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A MODEL FOR STRATEGIC PLANNING OF FAMILY PLANNING PROGRAMS

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INTRODUCTION

Family planning is recognized as a critical problem in achieving economic and social goals in underdeveloped countries, but it is also an important problem in the United States. It is estimated that there are 850,000 unwanted births in the U.S. each year.[1] More importantly, 40% of the births to poor and near-poor are unwanted.[2] This excess fertility has detrimental economic and health effects on the poor in America as in underdeveloped countries.[3] The parallels between family planning for the poor in the U.S. and in developing countries are striking. Ignorance, lack of persuasive communication, lack of availability, low levels of usage, and poorly managed family planning services are common dimensions to the programs of the U.S. and underdeveloped countries.

This paper will describe a model that may be helpful in improving the effectiveness of family planning programs. The model is intended to improve the decisions required for effective management of family planning. Four basic decision areas in family planning can be defined. They are:

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[1] See [2].

[2] See [3].

[3] See [1] for data in Louisiana.

(1) creative design of alternatives, (2) program formulation and strategy determination, (3) specification of tactics, and (4) organization, staffing, and control.[4] The creative design stage requires the utilization of technology to produce contraceptive products that fit the physical, social, and psychological needs of the consumer so that acceptance and use will be fostered. Program formulation requires a system model to budget for family planning so that overall social and economic goals can be achieved. The strategy determination stage converts the budget into an allocation of the resources to products, consumer segments, and controllable variables. This overall allocation is then translated by tactical decisions into detailed supply, personal selling and detailed communication plans. The strategic and tactical plans must be converted into action in a well structured, staffed, and controlled organization. This organizational phase is especially important since family planning services intersect with many health, educational, and governmental organizations which many times have conflicting goals.

The model proposed in this paper attacks only one of these decisions, the strategic planning decision. The model is based on the process of acceptance of family planning. Controllable variables are linked to this process and then the variables are selected to achieve the greatest birth rate reduction given the budget and system constraints. The model is associated with a data collection and analysis capability in what may be termed an information system. The model based system is designed to: (1) provide an understanding of the process of diffusion of contraceptive

[4] See [4] for a detailed discussion.

practices, (2) help specify the data needed to manage the system, (3) diagnose problems in existing programs, (4) forecast the results of alternate strategies, (5) specify improved strategies, and (6) foster adaptive control of the family planning program.

THE MODEL

The model is a mathematical description of the process by which people make decisions to accept family planning. The basic process is one of trial, evaluation, and adoption. People are placed in one of three classes based on their experience with contraceptive products. Those who have not used a contraceptive device are placed in the potential trial class. If they try a product they are placed in the evaluation class. See Figure 1. If they find the use experience satisfactory and use the device again, they are placed in the adoptor class. If they do not repeat usage they are returned to the potential trial class. For example, trial may be usage of one month of pills. Evaluation may lead to a second month's usage and finally adoption after three months of consecutive usage. Some methods such as sterilization imply a mandatory adoption after trial, but most other methods are reversible and lead to the series of decisions of trial, evaluation, and adoption. A successful family planning program encourages a high trial rate and leads to a high rate of adoption.

The potential group of people who might adopt family planning is heterogeneous. Each segment of people may require a different strategy. For example, in underdeveloped countries the literate and illiterate segments should be recognized. They will respond to strategies differently.

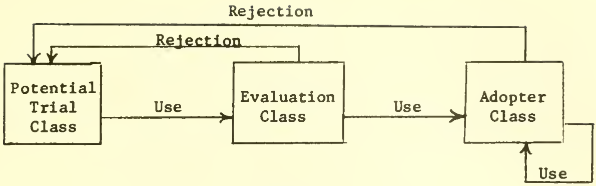

Figure 1

Acceptance Classes

Likewise, the number of children of the family or the geographic location of families (i.e. Urban-rural or states) may be important dimensions of segmentation. The model presumes each segment will follow the same behavioral steps of gaining awareness, developing intent, finding the product, and choice of product, but each segment responds differently to product alternatives and persuasion efforts. The process of acceptance will be described for one segment and then the effects of segment differences in strategy formulation will be discussed.

Trial Process

The trial process is described in Figure two. Potential triers gain specific awareness about family planning or contraceptive products. They then convert this into an intent to try a specific product or search for information about family planning methods. If the product is found in a clinic or retail store, or a clinic is visited, the decision to choose the product is described. Those who try the product move to the evaluation class while the others remain in the potential trial class in the next period. This flow will be described in mathematical form with the controllable communication, availability, and point of purchase

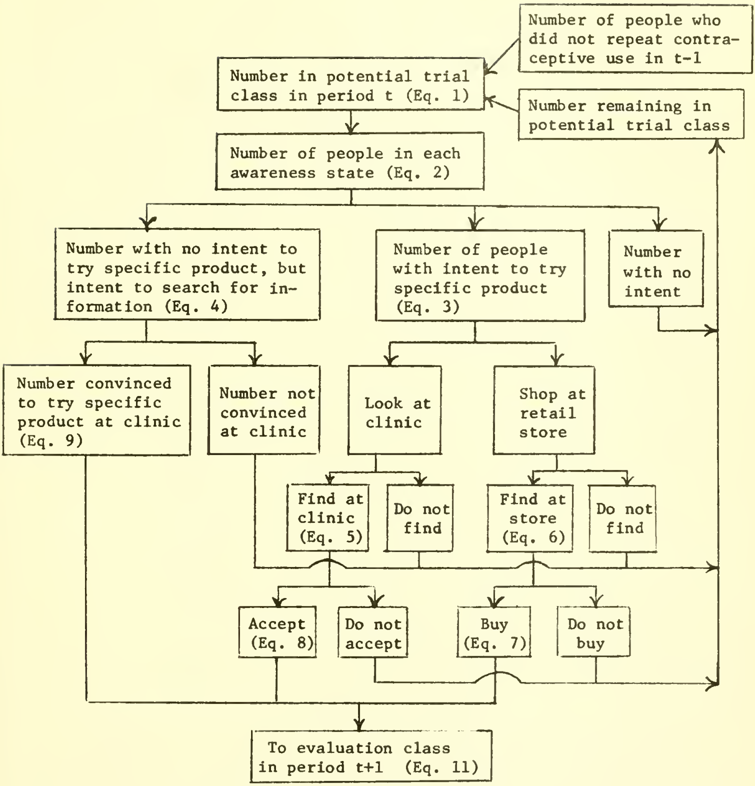

Figure 2

Potential Trial Class Process

variables explicitly linked to the process. Equation numbers appear in the flow diagram to aid in coordinating the mathematical statements to the process diagrams.

First, the number of people in the potential trial class is defined as that number of people in the segment not using a contraceptive product in the last period. That is, those not in the evaluation or adopter class in the previous period. See Figure One.

(1) $PTRY_t = TOTSEG_t - TRIAL_{t-1} - REPEAT_{t-1} - ADOPT_{t-1}$

$PTRY_t$ = number of people in potential trial class in period t

$TOTSEG_t$ = total number of couples in segment in period t

$TRIAL_{t-1}$ = total number of people who tried some product in t-1 (see Eq. 11)

$REPEAT_{t-1}$ = total number of people who repeated usage of some product in t-1 (see Eq. 14)

$ADOPT_{t-1}$ = total number of people who adopted some product in t-1 (see Eq. 16)

The awareness levels of the people in the potential trial class will be a function of communication efforts. Communication is the result of an resources to advertising or personal contacts by social workers. These efforts are parameterized as the expenditure of funds. The communication effort places people in specific awareness states. These states, denoted by subscript "a", define specific recall to product appeals or the overall

family program communication appeals. The awareness state of a = N is defined as those who have gained negative awareness about a product by past use of a product. Equation two defines the gain of awareness for those with no negative experience. The number of people with negative awareness is defined in Equation 2a.

(2) $AWARE_{a,t} = \overline{AWRPCT}\ (COM_{s,t}/RCOM_{s,t})\ X\ (PTRY_t - AWARE_{N,t})\ X\ AWRFCT_a$

$AWARE_{a,t}$ = number of people in awareness state a

a = 1, 2,... N-1

a = 1 = unaware

a = 2 = aware of positive value of family planning

a = 3 = aware of specific appeal of product one

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.
.

a = N-1 = aware of specific appeal of product P

(Note: P could be a combination of devices)

$\overline{AWRPCT}$ = percent of people aware of family planning or specific product appeals with a specific communication effort received by segment s in period t ($COM_{s,t}$) relative to reference communication in segment ($RCOM_{s,t}$).

$PTRY_t$ = number of people in potential trial class in period t

$AWRFCT_a$ = fraction of those aware who are in specific recall state a

$AWARE_{N,t}$ = number of people with negative awareness about family planning in period t

(2a) $$AWARE_{N,t} = \sum_P TNEG_{P,t} \quad \text{where } TNEG_{P,t} = NEGUSE_{P,t-1} + TNEG_{P,t-1}$$

$TNEG_{P,t}$ = total number of people who are not using any product who have had negative experience about product P at time t

$NEGUSE_{P,t-1}$ = number of people who have negative experience with product P in period t-1 (see Eq. 12)

This equation describes the number of people in specific awareness states as the number who gain some awareness times the fraction who gain a specific awareness. The overall awareness response function $\overline{AWRPCT}$ describes the percent of people aware at each level of expenditure.

The specific awareness is next converted to intent to try a product or to search for information. It is important to determine the intent rates since this is a measure of the action component of the communication appeal. Awareness alone is not enough since this must be converted to action before usage will be obtained. The intent to try a specific product is measured by the sum of the number of people in each awareness state who declare intent to try the product in special attitudinal scaling questionnaieres. The number with intent to try is:

(3) $INTTRY_{P,t} = \sum_a AWARE_{a,t} \times ITRY_{a,P}$

$INTTRY_{P,t}$ = number of people with intent to try product P in period t

$AWARE_{a,t}$ = number of people in awareness state a (a = 1, 2, ... N) (Eq. 2)

$ITRY_{a,P}$ = fraction of people in awareness state a who intend to try product P

Although people may not have a strong intent to try a specific product, the communication effort may cause people to search for information about specific products at a family planning clinic. The number who intend to search is:

(4) $INTSER_t = \sum_a AWARE_{a,t} \times ISERCH_a$

$INTSER_t$ = number of people with no intent to try a specific product but have an intent to search for information in period t

$AWARE_{a,t}$ = number in awareness class a in period t (see Eq. 2)

$ISERCH_a$ = fraction in awareness state a stating intent to search for information

People with no intent return to the potential trial class for the next period.

Those with intent to try next expend effort to find the product. The number who will find the product will depend upon where they look and the availability of the product. Those who find the product at a clinic are:

(5) $FINDIC_{P,t} = INTTRY_{P,t} \times LOOKC \times AVAILC_{P,t}$

- $FINDIC_{P,t}$ = number of people with intent who find product P at clinic in period t
- $INTTRY_{P,t}$ = number with intent to try product P in period t (see Eq. 3)
- LOOKC = fraction of people who state intent to try who will look for contraceptive device at clinic
- $AVAILC_{P,t}$ = fraction of clinics with product P available in period t

Those who find the product at a retail store are similar, exept the number is reduced by those who can not get a prescription for the product if it is required.

(6) $FINDIR_{P,t} = INTTRY_{P,t} \times PRES_P \times LOOKR \times AVAILR_{P,t}$

- $FINDIR_{P,t}$ = number with intent who find product P at retail store in period t
- $INTTRY_{P,t}$ = number with intent to try product P in period t
- $PRES_P$ = fraction of people who will look at retail store for product P who are able to obtain prescription for product P, if prescription is required

LOOKR = fraction of people who have intent to try who look in retail store

$AVAILR_{P,t}$ = fraction of stores with product P available in period t

The number who actually buy the product at the retail is the number who find the product times the fraction who exercise their intent. This fraction is important since it reflects the effects of the retail point of purchase atmosphere in promoting action. The fraction converting their intent into purchase is dependent upon this atmosphere. For example, the price or display size may measure point of purchase activity. The fraction buying is functional on this point of purchase activity.

$$(7)\quad BUYIR_{P,t} = FINDIR_{P,t} \times \overline{EXERR}(POPR_P/RPOPR_P)$$

$BUYIR_{P,t}$ = number who buy product at retail store

$FINDIR_{P,t}$ = number of people with intent who find product P at retail store in period t (see Eq. 6)

$\overline{EXERR}$ = fraction of people who exercise intent at point of purchase environment ($POPR_P$) for product P relative to reference point of purchase environment ($RPOPR_P$)

Likewise, those who accept the product at a clinic are the number who find it times the fraction who exercise their intent in response to the clinic's environment.

(8) $BUYIC_{P,t} = FINDIC_{P,t} \times EXERC$

$BUYIC_{P,t}$ = number who accept product P in period t at clinic

$FINDIC_{P,t}$ = number with intent to try who find product P at clinic in period t (see Eq. 5)

EXERC = fraction of people who exercise intent to try at clinic

The people who had no intent to buy a specific product but stated an intent to search for family information at the clinic must exercise their intent to search and become convinced of the difficulties of using some product. The percent of those who are convinced will depend upon the point of purchase personal communication effort and the clinical environment. The model makes the fraction who are convinced a function of the environment. This variable, POPC, is parameterized as a scaled rating of the quality of the personal selling effort at the clinic. This rating could be increased by more training of workers or by increasing the number of workers. The convincing process could be extended by using a multivariate function of the quality of communication, the amount of writing time, and a rating on the "pleasantness" of the physical environment. Equation 9 describes this clinical acceptance process. It is assumed that the product will not be accepted if the clinical worker attempts to push a product which the consumer views negatively. The number who accept the product at the clinic after searching for information is:

(9) $BUYSC_{P,t} = INTSER_t \times EXERS \times \overline{CONVIN}_P\,(POPC/RPOPC)$

$\times\ (1 - (TNEG_{P,t}/PTRY_t)) \times AVAILC_{P,t}$

$BUYSC_{P,t}$ = number of people who search for information and accept product P at clinic in period t

$INTSER_t$ = number of people who intend to search for information (see Eq. 4)

EXERS = fraction who exercise intent to search for information

$\overline{CONVIN}_P$ = fraction of people who will be convinced to try product P at a clinical point of purchase environment (POPC) relative to reference level (RPOPC) (Note: $\sum_P CONVIN_P \leq 100\%$)

$TNEG_{P,t}$ = number of people who have had negative use experience with product P (see Eq. 2a)

$PTRY_t$ = number of people in potential trial class in period t

$AVAILC_{P,t}$ = fraction of clinics who have product P available at time t

$1-(TNEG_{P,t}/PTRY_t)$ = the fraction of people who have not had a negative experience with product P

The total number of triers of a specific product is the number who accept at the clinic plus those who buy at retail.

(10) $TRY_{P,t} = BUYIR_{P,t} + BUYIC_{P,t} + BUYSC_{P,t}$

$TRY_{P,t}$ = number of people who try product P in period t

$BUYIR_{P,t}$ = see Eq. 7

$BUYIC_{P,t}$ = see Eq. 8

$BUYSC_{P,t}$ = see Eq. 9

The total of all product triers in the period is:

(11) $TRIAL_t = \sum_P TRY_{P,t}$

$TRIAL_t$ = number of people who tried some contraceptive device in t

Those who use the product proceed onto the evaluation class. The others remain in the potential trial class for the next period. Since some of the people with negative awareness ($AWARE_{N,t}$, Eq. 1) may have been convinced to try another product, the number of negative aware who had intent and exercised that intent are removed from the negative awareness state in proportion to their intent rate and the fraction of people who found and accepted the product.

<u>Evaluation Stage</u>

Those people who have tried the product evaluate the usage and decide if they are going to repeat usage of the product. That is, for example procure pills again or keep IUCD for another month. The repeat rate for sterilization will be one hundred percent except for ineffective surgical results. The repeat process is modeled in a simple way by observing the number of people with non-negative experience and the probability of their repeating. See Figure 3. Those with negative product experience (except sterilization) and those who do not repeat are returned to the potential trial class.

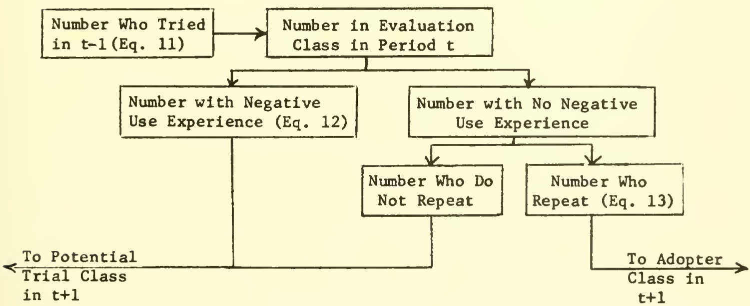

Figure 3
Evaluation Class Process

The number of users with negative experience is:

(12) $NEGUSE_{P,t} = TRY_{P,t-1} \times NEGEXP_P$

$NEGUSE_{P,t}$ = number of people with negative use experience with product P in period t in evaluation class

$TRY_{P,t-1}$ = number who tried product P in last period (t-1)

$NEGEXP_P$ = fraction of people who have unsatisfactory trial experience with product P

The number who rebuy is dependent upon the probability of repeat and the number with no negative experience. The number of repeaters is:

(13) $REBUY_{P,t} = (TRY_{P,t-1} - NEGUSE_{P,t}) \times RR_P$

$REBUY_{P,t}$ = number who procure product P in period t after trial in t-1

$TRY_{P,t-1}$ = number who tried product P in period t-1 (see Eq. 10)

RR_P = fraction of those who tried product P in period t-1 and will procure product again in period t

The total number of repeat users is:

(14) $REPEAT_t = \sum_P REBUY_{P,t}$

$REPEAT_t$ = total number of people who repeat usage of some product in period t

$REBUY_{P,t}$ = number who procure product P in period t after trial in period t-1

These repeaters go on to the adopter class in the next period while those who do not repeat are returned to the potential trial class.

Adoption Stage

After two consecutive months of usage of the contraceptive device, people are placed in the adopter class. Those who reuse the product again remain in adopter class, while those who do not are returned to the potential trial class. See Figure 4. The model at this stage is simply the probability of repeat times the number of people in the adopter class.

(15) $NADOPT_{P,t} = (REBUY_{P,t-1} + NADOPT_{P,t-1}) \times RADOPT_P$

$NADOPT_{P,t}$ = number of people who adopt product P in period t

$REBUY_{P,t-1}$ = number in evaluation class who repeated use of product P in period t-1

$RADOPT_P$ = fraction of people who repeated use of product P in period t-1 and who will use product again in period t

The total number of adopters of some product is:

(16) $ADOPT_t = \sum_P NADOPT_{P,t}$

$ADOPT_t$ = number of people who adopt some product in period t

$NADOPT_{P,t}$ = number of people who adopt product P in period t

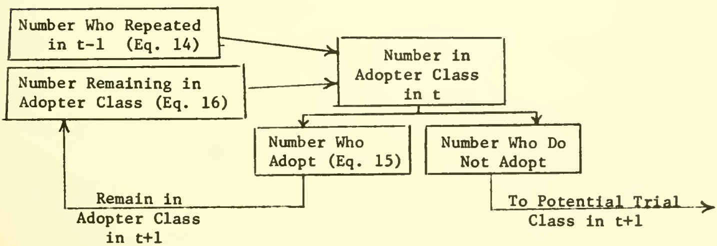

Figure 4
Adoption Class Process

Segment Effects

The previous sections described the process of acceptance for one segment. In the equations a subscript "s" for segments was surpressed. Each of the parameters would be subscripted for segments so that each segment could have a different response. With segments included, the total number of users of product P in each segment is:

$$(17)\quad TOTUSE_{s,P,t} = TRY_{s,P,t} + REBUY_{s,P,t} + NADOPT_{s,P,t}$$

$TOTUSE_{s,P,t}$ = total number of users of product P in segment s in period t

$TRY_{s,P,t}$ = number of triers of product P in segment s in period t (see Eq. 10)

$REBUY_{s,P,t}$ = number of repeat users of product P in segment s in period t (see Eq. 13)

$NADOPT_{s,P,t}$ = number of adopters of product P in segment s in period t (see Eq. 15)

The size of the segments may change due to growth and deaths. There also may be a shifting between segments by gaining literacy or geographic movement if segments are defined on a literate-illiterate or geographic basis. The number of potential users in the segment adjusted for these changes and women who are pregnant is:

$$(18)\quad TOTSEG_{s,t} = POPSEG_{t} \times IGROW_{s} \times IDECAY_{s} + \sum_{ss} SHIFTT_{s,ss} - \sum_{ss} SHIFTF_{s,ss} - \sum_{T=t-NP}^{t} PREG_{s,t}$$

$TOTSEG_{s,t}$ = number of couples in segment s who are not pregnant at time t

$POPSEG_{s,t}$ = total number of couples in segment s at time t

$IGROW_s$ = index of growth of segment s

$IDECAY_s$ = index of decay of segment s

$SHIFTT_{s,ss}$ = number of people shifting to segment s from ss ($ss \neq s$)

$SHIFTF_{s,ss}$ = number of people shifting from segment s to ss ($ss \neq s$)

(Note: if segment is defined by number of children, then will be needed additional equations to track the shifting between segments by births)

$PREG_{s,T}$ = number of women pregnant in segment s at period T

NP = number of months from conception to renewed fecundity

$$PREG_{s,T} = TOTSEG_{s,T-1} \times PROBP_s - BPRV_{s,T}$$

$PROBP_s$ = probability of pregnancy in a period for segment s

$BPRV_{s,T}$ = number of births prevented in period T and segment s by family planning (see Eq. 19)

TOTSEG is the input to Equation 1 and the definition of the potential trial class.

Finding the "best" strategy

With the model developed in the previous sections the number of users of each product in each segment can be determined given some level of communication, availability, and point of purchase activity. To find the best strategy, a criterion must be defined. The criterion for this model is measured by the number of births prevented. That is, if 1000 women are using a 100% effective contraceptive and the probability of pregnancy in one month is .1, then 100 births have been prevented in that month. The number of births prevented depends on the number of users, the fecundity of the segments, and the effectiveness of the device. In many devices, (e.g. pills, diaphram) the effectiveness is a function of the regularity of use, so in the model the effectiveness is a function of the regularity of use. The number of births prevented in a segment is:

(19) $$BPRV_{s,t} = \sum_{P} PROBP_{s} \times TOTUSE_{s,P,t} \times \overline{EFFECT}_{P}\,(REGUSE_{s})$$

$BPRV_{s,t}$ = total number of births prevented in period t in segment s

$PROBP_{s}$ = probability of pregnancy in period t for people in segment s

$TOTUSE_{s,P,t}$ = total number of users of product P in segment s in period t (see Eq. 17)

$\overline{EFFECT}_{P}$ = effectiveness of preventing a pregnancy with product P at a level of regularity of use ($REGUSE_{s}$)

Since changes in strategies will be evaluated, the incremented change in births prevented should be considered. This will be termed the differential births prevented and is:

$$(20) \quad DBPRV_t = \sum_s BPRV_{s,t} - FBPRV_t$$

$DBPRV_t$ = differential births prevented in period t

$BPRV_{s,t}$ = births prevented in period t in segment s

$FBPRV_t$ = forecasted number of births prevented in reference plan

The differential births when summed over a planning period (e.g. 5 or 10 years) is a reflection of the effect of a particular strategy. One more factor may be important. Since it would be better to prevent births sooner rather than later, the differential births prevented could be discounted at a rate which reflects the value of lowering the population sooner. This rate would have to be compatable with the systems model used to determine the family planning budget. The model criteria is the total discounted differential number of births prevented and is defined as:

$$(21) \quad DDBPRV = \sum_{t=1}^{TT} DBPRV_t \times \frac{1}{(1+DR)^t}$$

DDBPRV = discounted differential births prevented in period of TT periods

$DBPRV_t$ = differential births prevented in period t

DR = discount rate

The strategy problem is to maximize DDBPRV be setting the variables of communication ($COM_{s,t}$, Eq. 2), availability (AVAILR, Eq. 6 and AVAILC, Eq. 5) and point of purchase (POPC, Eq. 9 and POPR, Eq. 7),

subject to the constraints on the system. There may be many constraints. For example, production capacity may be limited for various devices, or the number of medical personnel may limit the number of users of a medically based device. The budget for production, communication, point of purchase incentive, and gaining availability are also limitations on the allowable strategy alternatives. The maximizing strategy could be found by the use of heuristic programming and a computer. The heuristic would be one of allocating resources in small increments until the marginal births prevented by each variable in each segment were equal. The constraints would be satisfied by setting the marginal return to zero when a capacity or budget restraint was violated. The heuristic could also be aided by a man-machine interaction that would allow the man to control the search through an on-line computer.[5] In this manner a good if not best strategy can be found. The output would be the best (1) allocation of communication to each segment, (2) level of availability, and (3) retail and clinical point of purchase incentives for each product.

It is also valuable to relax the constraints on the model and determine what the best strategy response is to this change. For example, if the production capacity for pills increased, how should resources be allocated to best use the additional production? The constraints are important linkages to other models such as production-inventory models. The strategy model can be used compatibly with these other sub-systems.

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[5] See [5] and [6] for examples of this technique.

DATA AND MEASUREMENT

In order to use the model, many parameters must be estimated. For example, the number of people aware, the level of intent, the repeat usage rate, the search habits of people, the probabilities of pregnancy, and effectiveness of devices in preventing pregnancy must be determined. Furthermore, some inputs are functions. For example awareness is a function of communication and the effectiveness of devices are a function of regularity of use. These parameters and functions can be approximated by collecting appropriate data and using statistical procedures. Table One gives the composition of a recommended data bank for this model along with the statistical method to be applied to the data to estimate model parameters.

Special surveys conducted on a sample of people in each segment are needed to estimate awareness, intent, and search habits. Physical audits of a sample of clinic and retail stores are used to document availability and point of purchase activity. A consumer panel in which people record in a diary their contraceptive purchases and usage is useful in estimating trial rates and repeat rates. The estimation of the functional relationships must be accomplished by experimentation. This entails setting alternate levels of the variable in various areas and observing and interpreting the results. Clinical studies provide the needed effectiveness levels of devices while demographic studies supply the fecundity and segment compositions. Internal data supply constraint levels and the reference planning levels.

These data when analyzed with statistics will provide estimates of the needed parameters, but it is important to allow managers to review these estimates since all the statistical assumptions may not have been satisfied, or bias in the data collection may have occurred. The subjective estimates

TABLE ONE
DATA ANALYSIS OUTLINE

DATA BANK	PARAMETERS	STATISTICS
Special Surveys		
awareness, intent, usage, distribution outlet preference (at home and point of purchase)	AWRPCT(2)* AWRFCT(2) ITRY(3) ISEARCH(4) LOOKC(5) LOOKR(6) PRES (6) NEGEXP(12)	Classification
Physical Audits		
retail stores clinic	AVAILC(5) AVAILR(5) CONVIN(9)	Regression
Consumer Panel		
Contraceptive usage regularity of use effectiveness	NEGEXP(12) EXERC(8) EXERR(7) EXERS(9) RR(13) RADOPT(15) REGUSE(19)	Classification, Inference
Experimental studies		
advertising, personal communication, point of purchase	AWRPCT(2) AWRFCT(2) EXERC (8) EXERR (7) CONVIN(9)	Experimental Design, Analysis of Variance, Regression
Clinical Studies	EFFECT(19)	Experimental Design
Demographic Data	PROBP(19) POPSEG(18) IGROW(18) IDECAY(18) SHIFTT(18) SHIFTF(18)	Classification, Probability
Internal Organization Data	FBPRV(20) CONSTRAINTS RCOM(2) RPOP(7) DR(21) TT(21)	

* Equation numbers are given in parentheses

of managers familiar with the system should be combined with the statistical results to produce the best estimates. The model could be given alternate input estimates to determine the sensitivity of the output and help determine where additional and more precise measurements are needed. In this way the manager can interact with the model and data to learn about the system's characteristics and behavior.

USES OF MODEL

The mathematical model produces a best strategy for promoting family planning, but its greatest usefulness probably is not this recommendation. The model is most valuable because it fosters understanding of the process by which family planning is accepted, it asks questions that should be answered in a well managed program, it aids in diagnosing problems in programs, and it fosters orderly planning of the family planning services.

The model represents a hypothesis of how the market operates and therefore causes managers to develop an explicit understanding of the diffusion process. It provides a basis of dispute that encourages learning since reconciling differences will lead to a concensus about how the acceptance process works. This is a necessary understanding for good management of any system. The model will allow knowledge to be transferred from one manager to another when personnel changes occur. The model when implemented on a computer could supply a valuable training tool for new decision makers.

The model is useful since it demands answers to questions such as, what fraction of people exercise their intent to search (EXERS, Eq. 9), where do people look for contraceptive devices (LOOKC, Eq. 5 and LOOKR Eq. 6), and how many people are convinced to use a product at a clinic (CONVIN, Eq. 9)? These questions

are basic and should be answered even if this model is not used. The model leads to collecting the needed data. With the model structure relevant questions are asked and data-based answers are demanded.

The collection of data also will help diagnose problems. For example, if awareness (AWRPCT, Eq. 2) is high but intents (ITRY, Eq. 3 and ISEARCH, Eq. 4) are low this indicates a problem in the communication appeals. If the proportion of negative use experience (NEGEXP, Eq. 12) is high this indicates a product problem. The model does not automatically indicate problems, but the review of the predicted effects of each of the observed parameters will help diagnose problems that require strategy changes in the product, communication, and delivery sub-systems.

The model when supported by continuing data will help diagnose the effects of changes in the market for contraceptives. The updated parameters will lead to new forecasts and new recommended changes. This allows the family planning program to be adaptive to environmental changes. Even if changes do not occur, continuing data collection will indicate failures in the execution of plans which can lead to effective control of the system.

Finally, the model does produce a recommendation for allocation changes and the direction of these changes should lead to changes in strategy or experimentation to evaluate these recommendations. In summary, the model and its surrounding data system are intended to foster effective planning and control of family planning programs.

LIMITATIONS AND EXTENTIONS

The model is subject to many limitations. First, the process description is relatively simple. For example, there is neither search for information at a retail store from a pharmacist nor is there any consumer word of mouth transfer included in the model. These limitations could be overcome by adding more equations to the model. The word of mouth could be added by determining through questionnaires how many positive and negative word of mouth communications are generated by users. If the word of mouth communication is received by a person unaware of the specific product he would be assigned to the specific product or negative awareness state (see Eq. 2)[6]. This added process element requires that more data be collected, but adds behavioral richness. In many situations this additional detail is warranted. For example, the failure of the IUCD in India was apparently due in part to a high volume of negative word of mouth communication. With the model requiring this input, the problem could have been diagnosed and communication directed to counter the word of mouth or better medical pre-screening instituted before insertion. Another extention to the process description would be to deal with the husband and wife separately, as well as in the conglomerate specified in the model. The awareness and intent of each could be defined and the search and acceptance parameterized for each combination of husband's and wife's awareness levels, intent - no intent, and convinced - not convinced states. This extention is not particularly difficult mathematically. It would require additional data about the family decision process, but this data would foster understanding that would be valuable as the model is used and grows in complexity.

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[6] See [6] for a mathematical definition of this word of mouth process.

The level of detail of the decision process in the model is rather macro. For example, the repeat rate (RR, Eq. 13) and adoption rate (RADOPT, Eq. 15) are single fractions. These could be broken down into a more detailed series of steps. Similarly more variables could be defined in the model to add more detail. For example, a multivariate clinic point of purchase response functic could be included. Samples given directly to people also could be considered. Samples would give them a pseudo trial and move them to the evaluation stage withou following the trial process of the model. This may be useful if there is a very weak link in the flow from awareness to procurement. Mathematically, the number who receive and use the samples would be transferred directly to the evaluation stage and classified on the basis of their use experience. A more disaggregate model could be built if the variables now in the model were broken down further. For example, the communication directed at a segment ($COM_{S,t}$, Eq. 2) could be further divided into personal sales efforts and advertising, each specific to a paricular product. In addition to adding variables, the response to variables could be time subscripted to encompass time trends. For example, the intent rates (ITRY, Eq. 3 and ISERCH, Eq. 4) could be time subscripted so that after the trial prone innovators try ,the intent rate would drop.

More detail might also be warranted in considering the process of gaining information and prescriptions from private doctors. This would call for segmenting those who use a private doctor as a source of contraceptive information. Equation six does include a simple prescription effect, but in some cases more detail may be useful.

The model views fairly straight forward contraceptive alternatives. More detail could be added to include post-partum programs by segmenting those who have just had children and quantifying their response to resources devoted to convincing them to adopt family planning. Abortion could be added by determining how many pregnant mothers (PREG, Eq. 18) would have an abortion under various program policies. Negative incentives for large families were not considered and if policy did not preclude them they could be added by linking their effects to the process.

Most of the limitations cited in this section could be overcome by adding more detail to the model process and collecting more data. This entails cost and the benefits of additional detail should be compared to these costs. The model as proposed requires substantial funds. Perhaps $200,000 would be needed to program, implement, and test this model. In addition, perhaps $100,000 per year for data collection would be required. The costs depend upon the number of segments and degree of accuracy desired in measurement, but a significant fund commitment is necessary. Since the economic and social gains for birth control are so great, it is this author's opinion that such expenditures are worthwhile to improve the management of family planning programs.

A final limitation to this model is its scope. It attacks only the strategy decision of managing the program. The model must be embedded in a decision-information system with budgeting, tactical, organizational, and control models. This total system must be backed by human training and motivation activities.

Although the model has a number of limitations, it is hoped that it is a good starting point for additional management science efforts in family planning. Certainly as a next step the model itself, after initial application, could be extended to overcome the limitations. In addition it could be simplified so that managers could evolve from a very basic model (a mod I version) to this model (mod II) and on to a yet-to-be-developed extension of the model (mod III). In this evolutionary manner, implementation could be fostered. The proposed mod II model defines the process of acceptance of family planning at a meaningful level of detail, links variables to the process, and improves management of family planning by asking the correct questions, fostering effective data collection, and recommending best strategies. This model building methodology when implemented and tested in a specific situation may be generalizable to many countries and thereby contribute on an international basis to the improvement of the management of family planning programs.

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