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MEDIAC:
An On-Line Media Planning System

346-68

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June 1, 1968

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Abstract

MEDIAC is an implemented on-line computer system which selects and schedules advertising media. The system is based on a market response model and a heuristic search routine, and is composed of several interactive programs which are operated from a remote console of a time shared computer. The process of implementing MEDIAC resulted in changes both to the system and its users. The underlying models have become more complex and the heuristic routines have been made more efficient. The users have tended to change the emphasis of their efforts in media planning.

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1. Introduction

The problem of media planning in advertising is a natural one for the application of mathematical models and computers. A great deal of data is available on who reads (or sees or hears) what. There is considerable data on what kinds of people are prospects for which types of product. There are many different media options available. Many judgments must be made. It would seem that there should be some organized way of combining judgments and data into a model, setting an objective, and then optimizing it to produce a good media plan.

Indeed, a number of people and organizations have tried to do this. (A review of published work may be found in Little and Lodish [1].) We here report on a model that we have constructed and brought up as an on-line media planning system. Since May 1967 the system has been available on a commercial basis under the name MEDIAC. The implementation of MEDIAC has brought about evolutionary changes both in the system and its users. Interaction with media planners has led to an increase in both the complexity of the model and the operating efficiency of the system. At the same time the media planners have changed their methods of planning due to exposure to MEDIAC.

In this paper we shall briefly describe the model, its optimization, and the computer system. Then we shall give an example of an application and discuss some of our experiences with the system.

2. Model

The media planning problem may be stated as follows: Given a set of media options, a budget, and various data about the media and the

audience to be reached, which options should be used and when should they be used in order to maximize profit or some related measure of performance? By a media option we ordinarily mean a detailed specification of the place, position, size, and other outward characteristics of an advertisement, but not the message and copy treatment. Thus, the role of media in the advertising process is to expose a chosen audience to the advertiser's messages in an efficient manner.

Relevant to this objective are at least the following phenomena:

- Market segmentation
- Sales potential of individual segments, i.e. their relative importance to the advertiser
- Media coverage in each segment
- Overlaps in media audiences, both across media and across time
- Forgetting by those exposed to the ads
- Diminishing returns at high exposure rates
- Media costs
- Intermedia differences in the value of an exposure
- Seasonality of sales potential and audiences

The purpose of our model is to combine the above phenomena into a flexible, consistent structure which the media planner can use to evaluate alternative media plans and concepts. The model will be verbally described below. For a detailed technical description, see [1].

First, it is supposed that market segments have been defined. Perhaps men and women have different sales potential and therefore represented as different segments. In addition, perhaps these are each broken down further into geographic regions and income classes. Segments may be defined in any

manner as long as suitable media coverage data can be supplied for them.

Second, an advertising insertion in a given medium creates a probability of exposure for a person in a specified market segment. The probability of exposure depends on the audience of the medium within the segment, and on the size, length, color, or other characteristics of the insertion. The exposure of a person to a medium is not independent of exposure to other media or to the same medium at another time, but depends on media overlap probabilities.

Third, the advertising exposure creates value in the people exposed, i.e. disposes them more toward buying the product. The amount of value created by one exposure depends on the medium and is called the exposure value of the medium.

Fourth, people forget. It is usually assumed that people forget a constant percentage of exposure value in each time period although more complicated relations are possible. Figure 1 shows how the retained exposure value of an individual might change with time.

Finally, people act. As the level of exposure for a person rises, so does the anticipated response, but it does so with diminishing returns. The relationship might be as shown in Figure 2.

The anticipated total response in a time period is the sales potential of each market segment times the average percent of potential achieved by people in that segment summed over all segments. The average percent of potential achieved in a segment is calculated by an analytic approximation that involves the characteristics of the probability distribution of exposures to people within the segment. Thus the model, a simulation by some definitions, is not a simulation in the sense that individuals in a population are treated one at a time by the computer.

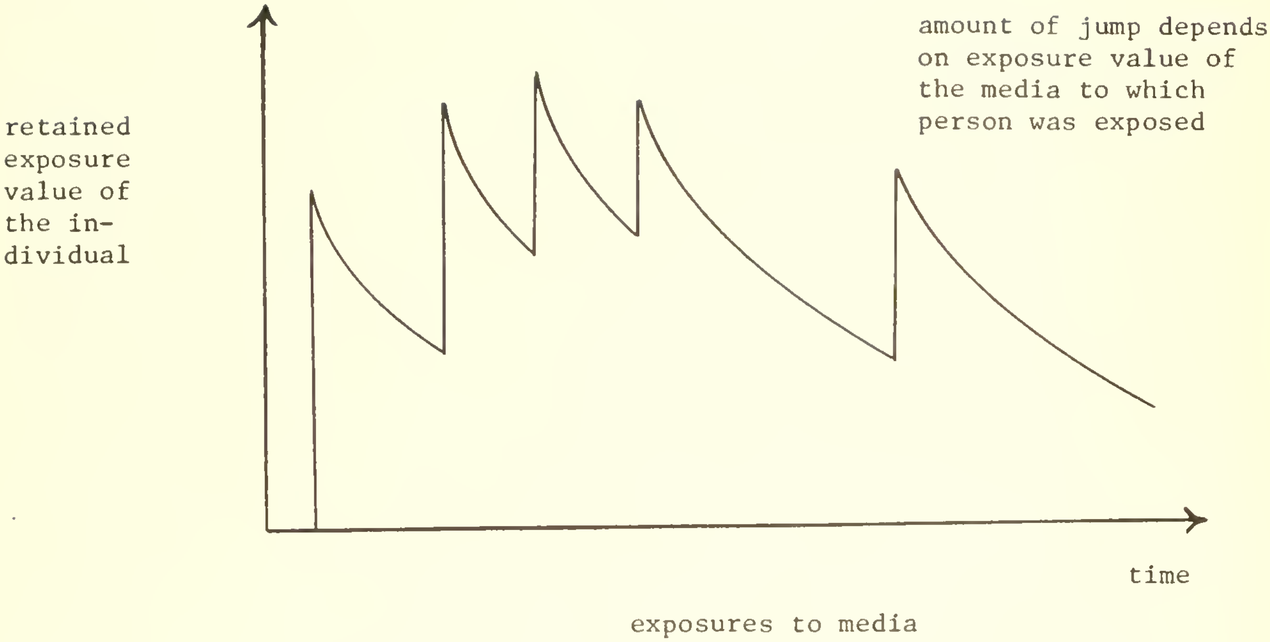

Figure 1. Retained exposure value as it might vary over time for a specific individual.

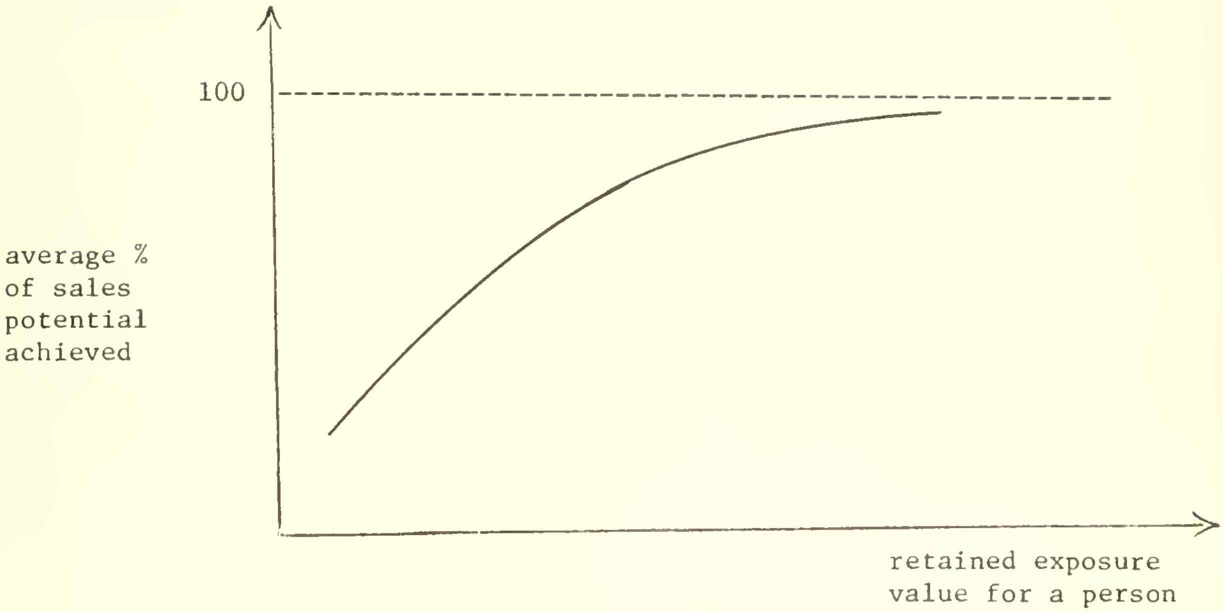

Figure 2. Customer response.

To summarize: advertising insertions in media generate exposures in the market segments. Exposures have value and raise the exposure level of some people in the segments, although this will decrease with time because of forgetting unless further exposures occur. The exposure level generates an anticipated response. Diminishing returns occur at high exposure levels.

3. Optimization

Heuristic methods are used to select and schedule media for large total response. The exact optimization problem is one of integer programming with a nonlinear objective function. Efficient exact methods are not available for this, but fairly simple heuristics appear to give very good results. The present routine starts from the set of required media (if any) and adds new media one at a time according to a criterion of largest incremental response per dollar, taking into account all media inserted up to that point. The routine stops when the budget is exhausted.

4. Computer System

The current version of MEDIAC contains four conversational programs which the user may call at his option:

(1) INPUT accepts data from a teletype and stores it on a disk file. The required data and its format are requested by the computer in English. The user may elect options which help to eliminate repetitions of certain input.

(2) CHANGE enables the user to change any stored data on the disk.

(3) PRINT prints out the input data stored on disk in a management report format.

(4) MEDIAC is the actual calculation program. Its input is a disk file prepared by INPUT or CHANGE. The user may use three

different options in this program. He may request:

1. Evaluation of a particular schedule in terms of its expected response in total and its effects in each market segment and time period.
2. Initial Ranking of all available media options. This is based on the incremental value per dollar for each option in the absence of others in the schedule. The rankings can serve as an effective initial media screening device.
3. Selection and Scheduling of the media options. A detailed output of the effects of the generated schedule in each market segment during each time period is also generated at the user's option as well as a chart of the schedule by time periods.

The system is up on a time share computer utility with which users communicate via telephone lines. MEDIAC represents a step beyond the computer utility toward a mathematical model utility.

5. Example

The following example is a slightly-coded and cut-down version of an actual application. The run was made as part of the planning process in the development of a television schedule.

The product at hand is used almost exclusively by women. We have dubbed it "Princess Widgets." Heaviest use is among women aged 25-34 in A (i.e. metropolitan) counties, although significant usage is found in other groups. The relevant market segments have been broken out by age and county type as follows:

Age: 25 and under / 25-34 / 35-49 / 50-64

County type: A / B / C + D (abbreviated C)

All twelve combinations are considered. Existing TV shows representative of types expected to be available in the planning period are used in the analysis. The shows selected for consideration have been chosen with the objective of permitting a mix that will cover high potential groups efficiently. The media abbreviations are:

ASOAPD = Daytime Serial A

BSOAPD = Daytime Serial B

DAGAME = Daytime Game

NMOVIE = Night Movie

NADVEN = Night Adventure

NSITUA = Night Situation

FRINGA = Fringe Spots in County Size A

FRINGB = Fringe Spots in County Size B

The following pages give a summary of input data for the problem and an abbreviated transcript of the console session at which this problem was run. Included are:

(1) Input of the data.

(2) Preliminary ranking of the media choices.

(3) Detailed build up on the schedule for the given budget and other input.

(4) Summary of final schedule.

(5) Detailed results of retained exposure value by market segment and time period.

TABLE I: INPUT DATA

PRODUCT: PRINCESS WIDGETS

Budget $600,000   5 Periods   12 Segments   9 Media

Media Data

Media Option	ASOAPD	BSOAPD	DAGAME	NMOVIE	NWESTN	NADVEN	NSITUA	FRINGA	FRI
Cost/Insertion	6800	11100	7300	55000	46400	37900	46000	5000	4
Exposure Value	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.
Probability of Exposure	.35	.35	.35	.40	.40	.40	.40	.35	.
Upper Bounds	12	8	12	4	4	4	4	40	4

Audience Seasonality: None

Segment Data

Market Segment	A 25 Und	A 25-34	A 35-49	A 50-64	B 25 Und	B 25-34	B 35-49	B 50-64	C 25 Und	C 25-34	C 35-49	C 50-6
Population	4000	4470	6930	5860	2810	3140	4880	4120	3490	3910	6060	512
Sales Potential	1.56	1.43	1.33	.98	1.49	1.36	1.25	.90	1.20	1.10	1.01	.7
Initial Exposure Value/ Person	.100	.098	.082	.064	.101	.095	.082	.061	.085	.083	.070	.05

Potential Seasonality: None

Other Data

Memory Constant: .250

% Potential Realized at Saturation: 100.

1 Average Exposure: 50.   2 Exposures: 70.   3 Exposures: 80

MARKET COVERAGES

	A 25und	A 25-34	A 35-47	A 50-64	B 25und	B 25-34	B 35-47	B 50-64	C 25und	C 25-34	C 35-49	5(
ASOAP	.096	.068	.056	.052	.104	.073	.060	.056	.115	.081	.067	.
BSOAP	.111	.096	.075	.079	.104	.090	.071	.074	.139	.120	.094	.
DAGAME	.093	.085	.081	.089	.103	.094	.090	.098	.096	.088	.084	.
NMOVIE	.321	.313	.249	.206	.302	.294	.235	.194	.274	.266	.212	.
NWESTN	.129	.051	.104	.114	.144	.102	.116	.127	.208	.147	.167	.
NADVEN	.209	.211	.192	.101	.241	.242	.220	.116	.166	.167	.153	.
NSITUA	.272	.245	.205	.208	.241	.217	.182	.184	.205	.185	.155	.
FRINGA	.120	.120	.100	.080	.000	.000	.000	.000	.000	.000	.000	.
FRINGB	.000	.000	.000	.000	.120	.120	.100	.080	.000	.000	.000	.

MEDIA DUPLICATIONS

	ASOAPD	BSOAPD	DAGAME	NMOVIE	NWESTN	NADVEN	NSITUA	FRINGA	FR]
ASOAPD	.036	.037	.035	.040	.034	.035	.037	.025	.(
BSOAPD		.048	.042	.051	.047	.048	.050	.041	.(
DAGAME			.043	.047	.042	.044	.046	.038	.(
NMOVIE				.133	.054	.059	.090	.050	.(
NWESTN					.067	.050	.070	.046	.(
NADVEN						.078	.071	.048	.(
NSITUA							.097	.050	.(
FRINGA								.050	.(
FRINGB									.(

```
-LEASE LOG IN:                                              
                                                            
FR/DY  8/17  9:5-                                           
                                                            
- -(U (G2A011)/0INPUT/                                      
                                                            
 TYPE NO. OF DOLLARS IN BUDGET,F9.                          
- 600000.,                                                  
 TYPE THE NO. OF TIME PERS,I3                               
- 5,                                                        
 TYPE NO. OF MKT SEGMENTS,I3                                
- 12,                                                       
 TYPE NO. OF MEDIA,I4                                       
- 9,                                                        
  TYPE THE PERCENT OF POTENTIAL REALIZED                    
 AFTER COMPLETE SATURATION WITH EXPOSURES,F4                
- 100.,                                                     
        :                :                                  
 TYPE NAME OF MKT SEG    1 A6                               
- A25UNP                                                    
 TYPE NO. OF PEOPLE,POTENTIAL FOR SEGMENT A25UNP,2F9        
- 4000.,1.56,                                               
        :                :                                  
  TYPE MEMORY CONSTANT,F4.                                  
- .25,                                                      
 TYPE NAME OF MEDIA     1 A6                                
- ASOAPD                                                    
 TYPE EXPOSURE VALUE,PROB. OF EXPOSURE,2F3.,OF ASOAPD       
- 1.,.35,                                                   
        :                :                                  
 TYPE MKT. SEG. COVERAGE OF ASOAPD SEGMENTS                 
 A25UA25-A35-A50-B25UB314-B35-B50-C25UC25-C35-C50-          
 .XXX.XXX.XXX.XXX.XXX.XXX.XXX.XXX.XXX.XXX.XXX.XXX           
- .096.068.056.052.104.073.061.056.115.081.067.063          
        :                :                                  
 TYPE COST PER INSERT F6. FOR  ASOAPD                       
- 6800.,                                                    
        :                :                                  
 TYPE NO OF SEGS WITH SEASONAL POTENTIAL                    
- 0,                                                        
 TYPE NO. OF CASES(PERIODS*MEDIA) WITH                      
 UPPER BOUNDS NOT EQUAL TO ONE                              
- 45,                                                       
 TYPE NO. OF MEDIA WITH UPPER BND. NOT =1                   
 WHOSE BNDS. ARE CONSTANT FOR ALL PERIODS                   
- 9,                                                        
 TYPE MEDIA NO.,CONSTANT UPPER BOUND,2I2                    
- 1,12,                                                     
 ASOAPD NOW HAS A CONSTANT BND. OF 12FOR ALL PERS.          
```

Enter the Time Sharing Syste[m]

— Indicates data typed by the user. All other typing is done by the computer except for comments at right.

Begin Data Bank generating Program

The computer asks for all da[ta] needed in English. The F, I and A letters refer to input format.

: Indicates cutting to save space. Actual trace is about 8 pages.

```
  TYPE DUPLICATIONS OF ASOAPD WITH
  ASOABSOADAGANMOV[illegible]NADVNSITFRINFRIN
  .XXX.XXX.XXX.XXX.XXX.XXX.[illegible].XXX.XXX
— .036.037.035.040.034.035.037.[illegible].025
                     :
  *STOP*
```

The data bank for this problem is now created.

The user then asks for an initial ranking of all the media options

```
— -GO (G2A011)/@MEDIAC/

  TYPE 1 IF INITIAL EXPOSURES ARE ZERO,   OTHERWISE 2
— 1,
  TYPE 1 IF RANKING WANTED,2 FOR FULL ALLOCATION
— 1,
  DAGAME T. P.   1 IMPACT/DOL=         .151
  DAGAME T. P.   2 IMPACT/DOL=         .151
  DAGAME T. P.   3 IMPACT/DOL=         .151
     :                          :
  ASOAPD T. P.   1 IMPACT/DOL=         .133
     :                          :
  FRINGA T. P.   1 IMPACT/DOL=         .123
     :                          :
  BSOAPD T. P.   1 IMPACT/DOL=         .107
     :                          :
  NMOVIE T. P.   1 IMPACT/DOL=         .067
     :                          :
  NADVEN T. P.   1 IMPACT/DOL=         .065
     :                          :
  NSITUA T. P.   1 IMPACT/DOL=         .065
     :                          :
  FRINBG T. P.   1 IMPACT/DOL=         .054
     :                          :
  NWESTN T. P.   1 IMPACT/DOL=         .039
     :                          :

  COMPUTER TIME          .09 MINUTES

  *STOP*
```

This time the user desires a full run of the MEDIAC selection and scheduling system.

```
— -GO (G2AØ11)/@MEDIAC/

  TYPE 1 IF INITIAL EXPOSURES ARE ZERO,   OTHERWISE 2
— 2,
  TYPE INITIAL EXPOSURES/CAP.IN SEGMENTA25UND F4.
— .1,

        .                                          .
        .                                          .
        .                                          .

  TYPE 1 IF RANKING WANTED,2 FOR FULL ALLOCATION
— 2,
  TYPE 1 IF SOME MEDIA HAVE ALREADY BEEN SELECTED,OTHERWISE 2
— 2,
```

If some media must be in the schedule, they are added here

```
1 INSERT IN DAGAME TIME PER  5 COST    73ØØ.REALIZED POT.    4797.
1 INSERT IN DAGAME TIME PER  3 COST   146ØØ.REALIZED POT.    5913.
1 INSERT IN DAGAME TIME PER  2 COST   219ØØ.REALIZED POT.    6996.
1 INSERT IN DAGAME TIME PER  4 COST   292ØØ.REALIZED POT.    8Ø55.
1 INSERT IN DAGAME TIME PER  1 COST   365ØØ.REALIZED POT.    9Ø94.
1 INSERT IN DAGAME TIME PER  5 COST   438ØØ.REALIZED POT.   1ØØ58.
1 INSERT IN DAGAME TIME PER  2 COST   511ØØ.REALIZED POT.   11ØØ4.
1 INSERT IN DAGAME TIME PER  4 COST   584ØØ.REALIZED POT.   11926.
1 INSERT IN DAGAME TIME PER  1 COST   657ØØ.REALIZED POT.   12838.
1 INSERT IN DAGAME TIME PER  3 COST   73ØØØ.REALIZED POT.   13725.
1 INSERT IN DAGAME TIME PER  1 COST   8Ø3ØØ.REALIZED POT.   14537.
1 INSERT IN DAGAME TIME PER  3 COST   876ØØ.REALIZED POT.   15322.
1 INSERT IN DAGAME TIME PER  5 COST   949ØØ.REALIZED POT.   1615Ø.
1 INSERT IN DAGAME TIME PER  2 COST  1Ø22ØØ.REALIZED POT.   16894.
1 INSERT IN DAGAME TIME PER  4 COST  1Ø95ØØ.REALIZED POT.   17638.
1 INSERT IN DAGAME TIME PER  1 COST  1168ØØ.REALIZED POT.   18329.
1 INSERT IN DAGAME TIME PER  3 COST  1241ØØ.REALIZED POT.   18966.
1 INSERT IN DAGAME TIME PER  5 COST  1314ØØ.REALIZED POT.   19673.
1 INSERT IN DAGAME TIME PER  2 COST  1387ØØ.REALIZED POT.   2Ø276.
1 INSERT IN DAGAME TIME PER  1 COST  146ØØØ.REALIZED POT.   2Ø855.
1 INSERT IN DAGAME TIME PER  4 COST  1533ØØ.REALIZED POT.   21457.
1 INSERT IN DAGAME TIME PER  1 COST  16Ø6ØØ.REALIZED POT.   21955.
1 INSERT IN DAGAME TIME PER  3 COST  1679ØØ.REALIZED POT.   22449.
1 INSERT IN DAGAME TIME PER  4 COST  1752ØØ.REALIZED POT.   22947.
1 INSERT IN DAGAME TIME PER  2 COST  1825ØØ.REALIZED POT.   23395.
1 INSERT IN DAGAME TIME PER  5 COST  1898ØØ.REALIZED POT.   23967.
1 INSERT IN NMOVIE TIME PER  3 COST  2448ØØ.REALIZED POT.   2695Ø.
1 INSERT IN NMOVIE TIME PER  5 COST  2998ØØ.REALIZED POT.   3ØØØ2.
1 INSERT IN DAGAME TIME PER  1 COST  3Ø71ØØ.REALIZED POT.   3Ø393.
1 INSERT IN NMOVIE TIME PER  2 COST  3621ØØ.REALIZED POT.   3327Ø.
1 INSERT IN NMOVIE TIME PER  4 COST  4171ØØ.REALIZED POT.   36129.
1 INSERT IN NMOVIE TIME PER  1 COST  4721ØØ.REALIZED POT.   38898.
1 INSERT IN NMOVIE TIME PER  3 COST  5271ØØ.REALIZED POT.   41519.
1 INSERT IN NMOVIE TIME PER  1 COST  5821ØØ.REALIZED POT.   44Ø82.
1 INSERT IN NMOVIE TIME PER  4 COST  6371ØØ.REALIZED POT.   46679.
```

```
           MEDIAC GENERATED SCHEDULE

MEDIA   PER.   1     2     3     4     5
DAGAME         7     6     6     6     6
NMOVIE         XX    X     XX    XX    X
```

The system prints a trace of the build up of the schedule and then a graphical display of the final schedule.

```
 TYPE1 FOR DETAILED OUTPUT,ELSE2
—1,
SEGMENT TIME P EX VAL/CP SEG E.V.   REALIZED POTENTIAL
  A25UND     1     .58416     2356.     1248.
  A25UND     2     .43682     1747.      960.
  A25UND     3     .52831     2113.     1108.
       .                        .
       .                        .
       .                        .

  COMPUTER TIME             .     MINUTES

  *STOP*

  +
— -LOG

  TIME USED 0:42:27
```

The user desires to see detailed output describing average retained exposure level/person and realized potential in each segment during each period of the analysis.

Total time used, including input, was 42 minutes of terminal time and .97 minutes of CPU time.

A few comments are worth making on the final schedule. Under the conditions of the problem, daytime shows covered the desired audience most efficiently. (See initial rankings.) As a result, the computer took the highest ranking daytime show, DAGAME, and used a considerable amount. If higher diminishing returns had been used, less DAGAME would have been scheduled because of its duplication with itself. After using considerable DAGAME, the computer skipped over the other daytime shows to the much lower ranked NMOVIE. This is because NMOVIE picks up new people not covered well by daytime TV. If the budget had been substantially larger, more media would probably have come in. The media director whose problem this is thought that fringe spots would be useful. However, even when their exposure value was increased slightly and their cost decreased slightly in a sensitivity test, they did not come into the schedule. Apparently, after the other shows have been carefully picked, the spots have little to offer in this situation.

6. Discussion

What have we learned from the exposure of our model and system to media planners?

Real world problems are viewed as large and analytically complex by those responsible for solving them, even though their past approaches have been analytically quite simple. We are constantly being pressed to increase our capacity particularly with respect to number of media alternatives, market segments and time periods. We have increased our capacity from 15 media, 20 segments, and 12 time periods to 25 media, 20 segments and 13 time periods and are currently working on a much larger version.

Although our system is computationally very efficient compared, say, to a simulation approach to media evaluation, we feel economic pressure to make the system and heuristics run faster so that bigger problems become feasible in relation to the research budgets of the users. We have made the system at least three times faster in the past year for medium sized problems and even faster relatively for problems as they become larger.

An unwelcome consequence of larger problems is that they become less practical to operate on a time shared basis. In some busy periods the user may wait for three or four hours for a run taking twenty minutes of central processor time. To overcome this we have set up a system of on-line ordered batch processing for these large problems. The user still runs the conversational input, change and print programs at the console to enter his data or make any data changes. He then calls another conversational program which constructs a disk file containing instructions for the options desired in the calculation program. The calculation program is run overnight in a batch mode and creates a disk file with the system output. The user then enters the time-sharing system in the morning and prints out the results at his terminal.

We have also felt pressure to include more phenomena in our model of the advertising process. We presently are working on including competitive advertising, the rub-off effect of other advertising by the same firm, and the synergistic effects of multiple media types. The research is constantly prodded by our users asking for the inclusion of new phenomena. When these phenomena are included, they will undoubtedly ask for others.

At the same time, we have the distinct impression that we should not introduce complications too fast. Although the concepts in our model

are all familiar to media planners, the process of developing data on each and putting them all into a single structure is not easy and requires time to absorb. This must be done for the most basic phenomena before going on to new complexities.

The interactive aspect of our system has been valuable in building confidence in the system among non-technical users. The user directly monitors what goes in to the computer without being subjected to the rather imposing tribal rituals demanded by punched cards, system programmers, and computer operators. The user feels that the system is in his control at all times and he knows exactly what data the computer is using to work on his problem. If any input mistakes are involved, he holds himself responsible. Most people seem to have more confidence in themselves than in other interfaces with the computer.

How has the use of MEDIAC affected the way our users think about their media planning decisions? MEDIAC tends to move the intuitive approach of the media planner to a more productive level. More effort goes into formulating the problem constructively than into trying to perceive the answer in one jump. Not that users automatically accept the model's answers, they test the answers against their intuition, dig into the model to find out what caused any substantial discrepancies and, in the process, appear to be updating and enriching their intuition.

The use of a rather comprehensive model structure has caused some planners to face problems whose importance had previously been unacknowledged. For example, one user tried three different response functions for a problem, one reflecting very high diminishing returns with repeated exposure, the second a moderate amount of diminishing returns, and the third almost

no diminishing returns. The MEDIAC generated schedule was quite different for each curve. The importance of defining his client's objectives in terms of the value of repeated exposure was thus dramatized by sensitivity analysis on the model.

The model tries to give the users a sensible, consistent, comprehensive structure for media planning. The model leads people to look at many issues and ferret out information on all of them. It also helps sort out relevant material from the deluge of data which planners invariably encounter.

Preparing problems for MEDIAC is often time consuming. Collecting the input data can be a time-consuming undertaking. A substantial amount of data manipulation is often needed because the data sources are frequently incomparable, the numbers are in different units, or the data must be extrapolated. We have made some headway into computerization of the data manipulation problem and consider it a fruitful area for development. Once the planner has done a few problems he usually finds short-cuts in input generation which save considerable amounts of time. Obtaining input for an average problem by an experienced MEDIAC user has taken from one to three man days.

Users have been quite pleased with the results they have achieved with MEDIAC. Improvements in the objective functions, as defined by the users, have ranged from about 5% to 25% relative to previous schedules. Some MEDIAC generated schedules have looked much like previous ones; others have been quite different. In cases that have looked different, it has been possible to find out what data or phenomena have caused the change. In almost all cases the media planner has preferred the new schedule.

References

1. J. D. C. Little and L. M. Lodish, "A Media Selection Calculus" Sloan School of Management Working Paper, 304-68 January 1968. (To appear in Operations Research.)