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A PAY-PER-PROGRAM TELEVISION NETWORK SIMULATION MODEL

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ABSTRACT: This paper describes a simulation model which was constructed to evaluate the financial implications of a national pay-per-program television network.

The model is currently being used to explore a number of consumer price/content scenarios prior to introduction and selection of a pay-per-program or pay-per-channel system. It affords the user a laboratory in which to test key marketing and financial assumptions and evaluate the consequences of their outcome measured in terms of revenue and cost.

The paper outlines the structure of the model and the reports it generates, multiple uses for the model and the levels of disaggregate reporting for the simulated pay television network.

1. INTRODUCTION

The technology necessary to deliver pay television (PATV) has been widely available in Canada for some time. In recent years both the private sector and the provincial governments have begun to press for legislation which will allow its introduction. Since authority over much of the communications field, including off-air broadcasting, rests with the federal government, it became necessary for them to study the entire question of PATV. One option proposed was the introduction of a national pay-per-program PATV network which would deliver programming to the entire country via cable companies.

The authors, as advisors to the federal government, created a simulation model to assess the financial implications of and the impact on special interest groups if PATV is introduced on a national basis in Canada. This paper outlines how the pay-per-program model is constructed and how it is used.

2. REQUIREMENTS FOR THE MODEL

The federal government decided at the outset that several key factors had to be included in the model. These factors are noted below:

(1) Language: Canada has two official languages. The proposed technology therefore had to be capable of delivering a product in two languages across the entire country. It also means that it must be possible to distinguish between English language and French language viewers.

(2) Canadian Content: The federal government is concerned that television contain an adequate amount of Canadian content. However, there is expected to be some relationship between Canadian content and consumer response. This relationship had to be built into the model. In addition, the funds made available to Canadian and foreign film producers had to be isolated and reallocated to show the possible financial impact on film producers.

(3) Cable Companies: Canada has many cable companies, each of which is granted a mono-

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poly in a geographic region. The model had to be capable of showing the impact of PATV on cable companies at least at the market area level of detail.

(4) Provincial Jurisdiction: The provinces of Canada have an active interest in the regulation of certain aspects of PATV. As a result all data had to be made available on a provincial basis.

(5) Hardware: Various suppliers of hardware such as satellites, cable lines, monitoring devices and so on, were particularly interested in PATV and, in many cases, were making presentations to the government suggesting how the network should be organized. In order to adequately assess these presentations and to ensure the reasonableness of the model itself, it was necessary to isolate the cost and financial implications of changing every major piece of hardware in the delivery system.

(6) Network Economics: Since the driving force behind PATV was to be a national network it was necessary to build a model which would assess all financial aspects of network operation, including net income, return on investment, investment required, and so on.

In order to meet the foregoing needs it was decided to initially divide the country into ten parts, coinciding with the ten provinces. Each province was subdivided into the major metropolitan areas, with another area representing the remainder of the province. A geographic area was divided into two parts representing the two language groups where there was a reasonably even split of French and English speaking residents. If one linguistic group was dominant the entire geographic area was deemed to speak the language. This resulted in 38 census market areas (CMA's) across Canada for which demographic data was available. Since more detailed data was not available it was not possible to do an analysis on each region serviced by a single cable company. Thus each CMA was serviced by one or more cable companies.

For a variety of reasons the model had to be made dynamic. Since PATV was not expected to be introduced everywhere in Canada simultaneously, it was necessary to allow the model the flexibility to introduce PATV into CMA's on a time sequential basis. This makes the model a much better representation of reality. In addition a number of events had to be allowed to take place in the model whether PATV was offered in a market or not. For example, the population in each CMA was assumed to grow through time, with the growth rate different for each CMA and independent of PATV introduction.

Since the primary focus of the model was to be an operation of a total national network it was necessary to accumulate all of the disaggregated data to provide aggregate results.

It was decided to run the model over a ten year planning horizon for three reasons. First, the risk of technological obsolescence beyond ten years was thought to be very great. Second, reliable demographic forecasts did not go beyond ten years. Third, in calculations of the internal rate of return on the network's investment, cash flows beyond ten years would only have a marginal impact. Because critical events were not expected to occur more frequently than quarterly, the model utilizes quarterly time periods.

3. CHOICE OF TECHNIQUE

The authors have chosen to simulate the network. This methodology was selected for several reasons.

First, an essential consideration in the problem is time itself. The analysis is dynamic and a number of variables change over time or change as a function of time. Simulation modeling lends considerable insight to dynamic analysis.

Second, the users of the model were concerned with a descriptive analysis of the network and its operations. (It is not the objective of this study to determine an optimal policy or strategy.) By modeling the complex inter-relationships which are inherent in the network, valuable insight can be learned regarding sensitivity of key variables.

Third, a simulation model affords the user flexibility - the ability to ask relevant "what if" questions. It is with this concept in mind the authors chose to make the model interactive. The user can enter into a dialogue with the computer to change key assumptions of the model without having to become familiar with the intricate details of the actual computer programs themselves.

An overview of the model is shown below:

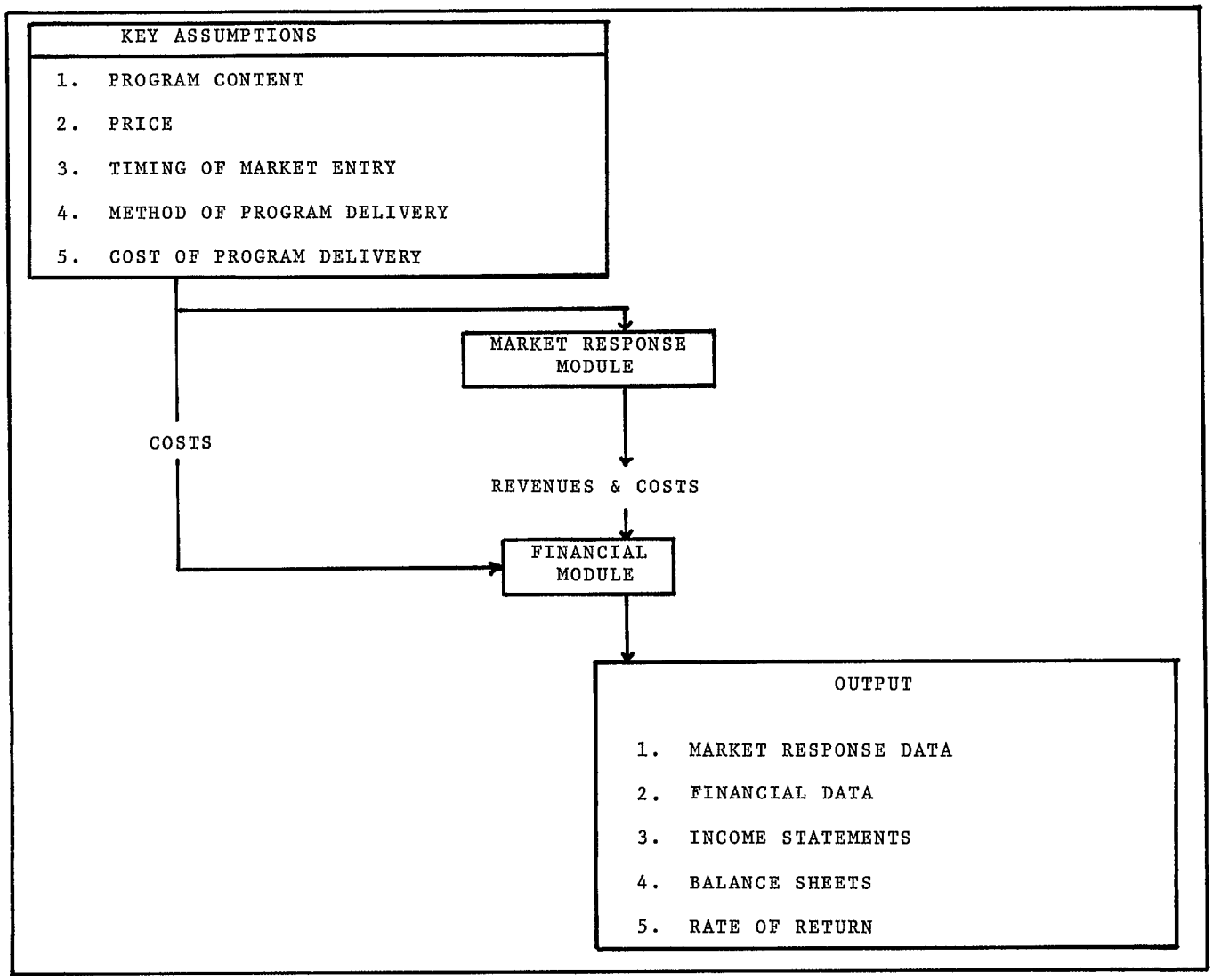

Figure 1 Overview of the model

Although the model lacks the elegance and sophistication of other mathematical techniques such as, for example, linear programming, it satisfies the needs of the user. In short, this approach was taken as it is relatively simple and pragmatic, and meets the needs of the user in terms of ease of use, flexibility and the ability to experiment with the system on a computer.

4. ESTIMATING CONSUMER RESPONSE TO PATV

Revenue from PATV is primarily derived from consumer households subscribing to the service and viewing the programs offered. Since the model iterates for ten years, or forty quarters, the network quarterly revenue estimate requires each CMA consumer revenue estimate for that quarter for all the CMA's on PATV service at that time. This estimate is derived in stepwise fashion for each quarter in the simulation.

In each iteration, total households are first estimated for each CMA using a function which reflects the differing household growth rates in CMA's. This estimate is combined with an estimate of percentage of households connected to cable service (since PATV is delivered via cable systems) to calculate the number of cabled households in each CMA. This estimate is then converted to PATV sign-ups via a dynamic sign-up rate function to estimate the quarterly percentage of cabled households that subscribe to PATV service. The model then computes the number of households on PATV service. Finally, PATV households are converted to quarterly estimates of the number of programs viewed by each subscribing household and multiplied by consumer prices to arrive at an estimate of CMA

revenue for the given quarter.

The market response module's quarterly sequence of computations are shown below:

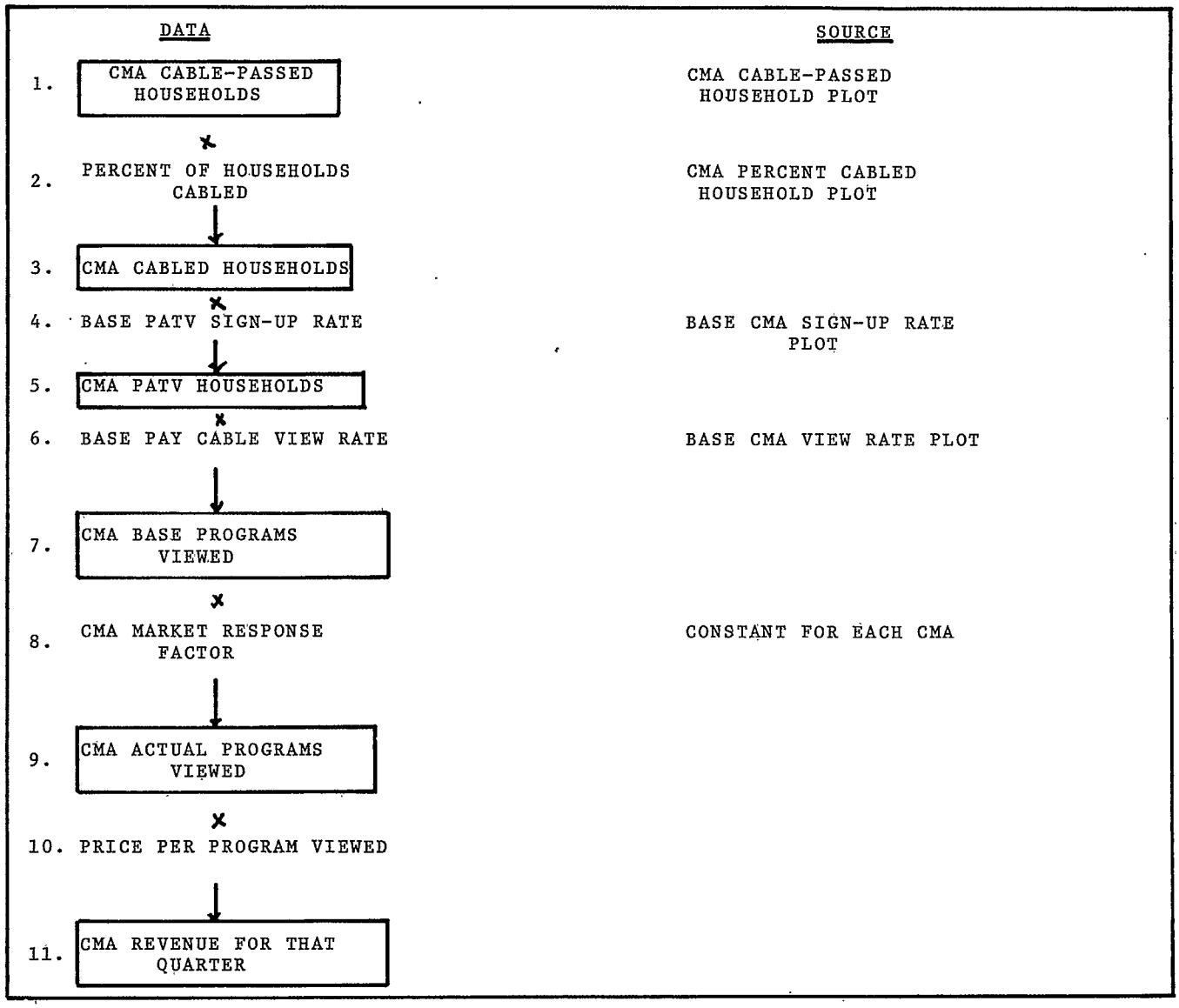

Figure 2 Market Response Module

The functions discussed above are capable of differentiating all of the various market response parameters between different CMA's. This level of detail is necessary since each CMA can have different characteristics on many dimensions and can therefore be assumed to respond differently to PATV.

5. EXPLORING DIFFERENT CONSUMER PRICE/CONTENT SCENARIOS

Two major marketing variables are the consumer price-per-program and the program content. The model is therefore designed to enable the user to test the sensitivity of financial outcomes to different price/content scenarios. Each of the major market response functions has parameters which can be varied by the user to reflect different consumer response assumptions to different scenarios. Given these parameters, the model simulates consumer response to a particular scenario over ten years of operation.

6. VALIDATION

The authors are not aware of any specific technique which can be used to validate this model in a direct sense, i.e., a test statistic. Therefore, to ensure that the model was performing as intended, a number of steps were taken to verify that the model simu-

lated the PATV network to the levels of realism mutually agreed upon by the builders of the model and its users.

Numerous runs were made under controlled conditions to check for internal consistency. This level of verification was achieved by controlling the conditions of a simulation run to such a degree that the results could be manually calculated. The output of the model was compared to these calculations before proceeding upon more complex experiments.

The methodology in this phase of validation was to audit the financial statements produced under special conditions, such as zero growth in a single CMA, and to perform a period by period comparison of income statements on an aggregated as well as disaggregated basis. Statements were checked at specific points in time, i.e., when key events were scheduled to take place, as well as over spans of time. If a discrepancy was uncovered, the logic of the model was scrutinized and changed where necessary.

A second means of validation was to compare the reasonableness of the simulation model's output to experience documented in the literature available. In this phase, the authors critically evaluated the assumptions of the model in terms of prior experience reported in the U.S. For example, the total households connected to PATV as a percentage of total households in the country was examined. The results produced by the computer model were then compared to the regional data available from PATV systems elsewhere and, in general, were found to be in agreement with historical experience.

Finally, expert opinion was sought and used whenever possible. The users of the model had a number of resources available to assist in this effort. The model was developed in distinct phases; user needs were discussed, goals and deadlines were mutually set, the user was informed of the results and a series of meetings were held to again ensure that the form of the output met the users' needs as well as the content of the output being reasonable in their opinion. Detailed reports and results were presented and discussed prior to proceeding to the next phase of the project.

6. MODEL OUTPUT

The model produces a number of detailed financial and marketing reports. Space limitations and the sensitive nature of the results obtained preclude a detailed presentation of these results in the Proceedings. Sample output will be displayed in the session in which this paper is presented.

The output of the model can be broadly classified in terms of marketing and financial data, each type serving unique purposes.

From a marketing perspective, which from a structural view precedes the generation of financial output, the user can examine specific numerical results, e.g., number of sign-ups to the network, programs watched, etc., on a national or regional basis, over time or at any point in time. It is also possible to examine the dynamics, numerically or graphically, of the subscribers' response to PATV, which can have a dramatic impact on the projected network operating results.

An example of numerical output obtained is total PATV households within a given market over time. In the figure below, a market was selected for analysis and two runs were made holding the content constant and varying price.

Year	Low Price	High Price
1	161,301	53,048
2	198,959	92,875
3	211,518	117,333
4	220,121	131,080
5	227,150	139,386
6	233,106	145,233
7	238,338	150,007
8	243,110	154,288

Figure 3 Price Sensitivity: Total PATV Households (CMA 14)

The financial output consists of income statements generated on a network or dissaggregate CMA basis at any point in time. Some example income statements are shown below. The purpose of these figures is to illustrate the form and content of the model's financial output. Due to the sensitive nature of this output, the numbers have been omitted.

REVENUE		
SUBSCRIBER REVENUE	XXX	
SIGN-UP REVENUE	XX	XXX
LESS CMA OPERATING EXPENSES		
SIGN-UP EXPENSE	XX	
EXHIBITION EXPENSE	XXX	XXX
CONTRIBUTION TO THE N.E.T.		XX

Figure 4 CMA Income Statement

INCLUDES CMA's:		
C01 C02		
SUBSCRIBER FEES		XXX
LESS PAYMENTS TO PRODUCERS		
CANADIAN FILM PRODUCERS FEES	XX	
NON-CANADIAN FILM PRODUCERS FEES	XXX	
LIVE EVENT PRODUCERS FEES	XX	XXX
GROSS MARGIN		XXX
SIGN-UP REVENUE		XX
AVAILABLE TO EXHIBITORS AND NETWORK		XXX
LESS EXHIBITOR EXPENSES		
SIGN-UP EXPENSE	X	
EXHIBITION EXPENSE	XXX	XXX
AVAILABLE TO NETWORK		XXX
LESS NETWORK OPERATING EXPENSES		
NEGOTIATION STAFF	XX	
NEGOTIATION CHIEF	XX	
PR TV GUIDE STAFF	XX	
PR TV GUIDE CHIEF	XX	
PLAYBACK STAFF	XXX	
PLAYBACK CHIEF	XX	
LEGAL COUNSEL	XX	
TRAVEL	XXX	
OFFICE SPACE	XXX	
SECTY AND SUPPORT STAFF	XX	
INTL ACCT STAFF	XX	
INTL ACCT CHIEF	XX	
PHONE RECPTS	XX	
CLERKS	XX	
WATS LINES	XXX	
CHIEF AND ASST	XXX	
REGIONAL STAFF	XX	
REGIONAL SECYS	XX	
SATELLITE RENTAL	XXX	
SENDUP CHARGES	XXX	
DEPRECIATION	XX	XXX
NET INCOME BEFORE TAX		XXX

Figure 5 Network Income Statement

Balance sheets are produced for the network at each period. These reports provide information to the user that is in many ways similar to that of a private corporation. In each statement sufficient level of detail is included to assess the impact of sensitivity

experimentation on key geographic sectors or specific participants in the network's operations.

Additional reports and financial data are returned. These consist of a source and use of funds statement for network operations and an internal rate of return for the network over the simulated planning horizon.

In addition to directly produced reports examination of the output can lend further insight to the network's operations. Summary information for each scenario is extracted and displayed in seven categories which are displayed below.

```
 I.  Revenue from Monthly Customer Charges (all 40 quarters)
       Canadian Film
       Foreign Film
       Live Events
            Total

II.  Fees Paid to Producers (all 40 quarters)
       Canadian Producers
       Foreign Producers
       Live Event Producers
            Total

III.  Selected Other Costs (all 40 quarters)
       Line Rental From Cable Companies
       Line Monitoring
       Satellite Rental

 IV.  Selected Income Statement Data (all 40 quarters)
       Total Net Income
       Total Cash

  V.  Timing of Profits and Losses
       Maximum Loss in a Quarter
       Quarter in which Maximum Occurs
       Quarters that are profitable

 VI.  Timing of Financing
       Maximum borrowing required
       Quarter in which Maximum Occurs
       Quarter in which Debt is Completely Repaid

VII.  Time Adjusted Rate of Return Per Quarter
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Figure 6. Scenario Economic Impact Factors

This data can be used to determine the viability of several unfolding scenarios, when the network breaks even, its external financing requirements and third party disbursements.

7. USERS OF THE MODEL

The model can be used by several of the parties involved in Canadian PATV, both in the private and public sectors. The usefulness of the model is enhanced by the "bottom line" real-time accessibility, the empirically based nature of the model's output, and by its capacity for sensitivity analysis.

In the public sector, the DOC, CRTC, CBC, and provincial ministries all have questions and concerns about the market and about the financial impact of PATV. In addition, many of the parties are likely to have different, sometimes conflicting, assumptions about virtually every aspect of PATV network's jurisdiction and operations. The model enables these parties to explore many major questions in a realistic fashion.

In the private sector, many companies will be involved in hardware design and supply, programming, distribution, advertising strategy, and other related activities. The model has the capacity to explore many of their critical questions about the overall market and about the financial nature of PATV and the private sector's role in it.

The model can be used to assess the impact of changing hardware/delivery technology by

changing cost parameters. The model utilizes cost assumptions which reflect sufficient production quantities of hardware to realize economies of scale. These estimates were provided by industry sources.

In the case of signal delivery, the model explicitly provides for alternative technology, allowing for a phased transition from microwave to satellite as the market unfolds.

In a more general sense, as new technology becomes available, changes to the cost structure can be made, reflecting these changes.

Changing technology does not have a direct impact on market penetration. If, through changing technology, costs are lowered, prices could also be lowered. This would push up penetration and would result in higher subscription levels. It is possible to hold profits at a reasonable level, revise costs downward (reflecting advanced technology) and revise penetration estimates at the new (lower prices) to assess market response to technologically lowered prices. Although trial and error experimentation of this nature is possible, the user has not requested this type of analysis.

The marketing development and resultant financial implications can be tested by varying the timing of CMA entry into the network. The network hardware configuration can be varied and the resultant cost implications explored. The distribution of PATV costs, investments, and revenues between the involved parties can also be varied and the effects explored. The model is robust. The experimentation it affords is perhaps its greatest strength.

8. USE OF THE MODEL FOR POLICY FORMULATION

The comprehensive nature of this model makes the inter-relationships between public and private sector participants explicit. This enables the public policy maker to evaluate the impact of his decisions on all parties involved.

A number of potential participants in a national PATV network have expressed their interest in the form of requests to the CRTC or submissions of testimony in public hearings. The simulation model can lend focus to the underlying economic interests and potential benefits to these parties.

In evaluating proposals for the structure of the network and participation in this major national project, the policy maker can address specific issues such as:

1) The costs of a national network versus several regional PATV networks.

2) The cost of a national bilingual policy for the network.

3) The economic viability, on a regional basis, of the network over time.

4) The potential returns to Canadian film producers, regional cable delivery systems, telephone companies, and foreign participants in the project.

9. COST/REFINEMENTS/TECHNICAL ASPECTS

The simulation model is constructed in FORTRAN and runs on a PRIME mini-computer. It consists of fifteen programs which are executed in an interactive mode. These programs serve three general needs of the user.

The first type of program is necessary to load or modify the information relating to each CMA and to the network itself. This program enables the user to examine, in detail, the conditions for a given simulation run.

The second type of program generates the data base necessary to produce detailed reporting on a network or CMA basis. The generated data base consists of a file for each CMA as well as a file for network (system-wide) expenses. When this data base generation module is invoked, a series of prompts are displayed to enable the user to vary any or all of the nine consumer response parameters.

The final type of program generates reports displayed at the terminal or directed to a file for printed output. When these programs are executed, the user is asked on which basis he wants the information with respect to a point in time, a span of time periods, on a CMA basis, or if more than one CMA is to be included.

Graphical output is also generated as part of the reporting module. It was felt that a picture of the response functions supplementing numerical data would enhance the understandability of the output. The CPU and disk storage space requirements are modest.

The model is being run in a time-sharing environment and consequently response and turn around time will vary with system usage. The authors have produced several complete runs in approximately 45 minutes per run, including time to obtain printed output. The largest resource requirements of any single program requires core storage for some 40,000 data items. The total system, including programs and data base, occupies less than 1% of available disc space on the PRIME 750 system.

The user can invoke any or all of the three general types of programs during a session, depending upon his needs. For example, if a change to a network cost element occurs, the network expense file can be updated independently of regenerating the CMA data base and a full set of reports can be run. This feature allows numerous changes of network data while saving considerable time.

In other instances, data specific to a given CMA can be changed and the CMA data base can be independently regenerated without having to recreate the network expense data base. This experimentation takes more computer time than changes to the network as generally more files are involved.

Finally, it is possible to return the simulator to one base case after a simulation run to ensure that any parameters changed during sensitivity analysis are changed back to their original values.

Future refinements requiring additional programming are anticipated. These include modification to the model to allow a simulation of an alternative pay-per-channel TV network. Additional programs which produce reports of aggregate marketing data over time are under development, as is enhanced graphical output using pen plotter hardware as opposed to current printer plot capabilities.

Although the model is structured to accomodate a Canada subdivided into 38 distinct regions, further refinement is possible. The possibility of modeling a single province also exists. The user has the ability to focus on any level of detail by simply modifying the data base or expanding the system's programs to add more regions.

The preliminary results presented the Department of Communications have resulted in some additional experiments being conducted which include:

1. Profitability of cable company operations in specific regions.

2. Regional versus national services.

3. Disaggregated results for specific regional areas.

These additional "what if" questions can readily be answered by the model, given updated cost/marketing data.