THIRD GENERATION CORPORATE SIMULATION MODELS

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This paper reviews the history of corporate simulation models over two periods - 1965 to 1973 and 1974 to 1980. It also contains the results of a survey of users of corporate econometric models. The paper concludes with some speculations on third generation corporate simulation models and the possible use of corporate simulation models by the government.

1. INTRODUCTION

As we enter the third decade of the use of corporate simulation models, it is appropriate that we review the history of corporate simulation models in the 1960s and 1970s and contemplate what may be expected to develop in this rapidly changing field in the 1980s.

Although there were a handful of corporate simulation models in existence prior to 1965, we shall define first generation models to be those developed between 1965 and 1973. Second generation models are those which appeared between 1974 and 1980. Third generation models are those developed in the 1980s.

We shall briefly summarize the history of first and second generation corporate simulation models. We also present the results of a survey of users of corporate econometric models, many of which are an integral part of corporate simulation models. Next, we speculate on some of the likely developments in the 1980s with third generation models including the interface of corporate simulation models with portfolio models (descriptive and optimization). Finally, we conclude with some comments on the computer software requirements of third generation corporate simulation models.

2. FIRST GENERATION CORPORATE SIMULATION MODELS: 1965 - 1973

In March of 1970 the TIMS College on Simulation and Gaming sponsored the first symposium ever held on "Corporate Simulation Models" at the University of Washington in Seattle (Schrieber 1970). Over 250 people attended and heard 25 speakers describe the corporate simulation models of such companies as Dow Chemical, Boeing Aircraft, AT&T, Sun Oil, Wells Fargo Bank, Boise Cascade, Weyerhaeuser, New York Life Insurance, Xerox, IBM, Honeywell, and Deere.

Almost without exception these early corporate simulations were essentially financial planning models capable of generating proforma financial statements. Furthermore, most of them were written in FORTRAN and were run in batch mode on the company's in-house computer. Some of these models were quite large and took a long time to develop. For example, the Sun Oil model, probably the most widely publicized model ever developed, took 23 person-years and over 3½ years elapsed time to build. For all practical purposes, the model was really never ever used by Sun's management.

TH0079-4/80/0000-0131$00.75 © 1980 IEEE.
Simulation with Discrete Models: A State-of-the-Art View
T.I. Ören, C.M. Shub, P.F. Roth (eds.)

By the early 1970s two important developments were underway. First, conversational computing became available, thus giving rise to commerical timesharing bureaus. Second, a number of first generation corporate simulation languages emerged to facilitate the coding of corporate simulation models. Among the early corporate simulation languages were PSG, FP-70, FORESIGHT, and PROPHIT II. Even though these simulation languages were primarily financial report generators with limited modeling capabilities, they did permit non-technical managers and analysts to develop their own corporate financial simulation models.

The first generation models tended to be stand-alone financial models with limited marketing and production components. Virtually all of these models were "What if?" models. There were no optimization models being used for overall corporate planning. All of the early models were deterministic.

3. SECOND GENERATION CORPORATE SIMULATION MODELS: 1974 - 1980

Between 1974 and 1980 the number of companies using corporate simulation models increased dramatically. By 1980 nearly all of the FORTUNE 1000 companies were routinely using some form of corporate simulation model and many smaller firms were starting to use them as well. This period in the evolution of corporate simulation models was characterized by (1) the development of integrated planning models, (2) attempts to integrate planning models into the planning process, (3) increased attention focused on the human aspects of corporate simulation modeling, (4) the introduction of a number of very powerful new corporate simulation languages, and (5) a substantial increase in the use of econometric models to link corporate simulation models to product markets and to the national economy.

During this period, companies like Eli Lilly, Ross Labs, Monsanto, The New York Times, Pennzoil, AVCO, and Wisconsin Power & Light developed business simulation models characterized by the fact that finance, marketing, and production modules were all integrated into one model. Others like United Air Lines, Lever Brothers, Hercules, Allis-Chalmers, Kraft, and Springs Mills developed the capability to develop business planning models for many different divisions and then to consolidate them into a single corporate model.

Most of the second generation models were strictly "What if?" models. However, there were a few exceptions. North Carolina National Bank linked a portfolio optimization model to its integrated bank planning model (Naylor 1979b). Ross Labs developed an integrated model which included a linear programming optimization model to minimize production and distribution costs over multiple plant locations (Naylor 1979b).

No longer were corporate simulation models merely appendages to the planning process, for companies such as The New York Times, Monsanto, and AVCO made substantial progress towards integrating their models into the planning process. Many companies began to obtain a better understanding of the politics of corporate planning and modeling (Naylor 1978).

During this stage of development there was a significant shift away from scientific programming languages like FORTRAN, PL/1, and APL in favor of several powerful and quite flexible corporate planning modeling languages such as EXPRESS, SIMPLAN, and XSIM (Mayo 1979 and Naylor 1979a). These software systems typically included: (1) a database, (2) a report generator, (3) graphics, (4) a security system, (5) the ability to solve linear, non-linear, recursive, and simultaneous equations, (6) risk analysis, (7) time series forecasting, and (8) econometric modeling. They were available on commercial timesharing bureaus and could also be installed on the client's in-house computer. Some of them could be linked to external econometric models and economic databases as well.

As recently as 1970, the number of companies with corporate econometric models was probably in the order of magnitude of less than 100. By 1980, if one considered the clients of Chase Econometrics, DRI, and Wharton, then one could conservatively estimate the number of companies using econometric models to be somewhere between 750 and 1,000.

4. CORPORATE ECONOMETRIC MODELS: THE RESULTS OF A SURVEY OF USERS

In March of 1980 we mailed a ten-page, in depth, questionnaire to 1691 corporate members of the National Association of Business Economists (NABE). There were a total of 268 responses (15.8% of the sample) of which 234 were usable. Of those companies which responded to our survey 66.5% indicated they are using econometric models, 4.9% are developing an econometric model, 4.9% are planning to develop such a model, and 23.7% have no plans whatsoever to develop an econometric model.

Ninety two percent of the respondents are members of NABE. As corporate economists, we were interested in their attitudes towards econometric modeling. Their responses appear in Table 1 below.

Table 1. Attitudes of Corporate Economists Towards the Use of Econometric Models

Attitude	Percentage
Very Interested	57.5%
Somewhat Interested	31.1%
Indifferent	6.2%
Not at all Interested	5.2%
	100.0%

We also asked the respondents to give their opinion of senior management's attitude towards econometrics. The top management responses in Table 2 are in sharp contrast to those of the corporate economists.

Table 2. Attitudes of Senior Management Towards the Use of Econometric Models

Attitude	Percentage
Very Interested	19.0%
Somewhat Interested	41.4%
Indifferent	27.3%
Not at all Interested	12.3%
	100.0%

Since over three-fourths of the respondents are either using, developing, or planning to develop econometric models, it is not surprising that nearly 90% of them expressed an interest in econometric models. On the other hand, it is safe to say that we still have a long way to go before top management is ready to embrace econometrics. However, it was somewhat surprising to find that top management of over 60% of the companies who responded were thought to be interested in econometric modeling.

Tables 3 and 4 shed some light on how econometric models are being used in American corporations. Not surprisingly, Table 3 shows that marketing is the activity that has been modeled most often. Table 4 shows some of the more important applications of econometric modeling.

Table 3. Activities Which Have Been Modeled with Econometrics

Activity	Percentage
Marketing	43.8%
Finance	41.1%
Corporate	31.5%
Production	17.1%
Manpower	11.0%

Table 4. Applications of Econometric Models

Application	Percentage
Long Term Forecasts	75.2%
Financial Forecasts	58.6%
Industry Forecasts	56.7%
Sales Forecasts	52.9%
Strategic Planning	51.6%
Budgeting	37.6%
Profit Planning	31.8%
Balance Sheet Projections	31.2%
Marketing Planning	31.2%
Cash Flow Analysis	30.6%
Cost/Price Projections	29.3%
Capital Budgeting	21.0%

That corporate economists are the principal users of corporate econometric models (Table 5) comes as no surprise. What was surprising to learn was that the Chief Executive Officer is among the users of the output data from econometric models in 58.7% of the companies in our sample. Table 5 gives some indication as to the more important users of the output generated by econometric models.

Table 5. Users of Output Data from Corporate Econometric Models

User	Percentage
Corporate Economist	63.9%
Chief Executive Officer	58.7%
Vice President of Finance	55.5%
Controller	41.9%
Marketing Analyst	40.6%
Chairman of the Board	40.0%
Financial Analyst	36.8%
Vice President of Marketing	36.1%
Treasurer	27.7%
Board Member	22.6%

Next we turn our attention to the development of corporate econometric models. Table 6 indicates the department that is primarily responsible for the development of the econometric model. Of those models included in our sample, 55.4% were developed entirely in-house without any outside assistance whatsoever, 34.5% were developed in-house with some outside assistance, and 21.6% were purchased from an outside vendor.

Table 6. Department Primarily Responsible for Model Development

Department	Percentage
Corporate Economics	50.3%
Corporate Planning	40.5%
Marketing	11.8%
Operations Research	11.1%
Management Science	7.8%

The price range to develop those econometric models which were either purchased from outside vendors or were developed with outside assistance varied from a low of $2,000 to a high of $250,000. The average cost to develop such a model was $45,532.

The econometric model in our sample with the earliest start date was initiated in 1962. The mean date for the initiation of model development was the second quarter of 1975. The average elapsed time before the model was used by management was 8½ months but the elapsed time ranged from one month to three years. The mean completion date was the first quarter of 1976. Although many companies began developing and using econometric models as recently as 1980, the average company in our sample has around four years of experience with econometric modeling.

This average time horizon for which forecasts have been generated by econometric models turned out to be 7.7 years. However, some companies are using their econometric models to produce forecasts for as long as 25 years out into the future.

For those companies which use their models to do simulation experiments the average cost to generate a single scenario forecast for one year was $268. The average cost of a single scenario forecast for five years out was $334.

Although a wide variety of different types of econometric models, estimation techniques, and solution techniques are being used, it is possible to generalize and say that the majority of the existing models are relatively simple in nature and do not incorporate a high degree of sophistication. Table 7 indicates that single-equation recursive models are much more popular than simultaneous-equation recursive models. This is not surprising since the former are much easier to specify and estimate than the latter. Although 27.2% of the models were single-equation models, some had as many as 2,500 equations. The average number of equations was 158.

Table 7. Type of Model

Model Type	Percentage
Multiple-Equation Recursive	47.1%
Single-Equation	27.2%

Table 7. Type of Model (continued)

Model Type	Percentage
Simultaneous Linear	20.6%
Simultaneous Non-Linear	14.7%

As for the time frame employed by the models, 56.3% were quarterly models, 38.4% were yearly models, and 15.2% were monthly models. (The fact that these percentages do not add up to one hundred is indicative of the fact that some models serve as quarterly and annual models.)

Ordinary least-squares is by far the most widely used econometric estimating technique. Ordinary least-squares was the choice of 86.6% companies in our sample and two-stage least-squares was a distant second with 22.7%. More exotic econometric estimation techniques such as full information maximum likelihood and three-stage least-squares were hardly mentioned at all by the respondents to our questionnaire. Table 8 indicates the extent to which several more specialized techniques are used by corporate economists.

Finally, nearly 90% of the econometric models included in our survey use national macroeconomic variables as input variables. Therein lies the rationale underlying the fact that 90% of the firms in our sample subscribe to some type of econometric service bureau which provides macroeconomic data and forecasts.

Table 8. Other Econometric Techniques

Technique	Percentage
Almon Lags	57.8%
Cochrane-Orcutt Correction	37.3%
Hildreth-Lu Correction	34.9%
Koyck Lags	32.5%
Higher Order Autocorrelation Correction	25.3%

From a computational standpoint, 69.2% of the models were developed with the aid of an outside computer service bureau. On the other hand, 44.8% were built using the company's in-house computer. Nearly 75% of the models were developed using a computer in an interactive, conversational mode. Forty seven percent were developed in batch mode on a computer and 11% were actually developed using a hand calculator. With the advent of higher level planning and modeling languages to facilitate the estimation, solution, and validation of econometric models, it was very surprising to find that FORTRAN was the most widely used computer language (Table 9) for econometric modeling. Of the seven languages used most extensively for corporate econometric modeling three are general purpose scientific languages - FORTRAN, APL, and PL/1. EPS, XSIM, EMPIRE, and SIMPLAN are special purpose planning and modeling systems.

Table 9. Computer Languages Employed

Language (Vendor)	Percentage
FORTRAN (IBM)	35.0%
EPS (DRI)	33.3%
XSIM (IDC)	13.0%
APL (IBM)	8.1%
PL/1 (IBM)	5.7%
EMPIRE (ADR)	4.9%
SIMPLAN (SSI)	4.1%
SAS (SAS)	3.3%

As we indicated previously, nearly 90% of the companies which responded to our survey subscribe to an econometric service bureau. Table 10 shows a breakdown of the various service bureaus which are used most by corporations to support their econometric modeling activities.

Table 10. Econometric Service Bureaus

Bureau	Percentage
DRI	68.3%
Chase Econometrics	32.4%
Wharton	17.6%

Of those firms who subscribe to an econometric service bureau, 59.6% receive only the printed forecasts from the bureau, 38.2% are able to read data interactively from the bureau's central computer, and 33.8%

actually have their corporate econometric model linked directly to the service bureau's macroeconomic database and forecasts. Table 11 attempts to identify the principal reasons why companies use econometric service bureaus. It is interesting to note in Table 11 that the degree of interest expressed in the database offered by these bureaus is almost equal to the level of interest in their national macroeconomic forecasting model. This can, in part, be explained by the poor forecasting track records of most macroeconometric models in the United States.

Table 11. Principal Interest in Econometric Service Bureaus

Interest	Percentage
National Macroeconomic Model	64.8%
Access to Database	63.4%
Industry Models	25.4%
State or Regional Models	12.7%

Three questions were included in our survey dealing with features offered by econometric service bureaus (Table 12), benefits derived from the use of their services (Table 13) and shortcomings associated with their use (Table 14).

Table 12. Features Provided by Econometric Service Bureaus

Feature	Percentage
Accurate Data	73.2%
Frequent Database Updates	70.4%
Consistent Forecasts	62.0%
Ease of Use	55.6%
Consulting Support	47.2%
Disaggregate Data	45.8%
Documentation	38.7%
Comprehensible Models	38.0%
Flexibility	34.5%
Manipulable Models	33.8%
Economical Computer Charges	12.7%

Table 13. Benefits of Econometric Service Bureaus

Benefits	Percentage
More Timely Information	66.9%
Ability to Explore Alternative Scenarios	55.6%
Reduced Personnel Time	53.5%
Greater Understanding of National Economy	52.8%
Ability to Test Own Assumptions	42.3%
Access to Consultants	35.9%
More Accurate Forecasts	33.1%
Cost Savings	19.0%

Table 14. Shortcomings of Econometric Service Bureaus

Shortcomings	Percentage
Computing Costs too High	46.6%
Subscription Cost too High	44.3%
Inaccurate Forecasts	37.4%
Incomprehensible Model	13.7%
Data not Disaggregated	12.2%
Poorly Documented	11.5%
Database Inefficiencies	10.7%
Not User-Oriented	9.9%
Inappropriate Output Variables	8.4%
Insufficient Technical Support	7.6%
Inflexibility	7.6%

Several items are noteworthy in Tables 12 - 14. First, in Table 12, the two most important features of econometric service bureaus are both database related. Second, in Table 13, forecasting accuracy is the seventh most important benefit of econometric service bureaus. Third, in Table 14 it was not surprising to find that high computer charges and subscription fees are considered to be the major limitations of econometric service bureaus given the importance attached to economical computer

charges and cost savings in Tables 12 and 13 respectively. Fourth, inaccurate forecasts ranked third behind high computer costs and subscription fees among the shortcomings of econometric service bureaus in Table 14.

In summary, users of econometric service bureaus seem to purchase these services primarily for the databases, consulting, and the ability to examine alternative economic scenarios. They continue to use these service bureaus in spite of their dissatification with the forecasting accuracy of their macroeconometric models and industry forecasting models and the charges incurred for these services.

To gain some insight into some of the major obstacles to the use of econometric models in corporations we included a question in our survey dealing with this topic. Table 15 contains the results.

Table 15. Obstacles to the Use of Econometric Models

Obstacle	Percentage
Management Bias Against Econometric Models	34.4%
Lack of Understanding of Econometric Models	34.4%
Insufficient Staff Time to Develop Models	32.2%
Insufficient In-House Expertise	30.0%
Insufficient Data	14.4%
Insufficient Financial Resources	12.2%
Insufficient Computer Power	6.7%

Advocates of econometric modeling will no doubt be pleased with some of the results presented in this paper. Believers in econometric models will note that the senior management of 60% of the companies in the survey were interested in econometric models and that the C.E.O. is among the users of the results of these models in 58.7% of the companies sampled. They will also take solice in the long list of econometric applications and benefits derived from econometric service bureaus.

On the other hand, critics of econometric models will revel in the statistics which showed that the top management of nearly forty percent of the companies in the sample were either indifferent towards or not at all interested in econometric modeling. They will also point out the results which express strong dissatisfaction with forecasting accuracy, computer costs, and subscription fees of econometric service bureaus.

Our purpose in conducting this survey of users of econometric models was neither to make the case for econometric models nor against them, but rather to try to ascertain to what extent they are actually being used, how they are used, and how they are regarded by corporate economists and top management.

We believe that corporate econometric modeling may be at a critical turning point. The 1980 recession will provide an acid test of the commitment of corporations to econometrics. The real question will be whether corporations will continue to use these tools when confronted with the combination of internal budgeting pressures created by the recession and the poor track record of econometric service bureaus in forecasting the economy of the United States. Will econometric models prove to be effective planning tools during a period of economic stress? Only time will tell.

5. THIRD GENERATION CORPORATE SIMULATION MODELS: 1980 -

The decade of the 1970s witnessed three parallel developments in the field of corporate planning. First, hundreds of companies developed and implemented successful corporate simulation models (Naylor 1978, 1979a, 1979b). Second, many of these same companies began using the so called portfolio models popularized by the Boston Consulting Group, McKinsey, Arthur D. Little, and PIMS (Abel and Hammond 1979). Even though the two approaches are quite complimentary in nature, the advocates of these two planning methodologies do not seem to talk to each other very often. Third, although textbooks in management science continue to espouse the virtues of optimization models, in reality, very few companies use optimization as a strategic planning tool. However, the experience gained with corporate simulation models in the past ten years may have made it possible to begin introducing portfolio optimization models linked to corporate simulation models in the executive suite as a strategic planning tool.

From our perspective, there are at least three major methodological challenges facing corporate model builders in the decade of the 1980s: (1) to examine the interfaces between corporate simulation models, portfolio planning models, and optimization models as strategic planning tools, (2) to attempt to develop an approach for integrating these three methodologies into the strategic planning process, and (3) to explore the possibility of using economics as a language and conceptual framework for strategic planning and modeling. A symposium held at Duke University entitled "The Integration of Corporate Planning Models and Economics into Corporate Strategy" dealt with each of these topics (Naylor 1980b). We shall address each of them in the following sections of this paper.

6. PORTFOLIO MODELS: DESCRIPTIVE

Assume that a company has a collection or portfolio of businesses, products, or profit centers and must decide how to allocate its scarce financial resources across the portfolio. Which businesses should be stimulated by investment in the hopes of producing growth and eventually increased cash flow? Which businesses should be retained but maintained at present levels of investment? Which businesses should be purged from the portfolio altogether since they offer little promise of either growth or cash? These are all examples of the problem of portfolio planning.

In the early 1960s under the leadership of Fred J. Borsch, the General Electric Company pioneered in the development of an analytical framework to faciliate this type of strategic decision making. Collectively these tools are called portfolio models. They have been popularized by a number of management consulting firms including the Boston Consulting Group (BCG), McKinsey and Company, and Arthur D. Little. By far the most popular of the portfolio models is the BCG model. The BCG approach which is based on two relatively simple concepts - the growth share matrix and the experience curve.

The basic idea of the growth share matrix is that a company can be divided into component products or businesses, each of which is separable from the others. Specifically, each business is characterized as having either a high or low market growth rate and either a high or low market share.

Products or businesses with high market share and low growth which frequently generate large amounts of cash are called cash cows. The excess cash generated by such products should not be reinvested in the products. Indeed, if the return on investment (ROI) is greater than the market growth rate, then the cash cannot be reinvested indefinitely without reducing the ROI. The appropriate strategy is to protect the current position of the cash cow while generating cash invested in other projects.

A business that is characterized by high growth and high market share is called a star. It usually shows positive profits but it may or may not produce positive cash flow. If the star remains a market leader then it will eventually evolve into a cash cow when growth is reduced and reinvestment requirements decline as well.

The problem child business is a business which has high market growth and low market share. The problem child has an inferior market position and typically requires more cash than it can generate. If cash is not provided, a problem child may fall behind and drop out of the market. However, even if cash is provided, the product may become a "dog" when the growth slows. Problem children require large injections of cash to buy market share. Such products are likely to be liabilities unless they can become market leaders.

Finally, products or businesses with low market share and slow growth are called dogs. Although dogs may show a positive profit, the profit must consistently be reinvested simply to maintain market share. Dogs are worthless and evidence of the failure to achieve a position of market leadership or to cut ones losses when faced with a "no win" situation.

In summary, the BCG growth share matrix represents a conceptual framework on which portfolio investment decisions can be based. A balanced portfolio of businesses calls for:

1. Heavy investment in stars whose high market share and high growth insure the future.
2. Protection of cash cows that supply the funds for future growth.
3. Selective investment in problem children to be converted into stars.
4. Liquidation of dogs.

The second major concept of the BCG is known as the experience curve. According to the BCG, the unit cost (in real terms) of manufacturing a product declines approximately 20 to 30% each time accumulated experience is doubled. Examples where the experience curve seems to apply include automobiles, integrated circuits, semiconductors, crushed limestone, gas ranges, polyvinylchloride, and steam turbine generators, to mention only a few.

As we previously indicated, the growth share matrix and the experience curve have been widely used by a number of major corporations during the decade of the 1970s. A limited number of companies like Monsanto can now produce growth share matrices and experience curves as outputs of their corporate simulation models. It seems likely that this approach will be widely emulated among users of third generation corporate simulation models.

7. PORTFOLIO OPTIMIZATION MODELS

Perhaps the best known portfolio optimization model is a model published by Hamilton and Moses (1973). The model was designed specifically for strategic planning in a large diversified company. The model

includes a full range of financial decisions including internal capital budgeting, acquisitions, divestments, debt creation/repayment, stock issue/repurchase, and dividend payout. The model employs mixed integer programming to select optimal investment and financing strategies over a multiperiod planning horizon.

This model permits two different types of strategy options - momentum strategies and development strategies. Momentum strategies represent a continuation of present activities in current lines of business. Development strategies reflect proposed changes in the nature or level of present activities.

The objective of the firm is to maximize earnings per share subject to a set of goal constraints, corporate constraints, and group constraints. Earnings are defined as

Earnings = (income from strategies) - (cost of corporate long-term debt) - (cost of long-term debt tied to strategies) - (cost of short-term debt) - (dividend cost of preferred securities) + (credit for early corporate debt repayment)

The different types of financial constraints included in the model are outlined below:

A. Goal Constraints
   1. Stable growth in earnings per share
   2. Return on assets
   3. Return on equity

B. Corporate Constraints
   1. Funds flow
      a. Inflow
         1) Selected strategies
         2) Divestments
         3) Equity sales
         4) Net debt proceeds
      b. Outflow
         1) Dividend payments
         2) Debt expenses
         3) Debt retirement
         4) Stock repurchases
   2. Interest coverage
   3. Leverage ratio - ratio of long-term debt to the sum of long-term debt plus equity
   4. Short term debt
   5. Additions to common stock
   6. Minimum corporate income

C. Group Constraints
   1. Business mix - restrictions on the mix of corporate activities in order to retain or promote a specified corporate character or to help reduce risk.
   2. Strategy/source constraints - constraints related to strategy and funds - source selection.
   3. Divestment - momentum strategy for each business must be accepted or divested, but not both.
   4. Development/momentum strategies - selection of an incremental development strategy has meaning if and only if the corresponding momentum strategy is accepted.
   5. Tied financing - limited to some maximum value associated with each strategy.
   6. Early debt repayment - total repayment over the planning horizon must not exceed the amount of debt outstanding at the end of the period.
   7. Funds - source limits - funds drawn from any source in a given time period may be limited to some range.

There is little or no indication that the Hamilton and Moses model has been used very extensively by corporate planners as a practical decision making tool. However, if a company has developed financial simulation models for each of its major divisions, then the extension of such models into the framework suggested by Hamilton and Moses does not represent an inordinate technological leap. We believe we will see a number of companies experiment with a combination of corporate simulation models and optimization models similar to the one descibed in this section. This development will represent a major challenge for management scientist, economists, and software developers alike.

8. THIRD GENERATION CORPORATE MODELING SOFTWARE

Second generation corporate modeling software was characterized by an attempt to cram as many planning and modeling features as possible into a single language - Risk Analysis, Econometric Modeling, Box-Jenkins, Optimization, and other techniques. We believe there may be an upper limit as to the number of bells and whistles which can be integrated into languages like EXPRESS, SIMPLAN, and XSIM. In other words, in terms of analytical power, it is difficult to envisage a substantial number of new techniques to be included in third generation corporate simulation languages. Below we shall summarize where we see third generation corporate modeling software going in the next decade.

First, it seems very likely that many of the existing languages will adopt a modularized approach. That is, it will become possible to acquire the database management capabilities and report generator of a modeling system without purchasing some of the more sophisticated modules including econometric modeling, risk analysis and optimization. As the user's level of experience and sophistication increases, additional modules can be acquired as they are needed.

Second, the existing second generation systems will soon be available on a variety of mini-computers and in the not too distant future possibly available even on micro-processors. This will mean that corporate simulation modeling will no longer be restricted to the really large corporations but rather that quite small companies will find it economically feasible to use these types of tools. Third, we do anticipate that the ability to interface with both the so called descriptive portfolio planning models of the BCG and the type of optimization models proposed by Hamilton and Moses will become important features of third generation corporate modeling software.

Fourth, there is every indication that third generation planning and modeling languages will become even easier to use than in the past. Some vendors will use "canned models" to introduce unsophiscated users to their systems thus permitting the user to start with very simple and restricted applications but then to switch over to the full power of the planning language as experience is gained with the system.

9. CORPORATE SIMULATION MODELS FOR GOVERNMENT: THE CHALLENGE OF THE 1980s (Naylor 1977 and 1979c)

Throughout the world, governments of all types are having increasing difficulty coping with an unprecedented degree of risk and uncertainty. Double-digit inflation, the potential collapse of the international monetary system, uncertainity over energy supplies and prices, international political conflicts, and alienation of the public from government are among the pressures currently being felt by all levels of government.

For example, a complete inability to anticipate the likely consequences of the cutoff of the supply of oil in Iran or to respond to the problem in a timely fashion imposed great stress on the U.S. economy and placed the Carter Administration in a very unfavorable light in the eyes of the public. The lack of any semblance of a rational energy plan makes it extremely difficult for Congress, the President, and the Energy Department to respond to a crisis such as the Three Mile Island nuclear accident. Our government (and many other governments throughout the world) suffers from the absence of (1) an overall sense of direction, (2) well-defined national goals and objectives, (3) an integrated strategy for achieving such goals and objectives, and (4) a process for answering difficult "What if?" questions that cut across department lines within the government.

In this country we seem to be saddled with a mentality that strongly approves the use of comprehensive strategic planning on the part of large companies such as International Business Machines, American Telephone & Telegraph, and General Motors but has traditionally condemned the role of government planning. An increasing number of corporate executives are beginning to reexamine their position on government planning. In 1975, for example, Henry Ford II called for the creation of a highly visible and vocal federal planning body, "not because some wild radicals demand it but because businessmen will demand it to keep the system from sputtering to a halt."

The real question is: "Is there not a need for comprehensive strategic planning across governmental department lines and disciplinary lines?" In the event of another oil embargo or the complete demise of the nation's nuclear power program, how will the economy be affected? What are the implications for national defense and military security? What about the environmental effects and the impact on the urban poor? Will these events alter international relations, thus necessitating a review of existing treaties?

We believe that some of the planning technology which has been developed in the private sector during the past decade is directly transferrable to the public sector. Just as computer based planning models have played a catalytic role in enhancing the planning processes of major corporations, they are capable of playing a similar role for governments at all levels. The real challenge of the 1980s

will be to try to convince government to begin using computer based planning models as a vehicle for enhancing its ability to do serious strategic planning.

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