advertising formula relationships, which reduces the yield of regular subscribers from trial readers.

If the management of the firm was not aware of the interrelatedness of the managed variables, it might easily be beguiled by the short-run, but transitory, corrective action of these variables under its control. For example, in competing against other magazines for readers, it might decide to substantially increase circulation promotion expenditure. To afford this strategy it might increase advertising 'rates', which could result in a decrease in advertising pages purchased in the magazine, a decline in the magazine volume and a decrease in the yield of regular subscribers from trial subscribers. In order to achieve its growth goal, the firm might be prompted to further increase its circulation promotion expenditure and further increase its advertising 'rates' to pay for this. Over an extended period of time, this could drive the firm from low to high circulation promotion expenditure and advertising 'rate', and from publishing a thick to a skinny magazine. The firm, with its extraordinary high promotion expenditure to maintain the level of readership, is now vulnerable to such happenings as business cycles, inflation in production costs and increases in postal rates. As Forrester has written concerning the counter-intuitive behavior of organizations in complex systems (3, p. 55):

Policies are being followed at the various points in the organization on the presumption that they will alleviate the difficulties. One can combine these policies into a computer model to show the consequences of how the policies interact with one another. In many instances it then emerges that the known policies describe a system which actually causes the troubles. In other words, the known and intended practices of the organization are fully sufficient to create the difficulty, regardless of what happens outside the company or in the marketplace. In fact, a downward spiral develops in which the presumed solution makes the difficulty worse and thereby causes redoubling of the presumed solution.

#### A POLICY FOR SURVIVAL

The root cause of the sagging profit margin lies in the positive feedback loop relating the number of pages in the magazine, and hence its cost, to the number of readers (Figure 6): 1) as the readership increases, 2) the price of advertising decreases stimulating advertising sales,

3) the increased number of advertising pages leads to the addition of more pages of editorial content, 4) the increased volume of pages attracts more trial subscribers to convert to regular readership, which leads to accelerated readership growth and a feeding back of the outcome to further reducing the price of advertising, and so on, until 5) a feedback effect results in costs rising more rapidly than the revenues and the profit margin is reduced.

If the management was aware of this process, then one might expect it to prevent the production costs from running away by controlling the number of pages in the magazine. Obviously some relationship between advertising and editorial content must be maintained, otherwise the magazine will become all advertising as the readership grows and the price of advertising declines. An obvious way out of this dilemma is to fix the amount of advertising by controlling the price of advertising. Keeping the advertising 'rate' per thousand readers constant will achieve this. This is illustrated in Figure 7.

In this experiment, the subscription 'rate' and circulation promotion expense are held constant, but the advertising 'rate' is adjusted every simulated year to effect a constant advertising 'rate' per thousand readers. It can be seen (Figure 7) that the advertising 'rate' is continually being revised in order to maintain a nearly constant advertising 'rate' per thousand readers. The performance measures do not now deteriorate. The relative growth of revenues and relative growth of readers measures are nearly constant, albeit at a much smaller value than for the first experiment. The profit margin, on the other hand, grows steadily throughout the experiment. The conclusion, therefore, is that continually adjusting the advertising 'rate' per thousand readers, leads to an increasing profit margin and constant revenue and readership growth. Growth of readers and revenues, however, is at a considerably lower level than for Figure 1. The management strategy built into this experiment leads to a profit maximizing rather than to a revenue maximizing behavior of the system.

#### IMPLICATIONS OF THE STUDY

The focus, impact and methodology of the study differs from the more conventional simulation studies in a number of ways. First, the focus is on stability of the organization and its survival rather than efficiency of operations and the derivation of optimal policies. Second, the use of such a model would be to startle the management of the company into taking radical action before a crisis developed rather than refining existing policies. Would the old Saturday Evening Post still be in existence if its management had played with such a simulation model? The indications are that it was a viable entity put to death by a management that failed to understand

## Implications of the Study (continued)

the ramifications of its policies in the complex interactive magazine publishing system (4, 8).

Lastly, the methodology employed consists of drawing an influence diagram, turning it into a corporate system simulation model, validating it (where possible), experimenting with it and interpreting the results. This is simple yet complex: simple in the fact that there are only some thirty active sets of equations describing the model and yet complex in the detective work required to build and validate it. Simple in the case of experimenting with the model firms and yet complex in the interpretation of its behavior dynamics. Coyle (1) describes a form of loop analysis to facilitate this interpretive work. The DYSMAP translator (6) will list all the feedback loops in a system model such as shown in Figure 1. This figure looks like a bowl of spaghetti but is composed of a number of interlocking feedback loops that determine its dynamic behavior. The System Dynamics Research Group at the University of Bradford (U.K.) is also putting together a computer-graphics package to redraw a model, such as Figure 1, to illuminate its feedback loop structure (7) which should add considerably to our armory of techniques for performing such an analysis.

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6. Ratnatunga, A.K. and C.J. Stewart, Dysmap User's Manual, University of Bradford (U.K.): System Dynamics Research Group, 1977.
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## FOOTNOTES

<sup>1</sup> A project is underway to build a simulation model of organizational decision making based on social psychological, political and behavioral theory of the firm principles.

<sup>2</sup> The coefficients of determination ( $R^2$ ) range from 95.9 to 97.4% and the precision of the regression coefficients (t-values) range from 2.7 to 30 (approximately 20 data points).

## BIBLIOGRAPHY

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2. Forrester J.W., Principles of Systems. Cambridge, Mass.: Wright-Allen Press, 1968.
3. Forrester, J.W., "Counterintuitive behavior of social systems." Technology Review, 73, 3: 52-68, 1970.
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FIGURE 1

CORPORATE SYSTEM MODEL OF  
A MAGAZINE PUBLISHING COMPANY

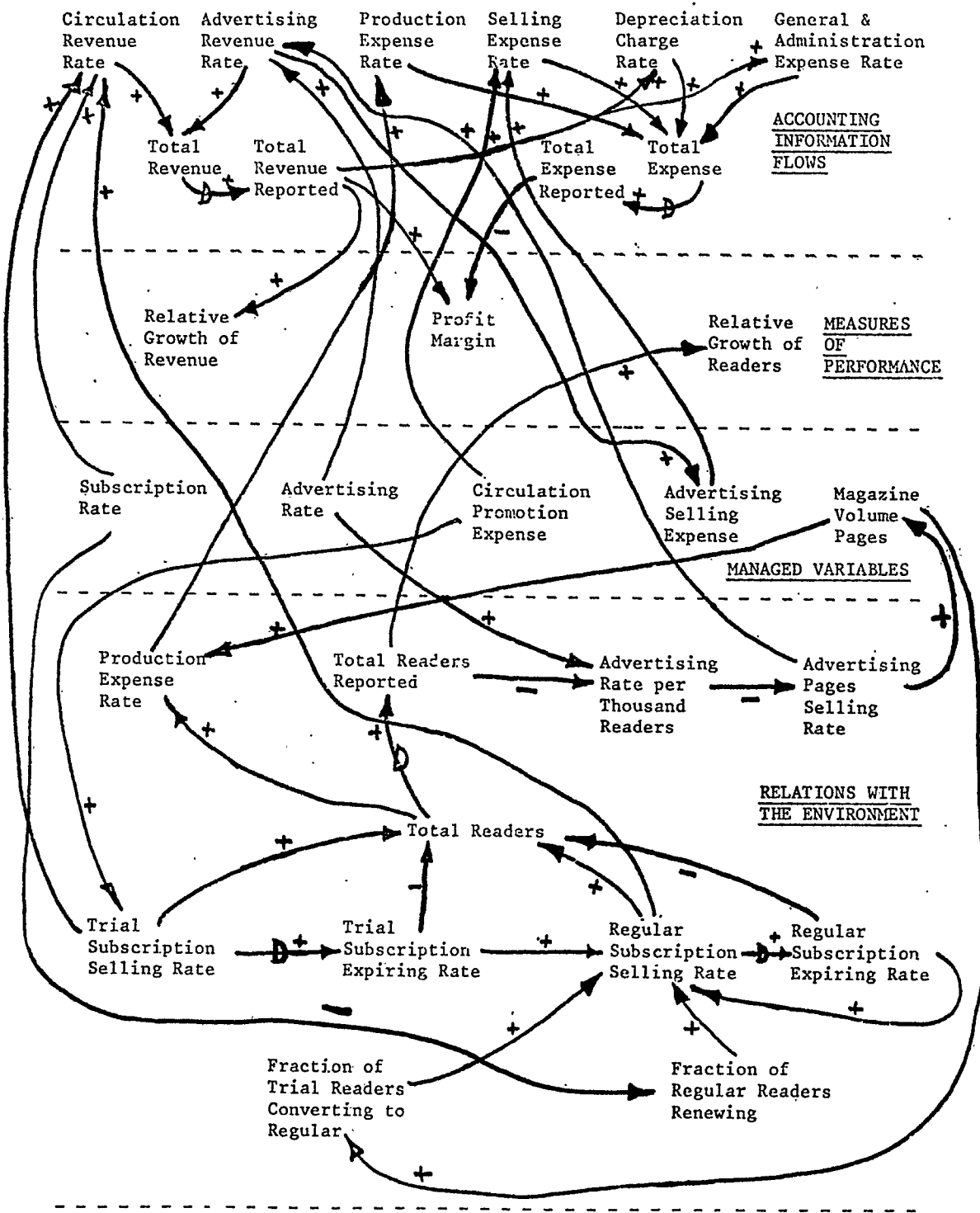
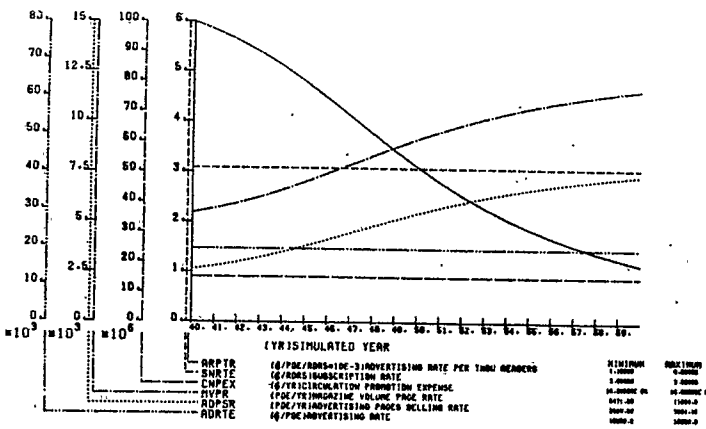


FIGURE 2

RESPONSE OF FREE RUNNING MODEL

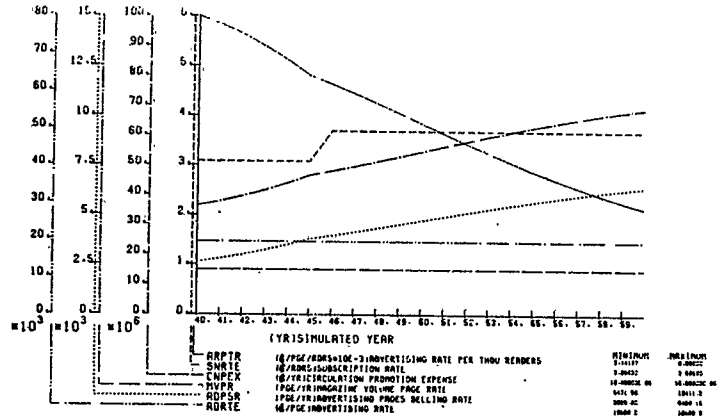


EXP #1 RESPONSE OF FREE RUNNING MODEL  
A MODEL OF THE SATURDAY EVENING POST

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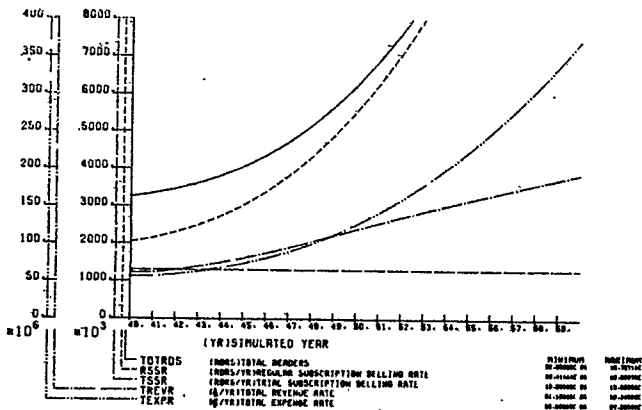
FIGURE 3

RESPONSE TO 20% INCREASE OF  
SUBSCRIPTION RATE IN YEAR 1945



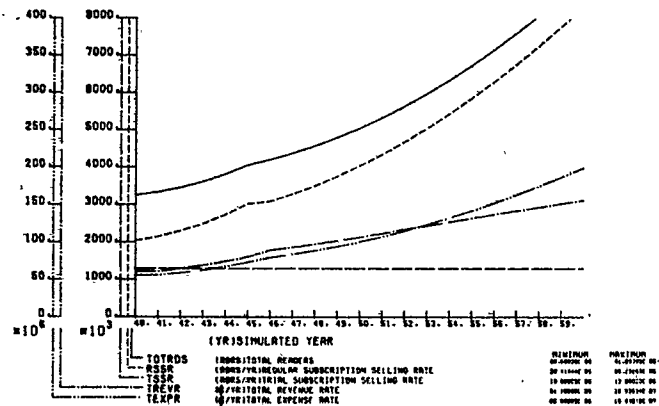
EXP #2 RESPONSE TO 20% INCREASE IN SUBSN RATE  
A MODEL OF THE SATURDAY EVENING POST

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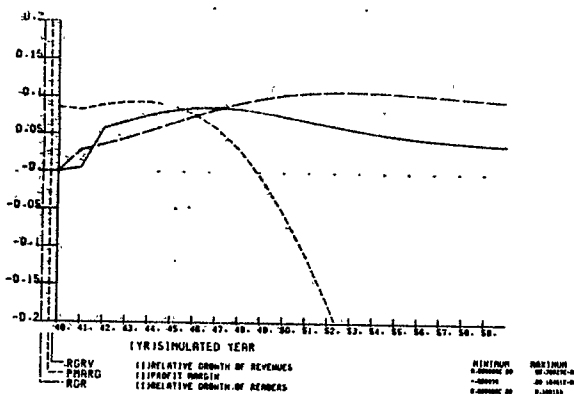
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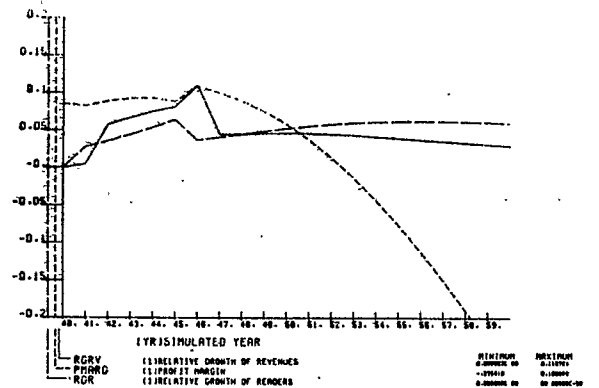
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EXP #1 RESPONSE OF FREE RUNNING MODEL  
A MODEL OF THE SATURDAY EVENING POST

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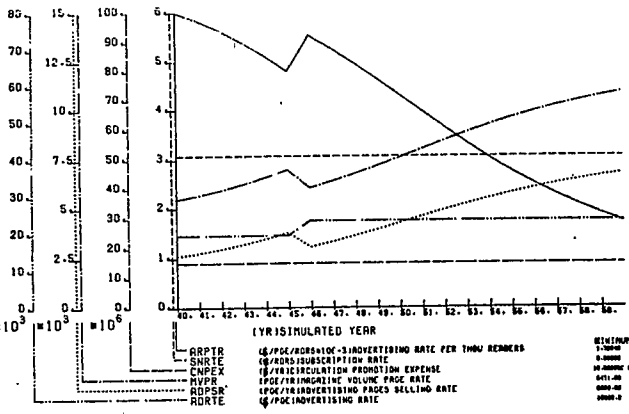


EXP #2 RESPONSE TO 20% INCREASE IN SUBSN RATE  
A MODEL OF THE SATURDAY EVENING POST

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FIGURE 4

RESPONSE TO 20% INCREASE OF  
ADVERTISING RATE IN YEAR 1945

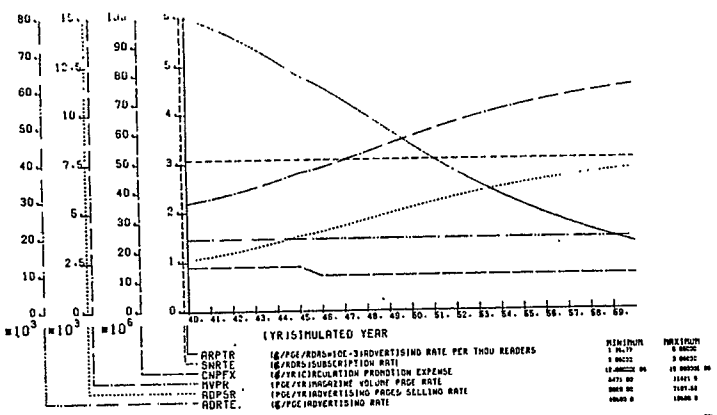


EXP #3 RESPONSE TO 20% INCREASE IN ADVERTG RATE  
A MODEL OF THE SATURDAY EVENING POST

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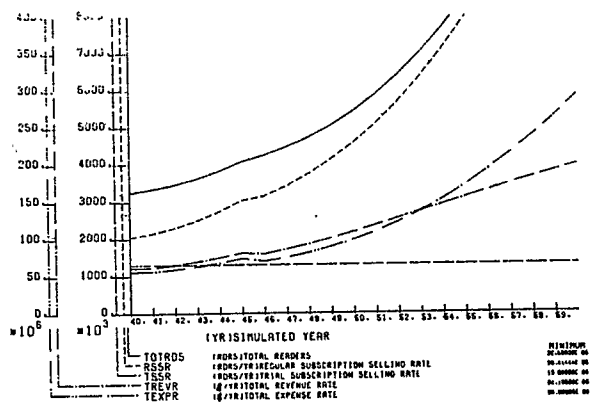
FIGURE 5

RESPONSE TO 20% DECREASE OF  
PROMOTION EXPENDITURE IN YEAR 1945



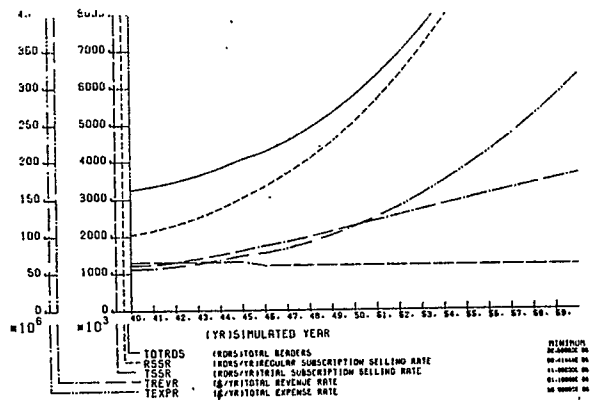
EXP #4 RESPONSE TO 20% DECREASE IN PROMN EXPENSE  
A MODEL OF THE SATURDAY EVENING POST

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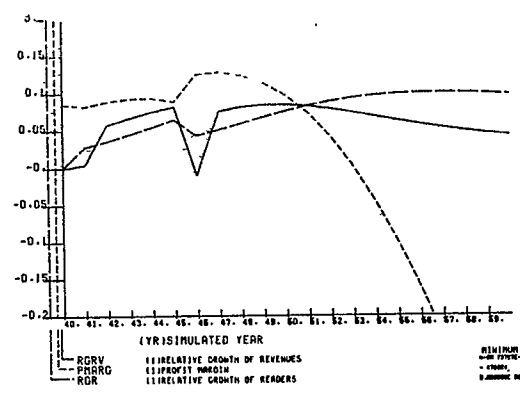
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A MODEL OF THE SATURDAY EVENING POST

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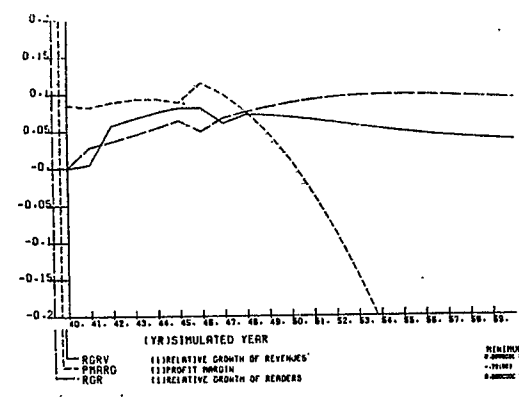
EXP #4 RESPONSE TO 20% DECREASE IN PROMN EXPENSE  
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EXP #3 RESPONSE TO 20% INCREASE IN ADVERTG RATE  
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EXP #4 RESPONSE TO 20% DECREASE IN PROMN EXPENSE  
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Figure 6 - SOURCE OF RUN AWAY POLICIES

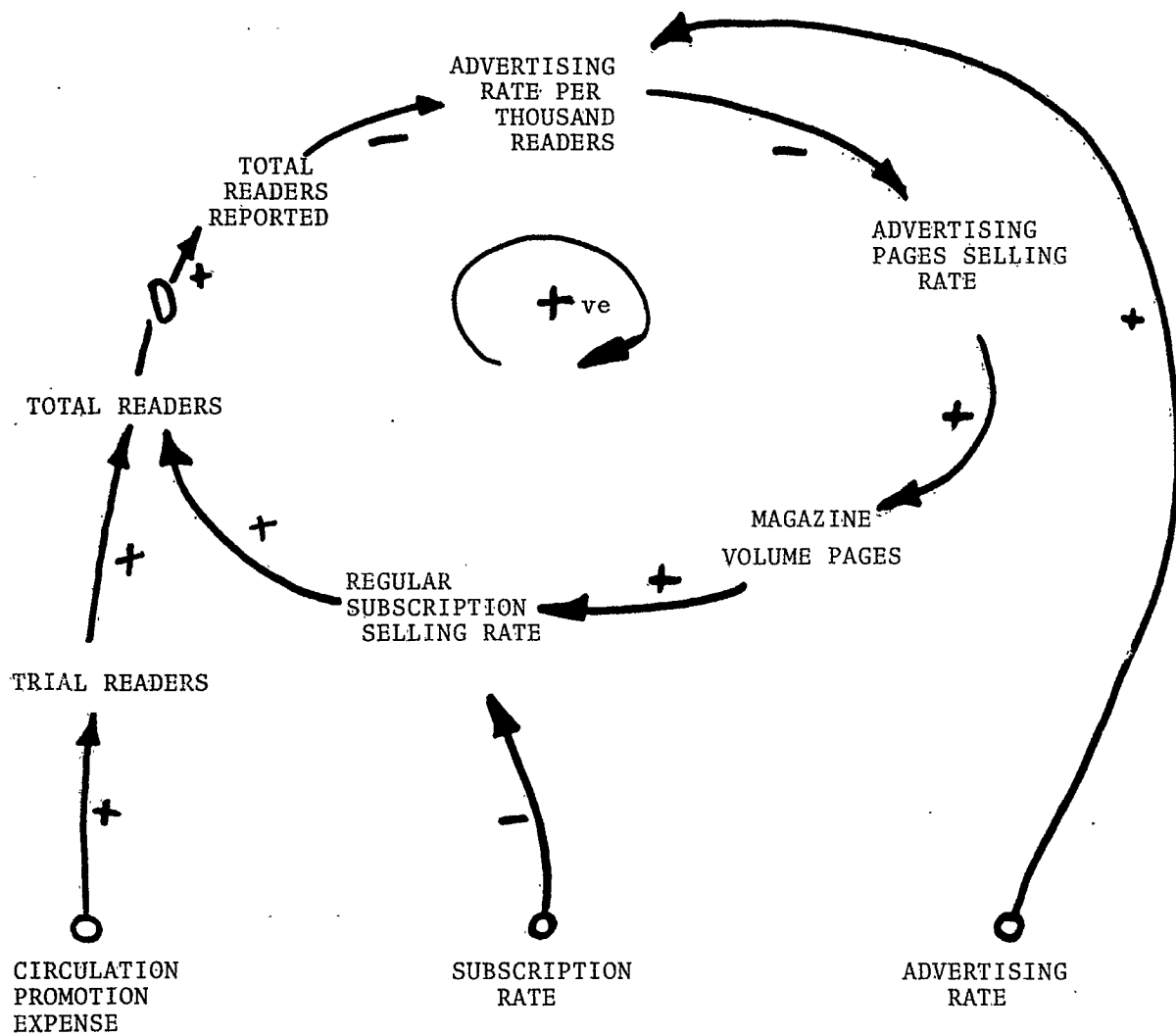
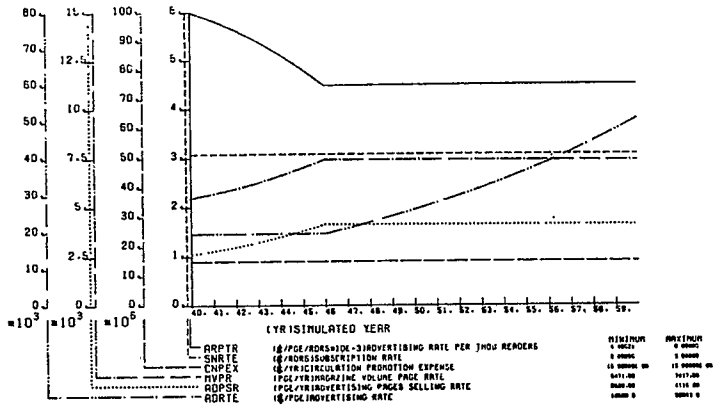




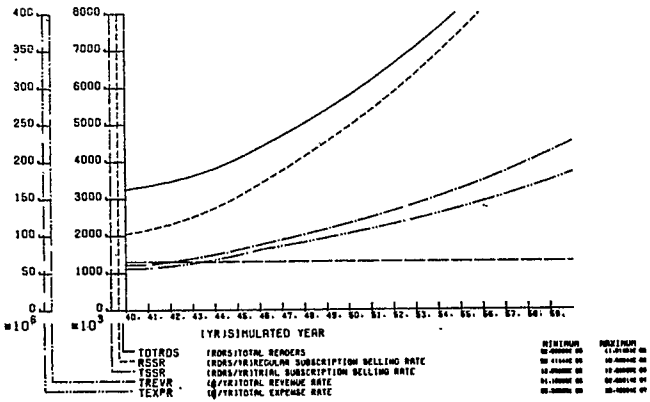
FIGURE 7

RESPONSE TO POLICY OF CONSTANT  
ADVERTISING-RATE-PER-THOUSAND-READERS



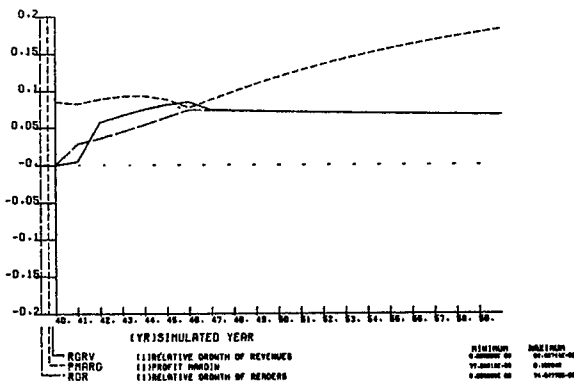
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