SOME COMMENTS ON THE PROBLEM OF SELF-AFFECTING PREDICTIONS

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December 1967

P-3735

PREFACE

One of the most interesting questions for the study of long-range prediction is that of whether predictions of the future are in effect manipulations of it, and if so, whether this fact affects the validity of the predictive process. This paper attempts to analyze and clarify the possible interaction of prediction and event.

The author considers the problem of the interaction between the making of social predictions and the events about which the predictions are made, and poses the following questions: (1) Is the interaction of prediction and event predictable? (2) Can the interaction of prediction and event be controlled? (3) How and to what extent should people making predictions try to take into account the possible effects of their predictions? (4) Is the entire phenomenon of self-affecting predictions of any practical use?

An attempt is made to devise a conceptual and/or computational model for the interaction of predictions and events. A flow chart is proposed as a possible conceptual framework for the problem, and other analytical methods are suggested for modeling some types of prediction-event interaction.

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CONTENTS

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1. INTRODUCTION

It is obvious that almost any attempt to study a social or psychological phenomenon will affect the phenomenon being studied. This effect has now been carefully investigated and well documented. It is equally clear that almost any attempt to make public predictions concerning a future social or psychological situation will affect future events and hence possibly affect the event predicted. However, this type of interaction between prediction and event has received very little detailed or systematic study.

Among the reasons for this disparity of attention are the following: Because the interaction between the situation being studied and the study itself is most noticeable in research in the social sciences, this effect has become a natural subject of interest and investigation by social scientists. Furthermore, many aspects of this phenomenon can be induced easily and accurately in a well-controlled experimental situation. However, the interaction between predictions and events is very different. This phenomenon is of greatest interest precisely when the number of people and the importance of the events involved are so great that the situation could not be reproduced accurately under controlled conditions. It is not clear how a question such as "What effect is there on a national economy when a national leader predicts prosperity for the next year?" can be studied experimentally. Yet this type of question is certainly worthy of study. In fact, it is largely the growth of the predictive ability of the social sciences that has made it so important.

2. WHAT ARE SELF-AFFECTING PREDICTIONS?

For the purposes of this study, the term "self-affecting prediction" is defined as an act by a predictive agent (person, group, oracle, etc.) that:

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1. Contains an explicit or implicit prediction about the future.
2. Is "public" in the sense that some person or group that might be part of a causal chain affecting the accuracy of the prediction is aware that the prediction has been made.
3. Might affect itself (i.e., there is a plausible causal chain by which the people aware of the prediction might significantly affect the events predicted.)

In short, the definition includes cases in which the prediction is implicit. It does not include cases in which the people who know that the prediction has been made cannot reasonably exert a significant influence on the events (e.g., changing a vote or two is, for our purposes, not a "significant influence" in a national election). Also, it does not include extremely improbable or nonstandard effects (e.g., psychokinesis). For an event to fall within this definition no evidence is required that the prediction does actually affect the events; in fact, the definition given will cover predictions that might affect themselves but do not.

Events about which predictions could be made, paired with possible sources for such predictions, are listed in Table 1 on page 3. A well-disseminated prediction about an event in the first column made by one of the corresponding sources in the second column would almost certainly be a self-affecting prediction by our definition. However, this list is not meant to indicate the range of the definition, but merely to define the spirit of the problem and to provide "typical" cases against which the relevance of later remarks can be measured.

3. WHAT WOULD WE LIKE TO KNOW?

The problem of the way in which a prediction can affect the event predicted is important, interesting, and extremely complicated. Obviously, we would like to know as much as we can. However, some questions stand out as being more tractable or of much more practical importance than the rest. For example:

1. Is the interaction of prediction and event predictable? This is not the first question in an infinite series of questions concerning

Table 1

PREDICTIONS AND THEIR SOURCES

Event Predicted	Source of Prediction
Election result	Poll taker Political analyst Candidate "Well-informed" citizen
Football game result	Sports writer Player Team coach Fan Bookmaker
Business conditions for next year	President High government official Wall Street Journal survey of businessmen Wall Street Journal survey of economists One economist Business writer, local paper
Scientific and technological changes in the next 10 years	Science fiction writer One scientist Group of scientists Presidential commission on the future of science and technology Time magazine article
Major changes in the world political situation in the next 30 years	State Department study group Historian Novelist Secretary-General of U.N. RAND study group
Dow Jones Averages for a year from today	Stock market analyst Average investor A stock market "theory"
Major social changes in U.S. in 10 years	Pravda editorial New York Times editorial Timothy Leary
Food crisis in 100 years; food crisis in 2 years	U.S. Department of Agriculture Prime Minister of India Secretary-General of U.N. Historian Peking newspaper

higher-order effects of predictions about the effect of predictions, but the pessimistic question of whether current knowledge and analytical techniques are sufficient to make any real progress in a systematic approach to the problem. Possibly, specific problems in this area should be "solved" by using intuition and insight and by avoiding any general approach.

2. What is a good conceptual and/or computational model for the interaction between predictions and events?

3. Can the interaction of prediction and event be controlled? How? For example, how effectively can careful consideration of the phrasing of a prediction, the time it is made, and the medium used to communicate it control the interaction?

4. How and to what extent should people making predictions try to take into account the possible effects of their predictions?

5. Is the entire phenomenon of self-affecting predictions of any practical use? For example, can a national leader implement policies by making the proper prediction in the proper way at the proper time?

4. WHAT IS KNOWN?

A brief search of the literature in various fields revealed no discussions of the problem of self-affecting predictions in the generalized sense in which we are considering the problem. However, some considerations of related problems or of specific instances of the general problem were found.

4.1. On the Possibility of Predictions

Three articles, [1], [3], [7], have considered the problem of whether the fact that a public prediction can affect the events predicted might preclude the possibility of making accurate public predictions. Instead of a summary of these articles, it will suffice to quote the conclusion of one of them [3].*

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It has been shown that, provided that correct private prediction is possible, correct public prediction is also conceptually possible. Two possibilities may be distinguished: (1) The public prediction does not affect the course of events because the agents are indifferent to or incapable of reacting to the public prediction. In this case correct public prediction coincides with correct private prediction. (2) Agents react to public prediction, and their reaction alters the course of events. The reaction can conceptually be known and taken into account. It has been shown that the boundedness of the variables of the predictive system and the continuity over the relevant intervals of the functions relating the variables to each other are sufficient, though not necessary, conditions for the existence of correct public predictions. These conditions were found to be normally fulfilled in the world about which predictive statements are to be made.

The argument of this paper establishes the falsity of the proposition that the agents' reaction to public prediction necessarily falsifies all such prediction and that therefore social scientists may never hope to predict both publicly and correctly. But it demonstrates no more than that correct public prediction is possible if the possibility of correct private prediction is accepted. About the possibility of private prediction it has nothing to say. So, in the end, the major difficulties of predicting in the domain of social phenomena turn out to be those of private prediction.

4.2. Elections

A great deal has been said and written about the possible effects of pre-election polls and broadcasts of early election results on the final outcome of elections. Fortunately, a recent review of the literature in this field [11] and several interesting recent studies [4], [5] are available. The conclusions of the review of greatest interest for this paper are the following:

1. Many types of interactions between publicizing pre-election polls, early broadcast of election returns, and final election results have been hypothesized.
2. There is no evidence known to support claims that these factors have a large net effect on election results.
3. It is not possible to rule out small effects on election results.

4. There is some evidence that the polls and broadcasts have several small effects on election results.

It was suggested earlier that the problem of self-affecting predictions would be a difficult problem to approach by performing controlled experiments or by gathering detailed data. This is in complete agreement with the implicit conclusion of [11], which expresses a pervasive dissatisfaction with the accuracy and relevance of experimental work on the "bandwagon effect." There is also a strong pessimism about the practicality and even possibility of ever getting definitive answers to questions about the interaction between broadcasting and analysis of early returns and final election results by performing a study.

4.3. The Stock Market

There is a constant flow of predictions about future stock market prices. The sources of these predictions are known and anonymous, individuals and groups, rich and poor. The predictions concern both short-term and long-term behavior, both specific stocks and the averages. They are based on detailed theoretical analysis and on mystical revelation. They reach the public by newspaper, magazine, book, mail, or word of mouth.

The constant question exists of how and to what extent these predictions affect stock market prices. In a rather long book [2] expounding in detail a modified version of the Dow theory as well as other technical guides to stock market strategy and tactics, Edwards and Magee indicate that they are at least aware of the problem. Chapter XXXV is titled "Effect of Technical Trading on Market Action." The question is put in the following form:

> The question often is asked...whether the technical method sets up, to some extent, an artificial market in which the market action is merely the reflection of chart action instead of the reverse.*

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*Page 391.

The "chart" referred to is the graphical method suggested in the book to analyze market behavior.

Unfortunately, the answer in the book is not very satisfying:

> This [setting up of artificial behavior] does not seem to be true...The market is big, too big for any person, corporation or combine to control as a speculative unit... The technician...is in the minority...And since the "orthodox" investors greatly outnumber the technicians we may confidently assume that technical trading will have little or no effect on the typical behavior of free markets.*

However, although their argument is unconvincing, there is no evidence to indicate that their conclusion is wrong.

The financial writers for newspapers are often willing to explain short-term price changes in averages or individual stocks by claiming that the changes were caused by transactions of investors who had accepted a specific prediction or theory. However, the same writers seem equally facile at explaining why "expected" interactions of prediction and event did not occur.

5. SOME APPROACHES TO THE PROBLEM

5.1. A Flow Chart

As might be expected for a problem that has so many varied types of instances, there does not seem to be any simple model for self-affecting predictions that covers all of the examples that naturally come to mind. However, a rather general flow chart for the problem may be proposed that makes it possible to place a wide variety of actual and hypothetical instances in a common frame of reference and hence compare them, at least to some extent.

Before describing and discussing the flow chart, it is convenient to introduce the T-t plane. The T-t plane is a useful framework within which to discuss those aspects of prediction-event interaction that involve the mental processes of some of the agents. Many thoughts have a specific time T associated with them in the sense that they are

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"about" that time. For example, plans for next Monday are thoughts "about" next Monday. Whenever this is the case we can associate a time T with this thought; this T is the time the thought is about. Also, with every thought we can associate a time t, the time at which the thought takes place. We can now consider the two numbers T and t to be coordinates on a plane. In this manner, a large class of thoughts can be assigned a specific location on this plane--the T-t plane.

Without forcing things too much, we can also place actions on this same plane. Instead of considering the action, consider the mental process governing the action: this will be characterized by having $T = t$. (Of course, these are not the only thoughts for which $T = t$.)

There are two lines on the T-t plane that are of natural interest. One is the line $T = t$ mentioned above. The other is the t = now line which can be regarded as moving steadily to the right. The T-t plane is represented in Fig. 1.

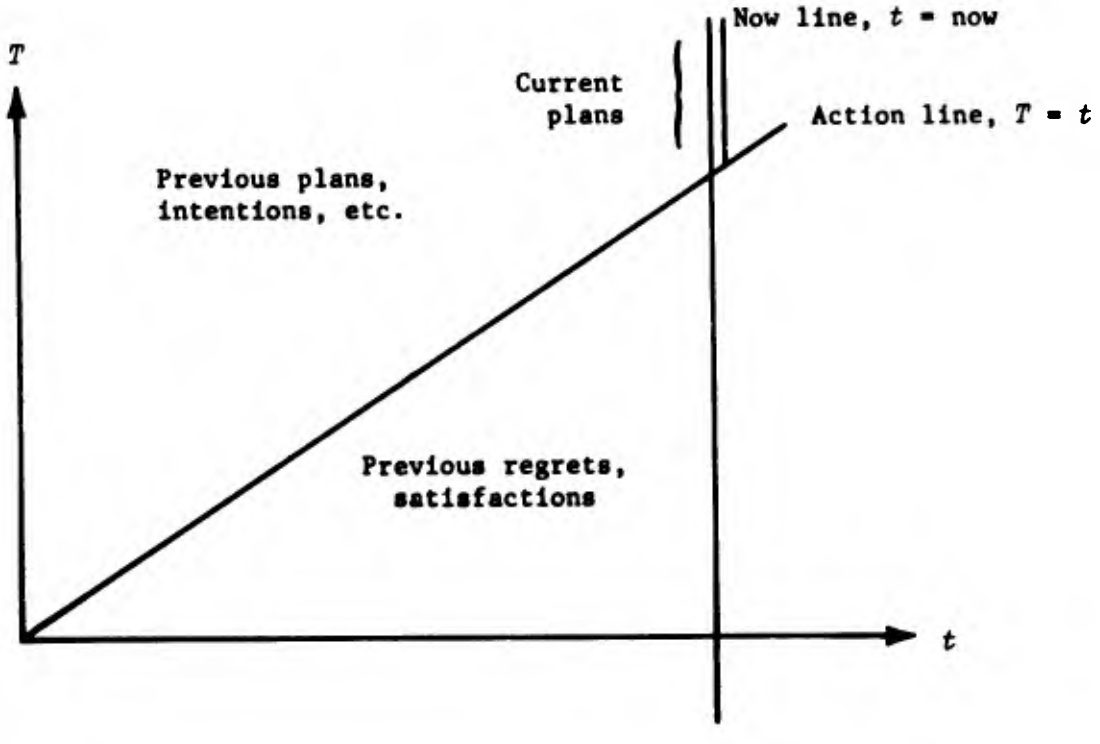

Fig. 1--The T-t plane

Figure 2 contains a flow chart for the interaction of a prediction with the event predicted. This flow chart is a device that attempts to isolate some of the many conceptually distinct activities that can occur when there is an interaction between a prediction and an event. Three main types of entities appear on the chart:

1. Propositions. These range from concrete physical items such as the source of the predictive act to mental constructs such as the "fully evaluated prediction." All these propositions are put in rectangles on the chart.

2. Evaluations. At several points on the chart one proposition is transformed into another via an evaluation. These evaluation processes are indicated by ovals on the chart.

3. Interactions. These are indicated by arrows on the chart. The arrows can be read as "gives rise to," "influences," "is used for," or any similar words. The arrows are broken down into four categories:

   a. The primary interactions are indicated by solid arrows.
   b. The secondary interactions are indicated by broken arrows.
   c. Appealing to general background is indicated by dotted arrows.
   d. Interactions that run the "wrong" way (i.e., go to an earlier region of the chart), and that hence can lead to higher-order effects, are indicated by dash arrows.

Although the distinction between these four types of interactions is arbitrary, it seems more useful than confusing. Two coordinates are indicated on the chart: "time" and "observability." No attempt was made to use these coordinates in any quantitative sense. However, an attempt was made to put entities which occur earlier farther to the left than those that occur later, and to put more specific and observable entities closer to the bottom.

Although most of the terminology on the chart should be self-explanatory, a few comments are necessary.

The "source" is the source of the prediction, i.e., the predictor.

The word "group" can be taken as the totality of people who are

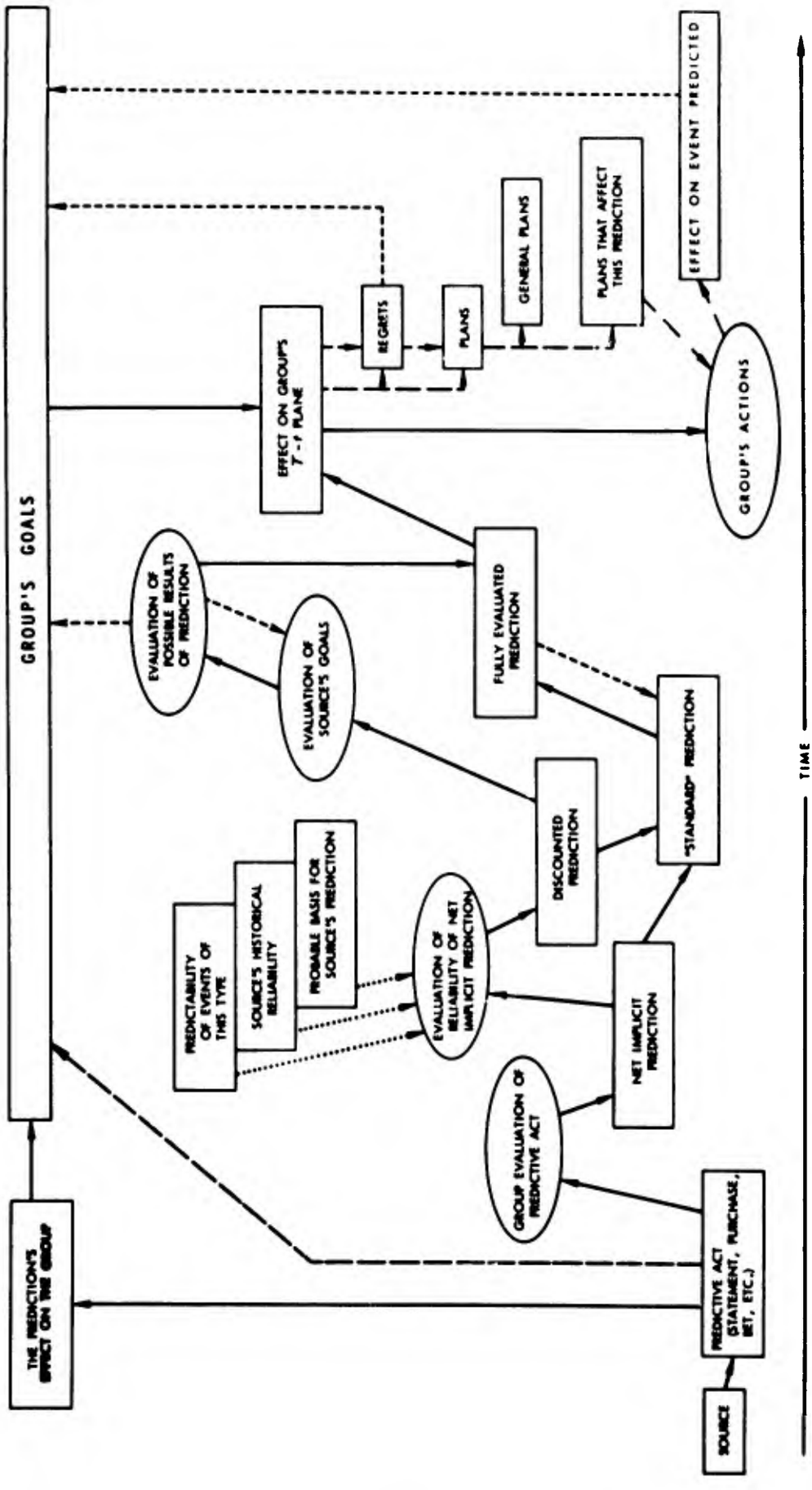

Fig. 2—Flow Chart

affected by the prediction in such a way that they might have an effect on the event predicted, or as some smaller group that could be thought of as a single entity for the example being considered, or as the world's population, or as a single individual. Hence, for a specific example, there are many possible "groups." The choice of which one to consider must be made by the reader.

The various stages that the prediction goes through are defined by their positions on the chart. For example, the "net implicit prediction" is a name for the result of evaluating the predictive content of an act.

The "'standard' prediction" is a vague sum of everything that might be considered as a preexisting prediction about the event being considered. Actual predictions that had been made about the event, the group's expectations, and the masses of predictions that are never verbalized but are common knowledge (e.g., 'The sun will rise tomorrow")--all these make up part of the "'standard' prediction."

The phrase "group's goals" is meant in the very wide sense of all of the aspects of the group's attitudes and world view that are possibly relevant to the situation being considered.

The "source's goals" referred to are all of the possible reasons why the predictor might have made the prediction. This includes the possibility that the source of the prediction might have little faith in the prediction itself and might be much more interested in the possible effects the prediction might have.

Most of the regions on the chart below and to the right of the box titled "effect on the group's T-t plane" could have been omitted as actually being aspects of the T-t plane. For example, "plans" are clearly a part of the T-t plane. Those regions were included as separate entities because it seemed to make the chart more useful.

5.2. Uses of the Flow Chart

A brief look at the chart suggests many ways in which the problem of self-affecting predictions can be split into several more or less independent problems. The first of these is "How does a predictive act affect a group's T-t plane?"; the second, "How does a group's T-t

plane and its goals or world view influence its actions?"; and the third, "How does a group's actions influence the 'course of history'?". In all three of these questions "how" should be interpreted as meaning both "by what mechanism" and "to what extent".

Another possible use of the chart is as an aid in developing a crude comparison system for prediction-event interaction. Various actual and hypothetical instances of interaction can be followed through the flow chart, and similarities or differences can be observed at various points.

Another possible use is as an aid in sensitivity analyses. It is clear that the total effect of a prediction will depend upon who makes the prediction, when it is made, what form it takes, etc. Following one prediction through the chart several times while varying these and other parameters helps to clarify one's intuition about the type and extent of the sensitivity of the prediction-event interaction to the controllable variables.

5.3. Other Approaches

The purpose of the flow chart is to establish a conceptual framework in which to consider self-affecting predictions. The problem seems sufficiently complex to make detailed modeling of the general case impractical. However, in some more restricted situations it is possible to set up naïve models that are of some interest.

5.3.1. Power Series. A vague emotional discomfort appears whenever an infinite hierarchy of interactions is suspected in a social situation. The purpose of this section is to suggest that the total effect of such interactions can be represented in many cases by a power series. It is hoped that this will lead to a better insight into the problem.

Two examples should suffice to explain the idea. Assume that the President announces at a news conference that he expects the stock market to drop very sharply in the next month. It is reasonable to assume that some investors will believe this statement and sell their holdings. Further, some investors will suspect that the selling

generated by people who believe the President will drive prices down and hence will sell their holdings. Further, some will think that the effect of people selling in the belief that sales by people who believed the President will force prices down will force prices down. And so it goes--through an infinite number of stages. This type of situation can be handled very easily by a power series. Let x be the proportion of all investors who think that the President is right on a first-order level (i.e., that he is right even without the effects caused by his making the prediction). We assume that just as x of the people who heard of what the President said believe it on the first order, so x of the people who believe it on the first order also believe it on the second order. That is, x times x is the proportion of people who will take the second-order effect into account. Similarly we assume that x is the proportion of people who have considered the nth order effect and will also consider the $(n + 1)$-th order effect. Let a_n be the importance attached to these effects by the people who consider the nth order effects. We will consider "importance" to be measured operationally, by the extent to which the people involved act (sell stocks) because they are confronted with the possibility of this effect. The amount of selling that will be generated by the President's statement is thus

$$\sum_{n=1}^{\infty} a_n x^n.$$

There are two immediate problems here. First, no mention is made of someone who does not consider the $(n - 1)$-th order effect but does consider the nth order effect. Second, it is assumed that people who have been affected by the $(n - 1)$-th order effect are still in a position to be affected by an nth order effect (stocks cannot be sold twice). Considering the level of accuracy of this model, it seems no loss to assume that these two omissions cancel each other. Of course, this type of argument gains nothing unless something can be said about the a_n. However, in this case we first assume that everything is normalized so that $a_1 = 1$. Now, it seems clear that all of

the a_n should be nonnegative, and that the sequence of a_n should be decreasing, or at least nonincreasing after the first few terms. Three simple examples of such sequences would be the following: $a_n = 1$ for all n, each a_n one-half the size of the previous one, and $a_n = 1/n \times a_{n-1}$. These three examples lead to three series which can be put into closed form:

$$a_n = 1; \qquad \sum a_n x^n = \frac{x}{1 - x};$$

$$a_n = \frac{1}{2^{n-1}}; \qquad \sum a_n x^n \quad \frac{2x}{2 - x};$$

$$a_n = \frac{1}{n!}; \qquad \sum a_n x^n = e^x - 1.$$

Of course there are many oversimplifications: It is assumed that all investors have the same amount of stock, that various levels of effect are independent, and that the various effects are additive. However, the net result is not too discouraging. The model predicts that the total effect will depend on two factors: first, the extent to which the people who consider the higher-order effects think them important, i.e., the a_n; second, the proportion of the people who have analyzed the situation to a given level who will also consider the next level of analysis, i.e., x. The model further predicts that if x is the proportion of people who pay any attention at all to the prediction, then the total effect is given by some function of x that is positive and increasing for x in the interval $0 \leq x \leq 1$; furthermore, all of the derivatives of this function are positive in this interval. According to the model we would also expect that for values of x near 0, the dependence of the function on x is linear to fairly good approximation, and that for x near 1 the behavior of the function is determined to a very great degree by the extent to which people act on the basis of higher-order effects (i.e., the behavior of a_n for large n).

Another example: Consider a game with two players, A and B. On signal, A and B each hold out one or two fingers. Player A wins if both hold out the same number of fingers; otherwise B wins. A and

B agree to play the game 10 times, the first 9 times for a dollar a game, the last game for a hundred dollars. In the first 9 games A always holds out one finger, while B randomizes and wins 4 games. It is now time for the last game and B must decide what to do. On the first level of analysis, A's previous strategy indicates that he will "always" put out one finger. The next level is B's thinking, "He wants me to think he will put out one finger but he will really put out two." The $(n + 1)$-th level of analysis is B's thinking "He wants me to accept the nth level of analysis and plans to take advantage of my accepting it."

A has made an implicit first-order prediction, performed a "predictive act" in the terminology of our flow chart--a prediction that he will again put out one finger. Let us assume that A now tries to analyze the situation before deciding how many fingers to put out. He must analyze the effect of his prediction on B.

Again we can use a power series to represent the effect. This time we will let x be the probability that if B carries the analysis to some level he will carry it one step farther. Hence the probability that B will carry the analysis to the nth stage or beyond is x^n. We could further assume that there is some number a_n that represents the probability that B will accept his own analysis through n levels if he stops at the nth level; however, to simplify things, we will assume that B accepts as correct and acts upon whatever level of analysis at which he stops. So, if B accepts the first-level analysis (that is, judging by past performance, A will again put out one finger), B will put out two fingers. Similarly B will put out two fingers if his analysis stops at the kth stage for some odd-numbered k. If B's analysis stops at an even-numbered stage he will put out one finger. The probability of B's stopping at the kth stage is $x^k(1 - x)$. Hence we have

The probability that B will not analyze the situation at all:

$$1 - x.$$

The probability that B's analysis will stop at an odd-numbered stage:

$$\sum_{n=0}^{\infty} (1 - x)x^{2n+1} = \frac{x}{1 + x} .$$

The probability that B's analysis would stop at an even-numbered stage:

$$\sum_{n=0}^{\infty} (1 - x)x^{2n+2} = \frac{x^2}{1 + x} .$$

Hence, assuming that B will randomize if he does not analyze, there is a slightly greater probability that B will put out two fingers. (For $0 \leq x \leq 1$, $x/(1 + x) \geq x^2/(1 + x)$.) One major flaw in this analysis is that B can do it too. Again, however, the results are not all discouraging. This model predicts that the probability of B's showing two fingers is always at least .5, is .5 if x is 0 or 1, and has a maximum of .58 at $x = -1 + \sqrt{2} \cong .41$. This seems a reasonable prediction if we do not assume that B will do the same type of analysis.

This particular model could be made somewhat more acceptable by introducing the a_n's mentioned earlier. (The values to be used for the a_n's would depend on whether B were a game theorist or nine-year-old.)

It seems clear that power series can be used to model some types of higher-order interactions of predictions and events. The power series can be used even if not all of the higher-order effects work in the same direction. With the power series approach, that total effect of the prediction on the event will be

$$\sum_{n=1}^{\infty} a_n x^n ,$$

with x as a measure of the probability that the $(n + 1)$-th level of analysis will be considered if the nth level has been considered, and a_n the probability that the nth level of analysis will be acted on if it is considered. It is relatively simple to imagine nontrivial cases in which an attempt can be made to evaluate x and a_n empirically.

5.3.2. Cybernetic models. In the last twenty years or so there has been a great growth in those fields of study which try to analyze and describe the behavior of those mechanical, electromechanical, and biological systems which exhibit a high degree of information feedback in their operation. The methods of these areas of study do not vary as widely as their names: cybernetics, control systems, time-lag control systems, self-organizing systems, homeostasis, and others.

Some of the methods that have been used successfully in these fields might be helpful in analyzing various instances of self-affecting predictions. A single example will suffice. Predictions that the world's population will be so large that the predicted actual or even potential world food supply will not be large enough to prevent mass starvation are made with disturbing frequency. It seems quite reasonable to assume that these predictions are an impetus toward advances in food production technology. One way to try to describe this situation in a semiquantitative way is to set up a system of difference or difference-differential equations. For example, we introduce the following notation:

t = time, with the zero point chosen in the recent past for convenience (e.g., $t = 0$ at the start of 1960).

$F(t)$ = the world's per person food supply at time t.

S = a minimal acceptable food supply per person.

$P(r,t)$ = the "intensity" of the prediction at time t that there will be a serious food shortage r years in the future. This "intensity" is some measure of the frequency and authority of the predictions of a food shortage.

a, b, c, h, j, k, m, n = positive constants.

Consider the following equation:

$$F(t) = F(0) + t^2(a + b \int_0^\infty P(r, t - c)e^{-jr}\, dr).$$

In effect, this equation says that food supply is equal to a constant "base" supply plus an additional supply generated by "natural"

improvements in technology and the use of land, plus a third term that represents the additional increase due to technological improvements generated in response to predictions of impending disaster. This third term is proportional to a weighted time average of the predictions that had been made c years earlier. (The selection of both the function t^2 and the weighting factor e^{-dr} was made arbitrarily.) Hence it is being assumed that all technological improvements are developed and implemented exactly c years after a project starts.

We also need a formula to describe $P(r,t)$. We can assume that the intensity of the predictions of famine depend linearly on the extent to which current food supply is below the minimal acceptable supply, and on the rate and direction of change of the per person food supply. We can further assume that the long-range predictions of famine rely more heavily on the rate of change of current supply than on current supply. Thus we can write the equation:

$$P(r,t) = he^{-r} \max(S - F(t), 0) + k(1 - e^{-r}) \max(ne^{mr} - F(t), 0).$$

The extra factor of ne^{mr} was included to account for the fact that a higher rate of increase in food supply is needed to justify long-term confidence than short-term confidence.

These two equations are only examples of the types of equations that could be used; many sets of similar types of equations have been studied in great detail in the areas mentioned at the beginning of this section (for example, in Refs. 5, 6, 8, 9, and 10). In short, it is hoped that some aspects of self-affecting predictions can be investigated by some of the standard methods used in other fields to study problems involving systems with feedback.

6. SOME COMMENTS ON PREDICTIVE CONTENT

In many predictions, the predictive content--that is, exactly what is being predicted about the future--is quite clear. However, there are many cases when this is not so. Some acts appear to have

a great deal of predictive content, yet in fact have almost none. Some acts have much more predictive content than might be immediately apparent. This section discusses various classes of events which have more or less predictive content than might be first thought.

6.1. Warnings and Conditional Predictions

A large class of statements can be interpreted as conditional predictions, as warnings, or as both. The archetype of this is a statement of the form "If A isn't done, then B will happen."

Often such a statement is much more a call to action on the issue of A than a forecast of the future. Such cases are of special interest. First, because direct attempts are being made to use the predictions to achieve certain goals, they are extreme instances of predictions interacting with the events being predicted. Second, the predictive content of such statements is sometimes much less than a cursory glance would indicate. For example, the statement "If A isn't done, then B will happen" is often a shorthand for a much weaker statement such as:

"If A isn't done, then B will become possible."

"If A isn't done, then B will become more probable."

"If A isn't done, then B will happen; but A will almost certainly be done."

"If A isn't done, then B will happen; if A is done B will probably happen anyway."

It is clear that these forms of the statement make much weaker explicit forecasts about the future than the original statement.

Of course, this type of rephrasing could be done to most predictions. However, in most cases it would be a clear distortion of the meaning of the original statement. Rephrasing which does not strongly change the original meaning can be done more often with conditional predictions than with other types.

If the flow chart introduced earlier is to be used with conditional predictions, especially with those dire warnings which are "hopefully self-negating," a special effort should be made to understand

what happens when the prediction passes through the areas marked "evaluation of source's goals" and "evaluation of possible results of predictions." In those areas on the chart, conditional predictions behave very differently from other kinds.

6.2. The Standard Optimistic Prediction

In any contest there is a tendency for the contestants--those involved either directly or by emotional and intellectual commitments--to predict victory for the side they favor. Obvious examples of such situations include players and coaches on athletic teams before a game, military and political leaders before and during a war, and politicians before an election.

The question is how, if at all, this constant barrage of optimistic predictions affects the outcome. An obvious path for interaction of the prediction with the results is to convince participants in the contest that others have faith in them and that they have good reason to be optimistic; this conviction should in turn improve the efficiency and effectiveness of the participants. Let us assume for a moment that this is the main interaction, and ignore "reverse psychology" and other effects.

We now have the question of how large the effect will be. I would like to suggest that there is almost no positive effect, and that the major reason for making these predictions of victory is to avoid a certain type of strong negative effect. Let us follow a simplified example through the flow chart.

Teams A and B are to play basketball. The newspapers have reported that betting has established team A as an 8-point favorite. In the locker room before the game the coach of team A tells his team that he thinks that they will win by 15 points; the coach of team B tells his team that he thinks they will win by 5. What is the effect of these predictions on the outcome?

The prediction of A's coach passes through the flow chart relatively unscathed until it comes to the regions marked "evaluation of source's goals" and "evaluation of possible results of prediction."

A player for A will probably evaluate the prediction along the following lines: "He wants us to win and knows that if we're confident it will help our playing He probably took this into account and told us something 5 to 10 points more optimistic than he actually believed." In this case the "fully evaluated prediction" on the flow chart would be the original prediction of a net score of +15 for A discounted 5 to 10 points--a prediction that A will win by 5 to 10. If a player for B does the same analysis for the prediction by B's coach, the result will be a prediction that A will win by 0 to 5 points. These are both in good agreement with the "'standard' prediction" established by the betting--that A will win by 8. Hence, in both cases the coaches did little more than repeat a disguised version of the "'standard' prediction." It would seem that this would have little effect on the outcome. (We are not now considering the effects of the "'standard' prediction" on the outcome.)

Suppose we change the situation. Suppose that the coach of B makes no prediction before the game. His silence is an admission that he has no opinion or is unwilling to state his opinion. In the area marked "group evaluation of predictive act" this silence would probably be reinterpreted as pessimism--a "net implicit prediction" that B will lose by 10 points or more (the coach could have predicted a close game). If we now follow this prediction through the rest of the chart using our earlier analysis we find a "fully evaluated prediction" that B will lose by 15 to 20 points. This is much more pessimistic that the standard prediction, and could have a disastrous effect on the team's morale.

In short, the absence of an optimistic statement might well be interpreted as a very strong pessimism which could in turn lead to disastrous effects. It seems quite possible that many optimistic predictions about outcomes of contests say in effect "Don't give up hope yet."

6.3. Consensus Predictions

Various facts can be regarded as the consensus of the predictions of a large group of people, arrived at in some formal manner. The most

obvious example is a prediction based on a pre-election poll, although in this case the prediction is based on a consensus of people's plans, not their predictions. (Suggesting that the people polled are "predicting" how they will vote seems only confusing.)

Two interesting examples are betting odds and stock prices. The major variable in determining the odds a bookmaker will offer on an event is how much has already been bet on the various possibilities. It seems reasonable to assume that placing a bet is often a predictive act. The prediction is that the event being bet on will happen, or at least is more probable than the current odds indicate. It also seems reasonable to assume that the size of the bet is influenced by the degree of conviction backing this prediction. So it is possible to consider the betting odds as a complicated, dollar-weighted, consensus prediction of all bettors. Similarly, a stock price can be regarded as a complicated way of expressing the consensus of the predictions of all investors about the future of the particular company, the stock market, and the economy in general.

6.4. Events as Predictions

Current events and recent history contain enough material for a very large number of predictions; some of these are actually made, some are not. Although in general the problem of self-affecting predictions concerns those predictions that are actually made, there is at least one interesting class of exceptions. Those are the predictions based on current events and recent history that are sufficiently interesting to be worth making, but are somehow considered sufficiently obvious that no one ever bothers to make them. A few examples of predictions of this type are:

> The total popular vote for the President in 1988 will be larger than the popular vote for the President in 1888.
>
> Los Angeles will not change its name in the next five years.
>
> The amount of school integration in the South will probably continue to increase for the next few years.

Predictions of this type help form the reservoir of "'standard' predictions" that most people have. Large numbers of predictions of this type can be generated at will from common knowledge. They are almost never articulated. Yet there is absolutely no reason to assume that they are less important in determining a person's expectations about the future than are formal predictions. In fact, intuition suggests that these obvious and unarticulated predictions are a major factor in determining a person's plans and expectations.

There are many interesting problems which, if we consider the predictive content of events, can be regarded as problems about self-affecting predictions. For example, the past generation or two has seen a spectacular growth in the development, dissemination, and success of various psychoanalytic theories. Almost every educated person in this country today is familiar with the vocabulary and some of the basic tenets of Freudian and other theories of personal behavior. With this knowledge come implicit predictions. An example of such a prediction is:

> If you are a young man, it is quite possible that you do or will have emotional difficulties which are, in part, causally related to the fact that your childhood relationship with your mother was unsatisfactory and never satisfactorily resolved.

Of course, there are many other such predictions. The question is whether such predictions affect the events. Is a young man who is aware of the sample prediction given above more, or less, likely to have the prediction come true in his case because of this awareness? In general, what effect has the widespread dissemination of psychoanalytic knowledge had on the type and frequency of emotional disorders in this country today? Does the child of parents who are psychoanalytically sophisticated have a better chance of growing up emotionally healthy because his parents will be influenced by scores of dire predictions? Unfortunately, we are again in the position of only being able to ask the questions.

7. PREDICTIONS AND POLICY

When a person must implement a policy change, there is often a temptation to use the making of a prediction as one means of implementation. But perhaps "temptation" is too strong a word, since sometimes no moral issue is involved.

As a first example, suppose a sales manager says to his salesmen, "If sales don't go up, we're going to replace the entire sales force." This example is clearly a prediction made to implement a policy which says that current sales are very unsatisfactory. Second, suppose that in the middle of a serious economic recession the President says, "I expect the recession to be completely over in six months." It is possible that such a statement has no intention other than to disseminate the President's forecast to anyone interested. However, it is also possible that the statement would be made partially in the hope that optimism by a leader might help end the recession sooner. It is also possible that the statement was made for the effect it might have and that the President has no good reason to think that the recession will end within a year.

In the first example, there seems to be no moral issue. In the second example, there is the problem of when the possible social utility of a prediction should justify making a prediction in which the predictor has little or no faith. Unfortunately, our previous discussion is far from sufficient to settle this problem. However, a glance at the flow chart does help us to point out several things that should be kept in mind when considering the use of predictions for policy implementation.

First of all, the long-term accuracy record, the "historical reliability," of the source is at stake. If a person develops a reputation as an inaccurate predictor, the value of his predictions is certain to decrease. Second, some of the effect of the prediction will be lost in the process of "evaluation of source's goals." People tend to pay relatively little attention to predictions that are obviously made for their effect on events. Finally, the situations in which one would be most tempted to use predictions to implement policy

are generally in areas that are not considered very predictable. For example, a prediction of a war between the United States and China in 25 years would have its effect minimized by the general consensus that long-term military and political events are not very predictable.

Of course, these observations might be reasons for not using predictions to try to influence events very often; they are not reasons for never trying to use predictions that way. There are, in fact, many common situations in which the making of a prediction seems to have been motivated partly by a desire to have people act on the prediction. For example, when the national budget is prepared, many groups appear before Congress to foretell the wonders they will accomplish if they receive enough money. To a certain extent, such forecasts are a sincere attempt to enlighten Congress; to an extent, they are merely an attempt to get money.

Many statements by prestigious people and groups can be interpreted as attempts to sway people by making predictions for which there is little justification. It is unfortunate that this aspect of political and social manipulation has received so little attention.

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