TELECOMMUNICATIONS EARNINGS ESTIMATION MODEL (TEEM)

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Abstract

TEEM is a corporate simulation model developed for the Security Analysts of Wells Fargo Bank. It is a probabilistic interactive model designed to estimate an income statement and a funds flow analysis for any manufacturing or distribution firm for which history data is readily available. The primary objective is to generate more accurate, systematic, and consistent estimates for companies which are of investment interest to Trust accounts. Both the analyst and the computer contribute unique and complementary facilities to the process: the computer contributes its abilities to organize and recall data, to calculate and to structure an estimation process, while the analyst contributes his information gathering abilities and his ability to integrate into the structure of the model.

1. INTRODUCTION

In order to provide the proper framework in which to describe TEEM it is necessary to elaborate on what the environment of the Security Analyst and the Portfolio Manager has been in the past, and what we foresee in the future.

Security Analysis is one of the few disciplines where techniques have not varied extensively over the past forty years. Until recently, the Security Analyst's function has been defined to be providing Portfolio Managers with recommendations on a small list of securities, selected from the large universe of common stocks. This list primarily contained qualitative information suggesting the purchase, holding, or selling of a stock, with some indication of the relative risk or "quality" involved. From this list, the Portfolio Manager would select stocks he thought had the risk and return attributes desired by his clients, and thus form a portfolio. Since the entire process was steeped in qualitative information, the success of Portfolio Managers was dependent upon highly subjective reputations of Security Analysts.

Recently, there has been a spurt of interest and research in quantitative techniques applied to the process of financial analysis. Sparked by demands for better performance on the part of pension funds and individual investors, and fueled by developments in the universities, much research has gone toward improving portfolio performance. If better portfolio performance is to be accomplished, it is necessary for the Security Analyst to improve the accuracy and usability of the inputs to the portfolio process. As we will see later, for effective Portfolio management, it is necessary that the Analyst provide not only his quantitative expectations of the future, but also the uncertainty of their expectations.

Since portfolios consist of collections of securities, usually common stocks, their value at any point in time is dependent on the market prices of the stocks. Since portfolios must be held over future time, it therefore seems reasonable to expect the Security Analyst to estimate future price behavior of corporate stocks. Because of the high degree of variability and instability of the stock market, it is difficult to accurately estimate stock behavior. Research (and theory) has shown, however, that estimates of future corporate earnings per share (EPS) tends to be one of the prime determinants of future stock price. The Security Analyst is thus faced with the problem of estimating EPS.

The problem of how the Analyst could be assisted in better estimating EPS was then addressed. Our first attempt was to develop an analytic model. We did a significant amount of alternate model foundation and hypothesis testing, trying to develop a model that could effectively predict EPS and other financial variables. We soon realized that if an effective model was to be developed, it would not only involve mathematical analysis of historic company data and macro-economic relationships; it would also have to integrate information acquired or developed by the analyst. A computer model alone simply could not intercept and interpret the vast spectrum of information relevant to the forecasting of corporate earnings.

With this in mind, TEEM was developed. The primary objective of TEEM was to create more accurate estimates of future corporate behavior through an interactive model.

TEEM is the acronym for Telecommunications Earnings Estimation Model. This probabilistic and interactive model allows an Analyst to derive an earnings estimate for a company by means of simulation. The model is probabilistic because estimates of financial variables are in the form of probability distributions; it is interactive because active participation by the Security Analyst is required to operate the model; it is simulative because the analyst is allowed to change estimates entered into the system after he has observed and evaluated their impact upon other variables.

Because of the complexity of the process that determines values of financial variables of any company, it is extremely difficult to create an analytical model of the company with any degree of predictive accuracy. TEEM simulates the financial aspects of a company proforming* the Income Statement and Balance Sheet of the company. It does

*Pro Forma financial statements are estimates of the values before the actual results are known.

not take into account all of the variables that cause changes; its level of abstraction does not extend beyond the domain of variables which are direct measurements of the financial characteristics of an individual company. It allows the analyst to vary estimates of company variables, and observe the effect on other variables within the model. For these reasons, we consider TEEM to be a simulation model where variables are observed as functions of varying states of nature.

The Operating Income Statement and the Funds Flow Statement provide the context within which TEEM operates. The advantage of this context are twofold. First, the "model" had been used thousands of times to express the financial behavior of a company. The Security Analyst is intimately familiar with both statements. Secondly, the use of these statements provides a readily available data base to study the causes and effects which affect earnings.* After these statements have been derived, TEEM then derives a Balance Sheet as well as an Overall Income Statement (which differs from the Operating Income Statement by the effects of Funds Flow transactions).

Thus, TEEM is a model built to simulate the expected financial behavior of one company at a time, one year at a time, but general enough to be useful in the study of any company for any year.

*This data has been collected by Standard and Poors Corporation and made available in machine readable form as their COMPUSTAT Service. COMPUSTAT provides twenty years of data on 64 variables for 1800 companies.

2. DESIGN GOALS

The obvious way to improve the existing environment was to provide facilities to the process which were previously unavailable; i.e. to advance the state of technology. The "tools" we had to work with consisted primarily of computing equipment and evolving disciplines in statistics and economics. (Our charter was to apply the evolving technologies to the day to day operations, not to engage in primary research).

The objective of the system was to improve the accuracy and usability of the forecasts being used to make investment decisions. How then can the available technology be used to improve the environment?

In order to determine that the proposed system did actually improve the estimates, it was necessary to impose the following constraints on the process: First, that all estimates be recorded and saved so that an analysis of their accuracy would be possible later. Second, that estimates be in a form which is subject to accuracy measurement; that is, be quantified. Thus all estimates can be assessed for their information content. This satisfied one of the operating criteria of the Management Science Department-that no system would be installed without a method of assessing its value.

This gave rise to the need for a data management system to control the estimate file. The real value of the data management system was far greater than merely the storage of "dead" estimates-we also had on hand a file of current estimates which could be used directly in logically subsequent decision systems; e.g. stock valuation models and portfolio management decision aiding systems.

Again, this satisfied our basic operating criteria that each system must be developed not in isolation, but in full knowledge of the source of the inputs and the usage of the outputs.

Another valuable side effect of this live data storage was that estimates could be kept up to date by the Security Analysts much more simply and consistently with far less lead time and errors than was ever possible before.

We realized that the Security Analyst presently possesses some facilities which are very difficult to duplicate in a model: rapid access to a wide variety of data, estimates, opinions, rumors, etc.-which a model could not attempt to approach-and intellectual capabilities which allow him to integrate these data via methods which a computer-only model would find extremely difficult to surpass. Thus we were led to the conclusion that our model had to be made interactive, i.e. that the Analyst had to be able to enter his information in the simplest (to the Analyst) possible manner.

This does not mean, however, that useful estimation cannot be performed by the computer, with all its storage, computational, and algorithmic capabilities, coupled with its absence of subjective bias! Indeed, much work had been completed which shows that historic data and macroeconomic estimates can be used to improve estimates. There are "economies of scale" which can be turned to advantage here- a Security Analyst cannot affort the time required to build a sophisticated model to handle one company, while it is quite reasonable to build a general model capable of estimating any company of interest.

How then do we link the system generated estimates with the Analyst generated estimates? This is accomplished by executing the following policy: the Analyst, not the model, is responsible for the accuracy of the estimate, and, therefore, the Analyst must explicitly accept a system generated estimate, or replace it with one of his own. Thus the system generated estimates are advisory to the Analyst-he is provided with the value of the estimate and a measure of the reliability of the estimate. System estimates are, in general, based on "everything normal" assumptions, and the Analyst should supercede the system estimate whenever he has information which leads him to believe that the year forecasted is an abnormal year. Of course, both Analyst generated and system generated estimates are stored for subsequent monitoring. This approach also dictates an "open structure" to the internal design of the model, so we can add system estimates when a technique is developed which has validity for all or for some sub-set of the companies.

Notice carefully the assumption here that interactive estimates are better than estimates made by man or by machine alone. The rationale is as follows: many management science type models when pitted against a human forecaster, will generate roughly similar average errors. However, if one examines the pattern of error, one finds that the patterns can be quite different-that the man and the machine are not making the same errors at the same points in time. In general, the machine excells where the process is orderly and the model can uncover the systematic elements. The man, on the other hand, tends to underperform the model on the systematic aspects but far out-perform on the detection and estimation of the abberations to the process. That is, the man can detect when the process is "out of control", and override the model at that point. Thus, with the model analyzing the systematic aspects, and the analyst alert for non-systematic elements, better forecasts should be derived than either agent alone could develop.

The establishment of statistical methodology in the forecasting of corporate variables allowed us to incorporate another highly desirable feature into our model: statistical measurement of forecasting errors made by our systematic models allowed us to make explicit statements of the expected accuracy of our estimates; that is our probabilistic forecasts.

In order to understand the concept of probabilistic forecasting, let us first examine the concept of point forecasting as it is widely understood, and used, by security analysts. Basically, single point forecasting is an attempt to distill all the avialable information and current expectations about a variable being forecasted into a single point value. However, since neither an analyst nor a model can claim omniscience in predicting future events, the point forecast is only one of many possible future values. Therefore, the weakness of point forecasting stems from the fact that the uncertainly necessarily associated with a single point estimate is not stated. The question "How sure are you about your forecast?" cannot be adequately answered. Equally important, point forecasting ignores asking the further question: "What other values are possible?"

Probabilistic forecasting, on the other hand, allows the statement of an estimate which incorporates the answers to both of these questions. That is, it incorporates two types of uncertainly: the variability introduced by the forecasting process due to incomplete information and/or erroneous methodology as well as that due to the inherent variability of the variable itself. In TEEM, answers to both types of uncertainly are achieved by manipulating probabilistic forecasts called PMO Forecasts.

Subjective probabilistic forecasting, however, is a means of expression with which the Analyst is not familiar; nor are its behavorial characteristics over time and across variables well understood by him. The ability to use probabilistic forecasts as an effective tool will have to be developed by the Analysts, through a combination of experience, monitoring, and formal study of statistical error.

One of the most difficult problems faced in the development of the system was the search for the best method for representation of explicit statements of uncertainty to the user of the system. In many applications histograms* or relative frequency distributions are used.

However, this approach is unacceptable for use in the TEEM system because:

(1) Storage space requirements for such estimates are too great.

(2) The vast amount of information cannot be presented such that the analyst can easily integrate it into his forecasting and decision making systems.

(3) The results may not be useable to logically subsequent systems.

In TEEM, we attempt to represent probability distributions in such a manner that they can be easily stored, manipulated, and communicated to the analyst in an "understandable" manner.

We believe that the analyst can reasonably understand probabilistic estimates in terms of three points: The Pessimistic estimate, the Most Likely estimate, and the Optimistic estimate. (Hence, the term PMO forecasts). This phraseology has considerable intuitive appeal for nearly anyone can attach reasonable correct (and useful) meanings to these terms. For statistical manipulation purposes, pessimistic is arbitrarily defined as being that value below which only five percent of the probability of occurrence lies. That is, if the experiment caould be replicated, we would expect five out of every one hundred results to lie below the pessimistic value. While the particular "odds" in this case, five percent, are arbitrary, it is necessary to set some standard in order that estimates are comparable. Optimistic has a similar meaning: it is the value above which five percent of the possible outcomes would occur.

*Since "histograms" are short for "historic frequency distribution", the term "antegram" may be more appropriate for statements of future uncertainty.

We are convinced that when the Analysts become accustomed to expressing their estimates probabilistically, they will prefer this method over the current single point estimates for two reasons: First, because he is not required to discard possibilities since the form of expression admits the prediction of more than one outcome. Second, because the users of this information are more satisfied because they have better information on which to base their decision.

Since the model we were constructing was innovative in many facets, we assumed from the beginning that the final result was not going to be achieved by the first version. That is, that we were building a protype of a model which was certain to evolve into a more sophisticated model. Thus our final major design goal was to make the model modular and open ended so that model additions and alterations could be easily and rapidly added.

Let me summarize the design goal of the model:

(1) Monitorable-capable of objective evaluation;

(2) Live storage-immediate accessability for updates and further usage.

(3) Interactive-allow input from and control by the analyst.

(4) Forecasting assistance-development and inclusion of technology to assist analyst in estimating;

(5) Probabilistic-explicit consideration of uncertainty of estimation;

(6) Extendable-as new methods are developed.

3. TECHNOLOGY OF THE MODEL

To satisfactorily achieve the goals of the model which are described above, certain hardware and software requirements had to be met. We depended on the outside world to meet the hardware requirements, which centered on the availability of a suitable computer complex. The software requirements mostly centered on the estimation and interactive techniques used in the model. The following is a discussion of these points.

The requirement that the model be an interactive one meant that the computer complex to be used had to be a timesharing one. Response and reliability of the computer system had to be fast and high because the user-the financial analyst-does not have the patience in executing a model that, say, a programmer does. That the financial analyst has less patience follows from the fact that he does not know, should not know, and really does not care what is occuring while his terminal sits silent before him: essentially, if he is doing nothing, the terminal should be doing something.

The only commercially available timesharing computer system at the time the development of the model began was the SDS 940. However, the SDS 940 proved to be grossly inadequate for the model: not only was response slow and reliability low, but the limited core available-16k words (in a system which used two words for a floating point variable) necessitated the use of multiple overlays to fit the entire model into this computer system, thus aggravating the response problem. It was not until the beginning of 1969 that a significantly better computer system-the IBM 360/67 of Interactive Data Corporation at Waltham, Massachusetts-was available to us. The IBM 360/67 has proved to be very reliable; response initially was excellent-Fortran routines which required 30-40 minutes to compile on the SDS 940 required less than two minutes on the IBM 360/67.* The relatively large amount of core available-256k words-does compensate to some extend for this slower response: we can fit the entire model (except for the data retrieving routine) into the system at once.**

Because the model had to derive forecasts based entirely on historic data, a bank of such data had to be created and maintained for most of the companies on the major stock exchanges as well as for

*However, as additional users have gained access to the system, response has deteriorated somewhat.

**The model consists of over 5000 Fortran statements.

the more prominent companies whose stocks are traded over the counter. IDC had this data bank, Compustat, as part of its services. Consequently, use of the IDC system not only avails us of a very good timesharing computer complex, it also relieves us of the problems of maintaining the data base.

The data itself is somewhat lacking in four respects:

(1) The data is not as detailed as one would like- a problem endemic to most sources of corporate financial data.

(2) The data relating to the income statement essentially dictates the structure of the model, which necessarily conforms to the model evoked in the data structure. However, it can be argued that this particular structure of the income statement is not the best with respect to accounting principles.

(3) Some of the data is not available; that is, it is missing;

(4) Accounting definitions, even if uniformly followed, are probably not the best economic descriptions of the firm.

Not much can be done with the first two and the last shortcomings except to bear with them. The problem of missing data of a corporate variable is handled as follows: If the missing data for the variable precedes all the available data with respect to time, it is ignored. If the missing data is amidst the available data with respect to time, it is assigned values calculated by treating it as a finite arithmetic progression whose first term is the immediately preceding piece of available data and whose last term is the immediately following piece of available data. If the missing data follows all the available data with respect to time, it is replaced by estimates of it derived from the available data. If the data is not available at all, the system estimates for this company are not derived.

The model could have been written in either SDS Fortran II or assembly language at the onset. Fortran was selected for two principal reasons: First the persons assigned to program the model already have knowledge of Fortran: learning the assembly language supposedly would have significantly delayed the project. Second, using Fortran would significantly reduce conversion problems if and when the model was moved to another computer system. As it was, it took less then one week to convert the model from SDS Fortran II to IBM Fortram IV. Simulation languages such as GPSS or Simscript were rejected because the facilities provided by these languages are, in general, oriented toward "job shop" applications, and were of little assistance to us in our model.

Because the model is an interactive one, a prime consideration in its design was to make the model as usable as possible by the analyst. A basic assumption, along this line of thought, was that the analyst knows extremely little, if anything, of computer or statistical concepts and terminology. Hence, the interaction between model and user in statistically oriented routines has been designed so that information required by the model is requested not in statistical jargon, but rather in financial terms. The usual form of the interaction between model and user is a request for information or data by the model followed by the user's reply. The model then processes the user's reply, proceeding until additional information or data is required from the user, at which time it again issues a request.

To further the usability of the model, the requests for information are as concise as possible so that the user need not wait unduly before he can enter his reply. Requests for control information have a finite set of correct responses; the user's reply to such a request is checked against this set. If the reply is illegal (i.e. is not in the set of correct responses) the model issues a question mark and repeats the request. If the user desires a listing of this set of correct responses when he is confronted by a request for control information, he can always indicate his wish to the model, which will then list the set. Another aid available to the user is his ability to direct the model to proceed to the beginning of a major routine-a known starting point-from any point within that routine where the model asks for control information. Thus, he need not execute a long string of dummy commands to recover from an incorrect response.

To facilitate the user's control of the execution of the model, the model has been divided into paragraphs (each of which corresponds to a major accounting line of the income statement and which consists of the estimation techniques available to forecast the corporate variables relating to that accounting line) and a director (which controls the execution of these paragraphs). There are three modes of executing the model: First, the "Continue" mode allows the user to interact with the model within desired paragraphs. Second, the "Default" mode allows the user to direct the model to accept as his estimates the system derived estimates for the variables in desired paragraphs. Third, the "Go To" mode allows the user to direct the model to accept as his estimates for the variables in desired paragraphs his previously accepted estimates; i.e., his "old" estimates, however derived, are retained.

These modes of operation are alternately used at will by the user to control the execution of the model: with one default to mode execution, he can direct the model to accept system estimates for the entire model. Then he can use the go to mode to direct the model to any accounting line which he wants to estimate, access the routines which allow him to estimate that accounting line via the continue mode, and utilize the go to mode to direct the model to its end so the effects of his change on the statement can be derived by the model. Needless to say, the programming required to keep all this control opaque to the user is extremely intricate.

The probabilistic aspect of the model is handled by the estimates themselves, which are described by Normal distributions. Because of the user's lack of statistical knowledge, these estimates are known in the model as PMO estimates (P for Pessimistic, M for Most Likely, and O for Optimistic) and are described(actually overspecified) by the three parameters, P, M, and O. The P-O range represents 3.3 standard deviations and hence include 90% of the total probability represented by the estimate. A "Normal combiner" routine was written to handle the arithmetic operations on these estimates. Addition and subtraction algorithms follow directly from statistical theory, while the multiplication and division routines are approximation formulas which are acceptably accurate within normal data range.

The two system forecasting techniques currently used by the model are elaborations of exponential smoothing for exogenous variables and linear first difference regression for endogenous variables. Again, these system estimates are calculated by the model only when it is directed to do so by the user and are accepted as estimates only by the user. It is important to note that the program has been designed so that new forecasting methods (whether statistical models or interactive aids) can be easily added to the model. One of the areas in which we expect the model to "grow" is the array of forecasting techniques available.

In addition to the system generated estimates, the Analyst had various options open to him which allows him to state his estimate in a manner easy and natural to him. He can state it directly, in terms of percentage change from last year, or perform extensive modification of a system generated estimate. The responses of the Analyst to queries from the model are in general short (he is assumed to be a poor typist), alphabetical and suggestive where possible, and consistent at all levels of execution within the model.

4. THE MODEL AS DEVELOPED

In this section we will briefly overview the model in its current operative form.

The analyst has direct access to the model via an IBM 2741 terminal, hooked over leased multiplexed lines to a 360/66 in Waltham, Massachusetts.

Exhibit A is a simple output of the income statement construction employed by the model. The "display" format shown here details 38 accounting lines, and is divided into two PMO triplet columns following fairly standard accounting presentation. The asterisks leading certain accounting lines indicate entry points to paragraphs: the analyst, through the Director can move (Continue, Default to, or Go to) from any paragraph entry point to any other. After a paragraph is entered, the analyst is able to estimate variables within the paragraph. The analyst is only allowed to deal with causal variables (exogenous to the model) such as Sales, Operating Expenses, Depreciation, etc. These causal variables are then combined as probability distributions into effect (or endogenous)

1965 INCOME STATEMENT FOR ATO

	P	M	O		P	M	O	
* SLS					0.0	0.0	0.0	C
* OEXP	0.0	0.0	0.0	D				
OINC					0.0	0.0	0.0	C
(PM)	0.0	0.0	0.0					
* DEPR	0.0	0.0	0.0	D				
SUBT....................................					0.0	0.0	0.0	C
* FCHG	0.0	0.0	0.0	D				
SUBT....................................					0.0	0.0	0.0	C
* NREC	0.0	0.0	0.0	D				
SUBT....................................					0.0	0.0	0.0	C
* OTHI	0.0	0.0	0.0	C				
USRE	0.0	0.0	0.0	C				
OTHE	0.0	0.0	0.0	C				
PBT					0.0	0.0	0.0	C
* TXCF	0.0	0.0	0.0	D				
PBTA					0.0	0.0	0.0	C
(PBTA/SLS)	0.0	0.0	0.0					
* ITAX	0.0	0.0	0.0	D				
(ITAX/PBTA)	0.0	0.0	0.0					
TAXP	0.0	0.0	0.0	D				
(TAXP/PBTA)	50.00	50.00	50.00					
DTAX	0.0	0.0	0.0	D				
CTAX	0.0	0.0	0.0	D				
IVCR	0.0	0.0	0.0	C				
PAT					0.0	0.0	0.0	C
(PAT/SLS)	0.0	0.0	0.0					
(CF)	0.0	0.0	0.0	C				
(CF/SHR)	0.0	0.0	0.0	C				
* MINI	0.0	0.0	0.0	D				
NINC					0.0	0.0	0.0	C
* PDIV	0.0	0.0	0.0	D				
NFC					0.0	0.0	0.0	C
EPS	0.0	0.0	0.0	D				
* CDIV	0.0	0.0	0.0	D				
(PAYR)	0.0	0.0	0.0					
DPS	0.0	0.0	0.0	D				
SUBT....................................					0.0	0.0	0.0	C
* NETN	0.0	0.0	0.0	D				
<>RE					0.0	0.0	0.0	C

(EXHIBIT A)

variables such as Operating Income, Profit before Taxes, etc.

The endogeneous variables that are printed in the left triplet and have parentheses around their identifications are variables that are derived ancilliary to the estimation process. These are the commonly used financial ratios useful in the comparison of companies. Note that EPS is one of the derived variables. This means that the Analyst is not able to directly estimate this most important variable. Earnings is dependent on all of the exogenous variables that precede it. This means that the Analyst explains the effect (i.e. EPS) based on causes (the exogenous variables). This is the essence of Proforma estimation.

There is no set execution order which the analyst must follow in the execution of TEEM. However, we can exemplify how an analyst could interact to achieve different goals by a few examples.

As a first example, let us observe an Analyst making his first estimate on a new company. Presumably he has read the readily available literature on the company and has developed some subjective estimates of some, but not all, exogenous variables.

The use of TEEM could then take the following form: the Analyst would succesively enter each paragraph and create a first-estimate of each exogenous variable. Within each paragraph he has forecasting tools at hand such as regression and exponential smoothing. He can use these tools to generate estimates based on the assumption that the future will follow patterns of the past, or he can always override the estimate and enter his own. It is necessary for him to explicitly accept some estimate before exiting each paragraph. He is, therefore, responsible for each estimate whether it is created by himself or by a forecasting tool.

Once this first pass through the entire Income Statement is completed, the entire statement can be displayed as in Exhibit A, to see whether or not it is intuitively reasonable. Where values are unacceptable, the Analyst can go back, make the appropriate changes, and then re-exhibit the statement. This process can continue until he converges on an acceptable set of estimates.

The flexibility inherent in the design of the Director allows the Analyst independence in the order in which he addresses the re-estimation of variables. The model follows the Analyst's direction and thought processes, not vice versa.

At any time during the use of TEEM the Analyst can save his results on a disk file. This provides him with the ability to reload, at any future time, the file into TEEM and modify the estimates. This is extremely useful since the Analyst operates in a dynamic environment where he is constantly gathering new information about the companies that he follows. Using TEEM, that information is immediately entered into the information stream; small changes which are in themselves insignificant do not accumulate to large, important unrecorded changes.

Another example (See Appendix) of a use of the TEEM structure is the performance of sensitivity analysis. As an example, the analyst could create a set of estimates which he thinks is reasonable for the company. He could then "Go To" the Sales paragraph (or any paragraph) and vary the Sales estimate and observe the effects. Since Sales is the first variable in the model, it has an effect on the entire Income Statement. After changing his Sales estimate, he can display the Income Statement (either selected parts or all) and observe the effects of his change in Sales.

Thus he can determine the importance of the Sales variable to the EPS variable of the company. If EPS is insensitive to changes in Sales, the Analyst need not devote his attention to improving his estimates of Sales. If, on the other hand, EPS is extremely sensitive to the value of Sales, the Analyst should attempt to improve the accuracy of his Sales estimate.

Questions about the "validity" of an interactive model can usually be turned into a challenge- "only as good as the user". We have tested the forecasting ability of our mechanical models and find, in general, what we expect: the model performs commendably on well behaved, statistically "clean" data, and horribly whenever the process is subjected to an abberation. To date, the hypothesis that a synergystic effect exists-that the man plus the model out-performs both the man unaided and the model unaided-is untested, and cannot be verified until years of annual data are recorded. One curious feature about the "validity" of the model is that where the mechanical forecasts are the most inaccurate (invalid) the company is most unpredictable. Under these circumstances, the the superior knowledge and analytic ability brought to the process by the Analyst are most valuable because the uncertainly of EPS would create volatility in the stock price which would generate large potential gains or losses.

As noted previously, the present version of the model represents a prototype. Because the model has been designed modularly and open endedly, additions and deletions of various features from the model can be achieved relatively easily, thereby enhancing the evolution capability of the model. Indeed, we expect that early in the use of the model we will find features which are not useful and can therefore be dropped, as well as features which are lacking and will therefore be added. In this way, TEEM will evolve into a highly viable and useful, if not almost indispensable, tool of the Security Analyst.

5. CONCLUSION

Implementation of a model like TEEM presents a number of problems usually not encountered in most other models. The chief difficulty lies in the fact that in this model the user is an integral part of the system: the user's full participation is crucial to the success of the model. Consequently the implementation process must insure that each user becomes facile in controlling the execution of the model and in interacting with it. However, we have discovered that we as Management Science Analysts approach the model much differently than the Financial Analyst-the user does.We are interested in the model as a technical tool, and view it in the rather general context of being applicable to a universe of companies. The Financial Analyst, however, views the model in a much more specific context: how can it help him estimate earnings of company XYZ? This difference in viewpoints does much to confound communication between the two groups, thereby impeding the implementation process.

Our initial impressions about the process of implementation were derived from the "better mousetrap" theory-that once the virtues of our model were known, the implementation would proceed simply and directly to a state of full usage, with little effort required on our part. This is sadly naive. The virtues of the model are not obvious, the ability to use the model is not innate, and the users are not panting to be allowed access to the model. What is required is a marketing and educational effort. But the skills necessary to complete a successful implementation are dissimilar from the skills necessary to develop the model. This had led us to the development of "Management Science Marketing"--the identification of implementation as a separable and distinguishable function, and the development of a staff whose specific charter is to implement systems developed by other progessional Management Scientists.

Thus the ultimate viability of interactive simulations such as TEEM rest jointly on three parties: the developers who must present a useful package, the implementers who demonstrate and promote its usefulness, and the ultimate user who applies it to the better execution of his daily tasks.

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EXHIBIT is

1. In the Director, the user exhibits the Income Statement as estimated up to this point.

1969 INCOME STATEMENT FOR IBM

	P	M	O		P	M	O	
* SLS					7320.70	7844.49	8368.28	C
* OEXP	4238.25	4536.12	4834.00	D				
OINC					3073.60	3308.37	3543.13	C
(PM)	41.55	42.17	42.79					
* DEPR	1110.28	1181.74	1253.19	D				
SUBT					1881.24	2126.63	2372.03	C
* FCHG	37.82	45.34	52.85	D				
SUBT					1835.78	2081.30	2326.81	C
* NREC	-0.0	0.0	0.0	D				
SUBT					1835.79	2081.30	2326.81	C
* OTHI	54.21	66.60	78.99	C				
USRE	-1.41	-0.01	1.40	C				
OTHE	54.30	66.61	78.02	C				
PBT					1902.08	2147.90	2393.72	C
* TXCF	0.0	0.0	0.0	D				
PBTA					1902.08	2147.90	2393.72	C
(PBTA/SLS)	23.80	27.43	31.05					
* ITAX	1013.01	1143.93	1274.85	D				
(ITAX/PBTA)	53.25	53.26	53.26					
TAXP	1013.01	1143.93	1274.85	D				
(TAXP/PBTA)	53.26	53.26	53.26					
DTAX	-0.0	0.0	0.0	D				
CTAX	1013.01	1143.93	1274.85	D				
IVCR	-0.0	0.0	0.0	C				
PAT					889.06	1003.97	1118.87	C
(PAT/SLS)	11.12	12.82	14.52					
(CF)	2050.40	2185.70	2321.01	C				
(CF/SHR)	18.15	19.35	20.55	C				
* MINI	-0.0	0.0	0.0	D				
NINC					889.06	1003.97	1118.87	C
* PDIV	-0.00	0.00	0.01	D				
NEC					889.06	1003.96	1118.86	C
EPS	7.87	8.89	9.90	D				
* CDIV	297.28	325.11	352.94	D				
(PAYR)	27.91	32.54	37.17					
DPS	2.63	2.88	3.12	D				
SUBT					560.63	678.85	797.08	C
* NETN	-0.0	0.0	0.0	D				
<>RE					560.63	678.85	797.08	C

(APPENDIX - 1 of 3)

```
$:g
GO TO sls
$:c

 CONTINUE
```

2. Then he goes to the Sales paragraph, where he

```
**SLS**
>5
  5-YOUR PREV EST
   *SLS : P= 7320.70 M= 7844.49 O= 8368.28
```

a. accesses his previous estimate of sales,

```
 ∇:m
MODIFY
   ROMPS(1):m
     M'=A(M)+B
        A=1.1
        B=0
   *SLS : P= 8105.14 M= 8628.93 O= 9152.72
```

b. increases this estimate of Sales by 10%, and

```
 ∇:a
 ACCEPTABLE
```

c. accepts the new estimate

```
$:g
GO TO term
$:e
EXHIBIT is
```

3. The user next directs the model to the Termination paragraph. The model proceeds to calculate the effects of the new Sales estimate on the Income Statement.

4. The user exhibits the Income Statement as determined by the 10% increase in Sales:

a. operating Income increases by 10.4%

b. Pretax Income (Profit Before Taxes, Adjusted) increases by 16.0%

1969 INCOME STATEMENT FOR IBM

	P	M	O		P	M	O	
* SLS					8105.14	8628.93	9152.72	C
* OEXP	4238.25	4536.12	4834.00	D				
OINC					3417.77	3652.53	3887.29	C
(PM)	41.76	42.33	42.89					
* DEPR	1110.28	1181.74	1253.19	D				
SUBT................................					2225.40	2470.79	2716.19	C
* FCHG	37.82	45.34	52.85	D				
SUBT................................					2179.95	2425.46	2670.97	C
* NREC	-0.0	0.0	0.0	D				
SUBT................................					2179.95	2425.46	2670.97	C
* OTHI	54.21	66.60	78.99	C				
USRE	-1.41	-0.01	1.40	C				
OTHE	54.30	66.61	78.92	C				
PBT					2246.24	2492.06	2737.88	C
* TXCF	0.0	0.0	0.0	D				
PBTA					2246.24	2492.06	2737.88	C
(PBTA/SLS)	25.57	28.92	32.26					
* ITAX	1196.31	1327.23	1458.15	D				
(ITAX/PBTA)	53.25	53.26	53.26					

TAXP	1196.31	1327.23	1458.15	D				
(TAXP/PBTA)	53.26	53.26	53.26					
DTAX	-0.0	0.0	0.0	D				
CTAX	1196.31	1327.23	1458.15	D				
IVCR	-0.0	0.0	0.0	C				
PAT					1049.93	1164.83	1279.74	C
(PAT/SLS)	11.95	13.52	15.08					
(CF)	2211.26	2346.57	2481.88	C				
(CF/SHR)	19.57	20.77	21.97	C				
* MINI	-0.0	0.0	0.0	D				
NINC					1049.93	1164.83	1279.74	C
* PDIV	-0.00	0.00	0.01	D				
NFC					1049.93	1164.83	1279.73	C
EPS	9.29	10.31	11.33	D				
* CDIV	297.28	325.11	352.94	D				
(PAYR)	24.36	28.01	31.66					
DPS	2.63	2.88	3.12	D				
SUBT..................................					721.50	839.72	957.94	C
* NETN	-0.0	0.0	0.0	D				
<>RE					721.50	839.72	957.94	C

c. earnings (net for common) increases by 16.0%

$: