PROJECT BRIDGES

MODELS FOR EDUCATIONAL PLANNING

RUSSELL G DAVIS, PROFESSOR, HARVARD UNIVERSITY

WITH

GERRY BODEKER

THOMAS CASSIDY

GARY EWERT

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CHRISTINA RAWLEY

MOHAMED OMAR YOUSEF

CAMBRIDGE, MASS, 10 September, 1986

* Note: Only writers included in this sample of materials are listed here; The others are mentioned in the outline and introduction

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Introductory Note

This is a sampling of chapters in fairly close to final draft form from a proposed volume for the BRIDGES Project. The working title is MODELS FOR EDUCATIONAL PLANNING: FROM GOAL STRUCTURES TO PROGRAM STRATEGIES WITH HEURISTIC AND ALGORITHMIC MODELS . The Table of Contents lists the chapters in this sample and notes the state of completion of some of the other key chapters. Most of the chapters exist in some form of life,but in some cases a great deal of work will be needed to whip them into final shape. No final drafts are likely before September of 1987. The bulk of the material has been written--or in some cases selected and rewritten from existing material by Davis;or produced by members of the A 822 Class in Planning in Spring,1986. In addition to the students in the course Noel McGinn also prepared a chapter;Jim Risan prepared a paper which may or may not fit;and Ernesto Cuadra is contributing a paper and model based on earlier work by Schiefelbein. Tom Cassidy also constributed.

In this draft some table and figure numbers may be inconsistent,because the material were taken from other chapters and drafts.

Russell G Davis

3'

Bridges Volume 1,Outline

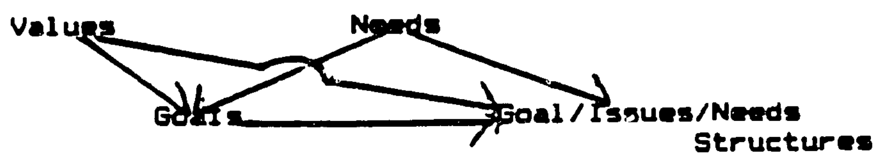
Models for Educational Planning: From Goal Structures to Program Strategies

by

The A-822 Group
Harvard Graduate School of Education
Cambridge
Spring,1986

I Introduction:

The Context of Educational Planning:Goals/Needs Structures



IA.Goal and Value Structures

1.Models to Develop Goals/Needs Structures Into Policy & Plans:

Overview of Goal/Needs/Themes /Issues in Heuristic Models

Davis(excerpts from chapters 3,20,21,22,New Volume)

IB.Issue and Problem Structures

2a.Identifying,sorting and structuring the problem field:

goals/needs/issues and themes

"KJ Method: Theory and Practice"
by
Yumiko Yokozeki,Armando Loera-Varela,Tsige Tsegenu

2b.Heuristics for framing future plans in terms of trends, values and goals

"The AASCU Paradigm:Projecting Out,Mapping Back"
by Dunham Rowley and R.Davis

*AASCU(American Association State Colleges&Universities)

Bridges Note: 1,2a and 2b describe models relevant to all six Bridges project areas; but are most relelvant to Access and Retention,Effective Schools,External Effectiveness and Interna.

Efficiency. Also plans for Teacher Training goals/needs; and for strategies in Classroom Management & Instructional Technology.

3. Identifying, mapping (Relating) structures of social values, perceptions of Issues, problems and needs in social planning and policy analysis: The Galileo Model.

"Galileo: Policy Planning Perspectives, Theoretical Background, and Implications for Planning Use"
by
Gary Ewert and Carla Linton

Note: Galileo, a heuristic model which maps views and values, is relevant to all six areas of Bridges, but particularly to Access/Retention; External Effectiveness; Internal Efficiency. It also can map attitudes and thoughts on Teacher Training Objectives and Strategies; Classroom Management Approaches, and Learning Technologies.

II. Externally Derived System Requirements Targets

II.A Social/Demographic Target Models

Population Size, Structure and Change will shape most social, economic and educational plans and policy frameworks; hence, demographic and social demand models are basic in planning:

4a. "Social and Demographic Models as a Basis for Planning"
by
R. Davis (Excerpts from Chapter 11, New Volume)

4b. "Demographic Analysis and Population Projection at the National Level: The Basic Components Model",
by
R. Davis (Excerpts from Ch 14, New Volume)

5. "Host: A Comprehensive Structure for Plan Forecasts and Analysis" (Population/Enrollment Modules)

by
Research Triangle Institute

Note: Current components are Population and School Enrollment

Modules,with small output and efficiency component,but plans are to build other components,e.g Efficiency,Required Inputs, Costs,Budget and Financial forecasts,Cost Effectiveness and Cost Efficiency...

6a."Popex:Spreadsheet Modeling for Population and Enrollment Forecasting:Potential and Limitations"
by
T.Cassidy and R. Davis

6b."Mainframe Model Variants:A Note on Demos and EdModels
by
R.Davis and T.Cassidy

6c. "Enrollment Analysis and Systems Flow In National School Systems of LDC's:The Basic Markovian Process Model and a Note on Cohort Analysis"
by
R. Davis (Excerpts from Ch 14,New Volume)

Note: Models in 4,5 and 6 relate to Access and Retention; Effectiveness,Efficiency,Teacher Training;and are also relevant to Teacher Training(needs),Learning Technologies (needs and effects),and Classroom Management(Needs/Effects)

II B.Economic Demand:Manpower Requirements Models

7."Models for Manpower Planning at the National Level: The Basic Method and Other Planning Schemas"
by
R. Davis(Excerpts from Ch 15,New Volume)

Note:Manpower models are mainly relevant to Effectiveness and External Efficiency(Needs,Targets,Effects);and to Teacher Training(Program Goals/Needs,Requirement Targets,Objectives..)

III A.Effectiveness,Efficiency,Inputs and Unit Costs

8a."Modeling for Efficiency:Getting More for the Money"
by
Rosemary Bellew,Winoto Doeriat,Gwang Jo Kim

Note:Introduction to Effectiveness,Efficiency,Cost Models

9. "Schiefelbein Model of System Flow, Thruput, Efficiency and Costs: A Modified Spreadsheet Model"
by
Ernesto Cuadra

Models in 8 and 9 relevant to Effectiveness, Efficiency, Classroom Management, Instructional Technology, Access & Retention, and Teacher Training. Covers: Goals, Objectives, Output, Outcomes, Effects and Effectiveness; Efficiency and Thruput in terms of time and unit and marginal costs.

III B. Effectivness, Efficiency, Cost, Budget&Financial Planning

Resource Allocation and Financial Planning Models

10a. "Systems Simulation, Resource Allocation, and Financial Planning Models: Developmental History"
by
Paulina Gonzalez

10b. "Resource Allocation and Financial Planning Models: A Note on the State of the Art"
by
R. Davis (excerpts from Ch 20-22, New Volume)

Financial Planning at National School Level

11. "A Financial Planning Model for A National School System"
by
Mohammad Omar Yousef

(IFPS modeling system model of Cost, Output, Efficiency and Financial Implications of Growth and Structural Reforms in the national school system of the Kingdom of Jordan)

Financial Planning at Institutional Level in LDC's

12. "Computer-Based Modeling Systems: A Case Study Using IFPS At Birzeit University, West Bank"
by
Haifa Baramki and James A. Toronto

Note: These models are relevant to Cost Effectiveness, Efficiency Access and Retention, and include planning in institutions of higher education in LDC's. Although this is not an area of main focus in Bridges it must be an area of concern in planning,because allocations to higher education must be included in the same goal and allocations structures and processes as allocations to primary,middle and secondary schools.Because resources and budgets are limited in LDC's, allocations to one level or type of schooling constrain allocations to another.Basic education may be a priority concern of Bridges research but it can not be an exclusive preoccupation of Bridges models,plans or analysis.

IV Models of Teaching Learning Dynamics

These models range from the most general perspective on the structure and process of education and schooling to close-in models of teaching/learning process;and include:

A.Studies of Educational Effects,Using Open-Systems,Black-Box, Production Function models and approaches of the kind that filled the literature during the Coleman,Jencks,Smith,Levin, Hanushek,Mayeske era of studies of effects of schooling in the US.There were thousands of such studies and reviews in Averch,Kerlinger...Education economics students still do them. Counterparts overseas were Bowles,Farrell/Schiefelbein,McGinn/ Davis,Klitgaard...and hundreds of these and similar studies (eg IEA) were reviewed by Alexander and Simmons,Schiefelbein... The analysis worked off the basic,linear model,and used regression,variance explained,unique variance and path analysis,among other approaches.These are not reviewed in this volume,although they could be relevant to all six Bridges areas of interest.If needed Davis could include excerpts from chapters in <u>New Volume</u>that cover them.

B.Analysis at a similar level of aggregation ,but slightly less removed from process and social dynamics are typified by the work of Rutter et al in 15,000 Hours,where the variables are non continuous,and scales non ratio;and non parametric statistical models(ChiSquare,Log Linear...)are used.These models are also relevant to Bridges,but not the focus of the model implementation group at HGSE.

C.General models of instruction,the older entries of Carroll, Deno,Restle,Schiefelbein/Davis,and newer attempts to model the effects of time on task,now under review by Loora,are also relelvant to Bridges,but not covered in this collection.Joyce and Weill provide comprehensive coverage of some of these teaching/instructional models,which are very relevant for Learning Technologies,Classroom Management and Teaching.

D.There has also been lively development of qualitative approaches to instructional research and evaluation, which include the so called qualitative methods of Murphy and others,ethnographic approaches,case studies and portraiture...Relevant,yes, but again not the approaches covered here.

E.Systems dynamic models get closer to process dynamics than the linear model and effects studies,but not perhaps to the same micro level of observation as case,ethnographic and participant observer approaches).SD models are covered here,on grounds that they can link the more aggregate level analysis,the level favored by planners,economists and quantitative analysts, with researchers engaged in studying Learning Technologies, Classroom Management,and close-in studies of effectiveness.

planning at systems,institution and program/project levels in LDC systems. This activity has been separate from the model development activity,although it may in the future be joined, since information is the indispensable support of modeling;and model characteristics and needs should serve to guide and to limit information collection,storage and retrieval. The two come together in what are called Decision Support Systems.

--Evaluation and use of data base management systems in the design of planning model specifications,in support of decision support systems,and for use in general development of the Bridges project itself;for example to store and retrieve reviews in three main areas:a)conventional published reviews of educational research and evaluation;b)reviews of computer packages useful for developing models applications,project management,and data base management;c)reviews of models that have been developed within modeling systems,in the form of individualized,special purpose models or as modules of more general structures,such as RTI's HOST.

The first area of work deals with the kinds of information (content,theme,substance coverage) needed and available at a reasonable cost in money and effort for planning at all levels, and for research and development in the six major areas of Bridges project. Only a small piece of this work has gone forward at Harvard,and several major collections of reviews have been launched at Harvard,and at cooperating institutions in the US and overseas.At Harvard the work covers,among other areas,Access and Retention,Classroom Management and Instruction...

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The second major form of activity is evaluation,design, and development of management information systems and decision support systems.Apart from reviewing literature and exploring ing some major packages for Harvard/Bridges own in-house use, not much has been done in this area yet.The use of data bases that are strong in text handling capacity,.Notebook on the PC and SPIRES on the mainframe CMS system,have been investigated by Davis,Cassidy and Naimi;and Notebook was chosen,to manage the Harvard reviews collection.The data base form for the reviews,packages and models section has been designed,and most entries are on discs(Annex A).Other area work is mainly in documentary form based on published reviews.PC sized systems(D Base,R Base and the data handling sections of Lotus) have been covered with the planning groups;and work in mid-sized mainframe packages,FOCUS and RAMIS,have been used, but do not appear immediately useful for Bridges overseas.

At this point more has been done on the first area of work,studying the type of information required,rather than developing decision support systems and models,although the future will require some study of information system development. This may require some work with applications generators and prototyping tools ,but will probably not be up at the large system,IDMS level,using Cullinane IDMS ADS/ONLINE dialog generators and some advanced tools of large MIS systems These seem beyond the BRIDGES needs and beyond the generalist staff's expertise.It was unfortunate that no student in the A-822 planning course,the group who produced most of these papers,chose to work in information systems design.There is considerable work ahead in the development of information systems models,and thus we would propose two more chapters in this volume:1)A general paper on the content and form of data and information needed in educational planning in LDC's. This could follow on from work for LDC's by Chesswas,Davis,McGinn, and a recent review of US experience in information use in planning and management done by Risan as part of Bridges work; 2) A review of MIS models and data management systems for Decision Support systems,with a plan for a prototyping development in MIS and DSS.These chapters should be part of this volume.It is important that Information and Data Base Management models and systems not be isolated from planning models;or from the other areas of research in Bridges.

15."Information Needs and Information Systems to Support Management Decisions in Education"(proposed) .

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INTRODUCTION

1.0 An Introductory Note on Dealing with Goals in Rational Planning

The task at hand here is rationally based social planning. The major assumption, based on many years of experience, is that goals must be dealt with in mid-range and long-range planning of complex education systems. Goals are difficult to deal with in any rational way because they are grounded in values, often deeply held, unarticulated, and tenaciously held. There is still no system--Habermas notwithstanding--for dealing with intersubjective conflicts in values and priorities. There is no solution to this problem that will satisfy all people within the systematic canons of any philosophical approach; much less will the system travel between different ideological or cultural systems. Yet for the rational planner, to attempt to plan education without goals suggests aimless and purposeless action with no other purpose than action itself. There is in truth much aimless activity in education, but according to a rational planner's biases this is useless at best and harmful at worst.

Even if social, economic, political, and cultural goals could be developed for education, there remain the problems of relating social goals to objectives, within education, and relating the objectives to activities, and the activities to resources, costs, and budget constraints. Also, there is the problem of evaluation of outputs and outcomes and the difficulty of feeding this back to correct the course toward the goals; or to modify goals. There are no absolute goals for all times and places, but there are always goals, according to the rational planner who defines educational goals as: statements of broad aim or fundamental purpose in education, referenced to political, social, cultural, economic, physical survival . . . outcomes. Objectives define the learning output that is sought within the teaching/learning context. Goals address broader outcomes. There are other ways of conceiving it, but this provides a basis for attempting to deal with goals in planning and planning models.

1.1 Goals and Planning: Introductory

In rational planning, goals are the fundament on which the plan structure is built and the planning process guided. Educational goals state the ends or purposes of education in broad cultural, social, economic, and political terms. Planning begins with a framework, or structure, of goals; develops alternative strategies in the form of policies, institutional structures, and programs; specifies the objectives, activities, and inputs required for the programs; and assesses the effects of the programs in terms of outputs and outcomes attained with respect of the objectives and goals. The outline of this idealized rational planning structure is shown in Schema 1.1.

A goal structure serves as the basis of rational planning, and goals serve planning by: (i) clarifying the educational ends and purposes to the planner himself and his constituency;

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SCHEMA 1.1

Outline of the Idealized Stages of Rational Planning At Education Systems Level

I. Goals
   Broad Statements of social, political and economic ends and purposes,
   Discuss, Debate, Validate, Order (Priorities), Dialectic to discuss - Why?
   (Answer to why comes out of Needs/Values interaction)

II. Broad Strategies for Attaining Goals
   Generally in Society
   1. Population (Client Targets) Who? (relates also to needs assessment)
   2. Activity (Assets, Services, Processes) What? (Needs/Resources assesment, broad)
   3. Human resource development through education and training. How? (generally)

III. Alternative Means for Attaining Goals -- Discussed, debated, modified, adopted, refined ...
   1. Through human resource development through education / training.
      alternative means to attain targets of II -- Tactics, How? Where? When?
   2. Through other means?

IV. Alternative policies to make possible, feasible, practical, easier the means of attainment (in III)

V. Alternative Programs to Implement Policies through Programs, Institutions ... How? (Specifics)
   Program Objectives (or Institutional Objectives)
   Program Activities *** (Specified and Scheduled)
   Program Modalities (Organization, Assets, Delivery Modes ...)
   Program Resources
   Program Outputs (Relate back to Goals in I)
   Program Costs and Budgets

VI. Effects (Outputs, Outcomes)
   Trace back through objectives to goals
   Criteria, objective functions, assessment, evaluation, cost/benefit, cost/effectiveness
   Feedback and recirculation through system from goals to effects,
      (Sometimes, though not often, re-examination of basic goals, rethinking, restating)

* At Program or Project Level, Goals are more often translated into Objectives (more focused purpose, and usually more specific outcomes and criterion levels, or objective functions specified).

** At Institution level (also Project, sometimes) Missions are often specified, e.g. the three major Missions of a university may be to instruct, or teach; to discover and develop knowledge; to provide service through social outreach.

*** At all levels of planning, specification of program activities is central. These must be directly derived from Goals and Needs Analysis (supplemented by Role or Task Analysis in some cases) and Work Breakdown Structures and Schedules can be specified, and from these Resource needs deduced, ... Costs can also be later compared to Effects and Benefits.

(ii) clarifying ends and purposes to others, the chief "others" being those presumed to receive the benefits of education and those who must pay; (iii) linking ends to means, so as to identify and test alternative strategies, policies and programs; and (iv) linking ends to means in the relationship between objectives, outputs and outcomes, and thus providing a focus for evaluation, assessment of efficiency, effectiveness, and accountability. MBO (management by objectives) is a system for explicitly establishing this linkage, but more importantly for gaining agreement and mobilizing organizational purpose around shared objectives.

Whether the rational model reflects reality is another matter--no ideal form ever does; but in a rational model, a goal framework is essential. Goals are evaluated, first by tracing them to their source values and establishing the worth and validity of these values; and second by tracing them to their effects and assessing the worth of outcomes that derive from objectives and outputs. Both evaluations are based on the criterion of relevance (Picker, 1969), which is established primarily by logic and deduction, and not by induction and empirical test.

1.2 The Source of Educational Goals

Educational planning goals derive from many sources (Schema 2). Past or present statements of the ends and purposes of education are part of any literate culture. These statements

Schema 2: A Context of Sources of Goals of Education

1. The Past:
   a. History and Traditions of the Immediate Surrounding Culture
   b. History and Traditions of Other Influencing Cultures
2. The Present:

A. Physical Environment/Human Ecology

a. Physical Environment, Climate, Space
b. Physical Resources, Limits Pressures
c. Demography, Size, Growth, Density

B. Social Context

Epistemological	Valuational	Structural
a) Social-Psychological		
i) Cognitive, Learning, Thought	i) Individual Values, Attitudes, Motivations, Ethics, Morality	Classes, Groups, Organizations, Hierarchies, Structures, Function, Process
ii) Positivism, Empiricism	ii) Group Values, Attitudes, Theories, Social Ethics	
iii) Hermeneutics		
iv) Universal Pragmatics		
b) Cultural: Arts, Language, Letters, Science/Technology	Values/Belief, Religion, Literature, Language, Art, Moral Codes, Theologies	Tribal, Ethno-Cultural, Language, Groups, Religious Sects
c) Political		
i) Rational Systems of Power/Compliance	Paradigms	i) Nations, States,...
ii) Participation	Theories	ii) Party Structures
iii) Communication	Ideologies	iii) Government Structures (Organizations, Bureaucracies)
iv) Mobilization	Marxian	iv) Law/Regulatory Structures
d) Economic		
Paradigms: Market Rationality, Plan Rationality	Theories of Value, Utility	Structure of Economy
Theories: Neo-Classical, Human Capital	Ideologies	Functioning of Economy
		Regulation of Economy

are amalgams of values, expectations, and beliefs about what the ultimate, or end, purposes of education are; derived from the immediate and current culture; from other cultures which influence them; and from historical experience and tradition passed on from earlier cultures. The goals, then, are derived by comparative and historical analysis. Heuristic planning models help order this analysis; algorithmic models and statistical methods are used for other planning tasks.

This collection of papers covers both heuristic and algorithmic models for planning education.

2.0 Sources and Modalities for Developing Goals

Goals for education derive from a variety of sources and are developed into goal statements and structures in a variety of ways.

Goals from historical and traditional sources may simply be accepted, as handed on through education itself; or slightly modified to fit current circumstances, issues, and problems. The goals are there. The planner, or his clients, accepts the goals, as given or slightly modified, and gets on with the tasks of developing strategies, policies, priorities, institutions, and objectives; in short, the plan. The use of the Ponca Sila (five traditional principles of Islam) is an example in the Indonesian education plan (Beeby, 1979).

A second source is similar to the first, but in this case, the goals have been more consciously and explicitly formulated by an individual, commentator, or social or political commission. There are a number of such sources that have served to base plan goals, and some have been reviewed--Spencer's list from Education: The Seven Cardinal Principles: The Ten Imperative Needs; the ASCD Goals; the Illinois Goals . . .

In a third approach, similar to the second, a citizens' commission, sometimes supported by a group of specialists and analysts, develop the goal list and framework from analysis of other goal/objective/plan frameworks and synthesize a new and better statement. The work of the Khotari Commission in India is one example; Christian Democrat groups developed plans for Chilean education before the Frei presidency began in the sixties; in Ethiopia and a number of other countries, the framework was a sector assessment with joint international and national participation.

A fourth approach, comparative study and analysis, is similar to the commission exercise, except the field for study and analysis is broadened to include the goals and experience of other countries. International agencies, particularly UNESCO, have aided this process, but other technical assistance agencies, USAID, the World and Regional Banks, have affected goals and objectives in other countries indirectly and sometimes unintentionally. Welsh (1980) offers a taxonomic structure for tracing goals to multinational contexts.

A fifth and common source for goals in centralized national systems is the base in constitutional or organic law; and these laws in turn may have been developed from earlier social history.

Yet a sixth source is the political platform or goal framework of political parties; and the dominant political party often imposes general goals for education. This is exemplified in Cuba, Jamaica, the German Democratic Republic, China, and Russia; and by earlier activity of the PRI in Mexico.

Within the centralized countries, where there are ministries, agencies, and national planning offices, goals for the educational sector may derive from these agencies and their plans, policies and regulations.

Heuristic models have been designed and developed precisely to aid in framing system and institutional goals (objectives), thus offering an eight source of models and methods for deriving goals. The AASCU Futures Creating Paradigm, Galileo, and the KS method, to be discussed later, offer frameworks for goal analysis. The Delphi exercise and other futurist models are examples.

A ninth and similar aid to developing goal structures, where participatory planning and contribution of beneficiaries are featured, is represented by the dialectical models and social interaction approaches for planning. COMPASS and the Policy Delphi are discussed in Davis, Ch. 9 (1987).

There are other sources and means for deriving goals, based on epistemologies which underlie rational planner and the application of deductive logic; and based on derivation from value premises (Frankena in Martin, 1979); or derived from analysis of relevance of goal to need to program (Scheffler, 1971; Picker, 1980). Habermas attempted to synthesize rational approaches, value approaches, and social interaction in the evaluation of communicative competence in social discourse (1973, 1979).

3.0 A General Type of Models and Modeling Approaches

Mannheim (1951) wrote that the goals of society and education could be deduced from the *principia media*, the broad social trends, currents, or forces that were emerging in a society and which would shape the future of that society. But Mannheim never precisely defined *principia media*, nor did he provide clear examples of what they were. Planners need more help and guidance in developing goal frameworks, and this is were models serve:

(1) *Heuristic models* help in developing value/needs/goal frameworks. The AASCU Paradigm, as we will see, gives examples of trends (population, economic growth, energy), and planners can analyze and project these trends in developing future goals for education systems. AASCU also provides examples of value shifts or discontinuities that impact on and change the direction of the trends. Examples are world harmony and peace, nationalism, localism . . . AASCU provides a systematic framework in which a comprehensive goal structure can be developed for institutional and systems planning.

(2) Algorithmic models are used in planning to translate values and goals to objectives, activities, and outcomes, usually expressing targets, flow and results in quantitative terms. Algorithmic models can be in the form of systems simulation models, programming and optimization models, comprehensive systems state-space and forecasting models, demographic or economic projection models, or comprehensive packages of integrated modules, as the Host model to be described in later chapters. The models can be built in spreadsheet formats in modeling systems packages, for mainframe computers or PCs; in forecasting packages, project planning packages, database management packages, or comprehensive packages. Many different model forms, modeling systems, applications generators, and modeling languages will be shown.

3.1 Models and Abstractions

Models are representations, often symbolic in form, of reality; models depict complex structures and processes, always in a form that is simpler than the real world referenced; for if models were not simpler than reality, there would be no point in having a model. Models are abstractions and serve well for representing structures and regular processes. But social processes are not often well structured or regular. Thus, models do not serve as an adequate representation, much less substitute, for social processes. For this reason the social process must be brought into the modeling and planning process

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as it exists in reality, not as someone dreams or wishes that it exists and functions. This means that the process in which models and plans are developed and used must be almost exactly like reality. The model can be symbolic, abstract, and a caricature of the real world, but the process in which it is used cannot be, at least in social planning models. The modeling process must be exactly as reality <u>is</u>; not simply like or similar to reality. Models--the symbolic representation--can be evaluated philosophically, checked for logic, checked epistemologically, ethically, aesthetically; but the modeling process can only be tested against reality experientially, in order to determine how it will hold up, how it will serve. For this test the model developer and user must look to what experience suggests for modeling and planning.

4.0 What Experience Teaches About Models and Planning

Experience in planning in developing countries suggests that ten problems are of major importance, although not the only major problems that planners and models must deal with. These cover:

(1) Goals: the setting and ordering (priorities) of goals; not simply listing goals, but developing a coherent goal structure based on priorities and relations among the goals, and tracing objectives from the goals and program needs.

(2) Developing alternative strategies pursuant to the

goals. Again, there is need for an ordered framework of strategies that trace the general goals.

(3) Recognizing that problems, needs, program responses, policies, and actions are linked and interactive, and when one is changed others may changes, which means that models must be comprehensive, dynamic and interactive.

(4) Realizing that there are always limits and constraints on resources and possible responses, and these are linked.

(5) Realizing that program activities are related at various levels, and to take one action may foreclose the possibility of another because of constraints or conflicts in the system. Again, a systems view is fundamental in modeling.

(6) Dealing with the fact that the only constant is change, and with the need to move toward some sort of equilibrium in a situation of constant flux. Models must portray dynamic process.

(7) Recognizing the dynamic between straight rational analysis and the reality of street rationality may be different, and elegant models and plans mean less than an open and participative process in which planners and clients, modelers and end-users, opinion leaders and followers understand and participate fully in model development and planning.

(8) Recognizing that there are many costs and many prices, and the cost and price often is a function of the viewpoint and the viewer's values. This applies to benefits as well.

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(9) Dealing with the fact that information is needed for planning, but the information must be relevant and manageable. An overload of useless information obscures reality.

(10) Evaluation and feedback must be built into the planning process from the outset and not jerry-built later to justify unforeseen outcomes.

There are models and computer-based methods for dealing effectively with all of these problems. Heuristic models--especially for developing goal frameworks and forecasting broad trends into the future--help with goals. Spreadsheet-based systems for model creation help the planner deal with the fact that problems and program responses are linked and interactive. Interactive programming models help deal with constraints. Spreadsheet models and programming models help deal with the impacts of one variable on another, or with sets of variables. They also permit the testing of alternative strategies and permit flexibility in dealing with continuing change. The interogration commands built onto basic spreadsheet models such as IFPS help the planner trace back from goals to the prior changes and adjustments to variables in the system needed to follow goal paths. Information bases and data systems help the planner deal with information load and overload; and economic analysis, cost benefit, and cost efficiency help deal with prices, cost, and benefits. Spreadsheet modeling also helps in dealing with projected future states. There are also models for evaluating both the educational and economic consequences of program decisions and choices, and large simulation models to guide allocations. Simple, interactive spreadsheet models can also attract and sustain participatory learning and development of plans, and sustain interest and support into the implementation stage.

5.0 Summary

At this point we need not march through the other three themes or additional educational planning themes that might be added. The chapters that follow do this. Computer models can help improve the technical analysis applied to forecasting demand, need, and the balance between income and expenses; a sounder basis for allocation and budgeting is provided; projects can be better scheduled and monitored and information managed; but the main interest should always be in how the tools of planning are used in social process. Do they increase participation quantitatively and qualitatively, enrich exchange, improve understanding, and increase the likelihood of acceptance, mobilization, and implementation? If yes, then they clearly help. If they become only another mask, talisman, or conjurer's legerdemain for a planning priesthood, then they will surely hurt. Thus, the emphasis here is not on what is used, but how it is used, and what results from this. The focus is social process because education is social process, and educational planning must capture its social dynamics and value nuances.

Chapter Two

Systems Models:An Overview of Development

1.0 Introductory Note

Large scale systems models are used in planning for national school systems and in institutional planning.These models,variously called _systems models_,_simulation models_, _large-scale simulation models_,_comprehensive allocation models_, _cost-simulation models_,_financial planning models_,_state-space models_...have been reviewed by Hopkins(1971),Weathersby(1970), McNamara(1971) Schiefelbein and Davis(1974),Hopkins and Massy (1982),Bloomfield and Updegrove(1981).All reviewers have noted the rigidity and excessive aggregation of large models,the extensive data requirements and costs,and the difficulties that general administrators and non technicians have in understanding and using the models.Early systems models developed at Michigan State by Koenig and Keeney(1966) and Zemach's State-Space model(1968),were much admired and influential,but little used.Later comprehensive systems,Judy's CAMPUS model (Comprehensive Analytical Method of Planning in the University Sphere,1969);NCHEM's RRPM(Resource Requirements Prediction Model, Hussein,1971),and European variants MSAR( ) and TUSS( ), were used in the sense of having real institutional data input and yielding intelligible output;but planning models were not institutionalized for on-going planning and management until the spreadsheet models appeared--TRADES (prototype,Stanford, 1978);EFPM(EDUCOM Financial Planning Model,1981);IFPS,Interactive Financial Planning Systems,EXECUCOM,1981).Almost all of these models were developed for institutional planning, and applied--if they were applied-- to university systems planning,mainly in the US.This was circumstantial and not inherent in the nature of the models which can be used in planning for school systems or for institutions.

1.1 The General Structure of Systems Planning Models

Whether used in planning for national systems of schools, or for institutional planning(where sub-system components are faculties,schools or departments),systems models can:i)assess or project external conditions(demographic,economic or social goals,needs,demands...) and map their effects onto the system; and iii)using systems goals,missions,policies,technologies and operating characteristics,translate systems activity levels into;iv) input and resource requirements and costs;v)system flows;v)system outputs;and vi) outcomes resulting from systems outputs and the conditions and effects of the environment.The significant feature is that the structures and processes are systematically connected--at least within the symbolically represented world of the model--and thus a change anywhere in the system process will translate into a change elsewhere in the system process.But again the changes are symbolic and representational--feigned happenings in the world of symbol. Not real.Simulated. Performed in the land of make believe and let's pretend. That's what simulation models are.They are only as good as the modeler's imagination,attention span and consistency.Sometimes this is very good indeed.Sometimes not.

1.2 The Components of Systems Models

Systems models may have any or all of these components:

a)A forecasting component for projecting external or contextual influences on the system in terms of goals or demands,i.e population growth,economic growth...

b)A forecasting component for projecting entrants into the system in terms of demographic growth and social policies...

c)A forecasting component for projecting internal flows in the system(in terms of external goals,targets and trends and internal policies;technological relations,costs and resources) using matrices of flow rates or coefficients,e.g a markovian model of promotion),r(repetition) and d(drop-out) rates ...

d)A set of transformation functions or matrices for translating activity levels or flows into resource requirements and costs, e.g. induced course load matrices...

e)A component for estimating and forecasting system output in terms of the prior components,i.e graduates of programs ...

f)A component for tracing future outcomes based on forecasts of systems outputs and external conditions,e.g graduates employed by occupations and sectors of the economy.

In comprehensive models,several,or all,of components a) through f) may be linked or joined,and the joining may appear to be seamless and blended into one model.

Planners and especially practitioners may debate the relative merits of developing and using a unified and comprehensive model--for example the HOST model in a later paper-- as compared with a set of separate component models represented by the spreadsheet projection models built in Lotus(The Cassidy-Davis,the Schiefelbein-Cuadra or the Nazareth models).Both approaches have virtues. HOST type models and large systems simulation models and comprehensive programming models(Schiefelbein/Davis,1977) are useful if the data are available and if work is largely in the hands of technicians charged with "producing" varying plans or forecasts of policy alternatives.They are not necessarily superior when the main object is training--it is easier for trainees to understand the build up of simpler and separate components. Nor do complex models encourage participation in the development and design stages,although they are useful for indicating the type of data and information that will be needed to develop decisions support structures for plans.But the data requirements are considerable and costly,and should not be allowed to discourage or delay planning process. In some cases work can start on simpler component modelsie.g when there is good demographic data but not systems flow data,or good internal systems flow and output data but not external economic data for forecasting manpower requirements.

The fact is that there has been no clear superiority demonstrated for either total reliance on comprehensive models or work limited to a component by component build up. In the Bridges project both approaches are used at the same time,and this fits the different needs of different LDC situations.At some point,however,whether the comprehensive or components presents no problems;but in sub-national area projections for provinces,states,or local districts,where internal migration data are not registered,this component requires a great deal more effort and analysis.Davis(New Volume,forthcoming 1987), covers national area population projection in Chapter 11 and sub-national projections in Chapter 12,where the difference is largely in procedures for estimating,accounting for,migration effects in local populations that are statistically unstable because they are small and open(to unknown migration effects).

2.2 The Data Components and Methods for Population Forecasts

Population forecasts are based on:1) basic data on the base year population,and the births,deaths and migration components data;2)demographic procedures and methods for applying the data according to;3)a systematic set of assumptions as to how trends will evolve over the course of the projection.

2.3.1 The Base Year Population

The base year population is generally based on the current national population census,either the decennial count,or the most recent census brought forward to current date by counting in births,deaths,migration or intercensal estimates of them. Census data is structured in standard form:cross-classified by sex and age(in single years,or five year age groups) and the age structure partly explains why projections are done in one year and five year increments.Table 2.1 shows the component data for a typical projection:a)Base Year Population,in five year age groups by sex;b)Mortality(from Model Life Tables);c) Fertility Assumptions(not shown);d)Migration(none here).

Table 2.1 Basic Data for Components Projection

Table 2.1

Basic Data and Components

Year Population (1975)

Group	Male	Female
-4	475,291	459,374
-9	402,120	392,669
-14	314,449	340,742
-19	302,190	315,684
.	.	.
[illegible]	2,382	4,030
[illegible]	1,093	1,718

External Migration

none

Mortality Component

Having studied the vital data and constructed an abridged life table, we conclude that our survival ratios will move according to the U.N. Model Life Tables:

1975-80	1980-85	1985-90
Level 80 ($^0e_0$ = 60.4)	Level 85	Level 90

Fertility Component

The rates of Hypothesis II (a). are used

Birth Ratio for Sexes

Male = .5089 Female = .4911

Table 2.2 Illustration of Mortality Multiplied Down the Diagnonal

Table 2.2

Partial Projection Table, Females (1975-1985)

Age-group	Base population (1975)	p^1	Pop. 1980	p^2	Pop. 1985
0-4	459,374	0.9731		0.9791	
5-9	392,669	0.9914	447,017	0.9932	
10-14	340,742	0.9906	389,292	0.9925	443,977
15-19	315,684	0.9865	337,539	0.9891	386,372
20-24	311,429	0.9839	311,422	.	.
25-29	289,619	0.9826	306,415	.	.
.	.	.	.	.	.

p^1 Survival rates from Level 80 of Model Life Tables for females

p^2 Survival rates from Level 85 of Model Life Tables for females
The assumption is that mortality improves

Note: The appropriate table for survival ratios is Table V found on pages 80-81 of Methods for Population Projections by Sex and Age, United Nations, 1956.

2.3.2 Mortality Component:Death and Survival Rates,Life Tables

Deaths(the mortality component) are estimated for for the period of the forecast(one or five years).Crude death data are registered by the department of vital statistics,in ministries of health;crude death rates are estimated by health or the national statistics office;then converted into the probability of dying(or surviving)at any age level for any definable population group,and tabled in life tables which can be used to estimate deaths or survivors from the original base-year population.Abridged life tables can be complied using the mortality(crude death rates)of any given country or area,or the mortality data of the country can be used to estimate the standard demographic statistic of life expectancy(expectation of life at birth) and this can be used to place the country according to mortality levels in model life tables and apply the corresponding survival rates by age,sex,race...The base year population by age and sex is simply multiplied by the corresponding survival rate[1] and the population is moved forward for the period(1 or 5 years,with deaths subtracted out). There are a number of different model life tables.POPEX uses the UN Tables. The Mortality Component in Table 2.1 refers to the UN Table

2.3.3 Births or the Fertility Component

Births are usually estimated by applying age-specific fertitility rates to the numbers of women in the fertile age-groups,commonly between age 15- and 45+.The rates come from the same source of vital statistics as the death rates.It is also common demographic practice to do these things:

1/ Table 2.2 illustrates how mortality rates are multiplied,and survivors are moved down the diagonal,and 0-4 are left open until births are estimated and put in for the lowest age group

Table 2.3 Births and Birth Survivors

Births and Survivors 1975-80

Age-group	Average of women in group 1975-80[a]	5-year fertility[b]	Births	Female[c]	Surviving[d]	Male	Surviving	Total
					(0.9208)			
15-19	326,612	.4065	132,768	65,202	60,038			
20-24	300,298	1.0715	321,769	158,021	145,506			
25-29	263,735	1.2565	331,383	162,742	149,853			
30-34	223,715	.9575	214,207	118,457	109,075			
35-39	199,583	.6700	133,721	65,670	60,469	(Total, male-female born		
40-44	175,226	.3130	54,846	26,933	24,802	and survived goes into		
45-49	145,662	.0760	11,070	5,436	5,006	0-4, 1980)		

[a] This is the average of the number of women in the age group in 1975 and the number that would be projected for 1980 if the first table had been completely filled out. There will be slight discrepancies because the calculations were not carried out and an approximation was used.

[b] This results from multiplying the rates in Table 4.2 by 5 (to obtain five-year rate). e.g., .0813 x 5 = .4065... .

[c] Total births multiplied by .4911 to obtain female births

[d] Births multiplied by birth survival rate taken from level 80 of U.N. Model Life Tables.

i)when forecasting from one period to the next the rates are applied to the average number of women in the age group,and this means: if there were 1.2 million women in the age group 20 in the base period,and 1.4 million 20 year old females were forecast in the next period,the fertility rates would be applied to the average of the two periods,i.e 1.3 million;

ii)when births are estimated as above.they are totaled and put into the first age category(0-1 in a single year projection,or 0-4 in a five year projection).Note that all the other age groups are calculated on the basis of survival rates applied to the base year population.) But first:

a)the number of births is reduced by deaths in the first year of life,or more positively,the number of surviving births is estimated by applying birth(0-1) survival rates in first year of life;

b)The survivors are classified into male and females by applying a birth-sex ratio which is generally standard the world over with slightly more than 50% of the births being male(Note female survival is generally higher in older ages).

2.3.4 The Migration Component

Migration is added in (if it is net +) or subtracted out(if it is net -); after the effects of births and deaths are accounted for.Migration is often .It is often put in as a constant,either plus or minus.In the US,Census projections have until recently used an annual constant of +400,000,which has been often criticized as an underestimate that ignores illegal immigrants.

Other estimates run to 1.5 million net plus a year.

2.4 The Model Methods and Procedure

The model is applied iteratively and repetitively for whatever the period of the forecast and according to whether the forecast uses single age groups and forecasts for one year, or five year age groups and forecasts in five-year bursts.The base year population,classified by age and sex(or other demographic variables,race or region if relevant),is multiplied by the age-sex survival rates,and the surviving population for the next period(one year or five) is estimated for all but the lowest age group,eg 0-1 or 0-4.Usually this ~~arranged~~ is done on the diagonal of the table,and the surviving population simply moved down to the next age group level.The population for the lowest age group is estimated by applying age-specific fertility rates to women in the age specific fertile groups(averaged);the total of births is reduced by birth/age survival rates,divided into males and females by birth/sex ratio and entered into the lowest age group of the population.The process then simply is repeated using this newly projected population as the new base year population.

2.5 School-Age Populations

If the population is projected in five year age groups, which is common practice by demographers,the results may have to be broken down into single year age groups in order to get totals for age groups of specific interest to planners, for example school entrants at age 6;or the total in primary school age,6-11...This is done by using Spraque

Multiplier panels(there are other multipliers,e.g Beers), which is simply a way of distributing populations grouped in five year totals into population classified by single ages.

2.6 A Note on Demographic Procedures

The components method or any other model or method for forecasting consists of basic data on births,deaths and migration;conversion of these data into usuable rates or rate tables,such as the survival rates used in life tables or age specific fertility rates;application of rates to data in a mechanical and iterative process for the period of the forecast;application of certain distribution rates or procedures,such as the birth/sex ratio to estimate males and females from total births,and the Sprague Multiplier Panels to distribute grouped ages into single ares.The entire method and procedure is outlined in a few pages in Davis(1980).It is explained again in the early panels of the Cassidy-Davis POPEX spreadsheet model.The simpliciity of the procedures should never mask the complexity and difficulty of making accurate projections,which reside not in the mechanical procedures but in:

A)The accuracy and reliability of the basic demographic data and the methods applied to analyze it.Anyone can run the mechanics of a projection,but it takes a skilled demographer to do the analysis required;and even with high skill,the demographer can fail to estimate future populations,precisely because they are future and the future can be "estimated" but never known beforehand, experts notwithstanding. All demographers have done forecasts that were off the mark, and the smaller and more open the area the larger, relatively, the error can be.

B) The quality of the assumptions and the consistency with which they are applied in any given exercise determines the forecast. A population projection usually offers a set of alternative (high, medium and low is a favorite) estimates based on different sets of assumptions. These projections correct by definition except for minor computational errors, because they indicate the population that would result if the basic data are correct and if the underlying assumptions guiding the projections turn out to be right. Projections are almost always multiple and alternative. A single forecast that is asserted to be the correct forecast is a prediction. Demographers usually do not do predictions; soothsayers and prophets do them. The first step in soothsaying is to catch a chicken that appears to have interesting entrails, but these procedures are best left to other volumes and other times.

3.1. Forecasting Internal Systems Flow and Thruput

Demographic models and methods are the basis of the forecasts of school-age population or the entrant age pool. Once the entrant age pool (children age 5, or 6, or 7, or whatever the school entry age(s) with which planners are working, the number of entrants into the system can be forecast by fixing an admission or coverage percent of the age-eligible children. This target percent can be any portion of the age eligible group that is specified as a plan or policy goal.The goal is usually politically inspired,but constrained by systems capacity,resource limitations,and limits on the target population physically able to attend. A target example: Forecast population = 2 million;target coverage= 90% ;

Entrants = 2 X .9 = 1,800,000

3.1.1 Incorporating Plan and Policy Goals

Any set of plan or policy goals can be incorporated into the demographic targets. The percent of the age eligible entrant pool to be admitted can be raised to a target percent, usually the physical limit(accessible or in capacity to attend) lies between 95 and 98%;or increased in annual increments of three or five percent.Groups,identifiable by demographic or geographical characteristics,can be singled out for special attention and coverage,e.g females,or rural populations,or females in rural areas,who are usually one of the most deprived groups;or members of ethnic or tribal or economic or social groups.Age is the prime eligibility criterion,however.

3.2 Models for Estimating Flow,Thruput and Graduates

The flow through a school system to the final grade and graduation is determined by four parameters.

a. The number entering the system, and in this case it will be limited to the number enrolling in grade 1 for the first time.

b. The number promoted from grade 1 to grade 2 and from grade 2 to grade 3 and on to grade 6, the final grade in the elementary level. (The same applies for flows from level to level, as, for example, the number who go from grade 6 of elementary to grade 7 of intermediate, and then to general secondary school. The flow can then be traced by the proportion who go from the final stage of schooling into the work force. This rate is sometimes called a work-force entry rate.)

c. The number who repeat the grade.

d. The number who drop out of the system at a given grade level.

The number who are promoted, who repeat, and who dropout can be converted to a proportion, or a rate, by dividing by the original number enrolled. If the original enrollment was 100, and 90 were promoted, 6 repeated, and 4 dropped out, the promotion rate would be .90, the repetition rate would be .06, and the dropout rate .04. These rates will be symbolized as p (proportion), r (repetition), and d (dropout). The rates always add to one, because they are proportions that cover all possibilities. Hence: $p + r + d = 1$. In the example given: $.90 + .06 + .04 = 1$.

Once the idea of flow rates, or transition proportions, is understood it is easy to summarize the procedure briefly and

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understand the way even larger systems models work. The same procedure is used over and over again. The computer simply multiplies enrollment by promotion rates to take the enrollments through the grades of the elementary level to graduation, and then multiplies the number of graduates by rates for continuing on to other school levels or for entry into the work force. Before presenting the general, or mathematical, form of the flow model, it is worth emphasizing a fundamental assumption. <u>It is assumed that the rates are stable over time, at least over the period of the forecast. Or it is assumed that the rates can be changed as a result of policy and program interventions. These assumed or target rates then become stable enough to project enrollments.</u> Hence, rates may be thought of either as historically determined, or as targets which are set. In developing countries, rates are not stable, but change over time. This puts a time limit on the validity of projections.

This section begins with flow rates already computed. The next section will discuss models and methods for estimating the rates in the first place. In countries where educational statistics are based on machine tabulation of individual promotion records, the estimates are usually readily available, valid, and reliable. In these same countries where there is social promotion (near-automatic promotion of all enrolled), the promotion rate may be almost 1. Dropout and repetition rates may be low, but there is always some dropout or repetition.

The challenge for analysts comes in countries where statistics are not based on individual records tabulated by machine, but instead are based on analysis of aggregate data. Only groups of students are followed through the grades by years, and the flow rates are estimated. Models and methods for making these estimates are covered in the next instructional unit.

3.3 Mathematical Form of the Flow Model

To estimate enrollments by grades for the following year, we multiply the enrollment by grades in the present year by promotion, repetition, and dropout rates, and add in the new enrollments coming into the grades during the year. This statement can be symbolized in compact algebraic notation:

$$z_{t+1} = A_t z_t + a_{t+1} \qquad 2)$$

Enrollments by grades in the following year t + 1	=	A (p, r, and d rates) multiplied by z (enroll), + a (entrants)

The procedure is clearer if we examine the way it is arranged for the computer. Note that the ordering of terms is changed slightly for the computer operation in Figure 2.1.

Figure 2.4
The Basic Flow Model for the Computer

Figure 5.2

The Basic Flow Model for the Computer

$$\overset{A_t}{\begin{bmatrix} r_{1t} & 0 & 0 & 0 & 0 & 0 & 0 \\ p_{1t} & r_{2t} & 0 & 0 & 0 & 0 & 0 \\ 0 & p_{2t} & r_{3t} & 0 & 0 & 0 & 0 \\ 0 & 0 & p_{3t} & r_{4t} & 0 & 0 & 0 \\ 0 & 0 & 0 & p_{4t} & r_{5t} & 0 & 0 \\ 0 & 0 & 0 & 0 & p_{5t} & r_{6t} & 0 \\ d_{1t} & d_{2t} & d_{3t} & d_{4t} & d_{5t} & d_{6t} & 1.0 \end{bmatrix}} \cdot \overset{z_t}{\begin{bmatrix} z_{1t} \\ z_{2t} \\ z_{3t} \\ z_{4t} \\ z_{5t} \\ z_{6t} \\ z_{dt} \end{bmatrix}} + \overset{a_{t+1}}{\begin{bmatrix} a_{1,t+1} \\ a_{2,t+1} \\ a_{3,t+1} \\ a_{4,t+1} \\ a_{5,t+1} \\ a_{6,t+1} \\ 0 \end{bmatrix}} = \overset{z_{t+1}}{\begin{bmatrix} z_{1,t+1} \\ z_{2,t+1} \\ z_{3,t+1} \\ z_{4,t+1} \\ z_{5,t+1} \\ z_{6,t+1} \\ z_{d,t+1} \end{bmatrix}}$$

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This says that when we multiply the enrollments in grades 1 to 6 in year t by the repetition (r), promotion (p), and dropout (d) rates, and add in new entrants, a_{t+1}, the result is the enrollments by grades in the following year, z_{t+1}. The arrangement may appear difficult to understand at first glance for those not accustomed to looking at mathematical expressions, but a simple numerical example, using actual country data, will make it clear. It is worth understanding the flow model because this is what the computer does hundreds of times in any model. The same model can be applied to all graded systems anywhere. Appendix 5.1 gives a brief review of matrix algebra and applies it to a simple example of enrollment projection.

3.4 An Arithmetical Example

Figure 2.5 shows the basic computer scheme illustrated with a simple arithmetical example which traces the flow of enrollments for students from the base year 1985-86 to the following year 1986-87 for the first six primary grades. A_t is the matrix of repetition, promotion, and dropout rates for the six grades of elementary schooling for this country. The repetition rates are .206, .150, etc., along the main diagonal. The promotion rates are .735, .840, to the left of the main diagonal. The dropout rates are along the bottom row, .06, .01, etc. For simplicity in this worked example we have excluded from consideration the dropout rates in the bottom row, and the final column of zeros in the matrix A_t. This means we are dealing only with the six rows and six columns within the inner lines of A_t, or, in other words, A_t is a six-row and six-column matrix. (Annex 21.A explains why this is done.)

The numbers shown in z_t are the enrollments in grades 1 to 6 in the year 1985-86. The number shown in a_{t+1} is the entering enrollment to grade 1 in 1985-86. (Note that this arrangement shows new enrollments entering only at grade 1, but in some situations new entrants in 1985-86 could come in at any grade.) The result z_{t+1} is the enrollments in grades 1 to 6.

Figure 2.5
Example of Enrollment Flows, Using the Computer Model

$$\overset{A_t}{\begin{bmatrix} .206 & 0 & 0 & 0 & 0 & 0 & 0 \\ .735 & .150 & 0 & 0 & 0 & 0 & 0 \\ 0 & .840 & .160 & 0 & 0 & 0 & 0 \\ 0 & 0 & .830 & .260 & 0 & 0 & 0 \\ 0 & 0 & 0 & .700 & .170 & 0 & 0 \\ 0 & 0 & 0 & 0 & .800 & .100 & 0 \\ .06 & .01 & .01 & .04 & .03 & .02 & 0 \end{bmatrix}} \cdot \overset{z_t}{\begin{bmatrix} 84206 \\ 66433 \\ 60335 \\ 61300 \\ 45750 \\ 36160 \end{bmatrix}} + \overset{a_{t+1}}{\begin{bmatrix} 58551 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}} = \overset{z_{t+1}}{\begin{bmatrix} 75897 \\ 71856 \\ 65460 \\ 66016 \\ 50688 \\ 40216 \end{bmatrix}}$$

Grade 1 = (.206)(84206) + 58551 = 75897
Grade 2 = (.735)(84206) + (.150)(66433) = 71856 + 0 = 71856

General Rule: Multiply each entry in the Matrix A_t row by each entry in the z_t column corresponding, and add in the a_{t+1} number.

At the bottom of Figure 2.5 is a simple worked example for grades 1 and 2. For grade 1 the repetition rate (.206) is multiplied by the first-grade enrollment (84,206) and the result added to the new entrants to grade 1 (58,551), giving a first-grade enrollment for the following year of 75,897. For grade 2 the promotion rate (.735) is multiplied by the first-grade enrollment (84,206), and this result is added to the repetition rate (.150) multiplied by the second-grade enrollment (66,433). The result is the second-grade enrollment in the following year

(71,856). If new entrants had been allowed at the second grade, these would have been added in, but the entry is 0 in this example. The same procedure is followed to yield the enrollments in the following grades: 3, 4, 5, and 6. If dropouts are being calculated, then each dropout rate in the bottom row is multiplied by each enrollment in the column z_t. For example, the dropout for the first grade is (.06) x 84,206 = 5,052.

4.0 Flow Analysis for Enrollment Projection in National Systems

Most LDC school systems are centrally organized at the national level, governed from a Ministry, usually located in the capital city, but more recently at least partially decentralized through the location of governance and administrative support in provincial, state, or regional offices. India is a giant exception with state systems as the major organizational form, but these are so large and bureaucracy so entrenched that they appear merely as a collection of country-sized, centralized systems.

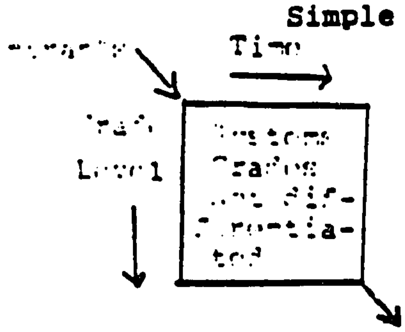
The models and methods for projecting enrollments in all systems, national and state, centralized and decentralized, are not basically different: (a) entrants into the first level of the system are forecast demographically; (b) flows of enrollments through the system are forecast, using flow models similar to the Markovian model examined in Figure 2.1.

When there are good enrollment data reported by grade and year, and when the flow parameters (promotion, repetition, and dropout rates) are available and accurate, Model 1 is no problem; but often data are only available for using other, cruder models, like 2, 3, and 4.

4.1 The Simplest Model and the Simplest Structural Rate

The simplest model treats time and grade as a simple undifferentiated structure and uses a structural ration as a simulated survival ratio for the entire system:

Model 2
Simple Structure Grade X Time



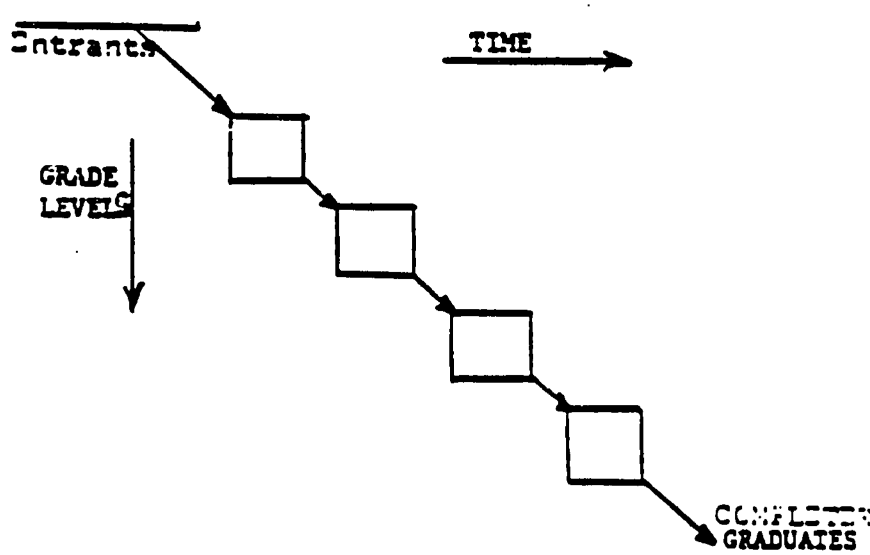
Structural Rate (Simulated Survival)

P = Graduates/Entrants

Completers (Graduates)

4.2 Progression Model and Progression Rate

Model 3
Progression Grade and Time

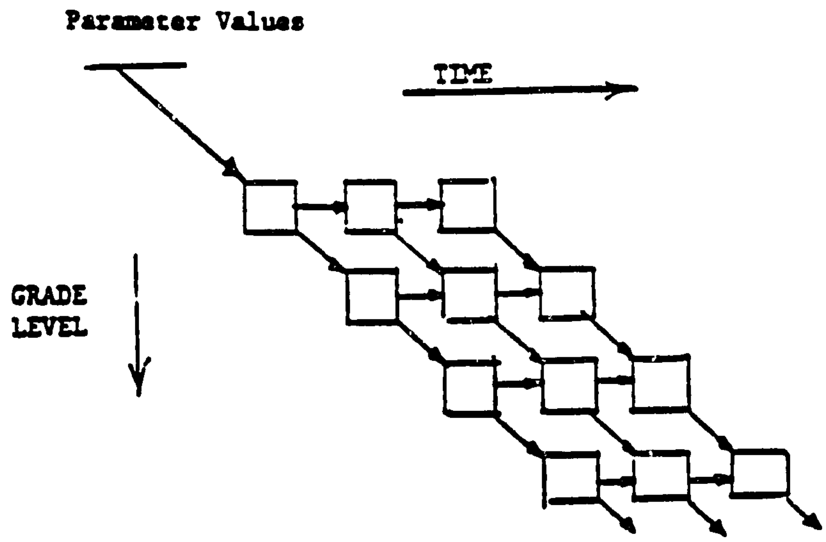


Rates are derived by diagonal analysis over time, usually as a single rate of progression (as in Davis, 1987, Chapter 13). Progression rate is more accurate, if past enrollments are divided for analytic purposes into "New Enrollments" and "Repeaters." With these data, and applying the assumptions and methods in Davis (1987, Chapter 13), analysts sometimes estimate promotion, repetition, and dropout rates, and these simulated flow coefficients can be used as transition rates (parameter values) in the Markovian-type model shown as Model 1. Or flow parameters can be estimated based on multiyear and multigrade enrollment data used to stimulate flow (Table 1). Least-squares fit may then be applied in equations 3) and 4). The Schiefelbein/Cuadra Model, to be described in paper 6, applies least-squares analysis to two successive years' enrollment.

4.3 Flow Models: Cohorts and Simulated Cohorts

In Model 4, flows are followed over grades and time periods to graduate or completer status or to some imposed cut-off point determined by time and grade status. The results of the analysis can be utilized in various computational formats, the main ones being Markovian-type flow models, which will be illustrated, and "cohort" flow models, which will be described. The difficulties of deriving true cohort data for estimating the flow parameters, for either type of model, are often underplayed, and subjective estimates and approximations slipped into the computational models without due notice. A section will illustrate these data problems.

Model 4
The Basis Model for Analyzing Flows and Estimating Parameter Values



4.4 Estimating the Flow Parameters in a System of Average Stability

Model 1 is easy to work. If the flow parameters are available, a simple computer program can be written which multiplies the coefficients in Matrix A by the base year enrollments in vector z_t; and adding new entrants from a_{t+1} to give the projected enrollments in z_{t+1}. The process can be cycled through as many years as the promotion rates (p), the repetition rates (r), and the dropout rates (d), which add to 1 and cover all transition states, can be assumed to hold for forecasting purposes. Rates can also be updated over the course of a forecast, and control corrections can be added in for future years. Sample calculations were shown for systems flows. The major problem, apart from the assumptions of parameter stability or change, which underlie all forecasts, is in estimating the flow rates in a practical and economic fashion.

For systems with a limited and stable number of entrants over the years, a regular flow within the system, with few dropouts and repetition--and with minimum numbers of the student type that puts anxiety into the hearts and minds of parents and planners alike, the stop-out-stop-in-kids--flow analysis is simple enough. This is not a characteristic of school systems or institutions in many countries outside the United States, or in some institutions within the U.S. In stable situations, the only sound basis for deriving flow rates is the same as the author described it, many years ago: "Cohort analysis, in which a group of students is followed through the systems from entrance to final status (dropout, graduate, death, migration) is the only certain way to determine flow, output, and efficiency in a system" (Davis, 1966).

However, since most planners cannot afford to do follow-up and longitudinal analysis, various approximations are used. A simple cross-sectional analysis is performed on one year of data (Model 1). Or, with multiyear, multigrade data, a simulated cohort is constructed by diagonal analysis (Models 2 and 3). Historical flows are projected forward to the present time. Or a partial cohort analysis is formed, after applying rules (cut-

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off after a set number of years) to make the tracking burden reasonable. Or cohorts are constructed out of a mixture of follow-up data and subjective estimates of dropout and average time in grade estimates (Oliver, Hopkins and Armacost, 1970; and Hopkins and Massy, 1982). Rarely is a true cohort tracked through the system, and one of the reasons is illustrated in Figure 1, where students' actual enrollment behavior was tracked through four class levels over a six-year period. Even extending the number of years by two beyond the number of levels, is, in a sense, arbitrary and misses some of the cohort who came back into the system. To the author's knowledge a true cohort follow-through has never been used in an actual enrollment projection. The simulated cohort data in Figure 2.6 was constructed retrospectively by asking students and parents (and checking one against the other) whether the student (i) enrolled and successfully completed the year; (ii) enrolled but did not successfully complete the year; (iii) did not enroll (in effect, dropped out between years).

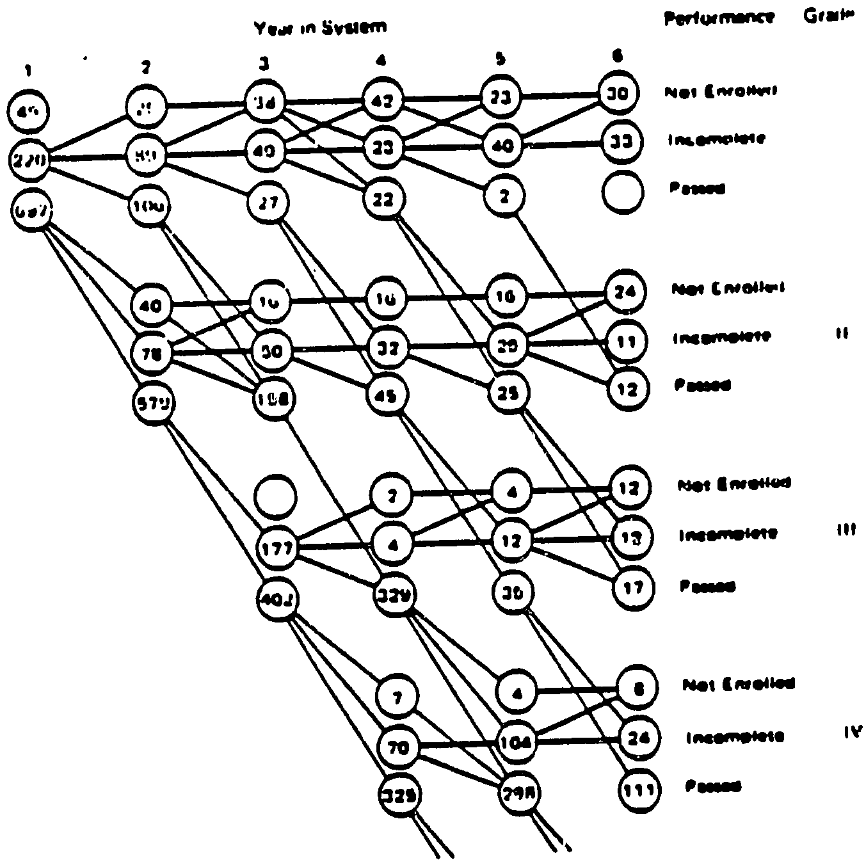
4.5 Checking Cohort Analysis and Flow Rates

The numbers in Figure 2.6 can be used to estimate continuance rates, or to estimate promotion, repetition, and dropout for a diagonal array like Model 5. The rates in Model 5, however, are based only on the pass, repeat, dropout rates of the cohort followed down the main diagonal (in other words, year-to-year survival based on one year). That this is an

Figure 2.6

Four Grade Historical Reconstruction of Flow

in Six-Year Period



Academic history of child in Guayana schools six or more years.*

* Based on a sample of eighty-one children weighted.

Source: McGinn and Davis, Venezuela Data Modified overestimate of promotion and an underestimate of repetition and dropout can be seen by comparing the year-to-year promotion of that noncohort (at least, it is not the original cohort) with the original data in Figure 1. In the last year for which the diagonal is traced, the estimate of fourth grade to graduate status is 325/402 or .81. If the 325 were expressed as a ratio to the original 962 entrants, it would be 325/962 = .34, which is too low because it expresses the flow only in terms of the survivors from the original who made it through without any delay. What really happens is that students are coming in and out of the system, as Figure 3 shows. In fact, after six years, 734 of the original 962 have graduated, and the rate is 734/962 or .76, somewhat near the other figure.

Model 5
Using Diagonal Rates as Flow Parameters (1 Year)

	1	2	3	4	G Status
1	r = .23				
2	p = .72	r = .11			
3		p = .83	r = .24		
4			p = .70	.17	
				.81 — graduate	
d.o.	d = .05	d = .06	d = .07	.02	

General flow models (Figure 2.1) do not reflect the complexity of tracking an actual cohort through four years of undergraduate studies to degree status; reach final year; reach other than final year; drop out (or otherwise disappear from count, which includes "couldn't locate). In actual systems there is continuous entry, dropout, and reentry, as Figure 3 data suggests.

4.6 Enrollment Tracking in the Stable System

Oliver and Hopkins (1970) and Hopkins and Massy (1982) discuss a flow analysis procedure and a flow model which they refer to as "a cohort flow model." They identify eight "cohorts" defined on the basis of students who enter at the same time, and proceed to final status, dropout or graduate. The eight cohorts defined in both versions of the analysis include such categories as h_1, students who enter as freshmen and graduate . . . They then estimate from data, or set subjectively, the average lifetime of a cohort in years, e.g., from entrance as a freshman to completing undergraduate degree. They also estimate dropout rates. Enrollment then can be expressed as:

$E = Vh$ where V is average cohort lifetime and h is number coming into cohort 3)

Given a stable system they can set up an equation showing the total enrollments as equal to the enrollments of the various cohorts:

$$v_1h_1 + v_2h_2 + v_3h_3 + \ldots v_kh_k = E_{1\ldots k} \text{ cohorts} \quad 4)$$

They can also add input/output equations, expressing units of resource to enrollment, and by stating resource constraints solve the system in terms of enrollment flows, given input constraints and final demand targets, just as in linear programming models shown in Davis (1987), Chapters 7 and 8.

The analysis approach and the models work well when the data on cohorts (lifetime averages) are obtainable and accurate, and when the system is stable and the estimates of the total enrollment are known. The results of using various approximations have been tested and hold up well over reasonable time. Approximations are the rule and rarely are flow data derived from extensive tracking of cohorts over time. Even when this is done, the flow coefficients may not hold long in the future.

4.7 Least-Square Fit to Enrollment Data in LDCs

Least-square fit to existing enrollment data can be applied, when data for several years are available and differentiated by New (new entrants), Repeaters (kept in same grade from previous year), and the Total of New and Repeaters. Table 2.1 (abridged from actual LDC data) shows data in this form, where enrollments divided into new entrants into grade; and repeaters in the same grade from the prior year (N = new entrants; R = repeaters; T = Total).

Using k to index the grade (k = grade 1 and k + 1 = grade 2) and t to index the year, the least-squares equation is:

$$N_{k+1}\ (5 + 2) = b\ T_k\ (t + 1) + c\ T_k\ (t) \qquad 5)$$

where:

new students in a grade $N_k(t+2)$ is a function of total enrollments (T_k) in the previous (lower) grade in two previous years (t+1, and t).

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Table 2.1

Enrollments in Venezuelan Primary Schools (1957–8 through 1963–4)

	229,955 242,203	125,838 133,325	102,586 111,314	75,209 83,882	55,373 61,751	40,394 44,691
	1	2	3	4	5	6
1957–58						
Total	263,037	143,962	119,029	93,196	68,576	48,276
Repeaters	75,200	24,374	20,980	17,213	10,933	4,770
New	186,872	119,588	98,049	75,983	57,643	43,506
Terminal =	(260,981)					
1958–59						
Total	371,062	163,367	132,540	102,383	76,706	54,155
Repeaters	86,474	25,239	19,781	14,986	8,456	2,593
New	284,588	138,128	112,759	87,397	68,250	51,562
T =	(366,094)					
1959–60						
Total	431,907	215,352	156,472	119,175	87,635	63,693
Repeaters	116,918	26,483	23,192	18,875	10,949	3,738
New	314,989	188,869	133,280	100,300	76,686	59,955
T =	(428,763)					
1960–61						
Total	463,711	259,467	192,869	136,316	99,294	71,321
Repeaters	137,844	32,534	26,364	20,963	12,420	4,599
New	325,867	226,933	166,505	115,353	86,874	66,722
T =	(463,063)					
1961–62						
Total	422,593	270,840	226,974	161,911	113,725	80,979
Repeaters	134,177	38,033	30,082	22,470	13,588	5,276
New	288,416	232,807	196,892	139,441	100,137	75,703
T =	(424,877)					
1962–63						
Total	409,535	259,768	241,716	183,249	132,099	91,420
Repeaters	123,496	40,822	37,459	27,281	15,510	5,700
New	286,039	218,946	204,257	155,968	116,589	85,720
T =	(409,249)					
1963–64						
Total	400,350	262,041	237,262	196,854	147,493	105,119
Repeaters	114,269	37,878	38,481	29,164	16,673	5,938
New	286,081	224,163	198,781	167,690	130,820	99,181

As, in the usual least-squares analysis, the function stated in equation 1) is differentiated partially, first with respect to the parameter b, and then with respect to the parameter c, set equal to 0 in two simultaneous linear equations and solved simultaneously for the two parameters b and c, which are expressed in terms of the raw data (T = Total; N = New, R = Repeat) reported in series data tables as in Table 1 abridged from Davis (1966).

The equations that express New enrollments as a function of Total enrollments in the prior grade for the prior two years are:

$$b = \frac{\left[\sum N_{k+1}(t+2)\ T_k(t+1)\right]\left[\sum T^2{}_k(t)\right] - \left[\sum N_{k+1}(t+2)\ T_k(t)\right]\left[\sum T_k(t+1)\ T_k(t)\right]}{\left[\sum T^2{}_k(t+1)\right]\left[\sum T^2{}_k(t)\right] - \left[\sum T_k(t+1)\ T_k(t)\right]^2} \quad 6)$$

$$c = \frac{\left[\sum T^2{}_k(t+1)\right]\left[\sum N_{t+1}(t+2)\ T_k(t)\right] - \left[\sum T_k(t+1)\ T_k(t)\right]\left[\sum N_{k+1}(t+2)\ T_k(t+1)\right]}{\left[\sum T^2{}_k(t+1)\right]\left[\sum T^2{}_k(t)\right] - \left[\sum T_k(t+1)\ T_k(t)\right]^2} \quad 7)$$

Once the parameters b and c are solved for using equations 6) and 7), which state the values in terms of the values of Totals and New enrollments for various years shown in Table 1, enrollments for future years can be forecast, starting with the base year (present year) of the forecast and using Formula 1. The problem is that the parameters do not hold up for more than a few years (five or six at the most), and new series have to be computed based in the actual data of each new year of enrollment data, as in the Schiefelbein Model. Flow analysis for enrollment projection is covered by Davis (1987, Chapter 14).

5.1 Forecasting External Economic Conditions: Projection Models

The economic forecasts that directly concern education planners in their broader role of human resource development planners are:

a) Forecasts of economic activity and growth in product, value added, or income. This covers the sum total of the goods and services produced by the national economy as measured in GNP (Gross National Product), GDP (Gross Domestic Product), and National Income, with the total broken down by main sectors of the economy.

b) Forecasts of EAP (Economically Active Population), Labor Force or Work Force, Employment, classified by sectors of the economy, and for manpower demand forecasts, by occupation and education levels.

c) Productivity, or product per head, derived from product and employment forecasts, and estimated by forecasts of growth, technological change, and organization for production.

d) Other forecasts detailed by industries or occupations of special interest, or by groups in the population; earnings; income levels . . .

Educational planners use economic forecasts primarily in setting goals for the education/training system in terms of product changes in the economy; for setting targets in terms of manpower demand, and requirements for educated and trained manpower estimated on the basis of demand and forecast supply (output) of education/training systems. The economic forecasts are usually accomplished by economic analysts in the national planning office, rather than planners in a ministry of education, but educational planners must be familiar enough with the economic forecasts to evaluate their general credibility and to incorporate them into human resource development forecasts and plans.

5.1.1 Manpower Planning Approaches and the Basic Forecasting Methods

Schema 2.1 outlines the simple models, methods, and basic information required to forecast manpower requirements and the output, or supply, of education/training systems. The term Manpower Demand refers to the forecasts of manpower requirements, and Educational Supply refers to the forecasts of enrollment flows and graduates of schools and training institutions. Demand is not a true labor market demand estimate, but simply projected expectations of labor force growth derived from projected growth of product.

This section will explain the basic methodology outlined in points a through c of I in Schema 2.1, where employment is projected by sectors of the economy. The Chilean instructional case that follows will illustrate this basic methodology. When the methodology is applied in actual planning, there are slight variations as steps are combined, or the ordering of steps may be different. Models and methods are never slavishly followed,

Schema 2.1
Outline for Manpower Planning
(page 1 of 2)

I. AGGREGATE LEVEL FORECASTS

1. **Basic Method**

   Steps

   a) Product forecast by sectors (plan targets)
      P ⟶
   b) Productivity forecasts
      $P_{p.w.}$ = product per worker
   c) $\frac{a}{b} = E$: Employment by sectors
   d) E distributed sectors by occupations
   e) Occupation distributed by education (levels and programs).
   f) Education "demand" aggregated

2. **Alternate Method (Growth in Occupation)**

   X_{ij} = number in occupation (i): sector (j) in the base year

   D_{ij} = future requirements in occupation (i), sector (j)

   Steps

   a) Project D_{ij}

$$D_{ik} = \sum_{j=1}^{n} (X_{ij})_t \; e\left[(b_{ij} \; r_{pj} + Y_{Lj})\right]^t$$

II. DISAGGREGATED (PIECEMEAL) REQUIREMENTS (TO SUPPLEMENT AGGREGATE FORECASTS)

1. **Service Sector/Government**
   A. Population based service norms/ratios
      a) Education (link to supply)
         i) Social Policy (coverage, demographic)
         ii) Education policy Program staffing, e.g. t/p ratios
      b) Health Services
         i) Coverage needs, demand
         ii) Delivery systems/norms/ staffing i.e. Beds/Doctors/Nurses/Parameds
      c) Other Government Services
         i) Defense (numbers, organization manning tables)
         ii) Police, fire sanitation (state, municipal)

2. **Core Industry Arrays**
   Input/Output, Forward/ Backward Linkages
   a) Scale/Technology/manning tables (present and future)

III. DEMAND/SUPPLY EFFECTS ON FORECASTS

1. **General Government Goals/Policies Analysis**
   A Growth Rates economy
      a) investment, monetary fiscal
      b) Employment plans, policies
   B. National Education: Demographic/Social targets
      a) access
      b) flow
      c) output, programs/issues
   C. Education Sector Policies
      a) input norms
      b) costs
      c) resource constraints revenue policies/finance H.R. lags(e.g. trained staff)
      d) Admissions/scholarship policies, subventions, systems & institutions
         i) influence access & flow
         ii) influence incentives choices

Schema 2.1
Outline for Manpower Planning
(page 2 of 2)

D_{ij} = (continued from previous page,with equation for b_{ij} parameter)

b_{ij} = rate of change of workers in occupation (i) as productivity in sector (j) changes

r_{pj} = National data historical trend productivity rate

Y_{Lj} = Growth in numbers of workers trend

e = Form of the growth curve is exponential

b) Distribute by Education levels and Programs

c) Aggregate Education "Demand"

3. Apply aggregate level ratios as checks, e.g.,

a) Participation rates
b) Demographic rates

b) Establishment surveys
Employment (Present & Future Estimates Wages and Salaries)
X occupation, given market share,
prices, scale, technology

3. Small Industries and Pvt. Services
Linked to other industries & service needs
Linked to population served ratios & technology
Linked to income & effective market

4. Agriculture
Crops/Acreage
Land Tenure Patterns
Cultivation Patterns
Export, World Demand, Export Policies,
Prices Domestic, Numbers, Diet, Income

5. Fill details in cells and check with Aggregates from I. Final iteration deficit Phase I.

Demand: Base stock + wastage - supply = Deficit
Intersection in subsequent iteration phases

2. Demand/Supply/Price Interactions
Econ.
A. Labor Market Information
a) job opportunity
i) openings, promotion
ii) earnings (wages, salaries)*
iii) other returns (phychic)
b) Guidance Information
Voc/Career choice
Educ/Career choice
B. Rate of Return Studies*
a) Earnings profiles
b) Employment probability

3. Social/Cultural Values
a) National
b) Community
c) Family
d) Individual

Value of Education

*Effects on Demand & Supply Choices (Elasticities if possible)

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the work depending on the information available, the pressure which deadlines impose on the planner, the competence and working style of analysts, and the level of precision required in the results.

Schema 2.1 outlines other information which may be available to the planner, information that will permit him to deepen and enrich the analysis and improve the result. The basic method for forecasting manpower requirements is primarily useful in providing a structure into which much more detailed and precise information can be incorporated, and results refined in subsequent iterations.

The sections that follow will run through the steps required to project manpower requirements using the basic method. The object of the projection is to provide an estimate of the requirements for educated and trained manpower during the future years of a plan. The projected manpower requirements can be expressed in terms of education and training requirements, which can then be compared to projections of supply from the education/training system. The resulting deficits or surpluses can then be used to guide the planning of education and training.

5.1.2 The Base-Year Work Force: Basic Tables and Formats

The first requirement is the base-year work force by economic sector (Agriculture, Industry, etc.), occupation (Manager, Engineer, etc.), and education level. Sector and occupation classification are discussed in the final sections of this unit.

Schema 2.2 shows the format for the distribution of the work force by occupation (in the rows of the table), and sectors of the economy in the columns of the table. Schema 2.2 has the work force distributed for the base year, x, and the target year, n. At this point we will fill in only the entries in column x, for the base year.

Schema 2.3 shows the format for the distribution of the work force by occupation and educational attainment for the base year. We now have the basic information required for starting the manpower projection. Note that the occupational classification is the common link between the sector classification (Schema 2.2) and the educational classification (Schema 2.3).

Schema 2.2
Distribution of Work Force by Occupation and Sector (Base Year x and Target Year n) of Economic Activity

Sectors	Total No.		Total %		Agriculture[a]		Mining		Manufacturing		Services ...	
Occupation	x	n	x	n	x	n	x	n	x	n	x	n
0 Professional												
1 Administrative												
2 Clerical												
3 Sales												
⋮												
5 Farmers												
⋮												
7 Artisan-Craftsman												
8 Operators												
9 Service Workers												
⋮												

[a]Each sector column includes number and percent of workers in occupations within the sector.

Schema 2.3
Educational Attainment by Occupation in Base Year x

Occupation	Col. 1 Total	Col. 2 University graduate studies complete (19 yrs.)	Col. 3 First degree level university (17 yrs.) Professional and higher normal	Col. 4 Sub-professional (15 yrs.)	Col. 5 Tech. complete (12 yrs.)	Col. 6 Secondary general	Col. 7 Lower normal complete (12 yrs.)	Col. 8 Primary complete (6)	Col. 9 Literacy grade (4 - 6
0. Professional/science						Includes those who finish 12th grade <u>only</u> plus those who finish 12th grade and go on to col. 2, 3, and 4 groups		Includes those who finish primary plus those who go on to cols. 5, 6 and 7 groups	Includes those who finish at least 4 grades plus col 8 group
No.									
%									
1. Administrative/managers									
No.									
%									
2. Clerical									
No.									
%									
.									
.									
7. Artisans									
No.									
%									
8. Operators									
No.									
%									

Note: Educational levels may be grouped in various ways. The basis is arbitrary. Here the groups are
Col. 2 includes all who finish through 19th grade.
Col. 3 includes all who finish 17th through 19th grade.
Col. 4 includes all who finish 15th grade sub-professional.
Col. 5 includes all who finish only 12th grade technical training plus the proportion of those who finish this track and attend higher education (both sub-professional and professional, i.e. lines 3 and 4).
Col. 6 includes all those who finish only 12th grade general preparation plus those who go on to higher education from this track (because schools must produce graduates who terminate at 12 and graduates who continue on.)
Col. 7 includes all those who finish only 12th grade lower normal plus that proportion from this track who go on to higher education.
Col. 8 includes all those who finish primary, plus those who finish grades 7 up to 12 (in the secondary tracks) plus the totals of 5, 6, and 7.
Col. 9 includes 8, plus those who finish at least 4 grades but less than a complete 6 years of primary.

5.2 Information Sources for the Basic Tables and Formats

This example sketches the basic methodology for national-level projections. National projections are done by educational planners working in systems outside the United States where the information is based on national-level aggregated data. In the U.S., most MP forecasts are for subnational levels, regional, state, or metropolitan area labor markets.

The prime source of information is the national census, which collects information on the work force and tables it by sectors, occupations, and sometimes by educational attainment. There may be a number of limitations on the information as commonly presented in census tables. The information may not be arrayed in the form of occupations by sectors, as in Schema 2.2, or in occupations by educational attainment levels, as in Schema

2.3. The information can be refined or further processed in special runs to meet the planner's specific needs.

A common problem is that the data may be too highly aggregated for use. Only single-digit classifications of occupation and sector (as in Schema 2.2) may be available, and special runs may be necessary to get the data into finer occupational or sectoral categories. The same may be true of educational categories.

Also, census information may not be in the appropriate format; different cross-tabulations may be required, or the information may need to be updated. The first plan year may be 1985 and the most recent census 1980. In this case, the census must be brought forward five years to current date, or to the base year of the planning exercise. The planner may use survey data from special work-force studies, e.g., skill surveys or establishment surveys. There may also be detailed occupational information for a specific large industry or enterprise. The basic census data can be updated, supplemented, and made more detailed with results from other studies and surveys of the work force.

5.3.0 The Basic Projection Methodology

The basic methodology proceeds in a series of steps which may be modified when applied. We will run through a simple set of steps and illustrate them with Chilean Manpower Planning Case data.

5.3.1 Employment Projected to the Target Year

Employment Projection (Step One)

a. Product has been projected from base year to target year by sector in overall development plan.

b. $\frac{\text{Product}}{\text{Workers}}$ = productivity, derived from analysis of trend years. On the basis of past trends or future expectations of increase or decrease in sectors, productivity rates are projected from base to target year.

c. Employment is then projected by sectors for target years, by division of a/b.

The projections of product and productivity may be taken directly from development plan estimates. Or the projections may be based on past or historical trends of product growth extrapolated to future years. Or the projection may rest on a combination of the two things, with trends modified by information on plant capacity, technology, and investment plans for expansion. Comparative experience, the growth experienced in other countries or economies, may also be used to guide the projections.

The simplicity of the first step is shown in the following symbols. The aim is to project employment from year x to year n. Employment, symbolized E, equals P (product) divided by $P_{p.w.}$ (product per worker).

$$nEx = \frac{P = \text{(Product (Projected))}}{P_{p.w.} = \text{(Product Per Worker)}} = \text{Projected employment}, _{x...n} \qquad 8)$$

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Product and product per worker are projected for each year x to n. Employment is projected separately each year for each sector. Sector product P, and product per worker $P_{p.w.}$ may be taken directly from the national development plan or estimated on the basis of performance of the economy, or assumed on the basis of informed judgments about development potential in sectors or specific industries. The growth experienced in other similar situations in other countries, or in other regions or industries in the same country, may also be used to guide the projections.

From the outset the results may depend on how well the national development planners have estimated product in sectors for the future year. This is a crucial estimate, and it underlies the employment projection, as it underlies almost all other attempts to derive manpower demand from the economy. The adequacy of any employment projection depends on the adequacy of the basic projection of growth in product.

Base-year estimates of product and productivity can be in error. If product and productivity are projected on the basis of a trend extrapolated from past years, the adequacy or representativeness of the base years is in question. If the product/productivity ratio is projected on the basis of what has happened in the sectors and assumptions about probable changes, the adequacy of these assumptions must be examined. The units in which the product is expressed can also be troublesome. Monetary values may have to be adjusted to a base year, and when this is difficult and no indexes are available, the product may have to be expressed in units of physical output.

Census data usually furnish the basic numbers in the work-force employed and unemployed. The census data may have to be updated to the base year by an establishment survey which covers new employment. The establishment survey may also be designed to get management's best estimate of likely expansion and future employment. Hence, it may furnish one basis of work-force estimates for future years.

When countries or industries are growing and changing, the establishment survey will have shortcomings as a basis for future year estimates. The survey covers only existing industries. Industries that may not yet exist or be identified as possibilities early in a plan period may come into existence and grow rapidly during the plan period. In some areas, planning may have reached the stage where most major industrial possibilities have been studied. Employment for these future industries may have been estimated through feasibility studies which also cover sources of raw material, investment and financing, production problems, and market and sales forecasts. On the basis of these studies, employment can be directly estimated for future years.

5.3.2 Other Methods for Estimating Employment

Planners may use a general sectoral employment estimate as a first approximation, but usually they go beyond this and work on estimates for individual industries or groups of industries within the sector. A general ratio of product to product-per-worker may be used to derive a first estimate of employment for an entire heavy industry group. Then, detailed employment estimates may be prepared for each individual industry, and the results adjusted and compared with the totals.

Product or productivity may be derived from investment ratios, or estimated on the basis of market demand, minimal effective size of the plant, and assumptions about the percentage of capacity at which it will operate. Product for one industry may be derived from another, e.g., oxygen from steel. Detailed input-output relationships may be built up to derive product for one industry, group of industries, or sector, from another. (See Table 2.1.)

One sectoral grouping may be major industries, a second group made up of industries supplying goods and services to the major industries, and a third group made up of industries supplying goods and services to households. The product and employment of the group of industries that supply goods and services to the major industries could be related to growth in the major industries. The product and employment of the industries supplying goods and services to households could be related to growth in population, households, household income and expenditure.

For light industries, and in the service and commerce sectors, employment may be derived from a ratio to the total population projected for the area. From the size of the population and the effective market, an estimate of the required output can be made; and from output, the number of workers required. Industry fact sheets or Manning Tables (detailed estimates of number and kinds of workers by jobs) can provide employment estimates and occupational distributions according to scale and technology of the industry. This detailed information may be summed into the general employment estimates for target years.

The result of the first step is employment in the target year by sector of economic activity.

5.3.3 Input/Output Tables and Models

Input/output tables which show the input of one industry to another industry and to final demand can be converted to coefficients and solved as a system of linear equations to yield the output of the industries required to meet some projected final demand target.

5.3.4 A Note on Input/Output Tables for Estimating Product and Employment

Table 2.2 sketches one form of an input/output table simplified. The sectors originating the product are listed along the row, and the sectors utilizing the product and thus reflecting intermediate demand are cross-tabbed across the columns, with the final column showing the sector output of the row that goes into final demand. The relationships between sectors can be expressed in physical units of input/output, and these converted into proportion coefficients along the rows, by dividing cell total by row total down each column as in Table 2.2.

Table 2.2
Input/Outputs in Product-Service Units

Dividing the cell totals down the column by the industry (row) totals, we get the inputs to each industry expressed as input/output coefficients in Table 2.3, e.g., 50/600 = .08; 40/350 = .11.

Table 2.3

The matrix in Table 2.2 can be written as equations[1] and the system can be solved, as in a linear program format (Davis, 1987, Ch. 8) and inputs from one industry derived from another (with changes over time); and labor demand or employment derived from given levels of final demand, technology (intermediate demand coefficients), and total demand targets. The coefficients (relationships) can also reflect changes over time, and thus represent shifts or elasticities. The significant point is

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1. Using D as final consumption, X_1 as total product of Industry 1, and x_{12} as input of Industry 1 to Industry 2, the system of balance equations can be written as:

$$x_{11} + x_{12} + x_{13} + D_1 \leq x_1$$

$$x_{21} + x_{22} + x_{23} + D_2 \leq x_2 \qquad 9)$$

$$x_{31} + x_{32} + x_{33} + D_3 \leq x_3$$

The system can be solved as a linear programming system (Davis, 1987, Chs. 7 and 8), and total output can be expressed as a function of final demand and the technological (input/output) coefficients:

$$X_1 = A_{11}D_1 + A_{12}D_2, \qquad 10)$$

where the As are defined technological (input/output) coefficients.

that this is an alternative way to derive employment by industry sectors, and employment by sectors is the result of the first step of the basic method. The first step yields employment for each sector. Input/output tables can be used to estimate product, productivity, and employment.

5.3.5 Methods for Checking Employment Estimates

When the data are put into the tables, several check ratios can be applied. Employment can be expanded to population economically active by estimating unemployment and adding it in. The economically active population as a percentage of the total population can serve as a control check. This participation rate can be further broken down for age groups, education levels, and sex, and compared with experience in the past and with data from other similar countries. The percentage distribution of employment by sectors can also serve as a check, e.g., the percentage in services as compared to the percentage in industry. Gross overestimates and underestimates will show up. The percentage of the work force found in broad sectors of the economy--for example, in the primary sector of agriculture--is also a check.

5.3.6 Supplementary Reading on Sectoral and Occupational Classification Schemes

To work with manpower data requires the systematic tabulating of sectoral and occupational data. The sectoral and

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occupational data are tabulated according to standard systems for classifying sectors and occupations. One-digit sectoral and occupational classification schemes were illustrated in Schema 2.2. In the Chilean case, one-digit classifications will be used, although the sectors and occupations are slightly different. In manpower analysis the planner may attempt to work with more refined classification schemes that use two or three digits and break industries and occupations into more detailed groupings. The classification of the work force by sectors and occupations is central to aggregate-level manpower forecasting and requires some additional explanation.

5.4 Sectoral or Industry Classification

The United Nations (UN, ST/STAT/Ser.,/27) defines what it refers to as industry (which is also called branch of economic activity or sector when a one-digit, large group is referred to) as follows:

> Industry refers to the kind of establishment in which the person works (or worked if unemployed). For purposes of international comparability, it is recommended that countries adopt the International Standard Industrial Classification of All Economic Activities (ISIC) most recently approved by the United Nations, or that they tabulate their statistical data so that the categories can be regrouped in accordance with the Standard Classification or at least with the divisions (one digit) of this classification.

The ISIC (United Nations Statistical Office) provides a taxonomy for classifying economically active civil populations. The major divisions or sectors are: 1 Mining; 2-3 Manufacturing; 4 Construction; 5 Public Utilities; 6 Commerce; 7 Transportation/Communications; 8 Services; 9 Not Specified. The eight divisions are divided into major groups (two-digit code) and subgroups (three-digit). The standard classification is usually modified for any given country. Government may be added as one of the main divisions. Services may be separated into more than one main division.

The basic scheme used in manpower planning in many countries is the one developed and used in the national census and statistics office, as in the Chilean case. Other government agencies, for example, the Ministry of Industry or the Ministry of Economics, may have slightly different schemes. In the United States, the Bureau of the Budget has developed the Standard Industrial Classification, and the industrial classification system developed by the Bureau of the Census is also used. There are systematic procedures for translating from one system to another (Dictionary of Occupational Titles, 1977). The NOICC System uses several classifications.

One of the standard classification systems may be used as a model, with appropriate modifications, according to the economy of the particular country. In any given country application there are usually modifications made, but there are disadvantages when a country departs too widely from one of the standard classifications. Comparability is difficult, and retabulation may require going back to the original census schedules, a difficult and expensive task. Still, simplification of the categories may be necessary because of deficient data. A simple three-sector breakdown (industry, agriculture, and services) may be all that is possible.

5.5 Occupational Classification

On occupations the United Nations' Principles and Recommendations for National Population Census states:

> Occupation refers to the kind of work done by the person employed (or performed previously by the unemployed) irrespective of the branch of economic activity, or the status (as employer, employee, etc.) in which the person should be classified. For purposes of international comparisons, each country should provide for the necessary subdivisions of its occupational classifications to make possible the classifying or reclassifying of the data in conformity with the latest education of the International Standard Classification of Occupation (ISCO).

ISCO classes civil populations economically active into nine major occupational groups (shown at the end of this unit). The major groups are subdivided into 70 minor groups (two-digit level) which are subdivided into 200 unit groups (three-digit level). Unit groups can be broken down further. Other systems of occupational classification are used. The U.S. Bureau of Labor Statistics has used a classification system based on the Dictionary of Occupational Titles (1977). The Inter-American Statistical Institute, on the basis of the 1950 Census of America and ISCO, worked out a classification scheme for the 1960 Census of America (COTA-1975). This system has been developed in various ways over the years, and it is the one used in the case on manpower planning in Paraguay. In an actual country situation, the basic system is modified according to the prevailing occupational structure. Some country systems tend to follow the original model too blindly.

5.5.1 Updating Occupational Data

Occupational classifications tend to become dated rather quickly, as new technologies and administrative hierarchies develop and new job classifications and occupational titles are created to fit the situation. Not only does the nature of the work change, but the educational requirements--and these are the two main bases for occupational classification--also change. The change is almost always upward, e.g., more training and education are required. In the United States, the Occupational Outlook Handbook is designed to keep new workers and guidance counselors informed about recent and possible changes in demand for workers, new work patterns, and new education and training requirements. The compilers state that some of the information will be out-of-date before the edition appears in print. The Dictionary of Occupational Titles is the best reference for complete coverage and, like the Occupational Outlook Handbook, has been revised in recent editions. The most recent Occupational Outlook Handbook is the 1978-79 edition (Bureau of Labor Statistics, U.S. Department of Labor).

The Dictionary of Occupational Titles, fourth edition (DOL, 1977) relates the classification system in the DOT to other government occupational language systems. The other occupational language systems are those of the Bureau of the Census, the Bureau of Labor Statistics, the U.S. Office of Education, and the Office of Management and Budget Standard Occupational Classification (SOC) program.

The need for constant reclassification updating and editing requires a modern data base management system. The NOICC (1984) occupational information system has a demonstration package in D-Base which can be easily updated. In the LDCs the decennial census is almost the sole source of manpower data. Often detailed sector/occupation tables do not appear until midway through the censal period. Even an advancing country like Mexico did not have detailed tables until five years after the 1980 census (Mexico, 1985). In the United States, the heart of the system is the OES I-O Matrix of industries.

5.6 Summary Comment at the End of Step One

The first step in the basic method of manpower forecasting is to project employment on the basis of product and product-per-worker. There was nothing special in the projection model or process, in that it followed the same basic methodologies of population projection or enrollment projection. The aspect of manpower forecasting that is distinctive is the classification of workers by occupation, sector, and educational levels. Systems for classifying workers have been discussed. A following section on references and further reading will provide additional information.

6.1 Step Two

In the first step of the basic method employment was projected by sectors of the economy. The remaining steps of the basic method will be presented, beginning with the distribution of employment by occupations within sectors for the target year and the base year. The distribution of employment by occupations for the base year is generally taken from census data, as in the Chilean case. Step two distributes employment by occupations within sectors, and relates education attainment levels to occupations.

To summarize the steps:

-- Employment is distributed by occupations within the sectors for the target year.

-- Educational attainment is related to occupations for the target year. This yields the educational requirements for the target year.

-- The outflow of educated workers from the base-year stock is estimated for the period from base year to target year. (This outflow is caused by death and retirement of workers during the projection period. In some areas, emigration is a major cause of outflow.)

-- The base-year stock, minus the outflow, is subtracted from the target-year projection of requirements to yield the number of educated workers required during the period.

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— The supply of educated and trained workers entering the work force during the period is projected and compared with the numbers of educated workers required (step five). The deficit or surplus can be used as a target to plan education and manpower development programs according to the so-called demand of the economy.

6.2 Distribution of Employment by Occupations Within Sectors (Step Two)

Step two of the basic method distributes the employment (projected in step one) by occupations within sectors. The base-year distribution of employment by occupations within sectors is provided by census tables supplemented by survey and specific sectoral or industry employment data. This distribution is used as a guide for distributing employment by occupations in the target year. However, for the years of the projection, the occupational distribution will change. The task is to analyze the factors which will affect this occupational distribution, and to make assumptions as to how it will change. There will always be growth in occupations requiring more employment and training, but the challenge is to develop a systematic method for projecting these changes. The basic method is systematic, but it is not free of subjectivity. The changes are based on the analyst's judgment. The issue, then, as in any projection method, is how adequate are the assumptions on which these changes are based.

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The U.S. National Projections (15.3) begin from a basis of assumptions that the basic structure of the economy, technology, and employment will not change. In the Chilean case the statement is made: The 1970 distribution is a modification of the 1960 pattern, based upon international comparative information from countries more economically advanced than Chile. In Chile, occupational distributions were based on those found in European countries, and the assumption is that Chile will follow the European experience closely enough so that the projections will serve. This comparative assumption will be discussed. It is often used and misused.

6.2.1 Setting Occupational Distribution

In step two, the percentage of workers in each occupation within each sector is set for the future year. This setting can be based on experience, opinion, and percentage distributions in the work forces of other countries. The simplest procedure is to assume that the same base-year percentages will hold in the target year. Usually, however, the planner takes into account the growth projected for the different sectors and industries from base to target year, the expectations of changes of inputs in labor and capital, and the experience of other countries, in order to set a reasonable distribution for the target year. The planner may also take into account the change in occupational structure in past years in the country and its influence on output. The major guidelines come from expected growth in certain key sectors, as assumed or projected in the overall plan. If growth is planned for the manufacturing industry, the percentages of professionals (0), administrators (1), artisan-craftsmen (7), and operators (8) might be raised in the manufacturing sector. How much would they be raised? There is no analytic answer to this. It would depend on how high the existing percentages are for the country in the base year, and how high they are in other countries that have similar outputs or industrial structures. It is sometimes possible to select a more developed country and to move the percentages up toward this target.

Distributions of percentages in occupations have been published for various countries. OECD, Occupational and Educational Structures of the Labor Force and Levels of Economic Development (1970) is also a source of guidance.

The study by Horowitz, Zymelman, and Herrnstadt, Manpower Requirements for Planning, Statistical Tables (1966) is old, but still useful methodologically, as is Zymelman's "Productivity, Skills and Education in Manufacturing Industries" (in Planning for Advanced Skills and Technologies, United Nations, New York, 1969). (These sources also provide the basis for setting educational attainment levels by occupations, which is the next step of the basic method.)

In step two, the occupational percentages set for the target year are multiplied by the employment for a specific sector or industry projected in step one. A few cells from

Schema 2.4 will suffice as an example. This part of the step is purely mechanical. The setting of the percentage distribution requires experience, judgment, and sometimes luck.

Schema 2.4
Number in a Given Sector, by Occupation, in Target Year n

Occupation	Total employment in sector, year n	Occupation %, in year n	No. in sector/occupation year n
	200,000		
0 Professionals	.	3	6,000[a]
1 Managers/Admin.	.	2	4,000
.	.	.	.
.	.	.	.
.	.	.	.
Total	.	100	

[a] .03 x 200,000 = 6,000

Occupational totals can then be summed for sectors, and the result is a table showing the numbers of workers in each occupation for the target year. In Schema 2.4 the occupational distribution for the target year is set. The occupational percentages are multiplied by employment projected for the sector in step one, and the result shows the number of workers in each occupation for the various sectors. This is shown more completely in the Chile case as described in Davis (1980).

As in any projection exercise, alternative occupational settings may be hypothesized. This will yield alternative projection series. For example, one projection might show occupational distributions unchanged from base year to target year; and a second projection may assume a large increase in occupations requiring more education and training.

6.3 Educational Requirements of the Work Force

The aim in the next step is to estimate the educational requirements of the work force in the target year. Educational classifications are arbitrary. (See Schema 2.5.)

Schema 2.5
Educational Attainment by Occupation in Target Year n

Occupation	Univ. grad. studies complete (19 yrs.) Hyp. I	Hyp. II	First degree level university (17 yrs.) Hyp. I	Hyp. II	Sub-professional...... 15 yrs. Hyp. I	Hyp. II	Literacy grade 4-6 Hyp. I	Hyp. II	Totals[c]
0 Professionals (Total = 100,000)	5,000[a]	7,000[b]							
1 Administrators									
.									
.									
7 Artisans									
8 Operators									
.									
.									
Totals[d]									

[a].05 x 100,000
[b].07 x 100,000
[c]Hyp. I = Hyp. II = 100,000
[d]Hyp. I ≠ Hyp. II

6.3.1 Distribution of Education by Occupations (Step Three)

The educational attainment percentages for the target year are then set for the various occupations. The general strategy may be to raise university and college attainments in the first two occupational categories, and to raise technical secondary-school training attainments for craftsmen and operators. For example, if the professional group having university-level preparation in the base year is 65 percent, the strategy might be to raise this to 90 percent for the target year. This is a substantial raise and will create a large demand on the educational system, inasmuch as the professional work force in the target year will be a much larger base number on which to levy the increase. This is so because the total population, including the work force, will almost certainly be growing during the plan period, and the percentage of professionals in the work force will have been raised in step two.

The same sources used for guiding the setting of occupational distributions, which were cited in the previous step, can also be used for setting educational attainment levels by occupations (see OECD, Occupational and Educational Structures of the Labour Force, and United Nations, Planning for Advanced Skills and Technologies). Care must be exercised in choosing comparative models. There is no standard educational attainment unit, although years completed is most often used. One country may require much more formal education than another country for a comparable occupation.

6.3.2 Estimating Education-Occupation Distributions

Alternate education-occupational settings may be used for the target year. In one set, the educational attainment coefficients of the base year may be maintained into the target year. Sets of educational attainment coefficients can be

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applied to yield different sets of alternative projections. Before coefficients are raised the consequences must be checked against the capacity and likely revenues available for expanding the educational and training facilities. Demand and supply projections are not independent. One can be used to check the other. The final operation in step three would appear as in Schema 2.6.

Step three yields the target-year estimate of educated people required in the work force. This comes from summing each educational level down the list of occupations.

6.3.3 A Note on Alternative Steps in Applying the Basic Manpower Requirements

Method: Beyond step three, there are alternative ways of arriving at a final demand and supply estimate for educated manpower:

— Reduce the base-year stock of educated workers by applying wastage rates. Wastage is loss from death and retirement over the years of the forecast. The original stock, reduced by wastage, would then be added to the new supply coming in from educational/training programs during the years of the forecast, and the result subtracted from projected requirements to estimate the final deficits and surpluses. This is essentially the procedure followed in a Dominican manpower case (see Schema 2.7).

Schema 2.6
Educational Attainment by Occupation in Target Year n

Occupation	Col. 1 Total	Col. 2 University graduate studies complete (19 yrs.)	Col. 3 First degree level university (17 yrs.) professional and higher normal	Col. 4 Sub-professional (15 yrs.)	Col. 5 Tech. complete (12 yrs.)	Col. 6 Secondary general	Col. 7 Lower normal complete (12 yrs.)	Col. 8 Primary complete (6)	Col. 9 Literacy grade (4-6)
0. Professional/science						includes those who finish 12th grade only plus those who finish 12th grade and go on to col. 2, 3, and 4 groups		includes those who finish primary plus those who go on to cols. 5, 6 and 7 groups	includes those who finish at least 4 grades plus col. 8 group
No.									
%									
1. Administrative/managers									
No.									
%									
2. Clerical									
No.									
%									
.									
.									
.									
7. Artisans									
No.									
%									
8. Operators									
No.									
%									

Note: Educational levels may be grouped in various ways. The basis is arbitrary. Here the groups are
Col. 2 includes all who finish through 19th grade.
Col. 3 includes all who finish 17th through 19th grade.
Col. 4 includes all who finish 15th grade sub-professional.
Col. 5 includes all who finish only 12th-grade technical training plus the proportion of those who finish this track and attend higher education (Both sub-professional and professional, i.e. lines 3 and 4).
Col. 6 includes all those who finish only 12th-grade general preparation plus those who go on to higher education from this track. (Because schools must produce graduates who terminate at 12 and graduates who continue on.)
Col. 7 includes all those who finish only 12th-grade lower normal plus that proportion from this track who go on to higher education.
Col. 8 includes all those who finish primary, plus those who finish grades 7 up to 12 (in the secondary tracks) plus the totals of 5, 6, and 7.
Col. 9 includes 8, plus those who finish at least 4 grades but less than a complete 6 years of primary.

Schema 2.7
Application of Outflow Rates to an Age-Stratified Occupational Group (Base Year x to Target year n)

Occupation: 0 Professional

Age group	Stock,[a] x	Outflow rate[b] x to x + 5	Outflow x to x + 5	Stock, x + 5...............	.........Stock, n
30-34	3,000	0.0282	85[c]	2915[d]	
35-39	5,000	0.0376	188	4812	
40-44	6,000	0.0625			**Note**
45-49	7,000	0.0915			Repeat process from x + 5 to x + 10, x + 10 to x + 15, until year n is reached.
.					
.					
.					
70-74	500	0.9081			
75+	120	0.6429			
Total outflows			W_1[d] Period 1, Total	W_2 Period 2, Total	

[a]fictitious
[b]from work force life table
[c]0.0282 x 3000
[d]3000 - 85

Note: The outflow by occupation can be converted to wastage by educational attainment levels because the educational attainment for the occupation is known in year x.

-- Alternatively, the planner can project the output of education and training institutions over the plan years, compare this to the projected requirements, and then add in additional requirements to allow for wastage from the original stock. There will also be some loss among new graduates who enter as workers over the course of the plan. This is the method followed in this text, and it is similar to the Chile case.

6.4 Aggregating Requirements by Education Levels (Step Five)

Schema 2.8 shows the requirements by occupations for each education level. The requirements for target-year education by occupation levels were taken from step three; outflow is added from step four; and step five is simple arithmetic. The number in the stock in the base year is subtracted from the requirements projected in the target year. To this difference is added the outflow over the intervening years (calculated for occupations within the education levels), and the final total is the requirements or demand for workers at given education levels, shown in Schema 2.8.

Schema 2.8
Demand for Education and Training

Educational Level: University Graduates
Studies Completed (19 years)

Occupation	Number year x (stock)	Number year n (projection)	Difference	Outflow x to n	Total educational requirements x to n
0 Professional	10,000	20,000	10,000	1,500	11,500
1 Administrators					
.					
.					
.					
Totals					

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Step five ends the manpower requirements projection. These estimates may then be used as targets for the education-training system. The output of the education-training system, or supply, can be compared to this demand estimate.

7.0 Comparison of Supply with Demand

To compare the requirements, or demand, with the supply or output of educational and training institutions requires a projection of the output of the education-training system. Supply is projected by applying enrollment flow models to the education and training system, as discussed in previous sections. The projected output, or supply, of the system is compared to the projected requirements to yield an estimate of deficits or surpluses in the supply of educated or trained people, as shown in Schema 2.9.

Schema 2.9
Comparison of Economic Demand and Educational Supply in Chilean Manpower Forecast

	Number Completing, 1960-1970		
	Economic demand[a]	Total supply[b]	Difference (demand-supply)
18 Grades (Univ)	12.213	6,440	+ 5,773 (deficit)
17 Grades (Univ)	38,643	25,920	+ 12,723
12 Grades (All Sec)[c]	117.952	181,570	- 63,618
6 Grades	497,539	1,063,440	- 565,901

[a] From Table 10.8.
[b] 1952 Graduate multiplied by 10 (note problems in this method)
[c] All Secondary except Feminine Technical

8.0 Employment Forecasting by the Alternate Method shown in Schema 15.1

Alternate methods of manpower requirements forecasting make use of the same essential methodologies in which a curve is

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fitted to past series data and a trend extrapolated to the future. In the Dominican case, the fit is to an exponential form:

$$D_{it} = \sum_{j=1}^{n} X_{ij} \, e^{(b_{ij} r_{tj} + Y_{tj})t} \qquad 11)$$

where:

D_{it} = requirements in occupation i, future year t;
X_{ij} = number of workers in occupation i, sector j;
e = 2.71828 . . . (Base of Natural Log System); this shows curve form;
Y_{tj} = change (increase or decrease) in number of workers (employment) in the sector j;
r_{tj} = change in productivity in sector j;
b_{ij} = elasticity coefficient which relates change in productivity in sector j to change in the numbers of workers in occupation i.

See Schema 2.10 for sample calculations.

In the Dominican case, different methods for projecting occupation and employment were used for different sectors:

i) For construction, transport, electricity/gas/water, the product for the sectors was first projected to the target year 1985, on the basis of a curve fit to past growth trends and a modification to reflect present and future expansion projects and plans.

Schema 2.10
Dominican Examples: Manufacturing Sector

Industry	Occupation		1985 extrapolation
Sugar	Engineers	Number 1970 = 22	$22\left[e^{.55(.049)} + .043\right]^{15}$ $= 22(1.07)^{15} = 22(2.759) = 61$
Textiles	Managers	Number 1970 = 62	$62\left[e^{.30(.10)} + .007\right]^{15}$ $= 62(1.037)^{15} = 62(1.7246) = 107$

ii) For the government services of education and health, employment and occupational distributions were based on population forecasts and service norms and on staffing ratios.

iii) For mining, where the sector is dominated by a few large modern enterprises, the expansion plans, including detailed manpower requirement forecasts, were incorporated directly into the general sectoral manpower requirements forecasts. Manning table data were also directly used.

8.1 Other Methodologies

There are as many other different methods or modifications of the basic methodology as there are planners and analysts at work on macro-level manpower forecasting.

8.2 Curve Fitting and Extrapolation

At the base of most alternative methods, e.g., formula 1) used in the Dominican case, are models and methods for curve fitting and extrapolation of one or more of the major components used in manpower forecasting: i) Product, ii) Productivity, or iii) Employment.

$$P_n = P_x (1 + r)^t \qquad 12)$$

Here product in year n is extrapolated on the assumption that it will increase at rate r compounded annually. An exponential curve, as in the Dominican formula, is simply the continuous function version of the compound interest formula. The same curve functions can be assumed, or fitted, in order to show increase in productivity, employment, employment in any given sector, or employment in any given occupation.

Estimates are also made on the basis of regression analysis, simple (single independent or "predictor" variable) or multiple (more than one independent):

$$P = a + bX \qquad 13)$$

A common practice is to fit the output or dependent variable (say, product) to a series of annual outputs in past years (where X stands for the year). With the constant a estimated, and with the parameter b coefficient, the analyst can substitute a future year X and extrapolate the product estimate.

$$P = a + b_1X_1 + b_2X_2 + \ldots b_nX_n \qquad 14)$$

Here the X_1, X_2, etc., independent variables are other variables that are related to the dependent variable product, for example, investment in capital, capital/output ratios . . . and can be used to estimate the parameters for future year forecasts.

8.3 Beyond Curve Fitting and Extrapolation

Many economic forecasts use regression analysis based on single equations models, and basically on one stage least squares. Curve fits or extrapolations from serial data have a similar underlying mathematical logic and similar limitations in the matter of dealing with simultaneity among variables, where the solution of one variable affects the values of another variable, and this is not accounted for in single-stage analysis. The package Forecast Master offers the analyst a wide variety of curve fits and tests for applying to serial data used in economic projections for planning.

Planning has also been based on sets of linear difference equations where the solution or assignment of value to one variable leads successively to the solution of other variables over time. Tinbergen pioneered in the development of this form of econometric modeling (1958); Tinbergen and Bos (1965) developed linear difference equation models for estimating and projecting manpower requirements and educational outputs in terms of economic growth. The path was simple:

i) Manpower with a given level of education was expressed as a linear function (by a coefficient of proportionality) of growth in product (as set in economic plan targets).

ii) The numbers in manpower/education-level categories were traced from step i) back to required levels of flow and output in the education, given: the numbers in the work force with a given level of education in a previous period; the numbers required to enter the work force to replace educated workers dying or retiring; and the numbers of educated workers needed for teachers (based on teacher/pupil ratios).

iii) Once base-period values of educated people in the work force were set, plan targets in economic growth set, staffing and technological ratios set (teacher/pupil ratios), and wastage rates estimated from past data, the analyst could substitute values and solve his way through the equation system in terms of prior period values.

One problem is that there were interaction and simultaneity in the system that were not adequately reflected in any single equation or single-stage analytic models, and planners moved to get around this with econometric models and dynamic programming models. The dynamic models will be discussed in later papers. Davis (1987, Ch. 10) explains and illustrates the other models.

8.4 A Note on Econometric Models

Econometric models are sets of linked linear equations that are solved simultaneously in order to obtain the value of an endogenous variable (solved within the model system) from the value of an exogenous variable(s) that has been previously estimated or assigned a value on the basis of other knowledge. For example, enrollment can be estimated on the basis of economic demand (taken from plan growth targets), and social demand estimated on the basis of a regression equation where the independent variables are X1 (population in school age), X2 (literacy level), X3 (income level) . . . The model is stated in terms of structural equations which represent the real world system modeled. The equations are solved so that the result is a reduced form equation in which the endogenous variable (variable of interest to be solved for) are stated as a function of exogenous variables that can be estimated from real-world data by regression. The regression analysis is performed in the first stage of the model solution, and the values substituted into the reduced form equations and a second-stage least-squares run to estimate the value of the endogenous variable. The endogenous variable value can then be used in a projection of future values in terms of changes in independent variables or estimators. There are some statistical problems in using the estimates, the main ones being multicollinearity (variables in the predictor set are highly correlated with each other), heteroscedasticity (error terms correlated), and autocorrelation (correlation in one variable value over time series). The magnitude and effect of these errors in time series data on which econometric models are based can be estimated using Forecast Master which has Durbin-Watson, A/C, and other tests.

8.5 Systems Dynamic Models

Systems dynamic models, the name, is associated with Jay Forester (1965, 1968, 1971) who applied the models and concepts to industrial engineering (where the level of the variables over time was the point of interest). He attempted to get around the problem of simultaneity in equation sets by modeling the system as a set of integral equations in continuous time, where the interval dt was taken so small as to approach simultaneity and the values are solved for serially but with simultaneity simulated, using numerical approximations (Euler's method) from calculus to evaluate the series values. Systems dynamic models were programmed for large computers, using Dynamo (Pugh, 1981), and more recently for PCs using Stella (Richmond, 1985). The uses of Stella will be explored in later papers.

9.0 Closing Comment on Forecasting Component Models

Econometric models and systems dynamic models applied to both macro- and micro-level analysis in educational planning are also covered more comprehensively in Davis (1987, Ch. 10). The Bridges Project will require models for linking macro-level models and methods of planning and policy analysis to the micro-level research and evaluation of teaching/learning required for program-level design and planning. Thus, an extensive review of systems dynamic modeling at macro level will be included in the following chapters.

9.1 Comprehensive Models

Comprehensive models may link all demographic, economic, and school component forecasts within a single systematically related structure or system in which process in one part of the system affects process in another. At any given time the planner may be interested mainly in only one components forecast model. In theory, synoptic planning favors comprehensive models in which all major components are assembled and linked; but practice may favor forecasts of one component at a time, either because of limited interest or need, or limited data and time.

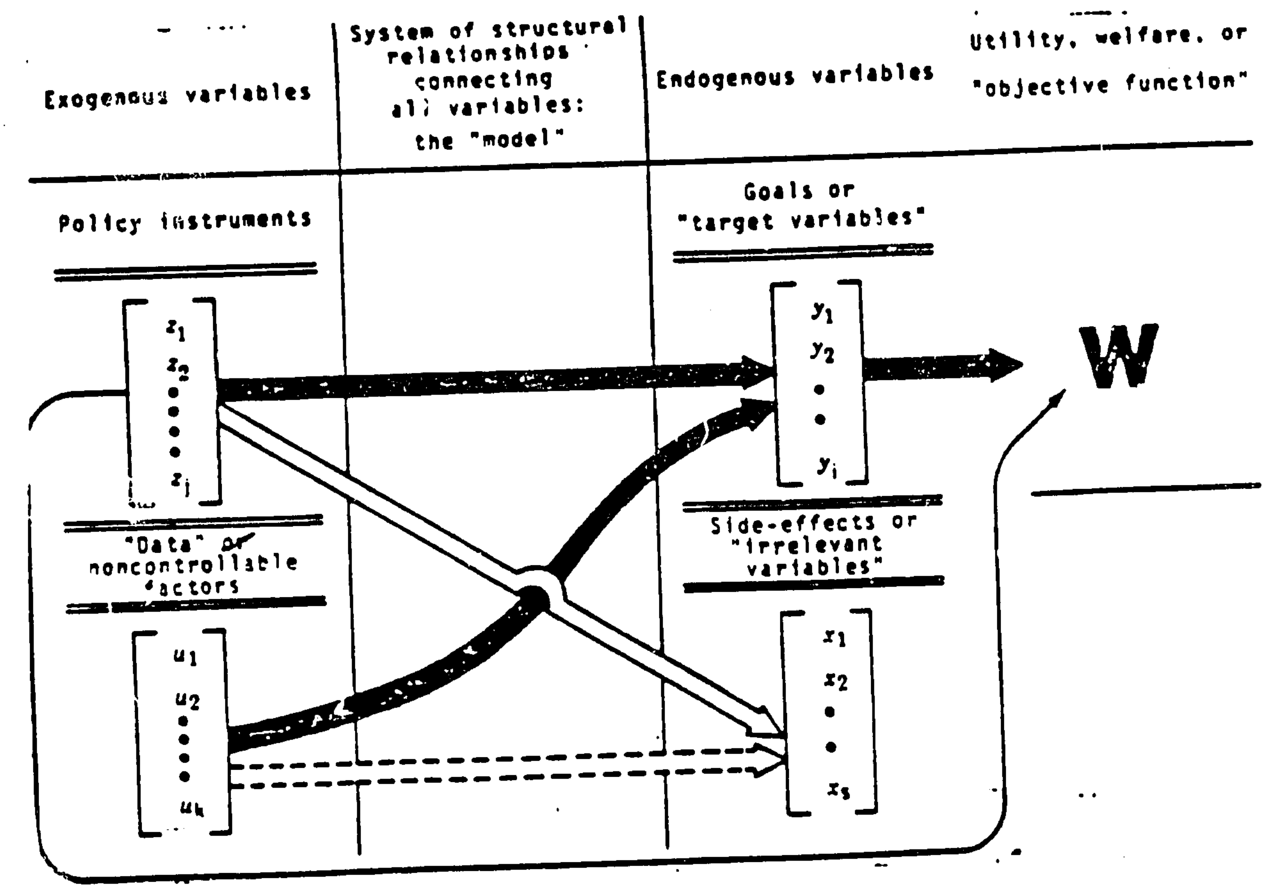
Chapter Four

State Of The Art Models

1.0 Models and Modeling Packages For Institution And Systems Planning

A model must be simple to serve its main purpose--to represent and depict a more complex reality in a simpler and more graphic form. The graphic models of complex socioeconomic systems serve best when they are uncluttered but comprehensive, as Figure 4.1, which Fox is (1868) and Tinbergen's (1952,1956) representation of a large and complex socioeconomic system.

Figure 4.1 Socioeconomic Systems Model



Source: Fox,K and J.K.SenGupta,"The Specification of Econometric Models for Planning Educational Systems", Kyklos v 21, p 665-695

The model is a system of structural relationships which connect all variables; exogenous variables that can be controlled by policy and program instruments, and factors that cannot be controlled; outcome or endogenous variables, including intended, target or goal variables; and variables that take on values side-effects, unintended, or irrelevant consequences.

The simple model of a complex socioeconomic system in Figure 1, has several features to note: i)the model is very general and can represent an institutional system or a school system; ii)to be general, the model must also be abstract and show few specific and situational details; iii)the model is graphic and shows antecedents and consequences clearly; iv)the model is simple. Because simplicity is a characteristic of useful systems models in graphic form, simplicity became a major characteristic of the systems for developing models for social systems planning. In the case of educational planning, simplicity became the mark of models for both institutional and school systems planning. To accomplish this, an approach of breathtaking simplicity came to dominate the state-of-the-art in the development and use of educational planning models. This was embodied in the spreadsheet matrix of rows and columns, an approach to modeling, that will bestop covered here.

Alas, simpler models and simpler modeling systems did not always lead to models that are truer to the richness of life. Something had to be sacrificed to cram the world into a matrix of rows and columns. Weathersby's model (1971, 1974) suggests two main fatures that were left out of simplified deterministic, systems modeling--the value system from which the modeler views the system he is modeling, and the uncertainty structure which is conditioned by the amount, kind and quality of information the modeler has about the system. The Weathersby model, incorporating this more comprehensive and subjective view of modeling, has been banished to Annex A of this chapter, in recognition of the fact that however attractive the model is, it was never implemented with data, much less appled in policy analysis and planning. Simple spreadsheet models were and are used; and it is to these we turn

1. The Transition to Simple and Flexible Spreadsheet Models

The large models described variously as systems models, cost simulation models (large), allocation models, financial planning models, or insitutional planning models evolved toward simpler rather than more complicated structures; as use in planning practice indicated the need for simpler model structures, more flexible and locally adaptive modeling process, more realistic data input demands, and less formidable technical demands on designers, planners and decision makers. Technology also played its part, through development of computer hardware and simpler and more user friendly software. A central development was in overlaying the model on a matrix (rows and columns) in a spreadsheet modeling package. From this, two lines of model developments branched: i)to large, elaborated systems (installed on mainframes for interactive use); and ii)to PC spreadsheet program packages, offering maximum simplicity and accessibility.

1.1 Spreadsheet Based Modeling System Developments

The two major branches of development are at base the same--the model represents the real world system by laying it out in rows and columns. When the model is applied to planning, the most convenient and powerfully simple notion is:

Variables in the Rows;

Time Periods in the Columns.

The Variables that characterize the status of the system and the variables that show growth in these variables are named and written in the rows; and changes in the status variables over time result when change rates are multiplied by status variables. These appear in the columns opposite the rows. Schema 4.1 is a typical spreadsheet model array. The simple structure is:

Columns/Time Periods

Year 1985 Year 1986 Year 1987.. Year n

Rows/Variables

1.FTE (student enrollment)

2.Tuition Rate

3.Tuition Income

4.GFTE (growth Rate FTE)
etc.

The model designer builds by linking variables to each other (within periods); for example in Schema 4.1, Variable 1 = Variable 3 X Variable 10; and Variable 10 is the sum of Variable 1 + Variable 2. Tuition Income derives from multiplying the total number of students by the tuition per student. Growth rate variables drive status variable values over time; e.g. base Year Freshman enrollment is 100. Enrollment projections or plan targets indicate that Freshmen enrollment will increase by 10% annually. Thus, the 1986 FTE enrollment will be 100 X 1.1 or 110. If the tuition rate is likely to increase, a variable GTUIT is introduced. The model is built up by identifying variables, linking them among themselves within time periods, and linking them across the time periods with growth rates.

The main branches of spreadsheet model development were: a)Large matrix-based, spreadsheet types of interactive modeling systems that began with TRADES at Stanford, and were developed for more general planning use (GENTRA) in other institutions, culminating in general modeling systems. These were basically spreadsheet type, but with elaborated analytic and decision support structures and report and graphics generation systems added on. EFPM (EDUCOM Financial Planning Model) and IFPS (Interactive Financial Planning Systems) are examples of later developments.

EFPM was developed and sponsored by EDUCOM an inter-

University computer and electronic communication consortium, that opted to mount its modeling system on large manframe computers (Cornell and Rice universities were two centers) that were accessible by phone links (Tymnet and Telenet). IFPS, developed systems that could be installed and accessed locally and interactively in institution-based CMS systems (e.g. VMS 370 at Harvard); and recently IFPS Personal, for use on PC's, has been marketed. Thus the two development streams merge in the PC.

b)Developments based on PC spreadsheet models, which began with the pioneering VisiCalc program, spawned a host of more elaborated spreadsheet programs, such as MultiPlan, Report Manager, Super-Calc; and the integrated systems (spreadsheet-Database-graphics...) LOTUS 123, and succeeding improvements.

At this time, LOTUS 123 is the most widely used by planners; but the fashion and state of the art change constantly.

Three main modeling package features go beyond the basic spreadsheet matrix structure:

1)LOTUS 123, Symphony, later versions of MultiPlan and other packages introduced and developed <u>integration</u>, i.e.incorporating data base management capability and graphivs with the basic spreadsheet feature. In the case of Symphony, export and import of data is facilitated by having a communications package for managing MODEM exchange with external computers and networks. These integrated packages interface with wordprocessing problems <u>and all</u> the THESAURUS and search features these bring.

2)Javelin and packages to come break out of the spreadsheet structure by offering multiple alternative formulations of relationships and multiple perspectives and views. The probing and investigating of an expert observer are simulated, the approach moves towards an expert system.

3)The decision support features of the large, MAINFRAME spreadsheet models; goal seeking and traceback; sensitivity and impact analysis and more systematic formulation of structured hypotheses sets and series of what-ifs, are now thought to PC packages, a prime example being IFPS Personal.

4)The trend is to incorporate more of the flexible, rich and subtle, but at the same time, systematic, repertoire of 'expert systems' approaches to modeling. Where this will stop or indeed, whether it will stop, is difficult to predict.

1.2.0 The Main Features of the Spreadsheet Models

Apart from the general matrix structure, Variables (Rows) X Time Periods (Columns), most spreadsheet models share these characteristics, when used by educational planners: a)simpler model structures that are easier for the non technician to understand and work with; b)simpler models that require less elaborate data as input; c)interactive process that attempts to bring model designers, users, decision makers and client beneficiaries into the modeling process.

1.2.1 Simplicity and Parsimony in Systems Description

By dealing with fewer and more central variables, the models became more open and easier to understand, and also required less data as input to the model. In developing these models, system analyst/planners must make an explicit effort at the outset, not merely to list all possible systems descriptor variables down the rows, but to identify the main, or primary planning variables that characterize and drive the system over time. In early Stanford models (TRADES and GENTRA) and in EFPM, the term Primary Planning Variables (PPV's) was used and this is a good term to concentrate on, in understanding, what drives a system. Parsimony means that only main system variables (systems movers and shakers) are identified, listed and manipulated. This is a fundamental requirement in modeling, insures clarity and focus and aids designers, users and clients. It also reduces the size of computer models and makes the models easier to manipulate in hands-on interactive use. Thus, another "BIG" feature of spreadsheet model is: interactive (Hands-On) Use.

1.2.2 Interactive Character of Modeling Systems

An early objective in model development was to make the modeling process interactive: first through direct interface of the designer/user in manipulating model values, directly observing changes in the system, and adjusting objectives and system variable values and parameters accordingly; secondly, by bringing decision makers and clients affected by the system into direct interaction with the model, when they set their own objectives, or changed variable values and parameters to achieve objectives within realistic system constraints (time, cost).

More recently concepts central to the notion of PROTOTYPING the values and technics PROTOTYPING brings to systems design and decision support systems, puts end-user participation into the very first steps of the process. This last feature, full client participation, first-to-last, top-to-bottom, has never been achieved, but it remains a prime goal.

Early model developments, CAP:SC (Computer Assisted Planning: Small Colleges), SEARCH (System for Exploring Alternative Resource Commitments in Higher Education), and Thompson's model (Washington, 1970) were attempts to open up and enhance participation in planning by making models simpler and more accessible to non technicians. HELP/PLAN TRAN (Midwest Research Institute, 1972) was both a simple and adaptable earlier format to aid in simplifying planning, and a format for generalized institutional use, i.e. a format or system for creating a tailor-made model to fit a given institution. With this feature, the early systems were moving toward later spreadsheet systems, but either they lacked the size and capacity of EFPM and the spreadsheets, or they were not as fully interactive in process. CAMPUS CONNECT, a later development of CAMPUS (cf previous chapter) attempted to keep size and disaggregation (specificity by programs and levels) and introduce some interactive flexibility, but the data requirements for such models were still burdensome; and for this they were criticized by Hopkins (1982), and others. Practitioners did not use the models when the press of daily work made it difficult to gather data that was not in a form for immediate input use. Mashand (1984), Lewis (1972), Risan's survey (1986) indicates little use of information systems in school district management in the US (1986). Facts and the conventional wisdom of practice gleaned on the second bounce, in direct exchanges of opinion among educator colleagues, topical fads, and fashions of the day in "professional" educational circles, external political and community pressures and budget constrints, all shaped school practice and management more than did survey research results, systematic evaluation of programs, or policy analysis. Data from research was little used in practice.

1.2.3. Changed Information Requirements

In the newer simpler models, data and system information requirements were reduced, simplified, and individualized. In the models, less data is needed; and simpler, institutionally specific information can be used. This results from greater simplicity in structure (fewer variables and relationships), which made the models more flexible and adaptible to local institutions, and increased openness and interactive process in modeling.

For all these reasons, "spreadsheet time" had arrived. Powerful hypothesis testing could be done, simply by changing one key variable value, growth rate or coefficient; and the effects observed throughout the system, and over time. This is the central key to the power of the spreadsheet model.

1.3.0 Development at Stanford

A series of models developed at Stanford by Hopkins, Massey and Dickmeyer were developed in the actual practice of management, planning and budgeting. While this field of model development was going forward in university management, spreadsheet modeling and Visicalc applications were being explored in business planning.

1.3.1 Models Developed at Stanford Prior to TRADEOFF Model

1)The Budget Adjustment Program (BAPO adjusted to achieve an operating balance over a plan period, by reducing expenditures and incresing income; 2)The Long-Range Financial Forecasting Model forecast over a five year period--expenses, income and the difference or balance between them (deficit/surplus). This forecast feature was central to later models; 3)The TRANS (transition toward balance) models combined forecasting and the tracing of equilibrium paths over time; 4)The Long Run Financial Equilibrium (LRFE) used the condition of balance (equilibrium) between expenditure and income as a binding constriant to solve for the rates of increase in income and expense necessary to achieve balance over the plan period. This constraint feature, developed later in EFPM, allowed analysts to study TRADEOFFS among key income and expenditure values, and the rate necessary to achieve balance.

1.3.2 The Basic Features of Modeling the new forms of model development required planners to identify the key variables, the primary planning variables that determined over time the income and expenditures of the educational system or institution being modeled. Some variables are PPV's (Primary Planning Variables) in any institution: FTE enrollments, tuition rates, state subsidies or endowment income on the income side; faculty types, numbers and average salaries on the expenditure side. In identifying the 10-20 PPV's, analysts study the essential structural characteristics and dynamics of the institution. The Primary Planning Variables are related to each other in technological equations. The variables or parameter values are set on the basis of system targets or norms (input ratios, e.g. staff/students) or derived from research or evaluation carried on in linked sub routines.

The essentials of newer planning were:

i)Primary Planning Variables (that drive income/expenditures in the system) are first identified.

ii)The variables are linked through equations i.e. student enrollments in a three year program add up to total enrollments; or through coefficients (33 students/teachers = .33) iii)The values of the Primary Planning Variables will change over time, and the estimated or projected changes are shown in the form of growth rates that are estimated or set. The way the system develops over the plan path is determined by the base year value of the key variables, the relationships among variables, and the growth or change in variables over the plan period.

1.3.3 Forecasts

Planners and analysts could put in policy hypotheses in the form of a changed base year variable values, increased or decreased growth rates or changed technological cioefficients. The model could then forecast future values in key variables in terms of changes in other related variables. Using a constraint--the need for balance between income and expenditures--the impacts of one variable(s) on another could be analyzed, and the sensitivity of one variable to changes in another variable studied, e.g. the increased need for student aid related to increase in tuition.

1.3.4 Tradeoff

Tradeoff was a feature of the analysis. The models forecast changes in income and expenditure and studied impacts, sensitivities and tradeoffs among primary planning variables, e.g. how much faculty salary must increase (fall), if tuition raises (falls), when the system is constrained to show a positive

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budget balance over the time period. Or the models tracked chains of related changes: If tuition rises and income increases, student need rises and student aid must increase; How will this tradeoff? TRADES first developed for Stanford evolved into a more general form, GENTRA, and in 1981 the general modeling system EFPM was being distributed through EDUCOM, the Inter-university Communications Council based in Princeton, New Jersey.

2.0 University Financial Planning Model: Spreadsheet Systems and EFPM

A university financial planning model is a coherent set of statements linking the variables which affect income and expenditures in the institutional system, so that variables and parameter values can be manipulated to forecast future states of the system and to make choice and tradeoff decisions between alternatives. EFPM is a system for creating university financial planning models.

2.1 Spreadsheet Models for Financial Planning: The Simple Structure

Models and modeling systems for financial planning are based on a simple spreadsheet structure, with variables in the rows and time periods in the columns. The values of the key variables are forecast over the time periods. The basic EDUCOM model was shown in figure 4.1. Schema 4.2 shows a spreadsheet model in EFPM language and format.

Schema 4.1 Spread Sheet Structure of Financial Planning Model Systems

	Time Periods (Years)					
	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5....
Key Planning Variables: Independent						
Enrollment by level or grades						
1. Freshmen	100	110	123	etc.		
2. Sophomores	95					
3. Tuition Rate	$5000					
4. Number of Faculty	43					
etc.						

Dependent Variables (examples)

10. FTE Enrollment (= 1+2+ ....)	These values are calculated from independent variable values, (e.g. 100 + 95 = 195)
11. Tuition Income (= 3 X 10) etc.	Or calculated on the basis of other dependent variable values, calculated originally from independent variables, e.g. (Tuition income = variable 10 X variable 3 = 195 X $5000)

Growth Variables

12. Growth rate Freshmen etc/	10% (These growth rates are applied to independent variable values over period of forecast, e.g. Freshmen in period 2 = 100 X 1.1 = 110)

Schema 4.2: EFPM Model Structure: Small, Illustrative Model

1	FROSH	100.0	0	FRESHMEN
2	SOPH	90.0	0	SOPHMORES
3	JUN	85.0	0	JUNIORS
4	SENIORS	80.0	0	SENIORS
6	TFTE		0	TOAL ENROLLED (FTE)
7	TUITRA	8.0000	3	TUITIONRATE
8	TUINC		0	TUITIONINCOME
9	FACFTE	38.0	0	FTEFACULTY
10	AVFASAL	30.0000	3	AVERAGEFACULTY SALARY
11	SALCOST		0	SALARYCOST
12	OTHEX	732.0	0	OTHEREXPENSE
13	TOEXP		0	TOTALEXPENSE
14	BALANCE		0	FUNDBALANCE
15	RETSO	90.000%	P	RETENTION SOPHMORES
16	RETJR	90.000%	P	RETENTION JUNIORS
17	RETSR	92.000%	P	RETENTION SENIORS
18	OTHEIN	760.0001	3	OTHER INCOME
19	GTUIRA	7.000%	P	GROWTHTUITIONRATE
20	GFACFTE	10.000%	P	GROWTHFACULTY
21	GFACSAL	12.000%	P	GROWTHFACULTYSALARY
22	TOINC		0	TOTAL INCOME
23	GFRESH	10.000%	P	GROWTHFRESHMEN

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Other variables continue

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BUDGET FUNCTIONS

6 TFTE	+ 1. Frosh	2 Sophs	3 Juniors	4 Seniors	(Total Enrolled)
8 TUINC	* 6 TFTE	7 TUITRA			(Tuition Incom)
22 TOINC	+ 8 TUINC	18 OTHEIN			(Total Income)

GROWTH FUNCTIONS

1	G	G Fresh	(Growth of Freshmen)
7	G	G TuiRa	(Growth Tuition Rate)

Note: Budget functions being dependent variables(result from operations o other independent variables) have 0 value in base period(above)
In TFTE the sum function is written: + followed by variables added.
In TUINC, the product is written: * followed by variables multiplied
Growth functions are written: Variable(that increases, e.g. FRESH);
G, the sign of the growth function, and GFRESH, the growth rate

2.1.1 Building the Model

The Model is built by writing Variables and Equation Formulas and Growth Formulas.

BRIEF METHODOLOGICAL NOTE ON GALILEO

R. G. Davis

Galileo is simpler to understand when it is first described in nontechnical terms in a problem situation. To determine the values, goals, and attitudes or views of one or more relevant social groups, the Galileo method proceeds through several stages:

1. Explores the topical or thematic structure of the situation with a questionnaire:

(a) A representative (random or stratified-random) sample is drawn from a population defined on the basis of its relevance to the issue under inquiry.

(b) An open-ended questionnaire, interview, or issue discussion is conducted with the group(s) identified and sampled.

(c) An analysis, called a "content analysis" in the usual imprecise manner of use of this term, is performed on the results of the interview (actually, the response record is scanned in a semi-systematic way to identify the basic list of concepts, themes, issues, and values that run through the interviews). This list of concept terms is then the basis for the questionnaire applied in the second stage.

2. A second survey is made, based on a random sample of subjects relevant to the inquiry, and in this survey the respondent groups are asked to make paired comparisons of the concepts in the list derived from the first phase:

(a) The list of concept terms from the first analysis, and sometimes some additional concepts felt to be relevant the study, are presented to one or more groups whose opinions, attitudes, or values are relevant to the study.

(b) The group(s) are asked to judge pairs of concepts on the basis of perceived difference or distance from each other.

(c) To provide a metric framework for judgment, the groups are given a reference pair distance, e.g., if the distance between a minimum performance and a maximum was 100, how would you judge the distance between X concept and Y concept?

(d) Galileo translates the (criterion-referenced) distances between pairs of concepts drawn from the list into physical distances. Each concept is paired against every other concept and the distance between all pairs judged.

(e) Galileo computes the average distance for each concept pair and arrays them in a triangular matrix, with 0's on the diagonal (no distance, since the same concept is on the row and column for the diagonal, and X11 distance is)), and the pair distance averages on the off diagonals.

(f) As an interesting first step, average distances between the pairs can be compared as a basis for judging how disparate or similar the concepts are judged to be. This provides some basis for judging the importance of each value when compared with some basic criterion-referenced value included in the list. An important example, the person

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judging--"self" or "you"--can be put in as one member of the pair for comparison with other objects, topics, or pair members; and distance between self and other objects compared. These can then be compared for different relevant reference groups, i.e., planners or parents, or public . . . The same comparisons can be made using a basic value preference and other objects or preferences represented in the list.

3. Analyzing the underlying value structure by factor analysis:

(a) The average distance matrix can be transformed into a scalar products matrix (with 0 on diagonals) and principal components (a more basic set of composite variables) obtained.

(b) Principal components of the matrix result, just as in factor analysis, by reducing the number of observed distances in the original set of paired concepts into a smaller number of basic component dimensions, chosen as "fitting" on the basis of orthogonality (they lie in a reference framework that is maximally different in terms of reference axes at right angles), and the chosen set explains the maximal amount of distance.

(c) The new components, constructed variables, can then be used as coordinate reference frameworks to map concepts in space, i.e., the closer they lie, the more similar they are judged; and conversely for distance and difference. Concepts are then mapped for similarity or difference in terms of physical proximity or distance. These can be used to frame and identify goal structures; to separate goal frameworks according to defined groups and their differences in judging distance and proximity among concepts, i.e., different groups may have an entirely different world of values mapped. The differences can also be monitored and assessed over time, and changes referenced to external events that affect them. When values differ significantly in distance for different groups, this difference will have significant affects in social plan implementation. Group goals that are very different bode ill for social cooperation and portend goal deflection in social plans, as when bureaucrats, politicians, and the public differ. When a value lies outside or distant from other clusters or structures of values, this may suggest that the isolated concept or value has little resonance at all for the group judging.

Galileo serves planning by:

1. Clarifying social issues and identifying agreement or disagreement on key issues that affect plans.

2. Clarifying social needs and perceptions of needs.

3. Clarifying social values.

4. Clarifying goals in terms of needs and values and perceived priorities for solutions.

5. Identifying social trade-offs when resource constraints do not permit full accomplishment of desired goals. This means providing a basis for satisfying when optimization is unrealistic.

6. All of the above, which apply mainly to goals, apply also to strategies, policies, and programs, and to assessing

consensus in evaluating the outcomes of plans and programs and the order of priority of next steps.

7. Galileo permits status assessment of attitudes, assessed cross-sectionally, and changes in group attitudes over time.

OPERATION OF THE GALILEO SYSTEM

Woelfel (1985) describes the computerized operation of the system:

1. The first step in the process is to identify the words or symbols which mark off the "neighborhood" where the object to be defined can be found. This is done by a series of in-depth interviews which can be conducted by phone. In the interviews, respondents are encouraged to discuss the object in as much detail as they wish.

2. Complete verbatim transcripts of interviews are entered into the computer where a series of programs (Galileo*CATPAC [tm]) parses the text, strips away structural words, and counts the remaining substantives which are searched for clusters using a diameter-method clustering algorithm; and dendograms describing the structures are produced. These clusters are the "markers" which define the neighborhood of the object to be defined.

3. The next step is to measure the relations of each of the marker concepts to the object in question and to each other. This is done by ratio-scaled paired comparisons of each

object with all others, using the format produced by a sequence of programs, Galileo*AQM.

4. Interviewers again present the paired comparisons to a sample of respondents and enter the answers directly into the system, using another series of programs, Galileo*SPED.

5. The system then produces spatial representations of the objects so that the distance between any pair of objects in the space is identical to its average measured dissimilarity. Simple tabular arrays of the distances are also produced with statistical information on precision of estimates. Interaction with the mainframe components of the Galileo system is by means of a menu-drive computer interface called Galileo*TELEGAL(tm).

Menu

1 Instructions	8 Develop Message Strategies
2 Enter Interview Data	9 Plot
3 CATPAC(tm)	10 Display Concept Sizes
4 Galileo(tm) Questionnaire	11 Display Standard Errors
5 Enter Galileo(tm) Data	12 Estimate Cost of Job
6 Runstream for Galileo(tm) v5.2	13 Leave a Message
7 Run the Job	14 Goodby2

Reports are delivered to users through telephone or computer system with Galileo software. A typical system is the CATS (Community Attitudes Toward SUNY) developed to monitor perceptions of STATE University of New York.

THE GALILEO MODEL

A REVIEW AND COMMENT

Gary Ewert
Carla Linton

> This theoretical model, often called the "Galileo" model, defines cognitive and cultural processes as changes in the relations among sets of cultural "objects" or concepts. The interrelationships among these objects are themselves measured by magnitude estimation pair comparisons, and the resulting dissimilarities matrices are entered into metric multidimensional scaling programs. The result of this work is that each of the cultural objects is then represented as a point in a multidimensional Riemann space. Cognitive and cultural processes may be defined within this framework as motions of these objects relative to the other objects within the space.
>
> J. Woelfel* and E. L. Fink, <u>The Measurement of Communication Processes: Galileo Theory and Method</u> (New York: Academic Press, 1980, p. x).

* We wish to express our gratitude to Joe Woelfel and his many colleagues for generously sharing their insights and time.

1.0 INTRODUCTION TO GALILEO

The Galileo Model is a multivariate technique for developing mathematical and graphical representations of social consensus about group attitudes on a specified topic of interest. It is the application of metric multidimensional scaling technique in which the variables relevant to a chosen topic of interest are judged pairwise for distance from each other, in order to construct an underlying structure of difference/similarity. All variables are criterion variables. The metric multidimensional scaling capitalizes on spatial separations and provides an analogy of physical mechanics in the social sciences.

Fundamental to the use of multidimensional scaling techniques is the development of distances, which in the Galileo Model is accomplished by asking people to estimate the amount of difference, in a unit-referenced manner, between each possible pair of concepts in a topic set. The concepts usually number about fifteen in a topic set, and the differences between and among all concepts are averaged across all respondents to develop the social meaning of each concept in reference to each other concept. The "self" as a concept is typically included to provide a reference point for the closeness of concepts to the individual which is often taken as desirability. The aggregated differences are used to develop a coordinate system in multidimensional space so that the distances among the concepts in

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the space equal the differences among them as perceived by the average person in the sample (Craig, 1983).

The topic is simply the specific area of interest, and the topic set of concepts is developed from open-ended interviews with sample respondents. The use of the social group as the basis for developing the topic concepts is to ensure that the topic set includes all relevant concepts around that specific topic. The resultant "map" therefore reflects the social consensus about the meaning of all concepts in the topic set in relation to all other concepts.

Galileo is both a theory and a measurement model. The theory deals with the structure and development of social cognitive space, the assumption of meaning being relational and situational. The measurement deals with the "mapping" of this socially meaningful reality. While the emphasis in this paper is on the measurement aspect of Galileo, Section 4 does deal with some aspects of the theory as it relates to the measurement component.

2.0 POLICY AND PLANNING PERSPECTIVE

2.1 Introduction

A review of the literature in the area of policy will lead the reader into policy formation and analysis, policy implementation, and policy evaluation. It will lead into social indicator models, through political science, into ethical philosophy, communication theories, and social/cultural models of change. At times the reader will be exposed to broad social policies being squeezed into narrow econometric analyses in the name of rationality and at other times see narrow rules referred to as policies which are not subjected to appropriately rigorous cost/benefit analysis. There is little consistency in the use of the term policy, even in the context of education. This overview section provides a conceptual context for mapping social reality in policy, as policy is understood in the framework of this paper.

2.2 Perspectives on Policy

An individual working on policy matters--education policy, for example--develops a working definition of what policy is, based on his experiences. These experiences have typically occurred at a particular level of involvement, such as the national, sectoral, system, or institutional levels of education policy development. The experiences may often prove frustrating. Well-planned policies, designed to assist others, may be mistrusted by the intended recipients or subverted by petty bureaucrats. This is too facile an analysis of why policies fail. The reasons lie deeper in the types of assumptions made by those seeking to formulate and design the policies. What do they believe is important? What is real for the people affected? What do both want, and what are their priorities? These questions point toward many of the assumptions that are often implicit and unarticulated in the early stages of development of policy issues.

Many of the articles on educational policy, referenced in ERIC, refer to school systems or post-secondary institutions and their operation, and do not deal with the implicit values that share the problem definitions of policy workers and decision maker. The treatment of the policy process refers to detailed prescription and techniques rather than issues that national education policy workers recognize as pertinent to policy statements or policy development models. National-level policy workers would view much of what is presented as policy more as specific guidelines and procedures. Policy workers at school levels would view national policies more as statements of principle than of policy. While this discussion focuses on national-level policy, it recognizes the need for planning, implementing, and evaluating policy effectiveness at all levels of policy activity. The methodological approach of Galileo is applicable to any level of policy activity.

2.3 Education Policy

Education policy is one sector of social policy which gives broad direction to educational goals. But total social policy is broader and represents the main goals to which society aspires (Hayes, 1979). Davis (1980) emphasizes the linkages of education policy with the economic and social needs of society, particularly at the level of goals. This linkage includes political and ideological factors and ultimately emerges as an expression of a society's aspirations, needs, and judgments as to where they are going. These expressions of social goals for education include implicit or explicit assumptions about cause and effect in terms of using educational resources to achieve their cultural values expressed as social goals. Education must deal with both the developing child and the training of adults for skilled labor. The disadvantage is that education is viewed as a "quick fix" in short training programs to reduce unemployment, and as a long-term solution to social and economic problems, as in the education and development of the child. The educator feels frustrated that society expects immediate results from any investment in education, particularly if resources are scarce, and yet the development of the child into an adult takes time, and payoff may be long deferred.

Education policy is usually expressed through legislation and associated regulations, laws, and governance structures. In these instances, cultural sanctions overlay the larger social goals on education policy, and delimit the range of acceptable options by setting discretionary guidelines within which schools mount programs to achieve the ideals that society has established for them. These restrictions may reflect a societal attempt to deal with the role of the whole society as the ultimate arbiter of education policy, while recognizing that only a few individuals actually articulate and attempt to institutionalize the essential social values in education policy. Another view is that these restrictions constrain the pursuit of one social goal at the expense of others, such as achieving energy self-sufficiency at the expense of quality of life goals. In any educational context, even in wealthy nations, to provide equal education to each person would be impossibly expensive. Arbitrary guidelines for government funding may even constrain the achievement of educational goals oriented to achieving equality of opportunity.

The ebb and flow of educational goals, as the conservative-liberal or economic boom-bust cycles dominate social priorities, requires attention. In good economic times there is more concern for equity and equality, and there are funds to match concerns. In poor economic times, conservative concerns arise and there is more stress on excellence (Tyack, 1983). Federal retrenchment in support and lean times in education in the United States during recent years is an example of conservative priorities for the lean years. Tyack points out that both cycles are hailed as education "reform." Education is conceptualized as separate from society. Since it is not possible to admit that society needs reform, education must be reformed. It becomes a surrogate for dealing with the real, perhaps unknown or perhaps simply uncontrollable external, causes of economic and social problems.

In effect, education policy is an attempt to achieve an idealized future social reality, particular to the cultural notion of the idea, and particular to the perceived current social reality. Whether this future is three months, twelve years, or a generation away, the assumption of fundamental cause and effect relationships between education policies and socio-economic goals determines that education policies will tend to change in response to changing social, economic, and technological conditions. Although the perceived linkage between education and broad socioeconomic goals changes through time and by level and type of education, it is clear that the linkage reflects either a societal hope that education will make the future better, or bitterness because education has not yet opened the doors to prosperity for all. The challenge for those involved in education is to be the recipient of both the hopes of the people and also to bear the brunt of public disenchantment in periods of economic slump. Schools are ever emerging, phoenix-like, to become the hope for future promise that is always receding. The inexhaustible faith in education as the path to a better society is a continuing source of wonder, given the continuing inability of education to "solve" the problems of any society.

2.4 Current Education Policy/Planning Difficulties

Laying aside for the moment the tremendous practical impediments inherent in using education as a preventative of social pathology, a major policy and planning bar that prevents education from solving the problems of society is that education is not planned on the basis of an empirically established social reality. The lack of an empirical basis for understanding the condition (social problem) or the treatment (education) has led to ritualized behavior. Universal and compulsory school attendance is ritualistically supported by a belief that, perhaps magically, each individual will somehow be socially freed and economically empowered. Almost all modern societies do seem to believe that education is an emancipating activity. One question is, why has education failed to live up to expectations? Another question is, how has such an oft-disappointed expectation endured?

One critical necessity for achieving social goals is first to establish them empirically, and then to monitor the current and idealized social realities of a culture as a basis for policy setting. For the education sector, the approach should resemble grocery shopping: (1) Review the facts of the situation--review your family's needs and available resources in order to determine what to buy and where to go to buy it; (2) Review the means and consequences: to go now means less crowded stores; to go to one store is easier than a trip to another; to buy steak now means macaroni the rest of the week; to get some items on sale in one store means missing bargains in other stores--there are tradeoffs; (3) Integrate general known causal relationships with specific situational knowledge of available means and estimates of effectiveness and efficiency--walking takes additional time and limits how much you can transport, which means shopping again soon; driving will take less time, but parking and traffic are a nuisance; (4) Select the most appropriate means of getting there based on some value criteria--walking saves nonrenewable energy, but increases the number of trips; driving saves nonrenewable time and reduces the number of trips to the store; etc. (Kurtz, 1965).

In education it is rare to analyze where to go, when to go, and why as a basis for choosing alternative ways of achieving objectives. The planning of a trip to the grocery store often receives more analysis. Most educational planning approaches focus on the "how," the mix of resource inputs, far more than on the "why," the aspirations of the society. Part of the difficulty may be with the type of information required. Social goals, needs, and realities are not easily translated into clear decision language. The major criticism of using perceptions of social goals, which are inherently value-based, is that it confuses facts with values. However, as Dunn, Dallmayr, and others point out (in Special Issue #2 of the Policy Studies Journal 1980-81), traditional policy and planning "facts" are based on value assumptions that should be, but usually are not, explicit.

Woelfel and Fink (1980) present the argument that all facts are confounded by the very act of measurement. What is required is not to despair, but to develop more sophisticated measuring methods for all types of evidence, including social values. To have education begin to realize the hopes all have for it means developing clearer understandings about: (1) what is the social ideal of education held by the people who are the presumed beneficiaries of schooling; (2) what is their perception of their current situation; (3) what do they perceive as the cause/effect relationships in the situation; and (4) what would/should an acceptable educational program do? Points (1) and (2) deal with the perceptions about the quality of life in a society or community, while points (3) and (4) deal with social impact concerns.

As Olsen _et al._ (1985) argue, both quality of life and social impact studies have split into subjective value and objective data views of society. These are two essential and complementary sides of the same question. A similar argument can be made for educational policy and planning approaches, although to this point economic data, analysis, and criteria have been dominant. Value-based data is not proposed as a substitute for the traditional econometric analyses, forecasts, and program planning approaches, but rather as an enhancement. The objective social conditions, which econometric and systems forecasting models are based on, have consequences for people, whether or not the people see the relationships these analyses are based on. However, if people are expected to act rationally in response to changing social conditions, the social conditions being modeled must have meaning for the people within their existing framework of values (Canan and Hennessy, 1985). Alinsky (   ) makes a similar point more succinctly by stating that social programs must start with people where they are at and not where leaders want them to be. He goes on further to qualify this by advocating that meaningful communication can only occur within the framework of the people's experience. While Canan and Hennessy and Alinsky come at this issue from different perspectives, it is clear that planners and policy developers, to be effective, cannot rely only on their own values and frames of reference to determine the value or desirability of any future condition--especially for other people (Olsen et al., 1985). The objective data used in modeling must be grounded in the meaningful context of the local value structures. While an econometric model can identify possibilities and the value-based model can identify desirability, both are required for the complete identification of what can and should be done.

The challenge of policy developers in the future will be the extent to which both the qualitative value base and quantitative data currently in use can be integrated into a comprehensive planning base for policy formation. Improved measurement techniques no longer permit the off-hand dismissal of value data from inclusion in policy analysis, and policy workers must be aware of opportunities for a more complete representation of the social context in which needs arise and policies for meeting those needs are addressed.

3.0 GALILEO AND POLICY PROCESS

3.1 Introduction

The Galileo Model provides a methodology with which to map the structure of social reality as a critical input into the planning, implementation, and evaluation of education policy. Integration of this methodology with existing techniques in policy and planning provides the means to have a complete (qualitative and impact analysis) answer to each policy question.

Before discussing the integration of the Galileo methodology with the policy/planning framework outlined, it may be useful to review the process of the Galileo Model. The first step in the process is the identification of the topic or issue to be examined. This can be as general or as abstract as desired, but the specification of a topic is required. The next step is to formulate an open-ended question which will be used to gather information from societal members about how they define the topic. For example, if our interest is in identifying how people define the current educational reality, we could ask them: "How would you describe schools today?" This question is then asked of individuals selected at random from the society, and their responses are recorded verbatim. The verbatim text records are stripped of articles, prepositions, and other minor words and a count of the remaining words is made. Clusters of words are examined to identify the major concept terms, which are then included in a survey with ratio-scaled pair comparison of each term with each other term. This survey is administered to a randomly selected sample. The sample depends on the usual statistical procedures, and whether it helps the analysis to stratify the data by subgroup. The results are then analyzed with metric multidimensional scaling techniques which produces the coordinate structures used as the basis for computing distances between concepts. It is possible to develop graphs and/or tables to present the data (Woelfel, 1985).

This description should serve to highlight the simplicity and ease of implementation of Galileo. A useful framework to introduce the application of Galileo to the policy area is the PIE model which represents the three general policy process phases of Planning, Implementation, and Evaluation. Although the specific emphasis in this paper is on the planning phase of the policy process, implementation and evaluation are briefly discussed as they relate to planning.

To highlight applications of the Galileo methodology, the Moloka'i community values and energy development project will be used (Canan and Hennessy, 198?). In this project, the planner/ researchers developed a community value map as the basis for attempting to "address responsibly the challenges of planning for an energy future that is socially desirable--one in which technological options are matched with community goals" (page

1).[1] The Moloka'i project was part of a graduate practicum in social impact assessment in the Department of Urban and Regional Planning at the University of Hawaii in early 1981. It won the 1982 national award from the American Planning Association as the best student project in the United States. The project methodology based the social impact assessment on the structure of community values. The opportunity to use this approach occurred because a technological solution had not been determined for energy self-sufficiency, although the community, the island of Moloka'i, had been selected. This provided the opportunity to fix the community planning objective as the selection of "a best mix of alternate energy options" (Canan and Hennessy, 1985) consonant with community values.

3.2 Planning

Policy planning typically starts with preconceptions about what social reality should be like and a vague sense of what social reality currently is like. This preconception of a difference between "what is" and "what is desired" lies at the basis of all policy. Definition of the type and severity of this difference determines what remedial responses will be considered as feasible based, of course, on the implicit cultural notions of cause and effect among available policy options. The Galileo Model will be discussed with reference to these three

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1. All quotes with respect to Moloka'i are taken from the Executive Summary of the final report on the project.

activities, which can be rephrased as: (1) social goal clarification, (2) needs assessment, and (3) selection of means.

3.2.1 Social Goal Clarification: The ideological underpinnings, or ontological, epistemological, and axiological beliefs, of a culture outline the image of the good future society and indicate the type of means appropriate for achieving that end (Holstein, 1974; Brameld, 1971). These ideological positions are often systematized beliefs used as theories of reality which are used as a substitute for empirically mapping social reality. Often experts will be consulted with respect to the current and anticipated future situations, but rarely, if ever, will the social aspirations of a society be determined by asking the people themselves. This may not be so much of a lack of respect for the individual members of the society as a lack of an appropriate methodology for mapping social values and goals. Lack of consultation with the intended recipients of policy benefits can create a cycle of dependency that leads to passive acceptance of authority, or confrontation in search of legitimizing ignored socially meaningful aspirations. In Tocqueville's terms, as paraphrased by Alinsky, "unless individual citizens are regularly involved in the action of governing themselves, self-government would pass from the scene" (page xxv).

The Galileo Model provides a methodology for going directly to the people, whether defined as a national or local society, to determine what the salient social goals and/or values are. The model does not impose a set of goals or ideological beliefs, but rather derives the framework of the mapping from the people themselves. The mapping exercise provides a graphic and mathematical representation of the goal structures which can be used as the empirical base for need assessments, as well as for monitoring changes in the structure of social goals through time in response to changing social, economic, and technological conditions. The question as to: "Who's goals are to be achieved?" can be made more pluralistic and participative through this approach. This reduces the reliance on political or other leaders as exclusive representatives of societal goals and values.

The Galileo process can also assist in the clarification process by identifying what people say the goals are as a starting point for discussion about what the goals really should be. Another feature is that subgroups in the society, who may be in goal conflict with each other, will have the means to communicate to each other the goal basis for the conflict. This could lead towards negotiation and resolution of potential political conflicts.

In the Moloka'i example, the purpose of the project was "to develop a community energy management plan that fits the lifestyles of Moloka'i residents and is in harmony with their values. Thus, researching the Moloka'i value system is an integral part of planning and managing the energy future of the island" (page 2). On the basis of the Galileo methodology they were able to develop maps of different groups with respec to their value clusters and with respect to the goal of energy self-sufficiency. Interestingly, "the values survey of decision makers throughout the State produced basically the same structure of values as found among the residents of Moloka'i" (page 5). This indicates that there was no need to use the clarification of goals or values as a basis for negotiating among conflicting goals by different groups.

3.2.2 <u>Needs Assessment</u>: The process of needs assessment is determining what the problem is, how it is to be measured, and how it can be responded to. More specifically, it determines, by defining the problem, how and what the range of alternative responses is going to be. If a needs assessment is based upon (1) a definition of social goals structured to fit within the framework of an ideology, and (2) an ideologically defined set of social indicators which are used to measure goal achievement, then the definition of needs is prescribed by the extent to which the observed social reality, as measured by carefully selected indicators, is at variance with the imposed definition of the social goals. The definition of indicators, which lies at the root of determining needs and social problems, is critical.

As Canan and Hennessey (1985) point out: "But on what bases are such 'simple statistics' of social conditions evaluated as positive or negative? While occasionally there are 'objective professional standards' (i.e., for health care delivery services or educational spending), note that these evaluations also depend on an implicit value placed on the social conditions which are being profiled. These values are typically those of a planner, bureaucrat, or politician usually removed from the actual social reality and from outside the community" (page 157, Journal of Planning, Education and Research, Vol. 4, No. 3). This type of bias may be avoided by mapping the existing social reality, as seen by the members of the society, against their definition of the social goals. This can reduce reliance on a preconceived prescribed set of needs or indicators. In fact, with the Galileo model, it would be a relatively simple matter to determine empirically which areas to address in accord with the seriousness of the need as perceived by the members of the society. In contrast to traditional methods, it is not necessary to define the area of need before assessing needs because the Galileo model approach could include the identification of the areas of need as part of, not exogenous to, the needs assessment study. The selection of measurement criteria, in the form of social indicators, should then be based upon a direct relationship with the particular goals and priorities identified through the Galileo model. Through this approach the model has the potential to make needs assessment reflective of existing social reality and less subject to preconceptions of social needs based on an ideological framework.

In Moloka'i the need for energy self-sufficiency had been predetermined, and the Galileo model was used as a means to evaluate alternative technological options for meeting this need. This begs the question as to whether or not the energy issue was the issue for the people of Moloka'i, or whether there were other, more immediate concerns from the residents' perspective. However, the results of the values survey identified values around which traditional planning approaches were built. Around each of the values, specific socioeconomic indicators were gathered to form an objective basis upon which to develop projections and to do impact analysis. For example, around values such as "Family Together," the number of divorces, marriages, and births per year were established as indicators; around "Slow Pace," indicators such as number of registered vehicles, cases of drunken driving, traffic accidents, traffic violations, and airline passenger departures were used.

For all of the values identified, administrative data was used to develop objective indicators which may be used to monitor the impact on the community of changes in any of these specific objective indicators. Having the indicators fit the people's values, rather than the other way around, appears to insure more relevance and interest; and the process furnishes more objective criteria for selecting indicators.

3.2.3 Selection of Means: Dunn (1981) and Dallmayr (1981) criticize the dominance of a cost/benefit orientation in the selection of policy alternatives, at the expense of a critical evaluation of the ethical and value implications implicit in each alternative course of action. Dunn's concern is that discussions about alternative policy actions are dominated by forms of instrumental reasoning, where the sole purpose of the analysis is to identify the most efficient means to achieve ends whose value is taken for granted. Dallmayr is concerned that there is a primary concern with "outputs," pragmatic problem-solving, and applied knowledge, without a clear *a priori* explicit specification of the criteria to be used in developing or selecting among options.

These concerns highlight where the Galileo model can effectively be used to address criticisms of traditional approaches to planning policy. Cost/benefit analyses per se are not the problem; the problem has been the tendency to rely on them exclusively in the development and evaluation of policy options, without the prior investigation of the value context and goal framework that Galileo accomplishes as an early move in social planning.

The Galileo model provides a way to involve members of the society affected by a social plan, in the identification of options and selection of the means to address their needs, as identified during the needs-assessment phase. Rather than have planners and policymakers rely only on their own values, goal frameworks, and assumptions as to the central issues and the needs of the client groups, Galileo derives a socially meaningful structure of values and beliefs about the desired and current social realities. This can then be used as a framework within which to identify and select options. This approach can be used in conjunction with other methods to develop what the society sees as the critical cause-and-effect relationships of needs and issues. As such, it is a precondition to the development of program alternatives. Those to be affected by the policy have a direct input into the establishment of criteria for the selection of alternative means. It does not preclude cost/benefit; it includes it, but as one of several approaches.

The Moloka'i project focused on the selection of a technological solution, but within the context of preserving community values. In effect, this established the community as the source of the framework used in the specification of the criteria for the development and selection of the alternatives.

3.3 Implementation

Policy is implemented according to program plans developed for the achievement of the policy intent, which is defined in social goals. Implementation of policy is assigned to administrative-bureaucratic structures which simplify the process of implementation by routinizing activities and using standardized procedures and criteria (Carley, 1981). Activities are routinized in order to simplify the decision environments and avoid conflicts by using rules and regulations as the basis for dealing with policy questions. In a bureaucracy, it may be more important that everyone is treated the same (equally) rather than fairly (equitably) with respect to needs addressed in the policy. The process of routinizing activities is not purposeful in the same way that policy development is; instead, it is incremental and cumulative. Many single actions and small decisions accumulate to result in resource allocation as a result of the routinized bureaucratic process (Carley, 1981; Lipsky, 1980). While the policy may be intended to make life better for society as a whole, the routinization of activities is designed to make life easier for the bureaucracy.

The Galileo model provides a means to map the bureaucratic reality within which a policy is to be translated into action through the allocation of resources. Galileo provides information for anticipating the impact of the bureaucracy on the articulation of the policy at the delivery point. The model cannot provide the basis for resolving the ongoing problem of goal deflection, in which an organization redefines the policy goal in terms of organizational goals which it can measure and achieve, without really dealing with the policy intent. In goal deflection, the "why" of the policy, its purpose, is subject to the "how" of implementation, which in turn controls the behavior of the individuals delivering the policy, so that the success or failure of a policy, within the confines of the organization, may be determined more by having followed the rules rather than accomplishing the intent of the policy.

In the Moloka'i project, the people were so actively involved, they were aware of what was to be expected and stood as on-site monitors of action. The survey process itself empowered them, but more potent was the capacity to objectify their values as known or mapped territory that could be identified and identified with. It may be that to monitor program implementation requires prior empowerment (energizing, mobilization) of the people receiving the service. With an objectified standard to judge the program, goal deflection means the people served are learning, growing, and changing.

3.4 Evaluation

Evaluation of a policy depends on the social indicators selected to indicate need during the planning phase of the policy. Social indicators, whether measures of input, throughput, or output, are surrogates of abstract or unmeasurable social concepts operationalized for use as measures in analysis and evaluation (Carley, 1981).

Inputs are the resources available to the process, while throughput is based on workload. Both involve quantities which can be counted. Output is subjective and difficult to measure, because each recipient of a policy effect has a different concept of the policy output. Aggregate output measures are typically proxies of policy effect. From an administrative/

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bureaucratic perspective, focusing on the quantifiable aspects of the process is easier to do and tends to support the goal deflection, if it occurs during policy implementation. In goal deflection, the organization redefines policy goals in terms of organizational goals which it can measure and achieve, without necessarily dealing with the policy intent. The "why" of policy, purpose, is subordinated to the "how" of implementation. The policy planning process requires defining performance indicators to determine policy effectiveness and to control the amount of goal deflection permitted. Since goal deflection is such a central problem in bureaucracies, policy indicators must be established during the policy-planning phase to monitor later implementation.

Organizations use input and throughput as indicators because they are quantifiable, though they may bear no real relationship to the policy intent. Measures of input include the fiscal, human, and capital resources allocated to the program. Throughput is a measure of workload or aggregate program effort. The argument, from the organization perspective, is: If we spent X dollars and invested Y effort, then something clearly has been achieved. What is that something? That something is X dollars spent and Y effort achieved. This leaves output. However, if output is the effect of the policy on individual recipients, it is subjective and difficult to measure individually, and abstract and inferential when measured in the aggregate.

Frohock (1979) argues that since there is no common cardinal scale for all individuals to assign a value to benefits and costs, this type of evaluation is suspect. Also, policy actions have diffused consequences, and people not directly involved are affected by the distribution of costs and benefits.

Galileo can deal with these two problems: (1) adequate subjective measures of policy effect, and (2) lack of a common criteria for cost/benefit assessment. In terms of Frohock's concerns, the model is based upon the establishment of a common measurement scale which has meaning to each individual in the society. Since the survey and social mapping are based on random sampling techniques, all members of a society affected either directly or indirectly are represented. In terms of identifying policy effectiveness, if the model is used during the planning phase, it can establish the base social reality map for the policy for a limited time frame. Ongoing monitoring can be done, using randomly drawn independent samples, to monitor the progress and direction of change in the social map as the policy is implemented. The original social goals are monitored periodically, because both social goals and social reality change through time. The model makes ongoing formative evaluation feasible and effective during the implementation of the policy. It provides a cross-check on the amount of goal deflection occurring in the bureaucracy. It evaluates the quality and validity of shifts in social goals. Shifts are as inevitable as change, which is the whole purpose of social development and human learning (Dunn,). The point is to track and evaluate the shifts and to fine-tune the system and correct course to accommodate them. Here Galileo's continuous monitoring and mapping serves plan implementation well.

3.5 Summary

The Galileo model enhances traditional policy techniques by the development of maps of social goals and social reality around a policy purpose. The Galileo process is dynamic and serves policy planning from the initial design process through implementation and evaluation.

4.0 ASSUMPTIONS/GALILEO MODEL AND THEORY

Compliance with five fundamental principles from physical science will result in "decisive improvement in the quality of social scientific knowledge" ( ).

"PRINCIPLE OF RELATIVIZATION states that no concept has absolute significance, but rather each concept can only be defined by comparison with some other arbitrarily designated concepts.

"PRINCIPLE OF OBJECTIVIZATION, according to Born (1965), 'aims at making observations as independent of the individual observer as possible [p. 2].,' requiring that observers 'formulate an agreement' about standards of comparison and observational procedures such that the results of performing observations do not depend on who made them.

"PRINCIPLE OF EMPIRICAL VERIFICATION states that 'concepts and statement which are not empirically verifiable should have no place in a physical theory [Born, 1965, p. 3].' This principle should not be confused with positivism . . ." but "should be taken to refer to observations made within and contingent upon the arbitrary and consensual framework of reference standards and observational rules established under the first two principles.

"PRINCIPLE OF MAXIMUM INFORMATION suggests that all components of the (arbitrary) science, such as the initial standards, measurement rules, and communication code . . . should be chosen such that the potential amount of information which can be carried by the system is a maximum.

"PRINCIPLE OF MINIMUM INFORMATION (Inertial Principle), which is closely related to the principle of maximum information, requires that the components of the science be established such that the 'actual' amount of information required to specify the state of the system of observations along any interval of time be at a minimum."

Three solutions described below involve the establishment of measurement conventions for the social sciences:

1. Establish functional relationship between alternative scales so relative sizes of the smallest discriminable interval may be assessed.

2. Determine absolute amount of reliable variance which can be generated by each scale.

3. Transform all scales to be compared into standard units (metric, not z scores). The logical unit of information is the bit. The aim is to determine absolute amount of reliable information produced by scaling operation.

Comparison of Likert scales or semantic differential scales commonly used by social scientists with ratio or interval scales reveals that Likert scales have a very small capacity to carry information, 2.32-3.46 bits per scale. Ratio-type scales, like that used in Galileo, yield 9.97 bits per pair comparison. Scaling methods suggested here would yield 30 times as much information per case as standard social science and marketing scales (pp. 201-202).

The utility of the ratio scale derives from the fact that it is formally infinite and may take on any numerical value.

5.0 IMPLICATIONS FOR USE RESULTING FROM THE ASSUMPTIONS UNDERLYING GALILEO

The Galileo theory and model can be used to expand the planning base for public policy by providing a more empirical, objective means for taking social values into account. The use of Galileo for social impact assessment on Moloka'i demonstrated the usefulness, effectiveness, and potential power of the model for community-based social impact assessment.

The Galileo model is an instrument for predicting the relationships between cultural concepts, attitudes, and beliefs. The model has also been used to change the relationship in a predicted direction relative to a given target. The generation of strategies for effectively changing behavior has been used in highly competitive marketing situations, in both public and private applications, and with 80-90% effectiveness.

The general theory of Galileo responds to a central problem for social sciences--that of multiple frames of reference between producers and users of knowledge. Galileo's usefulness goes beyond the pragmatic scaling of social concepts. It identifies theoretical leverage points and demonstrates that if these are taken into account, differing conceptions of reality between planner, policymaker, social scientist, and user can be mapped and understood.

6.0 APPLICATIONS OF GALILEO

The Galileo model "can be applied in any situation where a set of objects may be described in terms of the dissimilarities among the members of the set" (Woelfel and Danes, 1980, p. 358). It can be described by some kind of spatial representation. The number of communications applications is quite large. Whenever reliability of measures of dissimilarity are high, metric MDS is an appropriate procedure.

Studies are drawn from diverse areas of application. Some gather information from environment in order to design information structures which can be transmitted back to the environment. They are used to restructure the environment relative to the organization. Others use information to restructure the organization relative to its environment. Some aim to do both.

Woelfel and Fink (1980) provide data indicating that the Galileo methods "provide greater absolute magnitudes of precise and reliable information in typical applications without significant increase in cost or respondent burden" (p. 107).

Types of problems:

1. Physical measures of distance. E.g., is the Intercities distance matrix used on maps to gauge the distance between cities.

2. Network-type communication problems, especially when interaction is measured in real time.

3. Cognitive and cultural structures and processes. These are sets of objects among which people discriminate, e.g., voting, linguistics.

4. Market and market segments where products, services, candidates, etc., may be arrayed among important applications in both business and marketing, e.g., an educational clearing house reported . . . products (Woelfel and Fink, 1980, p. 206).

5. Important comparative applications within all these

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domains with rotation algorithm for least-square matching of space, e.g., cross-cultural communications.

6. Longitudinal or kinematic studies (multiple times as well as multiple spaces) where ongoing processes are interrupted or modified by some treatment.

7. When hypotheses about motion are added to process or kinematic MDS studies, dynamic models emerge with engineering applications in both prediction of future states or processes and active intervention in those processes. Intervention is accomplished with the aid of the message generation model, with important implications for marketing, political campaigning, dynamics of cultural change, and attitude formation.

Limits on applicability of Galileo arise because the conventions which increase understanding of cognitive or consensual space within the model do not all necessarily operate in the environments where the model is applied. The fact that the model may increase understanding of relative social values may not be appreciated or applied by key decision makers. This situation is akin to the problem of straight rationality and street rationality defined by Davis (unpublished, Chapter 1, p. 31).

More serious manifestations of the theoretical limitations involved are evident in the social change solution posed by Galileo. Manipulation of concepts to move selected targets closer to the "self-points" using multidimensional scaling is not new and has been shown to result in changed behavior. The

Galileo model, however, provides greater <u>precision</u>. The social change strategy that results is potentially more powerful and can be more precisely directed, or "manipulated."

7.0 RELEVANCE OF THE GALILEO MODEL TO THE BRIDGES PROJECT

7.1 <u>Introduction</u>

The Galileo model is evaluated here in relation to the possibilities it might offer for BRIDGES research and simulations model development. We have discussed how Galileo is a means of mapping social reality; how the map will change with regard to problems, economic conditions, and broad social goals. We have suggested that Galileo theory provides an understanding of how measurement conventions can effectively be applied in order to minimize the effect of translation among the proliferation of frames of reference not only between researcher, planner, and school system, but within school systems relative to the whole social system.

With respect to planning, Galileo can be used for goal clarification, needs assessment, as a means for identifying social indicators, for uncovering discrepancies in the conceptual frames for different populations and groups, as a means for more effectively establishing a baseline for evaluating change in the social system, for monitoring change, and for cross-checking on goal deflection.

7.2 Within BRIDGES Use

The BRIDGES project may use Galileo or a tool like Galileo as a projectwide planning, coordinating, monitoring, and evaluation tool as well as including it in the simulation capabilities of planners and policymakers in the third world. BRIDGES researchers can use Galileo to identify research problems "that are sensitive to interventions through educational policy" (McGinn et al., p. 26). The conceptual map produced by interviews and survey of the appropriate population can produce a highly informative array of issues and concerns around the topic of interest. Another map can be constructed using the same techniques for a related population, whether it be the decision makers in that population, or a subgroup or another population on the other side of the globe. Planners can give the BRIDGES researchers a precise map of their concern around access, or the amount of learning taking place, or the appropriateness of certain resource allocations or learning technologies. Because the map precisely portrays the relative concerns of the population, issues are inevitably unearthed.

BRIDGES researchers may use Galileo to better coordinate their research through the adoption of a scaling convention inherent in the model. This convention increases capacity for comparing very different cultures, subcultures, etc., on a precise scale. The scaling convention provides a language for comparing access concerns of Somalian planners with those of Guatemalan planners. Whether maps contain the same or different

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elements, comparison of relative dissimilarities between concepts can raise important issues.

Galileo can enable BRIDGES researchers to set realistic social indicators based on the concepts that ministers and policymakers, planners, supervisors, parents, or teachers have identified. These can be monitored.

7.3 Use Within Simulation Models for Education Planners

In addition to its use for coordinating and conducting research, Galileo aids system designers in deciding which information will be most valued by target populations, and which would also be valued by other countries in the region and between regions. There is likely to be considerable disagreement as to which information should be accommodated in these simulation models because there are so many viewpoints and so many levels of aggregation that must be accommodated. Galileo has been used as a valuable tool for arbitrating such differences by comparing competing maps. In some cases overlap exists that was not anticipated. When this occurs, conflict may be decreased and discussion focused more productively on areas of discrepancy.

Galileo provides BRIDGES with a tool for involving country participants in planning. Galileo can be used to get an early reading of country participants' views of their educational systems, information and other needs, and attitudes toward technology. This process can provide participants with more information as well as change the information environment. In the Moloka'i case, Canan and Hennessey (1985) argue that broad-based participative planning increases data accuracy, increases the consideration of variations in group priorities, gives people in communities the opportunity to fulfill their own moral responsibilities, decreases resistance to change, and decreases conflict while increasing constructive approaches to planning (p. 157).

Galileo fulfills various requirements specified for BRIDGES simulation models. It is assumed for this discussion that Galileo would not necessarily be made a part of the models, but that services to participating researchers and countries would be made available through BRIDGES. This assumption arises out of a concern for ensuring Galileo is not misused in volatile, rapidly changing political environments. Galileo inventors will not ship software unless they feel the perspective of users takes seriously the implications of misuse.

Galileo can provide more information, especially social/political information of the sort valued and reviewed by ministers, superintendents, and planners. Galileo can be used to answer the questions, "What are people thinking about . . .? What are people thinking about a whole range of complex and important issues that they have identified in initial interviews?" Galileo satisfies BRIDGES criteria for minimal information. The interview and survey methods are a way to sift out the issues of primary concern to the population and to demonstrate precisely how the concepts are related. Results are <u>immediate</u> instead of requiring complicated research studies. Changes are easily monitored daily, weekly, etc. This is especially easy to do after a baseline map has been generated. Changes in attitudes have been monitored over several months for a student population. Changes in public responsiveness to a product or qualities of the product have been monitored with relatively low cost. Galileo data collection is also immediate in the sense that it can be used easily without depending on language competence.

The precise self-referral nature of the conceptual maps lends them considerable weight in the political arena. For this reason, once they are understood, they may be more likely than many other sorts of simulation models to encourage/stimulate planners or policymakers to <u>examine traditional assumptions about effectiveness and cost of various learning technologies, new technologies, and the organization of educational systems</u> (McGinn *et al.*, p. 16). The reason: A precise measure of perceptions about their education system's performance relative to the population's aspirations gives decision makers and planners a reading they usually obtain only partially through chance, speculation, informants, the press, etc. When used properly, decision makers and planners will recognize that they are interacting with the pulse of public reality. They can get a precise reading of pressures in the environment.

It is true that decision makers may not want to share such information which, while partial, has also been privileged and often used as a tool of political advantage. Moloka'i residents who attempted to use their newly acquired, comprehensive, and sophisticated knowledge about their own values were dismissed later on in negotiations over another issue as inexpert. Advantages of social assessment which uses conceptual relationships generated by the population in a highly precise fashion must be weighed against political implications of use of such information in environments where information is typically hoarded or bartered for influence.

Although the Galileo model is conceptually abstract, it is simple in several important respects. The data input process involves uncomplicated interview and survey procedures. Inexperienced interviewers are among the most successful. One or a few questions are asked at the most. The responses are recorded verbatim and entered into the computer. The analysis of these entries is a simple stripping of redundant and irrelevant articles, etc., and a sorting into frequencies. The user interaction is straightforward and uncomplicated. Generation of the survey also follows mechanically from this process. Survey responses can be taken on the telephone and entered into the computer or entered from forms.

Interpretation of survey results is, of course, much more demanding conceptually, requiring, according to Canan (interview), constant interpretation. The graphic displays of multidimensional scaling are not easy to interpret immediately, but Canan pointed out that the concept can be explained easily. She noted that complexity of interpretation tends to involve the participants. Canan and Hennessey used a plexiglass display of the multidimensional space on Moloka'i, which invited participation. Once the community participants and decision makers knew the meaning of various output, they became much more sophisticated in interpreting outcomes.

Galileo will inspire more global conceptions for BRIDGES model builders and users. Use of information in the Galileo model is contextual. Predetermined categories are minimized with the result that consensual views are uncovered that would not be otherwise. Users can develop a "conception of their systems as systems, in which the implementation of policies in one part has effect on other parts" (McGinn *et al.*, p. 20).

What is suggested here is that Galileo offers the BRIDGES simulation models another source of information that has not been available before. Monitoring of perceptions about educational needs, access, classroom practices materials, and social conditions related to going to school are interrelated conceptually with many other issues in the community. Simulations will incorporate information about learning alternatives and different ways of achieving access as well as strategies for reporting changes in efficiency and effectiveness of such changes. Social impact information of the kind delivered by Galileo would provide another powerful and empowering information source that goes beyond existing data bases, global strategies, and encourages thinking about alternatives.

7.4 Summary

The Galileo model fills an important need in planning with the mapping of consensual space. I have specifically suggested that the model or one with similar characteristics can be used by the BRIDGES project to generate and clarify research ideas between researchers and target populations, and between researchers, to coordinate research between multiple regions and within cultures, and to establish appropriate social indicators. Galileo can be used simply to research the value and conceptions of a population and to determine which information is most valuable relative to social goals.

As a component with the proposed simulation models, Galileo can be used to reach agreement about information use and to involve participants in planning. Galileo meets BRIDGES requirements for minimal information by providing a tool for sifting out issues of primary concern. Information retrieval is immediate and can be easily updated and retrieved. Galileo maps have particular relevance for evaluating assumptions. They provide decision makers with systematic information which is usually left to change, i.e., what are various constituencies thinking? Galileo also encourages more global conceptions for model builders and users. It addresses a central concern of modelers in that it is contextual. Finally, it encourages thinking about alternatives by providing another important source of information.

Throughout this paper we have encouraged the use of Galileo for planning and for BRIDGES with respect to measurement of the conceptual space, rather than for social change purposes. Galileo is particularly useful because of the kind of information it provides and the power and precision with which it does so. The social change strategies have limited applicability in a planning context. We feel, however, that consideration of Galileo can also provide BRIDGES tool builders with insight into appropriate philosophy of science and the moral obligations of theory for broadest, most effective use of planning models.

BIBLIOGRAPHY

Alinsky, Saul D. Rules for Radicals, Vintage Books, New York, 1971.

Brameld, Theodore. Patterns of Educational Philosophy, Holt, Rinehart, and Winston, Inc., New York, 1971.

Canan, P.; Hennessey, M.; Miyashiro, K. K.; Shiroma, M.; Sichter, L.; Lewis, D.; Matteson, D.; Kono, L.; Dendle, W.; and Melrose, J. M. Moloka'i Data Book: Community Values and Energy Development, University of Hawaii, Honolulu, 1981.

Canan, Penelope and Hennessey, Michael. Community Values as the Context for Interpreting Social Impacts, Paper presented at the Annual Meeting of the American Sociological Association, San Francisco, September 1982.

Canan, Penelope and Hennessey, Michael. "Education in Social Impact Assessment and Planning," Journal of Planning Education and Research, Vol. 4, No. 3, April 1985.

Carley, Michael. Social Measurement and Social Indicators -- Indicators of Policy and Theory, George Allen & Unwin, London, 1981.

Craig, Robert T. "Galilean Rhetoric and Practical Theory," Communications Monographs, Vol. 50, December 1983.

Dallmayr, Fred R. "Critical Theory and Public Policy," Policy Studies Journal, Special Issue #2, 1980-81.

Davis, Russell G. Planning Education for Development, Harvard University, Cambridge, 1980.

Davis, Russell G. New Volume, Chapters 1, 2, 3, 4, and 9, Unpublished.

Dunn, William N. "Introduction by the Symposium Editor," Policy Studies Journal, Special Issue #2, 1980-81.

Frohock, Fred M. Public Policy -- Scope and Logic, Prentice-Hall, Inc., New Jersey, 1979.

Getzels, J. W. "The Problems of the Problem," in Hogarth, R. M. (ed.), Question Framing and Response Consistency, Jossey, San Francisco, 1982, pp. 37-49.

Hayes, Dale K. Education Policy, Governing Board Policies and the Management of Higher Education, Paper presented for the Inter-American Congress on Educational Administration, Brasilia, Brazil, December 1979.

Holstein, Hans J. Homo Cyberneticus 1 The Simulation of Everyday Life: A Synopsis, Uppsala, Sociografica, 1974.

Holstein, Hans J. Homo Cyberneticus 2 Towards an Epistemology of Dynamic Causal Modelling, Uppsala, Sociografica, 1974.

Holstein, Hans J. Homo Cyberneticus 3 Heuristic Simulation Programming, Uppsala, Sociografica, 1974.

Holstein, Hans J. Homo Cyberneticus 4 Artificial Psychology and Generative Micro-Sociology, Uppsala, Sociografica, 1974.

Holstein, Hans J. Homo Cyberneticus 5 A Macro-Sociological Framework, Uppsala, Sociografica, 1974.

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Holton, Gerald T. Origins of Scientific Thought: Kepler to Einstein, Harvard University Press, Cambridge, 1973.

Holzner, B. "The Sociology of Applied Knowledge," Sociological Symposium, Vol. 21, 1978, pp. 8-17.

Kurtz, Paul. Decision and the Condition of Man, Dell Publishing, New York, 1968.

Lipsky, Michael. Street Level Bureaucracy, Russell Sage Foundation, New York, 1980.

Marlier, J. Measurement of Individual Differences in Perceptions of, and Attitudinal Responses to, Issue Orientated Communication: Theoretical Considerations, Unpublished, Department of Communication, Northeastern University, Boston, 1977.

Olsen, M. E., Canan, P., and Hennessey, M. "An Integrated Value-Based Community Assessment Process," Sociological Methods and Research, Vol. 13, No. 3, February 1985.

Tyack, D. and James, T. "Learning from Past Efforts to Reform the High School," Phi Delta Kappan, February 1983.

Walker, Maila L. Science and Cultural Crisis -- An Intellectual Biography of Percy Williams Bridgeman, Unpublished doctoral dissertation, Harvard University, Cambridge, 1985.

Woelfel, Joseph. Annenberg Lecture #1, Unpublished, undated seminar transcript.

Woelfel, Joseph. "Galileo as a Cognitive System," Informatologia Yugoslavica 17 (1-2), 1985.

Woelfel, J. D. "The Western Model," in Kincaid, D. L., et al. (eds.), Eastern and Western Communication Theory, Unpublished, East-West Center, Honolulu, Hawaii, 1979.

Woelfel, J.; Cody, M. J.; Gillham, J. R.; and Holmes, R. "Basic Premises of Multidimensional Attitude Change Theory," Human Communication Research 6 (2), 1980, 153-67.

Woelfel, J. and Danes, J. E. "Multidimensional Scaling Models for Communication Research," in Monge, P. and Capella, J. (eds.), Multivariate Techniques in Communication Research, Academic Press, New York, 1980.

Woelfel, J. and Fink, E. The Measurement of Communication Processes: Galileo Theory and Method, Academic Press, New York, 1980.

FROM SYSTEM DYNAMICS TO EXPERT SYSTEMS:

STELLA - MODELING FOR THE OTHER 98%

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Educational Planning A-822
Spring 1986

Submitted by
Christina Rawley and Gerry Bodeker

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Introduction

In responding to the question, "Why model?" Edward B. Roberts notes that:

> A computer model differs principally in complexity, precision and explicitness from the informal subjective explanation or "mental model" that people ordinarily construct to guide their actions toward a goal (---). Like the informal mental model it is derived from a variety of data sources including facts, theories and educated guesses. Unlike the mental model, it is derived from a variety of data sources including facts, theories and educated guesses. Unlike the mental model, it is comprehensive, unambiguous, flexible and subject to rigorous logical manipulation and testing.[1]

In this paper we will examine the field of system dynamics - how the field evolved, the philosophy, the methodology, applications of system dynamics models. We will give particular attention to a new development in the field: the application of artificial intelligence to system dynamics modeling, which has led to the development of a new system dynamic expert system known as STELLA.

The first section of the paper describes the historical influences which gave rise to system dynamics. The evolution of the field from its early days as "industrial dynamics" is outlined and the issues facing system dynamicists in applying their models to the field of public policy will be discussed. Particular attention is given to the application of system dynamics to problems in education.

The second section of the paper presents a detailed investigation of STELLA and its applications, its ease of use, strengths and weaknesses, and potential for future development. A general evaluation of STELLA was conducted by:

a. introducing a group of naive users to STELLA;

b. interviewing expert users

c. interviewing a member of the STELLA design team;

Detailed findings from each of the above will be presented.

Finally, the paper will consider the implications of this new phase in the history of system dynamics brought about by the emergence of a system dynamics expert system.

BACKGROUND TO SYSTEM DYNAMICS

The field of system dynamics research arose out of developments in three broad areas:

1. Control Engineering. Military research and development efforts during World War II led to advances in the understanding and analysis of information feedback systems in complex electronic systems.

2. Cybernetics. Early pioneers in the field of cybernetics drew attention to the continual influence of feedback control processes in man and society (Norbert Wiener, 1968) and specfically in economics and business (Herbert Simon, 1952 and Arnold Tustin, 1953).[2] The computer simulation methods used in engineering design were extended to problems of business design, with the advent of reliable, high-speed digital computers. Experimental changes in industrial settings could be simulated on a computer over time-frame of several years, as opposed to the costly alterntive of mounting real-life experimental innovations.

3. Organizational Theory. During the 1950's there was widespread growth of interest in human decision-making processes. The field had grown out of military requirements in the area of automatic and semi-automatic weapon control. In the post-war years, the field came to reflect the concerns and priorities of the industrial sector, and subsequently of business and management more generally.

System dynamics was founded in 1956/7 when Professor Jay W. Forrester moved from head of the Computer Division at the M.I.T. Lincoln Laboratory to a professorship in the School of Management at M.I.T. Forrester had contributed to significant developments in understanding in each of three areas outlined above, and applied his expertise to the development of a philosophy, methodology, and research program for what was originally termed "the industrial dynamics program." As the range of applications of "industrial dynamics" broadened, the field came to be known as "system dynamics."

Philosophy

Edward B. Roberts, one of the three scientists who worked closely with Forrester in developing system dynamics, notes that the system dynamics philosophy is built on two premises: (1) that the behavior (or time history) of any complex system is principally caused by the system's causal structure - i.e. physical constraints, social goals, rewards, pressures, etc. that cause the units of the system (e.g. educational administrators) to behave the way they do and generate cumulatively the dominant dynamic tendencies of the total system; (2) that organizations are viewed most effectively in terms of their common underlying flows rather than in terms of discrete functions.[3]

The concept of two-way causation, or feedback, is central to the system dynamics approach to understanding system structure. Each closed chain of causal relationships forms a feedback loop. A system dynamics model is typically comprised of many such loops linked together. Variables are typically

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represented as endogenous to the system, with relatively few being represented as exogenous, i.e. influence the system but are not influenced by it. The notion of variables which are interdependent rather than dependent and independent characterizes the system dynamics approach.

Methodology

System dynamicists adapted the tools of flow diagramming, mathematical modeling, and computer simulation to fit the needs of their new approach. They borrowed from the signal-flow graphs of electrical engineering, and developed the cause-and-effect arrow diagramming to visually portray the underlying situation in managerial contexts. They created more formal flow diagramming and equation writing methods for representing organizational relationships according to the categories of level and rate. Donella Meadows (1980) describes a level as "the element in each feedback loop that represents the environment surrounding the decision-maker (---). Each level is an accumulation or stock of material or information." A rate is "the element representing the decision, action, or change (---) A rate is a flow of material or information to or from a level (e.g. birth rate, death rate, investment rate, etc.)."[4]

In system dynamics, two kinds of feedback loops are distinguished:

1. Posititive, or self-reinforcing, loo... ... tend to amplify any disturbance and to produce exponential gro...

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2. Negative, or goal-seeking loops - these tend to counteract any disturbance and to move the system toward an equilibrium point or goal.

The combination of these two kinds of loops are formulated as theorems relating the structure of a system to the system's dynamic behavioral tendencies. Systems dynamics theory highlights the critical role of time delays in determining the dynamic behavior of a system and emphasizes the characteristics and consequences of different types of time delays. Both lagged relationships and nonlinearities ar considered important in explaining system behavior.

In an effort to address the considerable problems of mathematically describing nonlinear, lagged feedback relationships, Forrester and his associates developed a computer simulation language called DYNAMO, which allows nonlinearities and time delays to be represented easily. A key feature of DYNAMO is that while expressing the postulates of the system dynamics paradigm in a very specialized form, it was designed to be easily understood by people with limited mathematical training. (Although DYNAMO is widely used by system dynamicists, other general purpose languages, such as FORTRAN may be used in writing a system dynamics program, and DYNAMO may be used to program linear open-system models that are not system dynamics models.)

MODEL DEVELOPMENT

Regarding the actual format of system dynamics models, Donella Meadows notes that, as they are typically used "at the general understanding stage of decision making (---), they tend to be fairly small (20 to 200 endogenous variables) and transparent."[5] The individual relationships in the models are usually derived directly from mental models, and thus have an intuitive validity and are easily understood. Central features of the model development process include:

1. Considerable emphasis is placed on closely involving the client in the modeling process;

2. Careful model documentation is required;

3. Every element and relationship in a model must have a readily identifiable real-world counterpart; nothing should be added for mathematical convenience or historical fit.

Randers (1980) has schematized the process of model construction in terms of four stages of development and application (See Figure 1).[6]

Figure 1: The Four Stages of Model Construction[7]

Conceptualization	Familiarization with the general problem area
	Definition of the question to be addressed -- either. What caused a given development? or, What are the likely effects of a given policy?
	Description of the time development of of interest (the reference mode) -- defining the time horizon and the range of time constants in the model
	Verbal description of the feedback loops that are assumed to have caused the reference mode (the basic mechanisms) -- defining the system boundary and the level of aggregation
	Development of powerful organizing concepts
	Description of the basic mechanisms in causal diagram form
Formulation	Postulation of detailed structure -- selectin levels, selecting rates and describing their determinants
	Selection of parameter values
Testing	Testing of the dynamic hypothesis -- Do th basic mechanisms actually create th reference mode?
	Testing of model assumptions -- Does th model include the important variables? Ar the assumbed relationships reasonable? Ar parameter values plausible?
Implementation	Testing of model behavior and sensitivity perturbations
	Testing the response to different policies
	Identification of potential users
	Translation of study insights to an accessit form
	Diffusion of study insights

PROBLEMS AND LIMITATIONS OF SYSTEM DYNAMICS

1. Meadows notes several limitations to DYNAMO:

(i) The ease of modeling with DYNAMO may give beginners a mechanical grasp of system dynamics without necessarily providing a full philosophical grounding in the system dynamics paradigm. The risk is seen to be that novices are likely to become overconfident and to oversell their skills and their models;

(ii) modelers may become caught in the process of playing with endless model variations, rather than carefully thinking through the experiments they have tried, and the lessons arising from these;

(iii) The simplicity of adding new elements and relationships to a model can lead modelers to create over complex and incomprehensible structures.

(Meadows' emphasis on the ease of use of DYNAMO is not universally shared by system dynamicists. Richmond (1985) has argued that the esoteric nature of DYNAMO and the system dynamics methodology in general, have served to retard the acceptance of system dynamics on a widesprad basis.[8] Richmond's response has been to develop a system dynamics expert system (STELLA) which aims to assist users with little or no computer or mathematical expertise to conceptualize and build high quality dynamic models. We will examine this system in the following section of this paper.)

2. The emphasis on simplicity in system dynamics leads modelers to try to avoid disaggregation as much as possible, as disaggregation into even a few interacting levels can complicate a model substantially. A possible consequence of avoiding disaggregation is that the modeler may discount or not detect questions of distribution.

3. No rigorous theory or procedure exists in system dynamics for performing sensitivity analysis. This is an important issue, as detection of a sensitive parameter may be central to policy development and planning. In general, system dynamics models tend to be less sensitive to precise refinements of parameter values.

4. The issue of model validity is handled qualitatively and informally in system dynamics. Utility, rather than validity, of models tends to be emphasized.

5. The system dynamics paradigm tends to lead the modeler to a long time horizon and wide boundaries in approaching any problem. Typically, however, clients have to respond to short-term pressures and constraints.

6. The systems approach leads to the assumption that most problems are endogenous to the system. Jennifer Robinson notes that this leads to conclusions which are "seldom neutral," and to recommendations which require structural change as the solution to organizational problems. Such recommendations may "be difficult and risky for clients to implement."[9] Meadows, has also noted that while not all organizational problems are structural in

nature the system dynamics approach predisposes the modeler to conceptualize them in structural terms.

SYSTEM DYNAMICS AND PUBLIC POLICY

A survey of policy-related models sponsored by the National Science Foundation's Research Applied to National Needs program examined 250 non defense modeling efforts dealing with some aspect of social policy making. The study found that "at least one-third and perhaps as many as two-thirds of the models failed to achieve their avowed purposes in the form of direct application to policy problems." The authors point to a gap between policy models and policy makers which leads to limited or non-utilization of models: "Under current modes of operation, a number of procedural and institutional factors limit the interaction of policymakers and modelers, and thus increase the likelihoood of imperfect communication."[10]

Pugh, in evaluating Forrester's Urban Dynamics model notes four policymaking roles of computer simulation:

1. Increasing the general understanding of a system in support of future policy making;
2. Developing policy alternatives;
3. Evaluating proposed policy alternatives;
4. Verifying results obtained by other models.

As noted earlier, the system dynamics approach was developed to address industrial needs and was later developed to fit the requirements of business and organizational management. Models were developed for specific industrial or corporate needs, usually at the request of the management of a particular organization. In the public policy arena, where there are multiple constituenceis, interacting levels of authority, diffuse organizational parameters and responsibilities, the situation facing the modeler is more complex than in industrial or corporate settings. The system dynamics approach has been increasingly applied to the public policy arena, both in and outside the U.S., and in the process has had to adjust to a new set of design and implementation considerations.

Stenberg (1980) has characterized the typical differences in the policy analysis environment between corporate setting and the public policy scene[11] (Figure 2). Stenberg notes that insights from a public policy study must be spread to many more people than those who participate in the modeling process, if the study is to have an impact. A key to this is seen to be the analyst's awareness of the reader's way of thinking. Robinson[12] draws attention to the strong emphasis in systems dynamics on client participation as contributing to the value of the system dynamics approach in such settings. Four general principles are outlined:

(1) involving the client in conceptualization;
(2) closer, more frequent modeller-client communication throughout the modeling process;
(3) starting simple;
(4) including client assumptions in model structure.

Public policy applications of system dynamics modeling have increased significantly in recent years. The 1985 conference of the System Dynamics Association saw more than a third of the papers

Figure 2: Typical differences in the policy analysis environment between corporate setting and the public policy scene[13]

Aspects of analysis	Corporate setting	Public policy scene
1. Owners of problem	Few;closely tied up with problem	Large number;each identifies only partly with problem
2. Objectives of concerned social institutions	Few; clearly defined	Many; diffuse
3. Sources of information	Interviews with employees; corporate records	Close to infinite number of decision-makers and area specialists; historical records; research results
4. Depth and scope of analysis	Limited to the problems of a specific company assuming the framework of the company as given	Includes several "sectors" of society and in each sector several organizations/ companies; longtime horizon forces analysis to deal with fundamental social processes, viewing the current social institutions as subject to change
5. Policy options	Few; clearly defined	Many; in the form of broad strategies
6. Participation of policy-makers in	High-intensity participation feasible	Only limited participation feasible
7. Nature of results from analysis	Specific policy recommendations	Framework forbroad policy discussions
8. Users of analysis	A few policy-makers and their staff	Many policy-makers & their constituency
9. Evaluation of analysis	Same as users	Same as users plus research community
10. Implementation of policy change	Involves a limited number of key policy-makers and can be carried through fairly rapidly once they have made up their minds	A slow process; policy makers have to solicit support from an electorate and/or members of several interest groups; institutions must often be changed.

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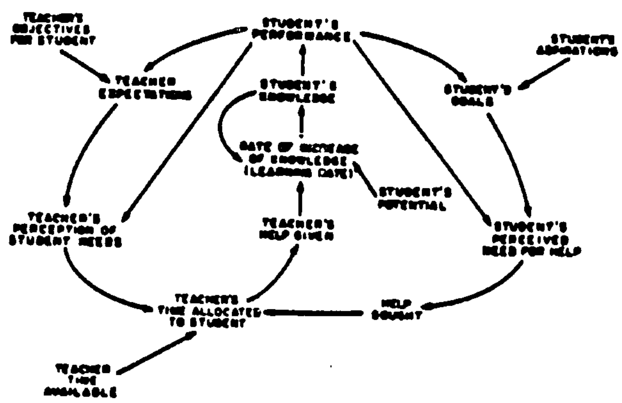
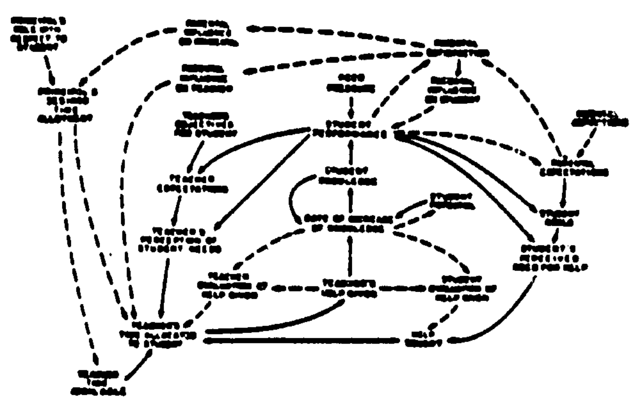
addressing public policy issues. An area which has received little attention until very recently is education.

SYSTEM DYNAMICS AND EDUCATION

The use of feedback systems in theoretical work on education is traced by Nancy Roberts to the work of Packer and Packer in 1959.[14] However, Roberts' own work in 1974 is reportedly the first to combine the concepts of educational feedback systems with computer modeling. Roberts' model simulated student performance in an elementary classroom. Building an initial model from key findings in the literature on factors influencing academic performance of an elementary school student, Roberts proceeded to run a series of computer simulations based on manipulation of critical variables. The result of the simulation exercises was an enlarged model which suggested other areas than those highlighted in the literature as affecting the dynamics of student performance.

Figure 3 presents the initial model and then the final model which emerged from the simulation exercise. A comparison of the initial systems diagram and the enlarged model reveals a greater degree of both complexity and explanatory power in the latter model. Roberts urges that similar modeling be undertaken in the areas of drug use in schools, school dropouts, and family dynamics.



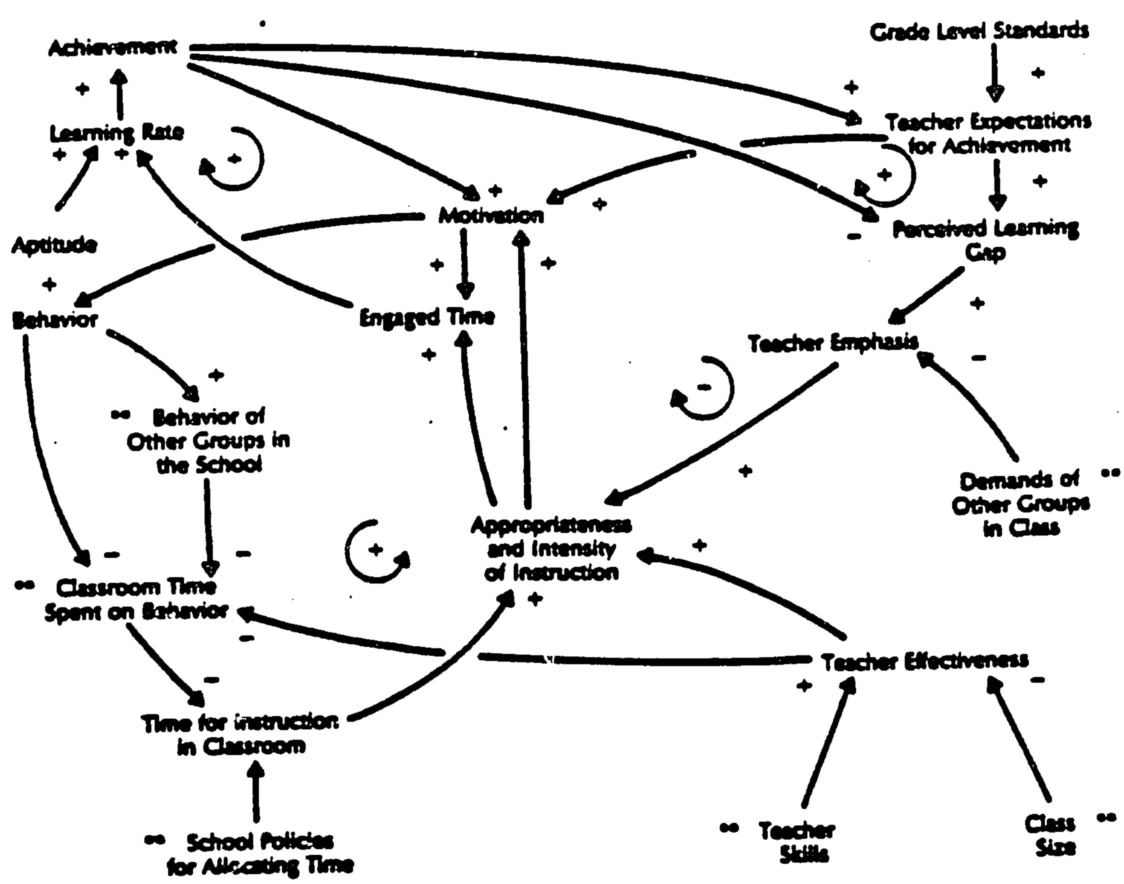


SOURCE ?

More recent work by Karl Clauset has also used a system dynamics approach in educational modeling. Clauset and Gaynor[16] used a similar approach to Roberts in systematically reviewing relevant literature and constructing a model around key findings. They express dissatisfaction with traditional unweighted, input-output models of school effectiveness and go on to propose that schools are systems that produce multiplier effects, and are thus most appropriately represented by a system dynamics approach to modeling. Figure 4 shows the causal model developed by Clauset and Gaynor. The points of intervention for policy makers are highlighted in this model by a double asterisk (**).

Figure 4

The Basic Feedback Structure and Points for Intervention in a Dynamic Theory of Schooling.*



** . Points of Intervention
To Improve Effectiveness

*In the figure, the plus and minus signs on the links between variables indicate the nature of the relationships (that is, direct or inverse). For example, a plus sign between achievement and motivation means that as achievement increases, motivation will also increase and as achievement decreases, motivation decreases. The minus sign between behavior and time spent on behavior means that as behavior worsens, more time must be spent on behavior and as behavior improves, less time is needed. The arrowheads on the links between variables indicate the direction of causation. The circular arrows with plus or minus signs inside them indicate whether a feedback loop is positive or negative. A loop containing an odd number of minus signs is a negative loop and exhibits goal-seeking behavior; one containing an even number of minus signs or all positive signs is a positive loop and exhibits self-reinforcing behavior.

Clauset and Gaynor note that the iterative approach employed in the construction of this system dynamics model involves a circular process of moving between the knowledge base, the theory, and the simulation model. The value of this process is that it leads to a deeper understanding of the problem at hand.

The new system dynamics "expert system", STELLA, takes a value of this iterative process out of the labs of expert system dynamicists and onto the screens of everyday Macintosh users. STELLA will be described and evaluated in the sections which follow. However, it is interesting to note in this section on System Dynamics and Education, that a primary focus of STELLA's developers is the field of education. Two papers presented at the 1985 Conference of the System Dynamics Association described the integration of STELLA into introductory physics and microeconomics courses. In each instance, STELLA was used to allow students to change the relationships between variables in equations derived from established theory, and to examine the assumptions underlying the various theories presented. The authors encouraged the use of a more interactive approach to the teaching of these disciplines.

The following sections present a detailed outline of STELLA, and consideration will also be given to recent and future applications in the field of education.

INTRODUCTION TO STELLA

STELLA is an acronym for Structural Thinking, Experiential Learning Laboratory with Animation. It is a first attempt at a system dynamics "expert system." "Expert systems" is a branch of a newly-emerging field of "Artificial Intelligence."[18]

STELLA is an icon-based modeling "language." The program includes knowledge of structural and computational "rules," as well as model-creation heuristics. It was created specifically for use on Macintosh computer. In fact, Barry Richmond, a student of Jay Forrester at MIT, had the idea for the program five or six years ago and it was only with the introduction of Macintosh to the public in 1984 that made STELLA possible. Richmond and a team of four other people created STELLA and introduced it to the public in November 1985.[19]

Richmond's idea for STELLA came from the concern that system dynamics needed to be more widely used. He advances the hypothesis that the field of system dynamics has not gained wide-spread use, even after twenty-five years of practice, because there has been a lack of clarity about its purpose. He suggests that its primary value is in education. The "real strength of system dynamics lies in its ability to enhance, enrich and extend the learning experience. Using system dynamics, people can learn faster, achieve a deeper level of understanding, and retain the resulting knowledge for a longer period of time."[20]

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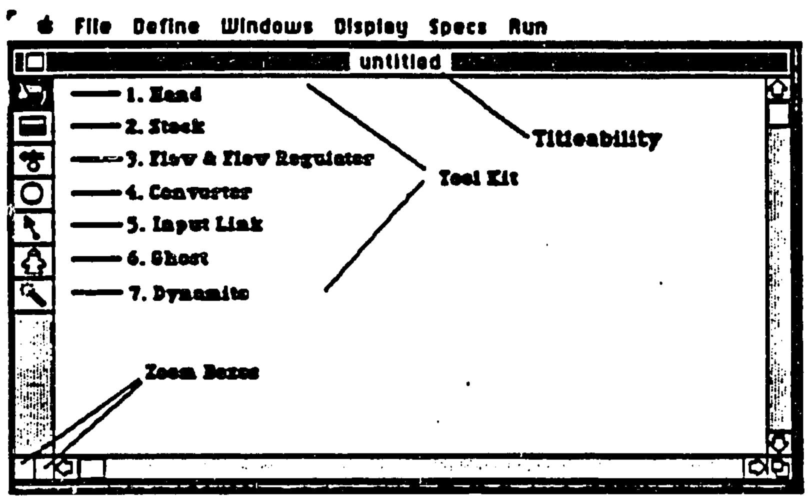
It is the _process_ of the discipline, therefore, that is the most valuable item. Widescale transfer of the process is seen to be important in increasing use of the discipline of system dynamics. This was the motivation for creating STELLA. STELLA was designed to facilitate efforts to bring the system dynamics framework to a broad audience. The software is designed to enable those lacking computer experience or a quantitative orientation to conceptualize, construct and analyze high-quality system dynamics models, while accelerating the development of an intuitive facility with a dynamic approach.

Description of the STELLA Program

Structural Components

In using STELLA, a structural diagram is constructed by selecting structural elements from a tool kit (Figure 5) positioned along the left-hand margin of the screen of Apple's Macintosh personal computer.

Figure 5



Each element selected is positioned on the screen and then connected to reflect the structural relationship being considered in a given problem. Each element represents a computer code containing sets of structural and computational rules.

The program's structural elements include stock, flow and flow regulator, converter and an input link.

1. The stock represents accumulation processes of net inflows minus outflows and is signified by a rectangle, in keeping with longstanding diagramming traditions in engineering and the physical sciences.

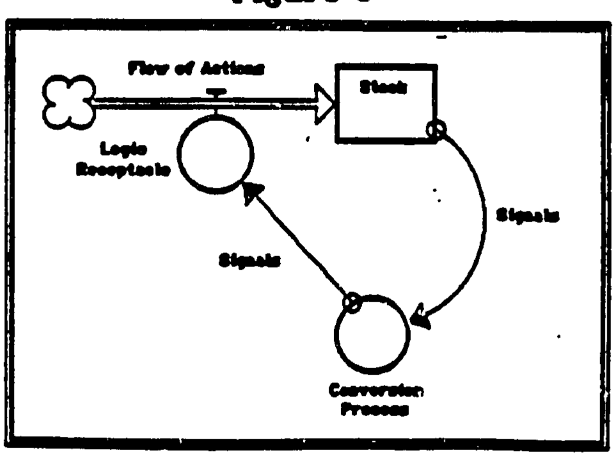
2. The Flow and flow regulator represent the rate of various flows into and out of the stocks. The algebraic direction of flow is automatically established as the arrowhead points the direction of *positive* flow. It is represented by a pipe, valve and a circle. Signals arrive as inputs to the circle which is the "logic receptacle" portion of the flow regulator. It translates information inputs into outputs that regulate a rate of flow. The valve settings regulate the flows into and out of the stocks.

3. The Converter, represented by a circle, is a receptacle for logic. It uses the logic to generate outputs. Within this framework, constants are seen as circles which have no inputs.

4. The Input link, represented as a thin arrow, connects elements as they are related to each other in the hypothesis presented.

Figure 6 below shows these four structural elements as they relate to each other in a simple feedback loop.

Figure 6



The stocks generate signals (pressures) to take actions. Actions regulate the flows. As flows change in volume, they in turn determine new values for the stocks. Stocks then generate new signals. This ongoing, circular control process in which conditions lead to actions which return to influence conditions is known as the feedback loop.

Dialogue Box

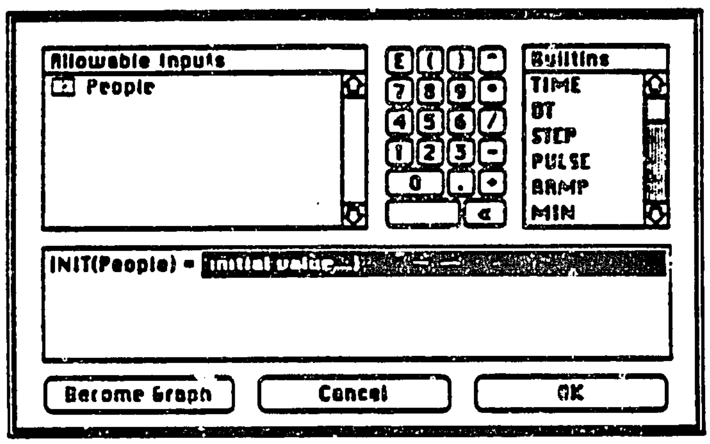


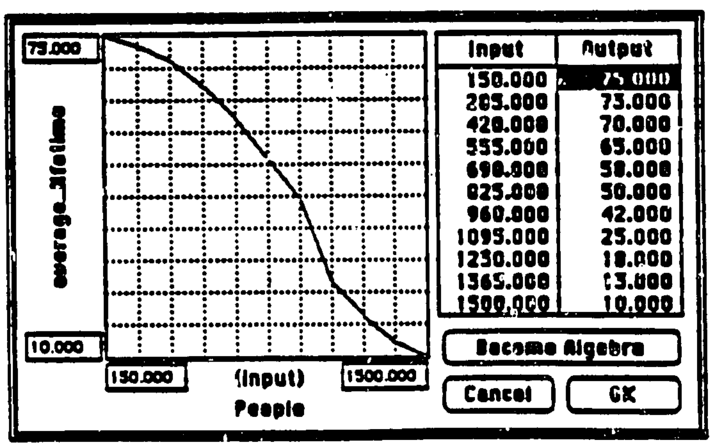
Figure 7

The dialogue box contains the equation logic for each of the structural elements. It is entered by "opening" the icon with a double-click of the mouse button. Each box contains a rectangle that displays the list of allowable inputs as they have been indicated in the model. A calculator is supplied for use in entering numbers, algebraic operators, and "comments" (for documenting equations). A list of "Built-Ins" is also provided which are designed to generate regular, time-varying behavior patterns used in testing the response patterns of a model. A rectangle at the bottom of the box prompts for an equation which can be inserted by a number or by clicking on the allowable variables as they are listed in the box above.

Graphical Functions

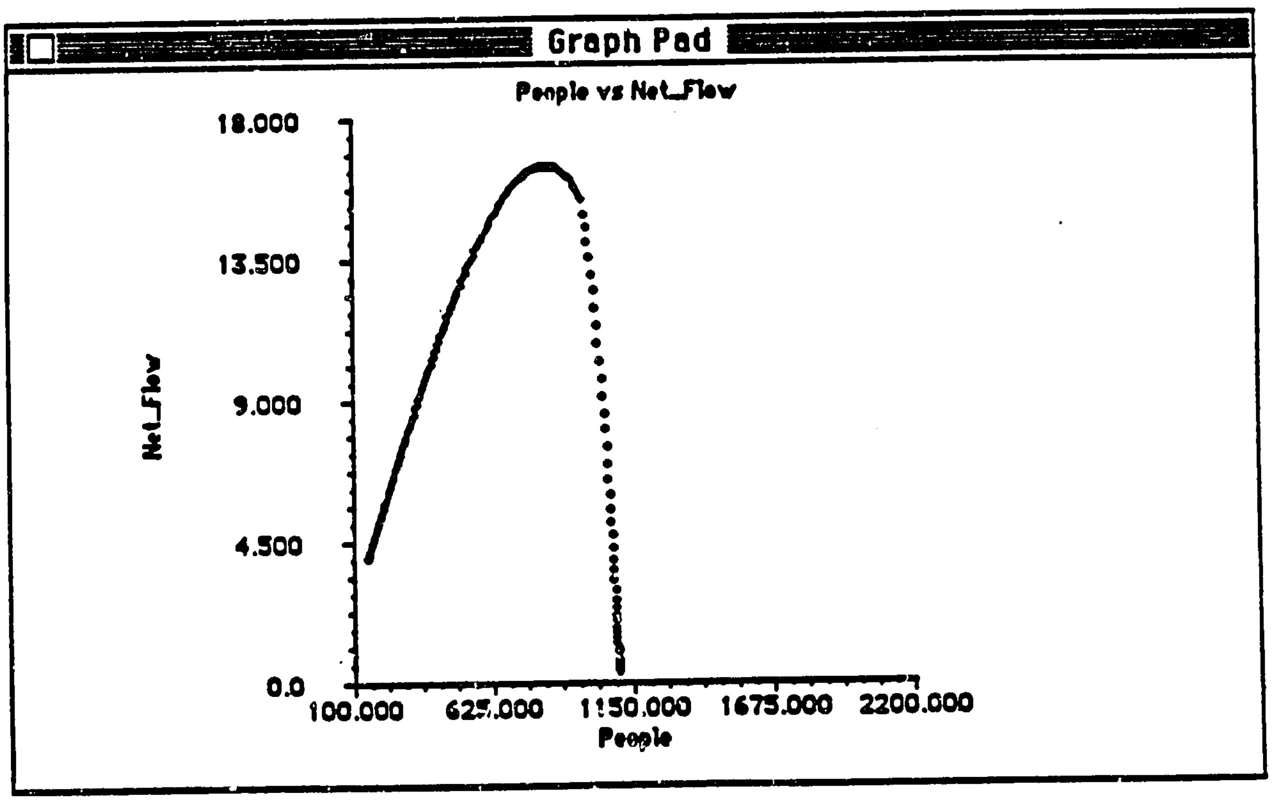
Graphical functions represent the relationship existing between two variables looked at over their full possible operating range, against a "fixed" backdrop. They show causal linkages between the two variables in isolation. Two types of graphical functions can be demonstrated with STELLA. By clicking on the "Become Graph" option in the dialogue box, a box will come forward showing a gridded axis and two columns labeled "input" and "output." To create the graphical function, you can "draw" the curve on the axis with the mouse, or you can enter "y" values into the "output" column. As the curve is drawn, the numerical values associated with "y" are computed automatically and appear in the column as the sketching is taking place. On the other hand, if numerical values are entered into the column, the corresponding linear curve will be drawn automatically (Figure 8).

Figure 8



The Graph Pad (Figure 9) command brings forward a blank axis that allows for plotting one element versus another from the list of variables that automatically runs a simulation.[17]

Figure 9



Current Applications

In the short time since STELLA was first introduced to the public in November 1985, the program has been used by educators, researchers and management consultants in a variety of ways. To date, circulation of STELLA is limited. 1,000 copies of the program have been sold by High-Performance Systems world-wide. We located a sampling of ten people in the Boston area and conducted hour-long phone interviews with four of these users. It is too soon to be able to properly assess the applications in depth, but our brief survey revealed that STELLA is being used in a variety of ways within and outside the educational community.

A series of books is being developed by High-Performance Systems to disseminate STELLA and system dynamics into the college educational market. Two texts, "Learning Laboratories in Physics" and "Learning Laboratories in Microeconomics," have been developed thus far. These books center on a "learning laboratory" approach to learning, using STELLA as the basis for an experiential, learner-controlled learning process.

Lesley College and the Technical Education Research Center (TERC) have received a grant from the National Science Foundation to study the use of computer tools in high school curriculum to help students build theories that help them understand the natural world in a general way. The curriculum is organized around four ways of producing graphs:

- from laboratory measurements;
- from an algebraic function;
- as a result coming from a system dynamic model;
- or from a table or spreadsheet.

STELLA will be used for the system dynamics modeling portion and EXCEL will be used for spreadsheets.

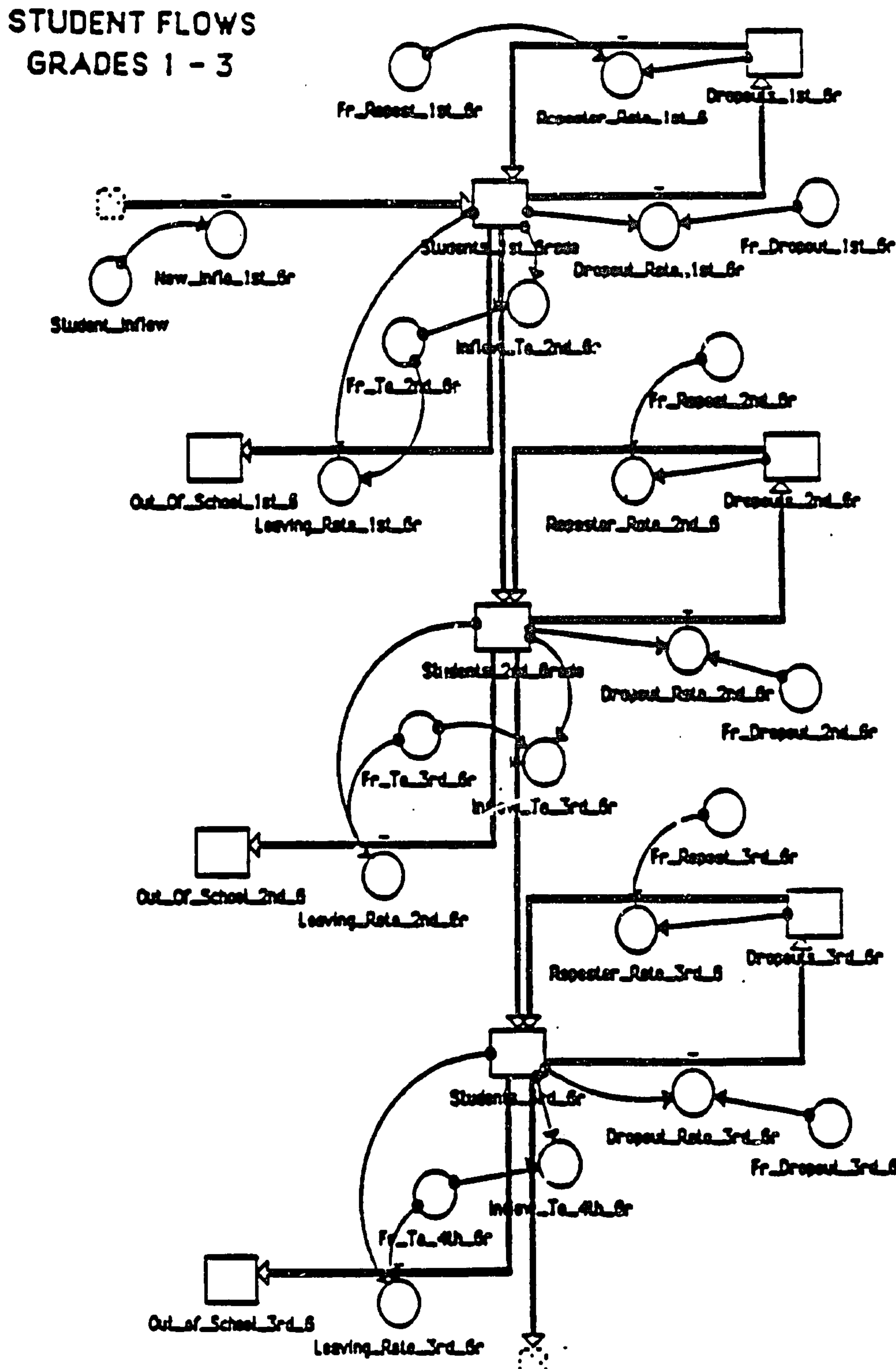
The Center for Wetland Resources at Louisiana State University has begun to integrate STELLA into the curriculum in a systems modeling course and one student is using it for thesis work.

The management consultant firm of Booz Allen & Hamilton has begun to use STELLA to involve their clients more directly in management decision making processes.

The New Management Style Project at M.I.T is using STELLA as a primary tool in an innovative program in systems thinking to train corporate executives the effects independent decisions have on the whole organization. Corporations participating include Polaroid, Cray Research, Holiday Inn Corporation, Analog Devices and the San Francisco Foundation. Twice a year executives participate in STELLA workshops at M.I.T. STELLA is also used as a planning tool daily within these organizations.

Outside the U.S., the Stord School of Education in Rommepbit, Norway is using STELLA in their curriculum and has applied for a site license. STELLA is also being used with government officials involved in economic development in Taiwan to demonstrate the impact of industrial growth on the environment.

Figure 10: Student Flows Grades 1-3



Source: K. H. Clauset, Jr. "Computer Simulation Modeling: Linking Research, Theory-Building, Planning, and Implementation" Nov. 25, 1985

The Popex Model

Thomas Cassidy and Russell G Davis

1.0 A Note: Spreadsheet Model or Template

POPEX2
Version: Test 1

A cohort-based population projection template
for use with LOTUS 1-2-3, Version 2.0
Requires 512K RAM.

The BRIDGES Project
Harvard Graduate School of Education

T. Cassidy
R. Davis

May 1986

[Press the Tab-key once]

The terms "model" and "template" mean the same thing, when referring to small, component, spreadsheet models. Popex model, was designed in Lotus by Cassidy, based on a model by Davis (1980). Popex projects total population, school-age population and the school-age entrant pool, using a components method of projection, described in Chapter Two. It works best for planning in the national education systems of LDC's, where external migration is not significant at national level. Popex does permit the inclusion of migration data, but it is not used in this example.

The template is designed in a series of screen views shown in the Template Map in Annex A.In general structure the design is:

A)A series of Introductions and descriptions,shown to the left of these next few pages:the title screen,shown on the previous page;the Introduction,on this page,and the Description Screens and the Popex Macro Menus,shown on the next page.This run along the top of the spreadsheet from A1 to Y 20 and can be accessed by a stroke on the Tab Key.

INTRODUCTION

Before attempting to use POPEX2 you should read the five screens to the right of this one. To move from screen to screen simply press the Tab-key. To move backwards press the Tab-key while holding the Shift-key down.

This template has been structured around a set of Command Menus with the intention of making it easier to move about the template, input data, view results tables and graphs, and print selected results tables. These are presented in the 4th screen. It is also possible to move about the template freely using the Tab, Shift & Tab, PgUp, and PgDn keys. To make this free-form movement easier template components have been layed out at even screen distances from one another starting at the HOME position.

A general familiarity with LOTUS 1-2-3, particularly with the form and use of 1-2-3 Menus, will make use of this template easier. If you are a new comer to 1-2-3, locate the ESC-key on the keyboard, it can be used to escape from most any unexpected situation. If ever ESC shouldn't work, hold the CTRL-key down, press the Break-key, release both and then press the ESC-key.

DESCRIPTION (Screen 1 of 3)

POPEX2 is a program that:

1. Projects individual cohort and total population fifteen years out from a base year in three 5-year periods.

2. Interpolates age-sex specific populations for ages 0-19 for the base year and each five year period.

3. Calculates the number of 4, 5, 6, and 7 year olds for use in school enrollment projections.

DESCRIPTION (Screen 2 of 3)

Populations are projected using the following method:

FUTURE POP = BASE YR POP + BIRTHS - DEATHS +/- MIGRATION

Births, meaning survivors of birth, are a function of the number of women of child-bearing age multiplied by a set of fertility rates which are then multiplied by survival ratios obtained from the UN Model Life Tables.

Deaths are calculated using appropriate survival ratios for specific age-sex cohorts obtained from the UN Model Life Tables.

Populations, projected by age-sex cohorts, are distributed to specific ages using Sprague Multipliers.

DESCRIPTION (Screen 3 of 3)

*NOTE: Migration is not a fully integrated component of this version of POPEX2. Thus, this template is of limited use in situations where national level migration is a significant factor.

POPEX2 MENUS

Reviewing the various components of POPEX2, inputting data, viewing graphs, printing, and accessing this and other help screens are most easily accomplished using one of several selection menus. Menus are invoked by pressing a specified key while holding the ALT-key down. The menus available and the keys used to invoke them are:

1. The "Components Menu"	ALT-key & C-key
2. The "Input Menu"	ALT-key & I-key
3. The "Population Tables Menu"	ALT-key & T-key
4. The "Graphs Menu"	ALT-key & G-key
5. The "Print Menu"	ALT-key & P-key
6. The "Help Menu"	ALT-key & H-key

Use the Space Bar to make selections within menus and the Return-key to invoke your selection.

Description Screens

These cover:

Screen 1-The purpose and use of Popex

Screen 2-Basic demographics of Popex:

a)Basic balance equation: Base Year Population and the three demographic components;

b)Description of the main components:Births or Fertility;Deaths,or Mortality;and Migration,which is not put in ,in this exercise.

Screen 3-The Popex Menus:

a)The Components Menu;b) Input Menu;and c) Population Projection Menu;d)Graphs;e) f)Print and g)Help Menus

Menus shown as they appear on Popex menu line,Annex B.

BASE YEAR POPULATION 1980

AGE-GROUP	MALE	FEMALE	TOTAL
0-4	475291	459374	934665
5-9	402120	392669	794789
10-14	314449	340742	655191
15-19	302190	315684	617874
20-24	299000	307654	606654
25-29	269765	274567	544332
30-34	248768	256787	505555
35-39	234543	243543	478086
40-44	217657	229800	447457
45-49	188765	201324	390089
50-54	245678	261460	507138
55-59	215678	236789	452467
60-64	191345	201222	392567
65-69	175678	189789	365467
70-74	98890	122345	221235
75-79	64599	85678	150277
80+	28970	46789	75759
TOTAL	3973386	4166216	8139602

The "Components" menu and the "Input" menu access the same essential data, since the component data is input to a components projection. Both components and input begin with the Base Year Population, which is directly under the first screen, as shown in the Template Map. A21 to D44. The Base Year Population in this Popex example exercise is printed to the left.

The Components and the Input Menus

The Components Menu accesses fertility rates assumed, survival rates from model life tables, births and survivors, migration, UN Model Life Tables, and Sprague Mul tiplier panels. The Input Menu does not directly use the Life Tables and Multipliers.

Components Menu

BASE YR POP	FERTILITY	MORTALITY	BIRTHS	MIGRATION	LIFE TABLE	SPRAGUE MULT

INPUT MENU

BASE YR POP	FERTILITY	MORTALITY	BIRTHS	MIGRATION

Note: See Annex B for sub heading explanations of the menus

FERTILITY (rates per 1000 women)

Which hypothesis? (1 or 2) 1 (Enter data below in the table of your choice.)

Hypothesis 1 - Unchanging Fertility (Enter data for all age cohorts in the Base year only.)

AGE	Base Yr 1980	1985	1990	1995
15-19	85.0	85.0	85.0	85.0
20-24	222.0	222.0	222.0	222.0
25-29	250.0	250.0	250.0	250.0
30-34	198.7	198.7	198.7	198.7
35-39	139.0	139.0	139.0	139.0
40-44	64.9	64.9	64.9	64.9
45-49	15.8	15.8	15.8	15.8

Hypothesis 2 - Declining Fertility (Enter data for all age cohorts, all years.)

AGE	1980	1985	1990	1995
15-19	84.4	81.3	78.4	75.7
20-24	223.3	214.3	206.7	199.4
25-29	260.4	251.3	242.2	233.6
30-34	198.7	191.5	184.9	178.3
35-39	139.0	134.0	129.2	124.6
40-44	64.9	62.6	60.4	58.3
45-49	15.8	15.2	14.7	14.1

MORTALITY

Survival Ratios (Source - UN Model Life Tables)

PERIOD	UN MORTALITY LEVEL
1980 TO 1985	75
1985 TO 1990	80
1990 TO 1995	85

NOTE: To view the UN Model Life Tables use the "Components Menu" (ALT-key & C-key).

MORTALITY

Survival Ratios (Source - UN Model Life Tables)

PERIOD UN MORTALITY LEVEL

<u>Fertility</u>

Calling BASE YR POP on the Input or Components menus takes the user to the base year population screen in which the population is arrayed by sex and five year age groups, as the one shown for the Popex example shown on the previous page. The Sprague Multiplier panels, also accessible from the Components menu, spreads five year age groupings into single years.

FERTILITY on either of the menus yields the two tables shown to the left. The first assumes constant fertility over the forecast, and the second assumes the rates (age-specific) decline over the three five-year forecast periods. <u>Mortality</u> shows survival rate levels from UN Model Life Tables, improving over the forecast.

BIRTHS AND SURVIVORS

1980 - 1985 BIRTH FRACTION (% FEMALES) = 0.4911

FERTILE AGE-GROUP	AVG # of WMN in GRP	5-YR FERTILITY	TOT BIRTHS	TOT FEMALE BIRTHS	SURVIVAL RATIO	1985 TOT FEMALE SURVIVE
15-19	326270	0.4250	138665	68098	0.9036	61534
20-24	309111	1.1100	343114	168503	0.9036	152260
25-29	293141	1.2500	360177	176883	0.9036	159831
30-34	262821	0.9935	261113	128233	0.9036	115871
35-39	247301	0.6950	171875	84409	0.9036	76271
40-44	233615	0.3245	75608	37229	0.9036	33640
45-49	212011	0.0790	16749	8225	0.9036	7432
						606846

BIRTHS AND SURVIVORS

1985.00 - ####### BIRTH FRACTION (% FEMALES) = 0.49

FERTILE AGE-GROUP	AVG # of WMN in GRP	5-YR FERTILITY	TOT BIRTHS	TOT FEMALE BIRTHS	SURVIVAL RATIO	1990.00 TOT FEMALE SURVIVE
15-19	#######	0.4250	153372	75321	0.9208	69356
20-24	#######	1.1100	356798	175224	0.9208	161346
25-29	#######	1.2500	379554	186399	0.9208	171636
30-34	#######	0.9935	280824	137913	0.9208	126990
35-39	#######	0.6950	178905	87860	0.9208	80902
40-44	#######	0.3245	78374	38489	0.9208	35441
45-49	#######	0.0790	17919	8800	0.9208	8103
						653780

__Note__: The Fertility and Mortality components shown on the previous page, permit choices based on different different assumptions. This is what __projections__ are. In Popex choice points are back-lighted to indicate that they can be changed on the template as __input__, whereas other labels and data arrays (model tables) are cell protected against accidental change.

__Births and Survivors__ are shown to the left for the three periods. Births are estimated on the basis of age specific fertility rates multiplied by the average number of women (between base and forecast periods) in the age group; Male/Female Birth Fractions are applied, and birth survival rates to each year, 0-4) applied. This gives the new numbers in the

BIRTHS AND SURVIVORS

1990.00 - #######   BIRTH FRACTION (% FEMALES) = 0.49

FERTILE AGE-GROUP	AVG # of WMN in GRP	5-YR FERTILITY	TOT BIRTHS	TOT FEMALE BIRTHS	SURVIVAL RATIO	1995.00 TOT FEMALE SURVIVE
15-19	#######	0.4250	174662	85777	0.9208	78983
20-24	#######	1.1100	395720	194338	0.9208	178946
25-29	#######	1.2500	395954	194453	0.9208	179052
30-34	#######	0.9935	296906	145811	0.9208	134262
35-39	#######	0.6950	193056	94810	0.9208	87301
40-44	#######	0.3245	81652	40198	0.9208	37014
45-49	#######	0.0790	18590	9130	0.9208	8407
						703972

0-4 age group for the next forecast period.Note that the 653780 females are put in the 0-4 group for year 1990 in the Projection Tables on Page 7.(Recall:all the other age groups from 5 years old and above were derived as survivors from the previous age group in the previous period.)

Births are Survivors are projected for the three periods of the exercise, 1980-1985;1985-1990;and 1990;1995.This also shows that the process is simply iterative,and every five years new rates are input, and the procedures is the same.

B320: MENU

BASE OF POP FERTILITY MORTALITY BIRTHS MIGRATION LIFE TABLES SPRAGUE

(Not a required input in this version of POPE12).

	BG	BH	BI	BJ	BK	BL	BM	BN
20								
21		MIGRATION - FEMALES						
22								
23				1980.00	1985.00	1990.00		
24				TO	TO	TO		
25		AGE-GROUP		1985.00	1990.00	1995.00		
26		---------		------	------	------		
27		0-4		1.00	1.00	1.00		
28		5-9		2.00	2.00	2.00		
29		10-14		3.00	3.00	3.00		
30		15-19		4.00	4.00	4.00		
31		20-24		5.00	5.00	5.00		
32		25-29		6.00	6.00	6.00		
33		30-34		7.00	7.00	7.00		
34		35-39		8.00	8.00	8.00		
35		40-44		9.00	9.00	9.00		
36		45-49		10.00	10.00	10.00		
37		50-54		11.00	11.00	11.00		
38		55-59		12.00	12.00	12.00		
39		60-64		13.00	13.00	13.00		

25-Aug-86 09:51 AM CMD CALC

Migration

Migration in this exercise is simply a place-holder component to indicate that in some countries external migration is significant,and data are available to deal with it as a component.In most countries neither of these conditions holds.In the US,and other countries, migration is put in as a constant and it is age and sex specific,as shown for Females,included as an example in this exercise.

Model Life Tables

On the following page are Survival Rates for Males and Females,excerpted from UN Model Life Tables.Other model tables are Coale Demeny Regional Tables(1966). The age-specific survival rates are tabled in 7 levels based on increasing levels of life expectancy at birth.

MODEL LIFE TABLES (Survival ratios)

SEX & AGE IN YEARS	LEVEL 60	LEVEL 65	LEVEL 70	LEVEL 75	LEVEL 80	LEVEL 85	LEVEL 90
	(AA 50.0)	(AA 52.5)	(AA 55.0)	(AA 57.6)	(AA 60.4)	(AA 63.2)	(AA 65.8)
MALES							
(BIRTHS)	0.8406	0.8557	0.8703	0.8877	0.9070	0.9262	0.9438
0-4	0.9445	0.9518	0.9584	0.9648	0.9708	0.9765	0.9818
5-9	0.9834	0.9856	0.9876	0.9893	0.9909	0.9924	0.9937
10-14	0.9827	0.9848	0.9867	0.9884	0.9900	0.9914	0.9929
15-19	0.9741	0.9772	0.9798	0.9824	0.9848	0.9871	0.9893
20-24	0.9688	0.9725	0.9758	0.9709	0.9819	0.9847	0.9873
25-29	0.9673	0.9712	0.9748	0.9781	0.9811	0.9840	0.9866
30-34	0.9644	0.9686	0.9725	0.9760	0.9792	0.9822	0.9849
35-39	0.9580	0.9628	0.9671	0.9711	0.9746	0.9779	0.9808
40-44	0.9467	0.9523	0.9573	0.9617	0.9658	0.9696	0.9728
45-49	0.9294	0.9359	0.9419	0.9469	0.9516	0.9558	0.9596
50-54	0.9045	0.9121	0.9189	0.9250	0.9306	0.9356	0.9400
55-59	0.8678	0.8767	0.8847	0.8919	0.8985	0.9044	0.9098
60-64	0.8141	0.8246	0.8338	0.8423	0.8502	0.8573	0.8639
65-69	0.7367	0.7487	0.7598	0.7698	0.7794	0.7881	0.7963
70-74	0.6334	0.6469	0.6594	0.6708	0.6816	0.6917	0.7012
75-79	0.5049	0.5193	0.5326	0.5449	0.5566	0.5675	0.5779
80+	0.2988	0.3091	0.3186	0.3272	0.3358	0.3426	0.3493
FEMALES							
(BIRTHS)	0.8594	0.8739	0.8882	0.9036	0.9208	0.9380	0.9535
0-4	0.9463	0.9537	0.9607	0.9669	0.9731	0.9791	0.9844
5-9	0.9828	0.9852	0.9874	0.9895	0.9914	0.9932	0.9948
10-14	0.9819	0.9843	0.9865	0.9886	0.9906	0.9925	0.9941
15-19	0.9745	0.9778	0.9809	0.9838	0.9865	0.9891	0.9914
20-24	0.9694	0.9735	0.9771	0.9807	0.9839	0.9869	0.9896
25-29	0.9674	0.9718	0.9756	0.9792	0.9826	0.9858	0.9884
30-34	0.9654	0.9700	0.9739	0.9777	0.9811	0.9842	0.9868
35-39	0.9622	0.9669	0.9710	0.9749	0.9783	0.9814	0.9841
40-44	0.9556	0.9606	0.9650	0.9691	0.9727	0.9759	0.9788
45-49	0.9437	0.9493	0.9543	0.9589	0.9631	0.9668	0.9700
50-54	0.9252	0.9318	0.9377	0.9433	0.9482	0.9529	0.9570
55-59	0.8949	0.9030	0.9104	0.9175	0.9238	0.9298	0.9351
60-64	0.8459	0.8559	0.8653	0.8743	0.8825	0.8903	0.8971
65-69	0.7710	0.7832	0.7949	0.8059	0.8162	0.8259	0.8345
70-74	0.6662	0.6804	0.6940	0.7073	0.7197	0.7316	0.7422
75-79	0.5369	0.5523	0.5672	0.5819	0.5955	0.6088	0.6207
80+	0.3211	0.3313	0.3406	0.3495	0.3376	0.3652	0.3719

The Projection Results

The results of using the projection template can be called up by menu which covers:

Population Tables (menu)

POP-F   POP-M   POP-TOT (No Migrat)   POP-TOT (w Migrat)   Age/Sex   New Entrants

The projection results are:1)The Female Population,projected to 1985,1990 and 1995;2)Male Population,same years;3)Total Population without Migration;4)Total Population(with Migration,in this case dummied in);5)Age/Sex all periods;6)New Entrants which are age-sex single age for ages 4,5,6,7,which cover most possible entry ages in most countries of the world. This last is,of course,the point of the model,as far as educational planners go.

POPULATION PROJECTION - FEMALES

AGE-GROUP	BASE 1980	SURVIVAL RATIO	FEMALE POP 1985	SURVIVAL RATIO	FEMALE POP 1990	SURVIVAL RATIO	FEMALE POP 1995
0-4	459374	0.9669	606846	0.9731	653780	0.9791	703972
5-9	392669	0.9895	444169	0.9914	590522	0.9932	640116
10-14	340742	0.9886	388546	0.9906	440349	0.9925	586306
15-19	315684	0.9838	336858	0.9865	384894	0.9891	437046
20-24	307654	0.9807	310570	0.9839	332310	0.9869	380698
25-29	274567	0.9792	301716	0.9826	305570	0.9858	327957
30-34	256787	0.9777	268856	0.9811	296466	0.9842	301231
35-39	243543	0.9749	251061	0.9783	263775	0.9814	291782
40-44	229800	0.9691	237430	0.9727	245613	0.9759	258868
45-49	201324	0.9589	222699	0.9631	230948	0.9668	239693
50-54	261460	0.9433	193050	0.9482	214482	0.9529	223281
55-59	236789	0.9175	246635	0.9238	183050	0.9298	204379
60-64	201222	0.8743	217254	0.8825	227842	0.8903	170200
65-69	189789	0.8059	175928	0.8162	191727	0.8259	202847
70-74	122345	0.7073	152951	0.7197	143593	0.7316	158347
75-79	85678	0.5819	86535	0.5955	110079	0.6088	105052
80+	46789	0.3495	66209	0.3576	75208	0.3652	94482
he TOTAL	4166216		4507312		4890204		5326458

POPULATION PROJECTION - MALES

AGE-GROUP	BASE 1980	SURVIVAL RATIO	MALE POP 1985	SURVIVAL RATIO	MALE POP 1990	SURVIVAL RATIO	MALE POP 1995
0-4	475291	0.9648	617769	0.9708	667316	0.9765	718548
5-9	402120	0.9893	458561	0.9909	599731	0.9924	651634
10-14	314449	0.9884	397817	0.9900	454388	0.9914	595173
15-19	302190	0.9824	310801	0.9848	393839	0.9871	450480
20-24	299000	0.9789	296871	0.9819	306077	0.9847	382759
25-29	269765	0.9781	292691	0.9811	291498	0.9840	301394
30-34	246768	0.9760	263057	0.9792	287159	0.9822	286834
35-39	234543	0.9711	242798	0.9746	258369	0.9779	282048
40-44	217657	0.9617	227765	0.9658	236631	0.9696	252659
45-49	188765	0.9469	209321	0.9516	219975	0.9558	229437
50-54	243678	0.9250	178742	0.9306	199190	0.9356	210252
55-59	215678	0.8919	227252	0.8985	166337	0.9044	186362
60-64	191345	0.8423	192363	0.8502	204186	0.8573	150435
65-69	175679	0.7698	161170	0.7794	163547	0.7881	175049
70-74	98890	0.6708	135237	0.6816	125616	0.6917	128892
75-79	64599	0.5449	66335	0.5566	92177	0.5675	86988
80+	28970	0.3272	44679	0.3352	51899	0.3426	70091
TOTAL	3973386		4324030		4717935		5164935

POPULATION PROJECTION - TOTAL (FEMALE & MALE) WITH NO MIGRATION

AGE-GROUP	BASE 1980	1985	1990	1995
0-4	934665	1224615	1321096	1422520
5-9	794789	902729	1190252	1291750
10-14	655191	786363	894737	1181679
15-19	617874	647659	778733	887526
20-24	606654	607441	638387	769457
25-29	544332	594407	597068	629351
30-34	505555	532713	583626	588065
35-39	478086	493858	522144	573830
40-44	447457	465195	482243	511527
45-49	390089	432020	450923	469130
50-54	507138	371791	413671	433533
55-59	452467	473887	349387	390741
60-64	392567	409617	432028	320635
65-69	365467	337098	355274	377896
70-74	221235	288188	269209	287239
75-79	150277	152870	202256	191941
80+	75739	110888	127106	164573
TOTAL POP	8139602	8831342	9608139	10491394

New Entrants

NEW ENTRANTS: AGE 5	BASE YEAR 1980	1985	1990	1995
************	-------	-------	-------	-------
FEMALE	83571	96937	128562	131276
MALE	88036	99502	130182	133924
	-------	-------	-------	-------
TOTAL	171608	196439	258744	265200

NEW ENTRANTS: AGE 6	BASE YEAR 1980	1985	1990	1995
************	-------	-------	-------	-------
FEMALE	80944	91947	124174	129483
MALE	84418	94719	125816	131963
	-------	-------	-------	-------
CHECK TOTAL	165362	186666	249990	261446

NEW ENTRANTS: AGE 7	BASE YEAR 1980	1985	1990	1995
************	-------	-------	-------	-------
FEMALE	78416	87977	118800	127941
MALE	80540	90924	120568	130243
	-------	-------	-------	-------
TOTAL	158956	178902	239368	258184

New Entrants are obtained by splitting the five year age group 0-4 into single years,0-1,1-2.2-3,3-4, 4-5;and then splitting the 5-9 into 5-6,6-7 etc.To the left are shown the results for the 5,6 and 7 year old males and females.

The single year age groups are obtained by using Sprague Multipliers to split the 0-4.5-9,10-14 age groupings into single years. This is shown in the final table.

INTERPOLATION OF NUMBERS OF FEMALES AGED 0-14 BY SINGLE YEARS OF
AGE IN 1980.00 USING SPRAGUE MULTIPLIERS

AGES	0-4	5-9	10-14	15-19	20-24	SUM	
**							FEMALES
****	0.3616	-0.2768	0.1488	-0.0336		97514	
****	0.2640	-0.0960	0.0400	-0.0080		94683	AGE 1
****	0.1840	0.0400	-0.0320	0.0080		91853	AGE 2
****	0.1200	0.1360	-0.0720	0.0160		89045	AGE 3
****	0.0704	0.1968	-0.0848	0.0176		86278	AGE 4
					check	459374	(AGES 0-4)
****	0.0336	0.2272	-0.0752	0.0144		83571	AGE 5
****	0.0080	0.2320	-0.0480	0.0080		80944	AGE 6
****	-0.0080	0.2160	-0.0080	0.0000		78416	AGE 7
****	-0.0160	0.1840	0.0400	-0.0080		76005	AGE 8
****	-0.0176	0.1408	0.0912	-0.0144		73733	AGE 9
					check	392669	(AGES 5-9)
****	-0.0128	0.0848	0.1504	-0.0240	0.0016	71582	AGE 10
****	-0.0016	0.0144	0.2224	-0.0416	0.0064	69537	AGE 11
****	0.0064	-0.0336	0.2544	-0.0336	0.0064	67793	AGE 12
****	0.0064	-0.0416	0.2224	0.0144	-0.0016	66440	AGE 13
****	0.0016	-0.0240	0.1504	0.0848	-0.0128	65391	AGE 14
					check	*********	(AGES 10-14)

Summary Comment on POPEX

Annex A shows the Template Map of Popex,with the screens identified by spreadsheet location.Annex B shows the menus designed with the various macros,which are located in the MACRO screens on the Template Map.Annex C shows the design of the Macros,so that the template can be structurally customized to fit the needs of any user. Any given user,of course,can restructure the tables and change the data to fit a given planning and projection situation.That is the whole point of template models.

Once the model is implemented and the projections made for any given planning situation,a number of spreadsheet features can be used to assist planners:

1)What-If and hypothesis testing can be done by changing any of the data values,parameter values or even structural characteristics to fit the specific country and school system. A planner could for example experiment with changed hypotheses about the demographic components(increased births) and trace the consequences for new entrants in future years.

2)Analysts can also develop sensitivity tables,and in Popex some versions have demonstration Sensitivity table areas. In sensitivity testing,the analyst can change one or more values of variables,and assess the degree to which other variable values are senstive to these changes.

One feature of Popex should be noted,and instructions alert users to this:Automatic Recalculation of the spreadsheet values has been turned off,and the Recalc is on manual,as a lighted area at the foot of the spreadsheet shows the user. The reason for this is that the spreadsheet is quite large and changes take time to make in a large system. Another reason is to remind the user that mindless changes--without prior systematic thought and policy and program reference--are of small use in planning. Changes in hypotheses,and the building of scenarios out of sets of changes and hypotheses should be carefully thought out beforehand in terms of the real life system that the template model represents. When that is done and the changes are introduced and the changes in the results observed,then the planner is doing analysis of value. Spreadsheet models are suited to this work.

TEMPLATE MAP

This map spans 4 screens across and up to 5 screens down.

```
A1***************   I1***************   Q1***************
 *Introduction*      *Introduction*      *Description *
 *            *      *            *      *  Screen 1  *
 **************H20   **************P20   **************Y20

A21**************   I21**************   Q21**************
 * Base Year  *      *            *      * Mortality  *
 * Population *      * Fertility  *      *   Data     *
 *            *      *   Data     *      **************Y40
 **************D44   *            *
                     **************N50


A52**********************************
 *                                *
 *                                *
 *     UN Model Life Tables       *          MORE >
 *                                *
 *                                *
 **********************************N112
```

POPEX ANNEX A

```
Z1***************    AI1 **************    AO1***************    AZ1***************
  *Description *      *Description *        *   POPEX    *         *    Data    *
  *  Screen 2  *      *  Screen 3  *        *   Menus    *         *    Entry   *
  **************AH20  **************AP20    **************AY20     **************

Z21**************                         AO21***************
  *            *                            *  Birth Data  *
  * Female Pop *                            *  1st 5-year  *
  * Projection *                            *    Period    *
  *            *                            ****************BE40
  **************AH50
                                          AO41***************
                                            *  Birth Data  *
                                            *  2nd 5-year  *
Z51**************                           *    Period    *
  *            *                            ****************BE60
  *  Male Pop  *
  * Projection *                          AO61***************
  *            *                            *  Birth Data  *
  *            *                            *  3rd 5-year  *
  **************AH90                        *    Period    *
                                            ****************BE80

Z101*************
  *            *                            (Nothing below)
  * Total  Pop *                                    *
  * Projection *
  * (no migrat)*
  *            *
  **************AH130


Z141*************
  *            *
  * Total  Pop *
  * Projection *     AI161**************
  * (w/migrat) *        *   Age 4    *
  *            *        * All periods*
  **************AH170   **************AN166

                     AI180**************
Z181*************       *   Age 5    *
  *  Age-Sex   *        * All periods*
  * Projection *        **************AN186
  *            *
  * Base Year  *
  *            *     AI200**************
  **************AH208   *   Age 6    *
                        * All periods*
                        **************AN206
Z221*************
  *  Age-Sex   *     AI220**************
  * Projection *        *   Age 7    *
  * End of the *        * All periods*
  * 1st 5-year *        **************AN226
```

201

BM1 ***************

* Recalculation *

***************BO20

BP1 *****************

* Note *

*****************BW20

* Migration *
* Females *

**************BL45

BQ21 ********************

Interpolation
of Females
Ages 0-19
Using
Sprague
Multipliers

Base Year

********************BX65

BZ21 ********************

Interpolation
of Males
Ages 0-19
Using
Sprague
Multipliers

Base Year

********************CG65

****

M
A
C
R
O
S

*********CO85

(Nothing below)

BM4 ***************

* Migration *
* Males *

**************BL85

BQ ********************

Interpolation
of Females
Ages 0-19
Using
Sprague
Multipliers

End of the
1st 5-year
Period

BZ81 ********************

Interpolation
of Males
Ages 0-19
Using
Sprague
Multipliers

End of the
1st 5-year
Period

BM10 ***************

* Migration *
* Total *

**************BL125

********************BX125

********************CG125

(Nothing below)

BQ1 ********************

Interpolation
of Females
Ages 0-19
Using
Sprague
Multipliers

End of the
2nd 5-year
Period

BZ14 ********************

Interpolation
of Males
Ages 0-19
Using
Sprague
Multipliers

End of the
2nd 5-year
Period

BQ2

Interpolation
cf Females
Ages 0-19
Using
Spraque
Multipliers

End of the
3rd 5-year
Period

BX245

BZ20

Interpolation
of Males
Ages 0-19
Using
Spraque
Multipliers

End of the
3rd 5-year
Period

CG245

The Components Menu POPEX ANNEX B Screen Menus

The menus available and the keys used to invoke them are:

Base Yr Population Fertility Mortality Births Migration Life Tables Sprag[ue]

- Base Yr Population → Base Year Population
- Fertility → Fertility Rate Assumptions
- Mortality → Mortality levels from UN Model Life Tables
- Births → Total Births & Survivors
- Migration → Not Required here
- Life Tables → UN Model Life Tables
- Sprague → Distribution into single years, using Sprague Multiplier Tables

The Input Menu

BASE YR POP FERTILITY MORTALITY BIRTHS MIGRATION

- BASE YR POP → Go to Base Year Population Screen for Input Data
- FERTILITY → Go to Fertility Rates Screen for Input Data
- MORTALITY → Select Mortality from UN Model Life Tables
- BIRTHS → Select Birth Fraction for Period
- MIGRATION → Go to Migration Tabl[e] (Note not filled in her[e])

Population Tables Menu(projection exercise results)

POP -F   POP-M   POP-TOT(No migrat)   POP-TOT(w Migrat)   AGE/Sex   NEWENTRANTS

- POP -F / POP-M:
  - Population projections Females
  - Population Projections Males
- POP-TOT(No migrat): Total Male/Female no Migration
- POP-TOT(w Migrat): Total Male/Female with migration
- AGE/Sex: Age/Sex Projections All Periods
- NEWENTRANTS: New Entrants Projected Ages 4,5,6,7

GRAPHICS Menu

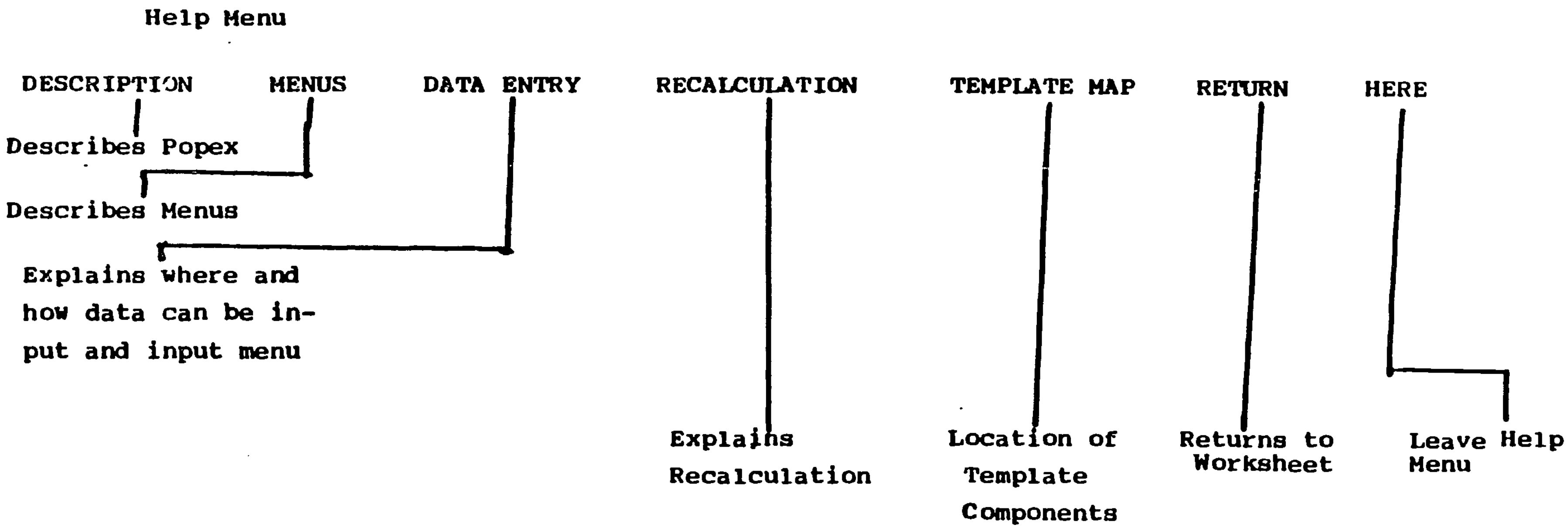
LINE GRAPHS   BAR GRAPHS

- LINE GRAPHS: Line Graphs of Population Projections
- BAR GRAPHS: Bar Graphs of Population Projectic

Print Menu

POP TABLES   AGE-SEX TABLES

(Note : will print when menu selection invoked)



Help Menu
DESCRIPTION
MENUS
DATA ENTRY
RECALCULATION
TEMPLATE MAP
RETURN
HERE
Describes Popex
Describes Menus
Explains where and how data can be in- put and input menu
Explains Recalculation
Location of Template Components
Returns to Worksheet
Leave Help Menu

POPEX ANNEX C

MACRO Screen and Commands

```
\c       {menubranch locate}

Locate   BASE YR POP              FERTILITY                MORTALITY           BIRTHS              MIGRATION     LIFE TABLES
 SPRAGUE
         Base Year Population.    Fertility rate assumptions. Mortality levels useTotal births and sur(Not a requireMM Model Lif
e The calculation of age - sex
         {GOTO}BASE~              {GOTO}FERTIL~            {GOTO}MORTAL~       {BRANCH B/S}        {BRANCH MIGRATION}{GOTO}LIFTAB
~ {BRANCH \s}

\T       {menubranch popproj}

Popproj  POP-F                    POP-M                    POP-TOT(no migrat)  POP-TOT(w/migrat)   AGE-SEX PROJ  NEW ENTRANTS
         Population projections foPopulation projections for mTotal(female + male)Total(female + male)Projections for all period
s by age & sex, ages 0-19.
         {GOTO}FEMALES~           {GOTO}MALES~             {GOTO}NOMIGRAT~     {GOTO}W/MIGRAT~     {BRANCH \a}   {BRANCH \E}

\A       {menubranch agesex}

AgeSex   BASE YR                  1ST PROJ PERIOD          2ND PROJ PERIOD     3RD PROJ PERIOD     NEW ENTRANTS
         Base year population agesEnd of 1st 5-year period,  pEnd of 2nd 5-year peEnd of 3rd 5-year peMenu for selection of appr
opriate new entrant age group.
         {GOTO}YBASE~             {GOTO}ONE~               {GOTO}TWO~          {GOTO}THREE~        {BRANCH \E}

\S       {menubranch sprague}

Sprague  BASE YR-F                BASE YR-M                1ST-F               1ST-M               2ND-F         2ND-M
 3RD-F      3RD-M
         Interpolation of the numbInterpolation of the number The number of femaleThe number of males The number of The number o
f The number oThe number of ma
         {GOTO}BF~                {GOTO}BM~                {GOTO}OF~           {GOTO}OM~           {GOTO}TF~     {GOTO}TM~
 {GOTO}THRF~ {GOTO}THRM~

\G       {menubranch graph}

Graph    LINE GRAPHS              BAR GRAPHS
         Line graphs of populationBar graphs of population projections.
         {BRANCH LINE}            {BRANCH BAR}

\H       {paneloff}/rndHERE~
         /rncHERE~~{panelon}
Menu     {menubranch helpmenu}

Helpmenu DESCRIPTION              MENUS                    DATA ENTRY          RECALCULATION       TEMPLATE MAP  RETURN
 HERE
         A description of POPEX2. Menus that allow you to moveExplanation of allowInformation on manuaLocations of tReturn to th
e Stop here, leave the Help Me
         {GOTO}HELP1~             {GOTO}HELP2~             {GOTO}HELP3~        {GOTO}RECALC~       {GOTO}MAP1~   {GOTO}HERE~
 {QUIT}~
         {BRANCH DESCRIP}         {BRANCH MENU}            {BRANCH MENU}       {BRANCH MENU}       {BRANCH MENU} {QUIT}~
```

```
LIFE TABLES   SPRAGUE
UN Model Life The calculation of age - sex disrtributions using Sprague Multipliers.
{GOTO}LIFTAB~ {BRANCH \s}


NEW ENTRANTS
r all periods by age & sex, ages 0-19.
{BRANCH \E}


tion of appropriate new entrant age group.


2ND-M         3RD-F       3RD-M
The number of The number oThe number of males ages 0-19 at the end of the third project
{GOTO}TM~     {GOTO}THRF~ {GOTO}THRM~


RETURN        HERE
Return to the Stop here, leave the Help Menu, do not return to previous location.
{GOTO}HERE~   {QUIT}~
{QUIT}~
```

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PLANNING SECONDARY EDUCATION IN JORDAN:
A MODEL COMBINING THE AASCU PARADIGM AND IFPS

Mohammad Omar Yousef

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LIST OF TABLES

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GENERAL BACKGROUND:
HUMAN CAPITAL FORMATION IN LDCs (LESS DEVELOPED COUNTRIES)

Developing countries have tried to imitate and follow the experience of developed ones, where education has contributed to growth. This experience supports the theory of human capital that education is an investment that enhances human capability for production. Education/training not only provided the base for skill formation required for industrialization, education also had an important role in the social and cultural transformation of societies undergoing modernization and development.

It is also argued that the greatest obstacle to development was the traditional type of structures, orientation, and behavioral patterns that predominated in tradition-bround societies. To enter the modern world, underdeveloped societies have to overcome traditional norms and structures, thus opening the way for social, economic, and political transformation.

Under one interpretation of human capital theory, a high level of effort and resources was channelled to the expansion of secondary and post-secondary education at the expense of primary and basic education. This policy, given limited resources in LDCs, resulted in the distribution of educational resources in benefit of the minority over the mass of population. In some less developed ccuntries there is a rapid growth in product and productivity but slow growth in employment, and increasing numbers of educated unemployed, as a growing surplus of school graduates and leavers exceed occupational demands in modern sector industries.

The Background in Jordan

Jordan is one of the developing countries that has undergone a big change in educational expansion in the 1950s. Elementary schools were opened everywhere, in every village, big or small, and secondary schools were established in towns and cities. Education seemed to be such a good investment that village people sent their children to secondary schools in neighboring towns. With free tuition, the private rate of return was much higher than the social rate.

Jordan expanded, and is still expanding, secondary education in general. In the East Bank alone secondary enrollments jumped from 32,000 to 94,000 in 1976-1985, and high-school graduates reached 27,487 in 1985. These graduates were channeled into two streams:

1. Some joined the universities and university colleges.
2. The others, the majority, were unable to join higher-education institutions, either because of low scores in the general secondary examination, or because they could not pass that examination.

This majority of students are now unemployed, although there are opportunities for them in both agriculture and construction as unskilled labor. Short of workers to do these jobs, Jordan imports them from Egypt. Also, many pieces of land are left unused because of lack of manpower to work the land.

Had these unemployed and partly educated high-school graduates been directed to the work market at the age of fifteen, before they went into secondary education, they would have gone to agriculture to work with their families in villages, or to construction. Masonry, plastering, plumbing, or other occupations in small industries might be learned on-the-job, or through apprenticeship, outside vocational schools.

It would benefit the economy, and individuals as well, to reduce secondary enrollments, giving this opportunity to students who have the capability of receiving high education, at most the 50% of preparatory-school graduates who do well in the general secondary entrance examination. Yet, for political purposes, the promotion ceiling was raised to more than 80%.

Applying the AASCU Paradigm and IFPS Modeling to planning education in Jordan, indicates a policy of reducing secondary education quantitatively, improving the quality of this education, and developing training to meet the manpower requirements of the country.

STAGE I OF THE AASCU PARADIGM: FUTURE SOCIETAL TRENDS

The conditions which favored a policy of unlimited secondary education in the last two decades have been changing. These social changes will affect our plans or planning process, and they should be regarded with care when developing our goal and objectives.

The following trends of changes can be perceived clearly in our society.

1. **Population**

The growth trend of population in Jordan is clear. The average annual growth was 4% in the period of 1980-85. The number in the East Bank is now 2,495,000; the number of secondary students jumped in the same period from 73,500 to 94,008; and high-school graduates increased from 22,500 to 27,487. This increase in population will necessitate more primary schools, agricultural output, and housing. Secondary education should prepare people to meet these production needs.

2. **Economy**

Agriculture, the backbone of the economy, needs more hands to work on the unused land. Labor is imported from Egypt because villages send their children to secondary schools, and after graduation they do not go back to the land. Construction works and small industries can absorb many workers in unskilled work. Skills can be learned on-the-job, or through apprenticeship.

3. **Work**

Expansion in small industries, construction works, and agriculture to meet the need of the population and the economic growth, will give opportunities to young people to start work after they finish the compulsory education at the age of fifteen before high school.

4. **External Affairs**

The open market for white-collar workers in Saudi Arabia and the Gulf oil states is no longer available. Graduates must be absorbed in the local market, which would have to expand to create jobs for high-school graduates. Financial aid from the oil states has been cut down due to the Gulf War, and there are very limited resources to maintain even the existing schools.

5. **Women**

The trend of women entering the modern work force is increasing, and will increase more in the future, as the scope of work open to women is enlarged. They now go to light industries, services, and to agriculture in the country. After high school they will not work on the farms.

6. **Lifestyle**

Life has become complicated, and the luxuries of the past are necessities nowadays. The standard of living is getting higher and higher. The income of the head of the family is no longer sufficient to give all the children secondary education.

Parents send the bright children, and let the others start work to help the family income.

STAGE II: SOCIETAL VALUE SHIFTS

Values change and this accelerates other changes in the society, which brings changes in education. The following values will importantly impact general secondary education.

1. Change/Respect for Manual Work

The passive or negative attitude towards manual work which prevailed in the past has been reversed. People no longer despise manual work, as it is now more financially rewarding than some mental works. Many white-collar workers are unemployed, unlike blue-collar workers, who are in great demand.

2. Foresight

People in the past rushed to government jobs after high school because they were more secure and promised pensions on retirement. But young people now realize the difference between the limited salaries of civil servants and the opportunities open to workers in the private sector, who can advance in their jobs or start their own businesses.

3. Responsibility

People are also aware of their responsibility to cultivate their land, which has become partly unused because of lack of labor. As this labor disappears landowners will have to depend on members of the family, who should start such work at an earlier age, especially when their school records show they do not have a promising future in higher education. Parents will not force their children to go on to high school when they are not capable.

4. Leisure

Parents cannot continue to work from sunrise to sunset on their land, so they will encourage their children to work with them. In small farms children must help, to give their parents time to rest, and parents are finding more things to do with their free time.

5. Interdependence and Pluralism

The family in the past depended on the head to earn a living for all. It is no longer the case now, as life is getting more difficult, and it requires more than one earner to ensure decent life for the family. Therefore, some children will have to go to the labor market after finishing the compulsory stage of education.

STAGE III:

POLICY-MAKING MATRIX FOR TREND AREAS

The trends identified before will affect the various education sectors, as shown in Policy Matrix One. The sectors affected are:

1. academic secondary education,
2. nonformal vocational education and apprenticeship,

3. agricultural works,

4. construction works and small industries,

5. educated unemployed.

Matrix One

	1	2	3	4	5
Sector	Academic Secondary Education	Nonformal Voc.Ed.& Apprent.	Agricul. Works	Construct. Work/Small Industry	Educated Unemployed
National Trend					
Population (P)	P1	P2	P3	P4	P5
Economy (E)	E1	E2	E3	E4	E5
Work (W)	W1	W2	W3	W4	W5
Women (Wo)	Wo1	Wo2	Wo3	Wo4	Wo5
Lifestyle (LS)	LS1	LS2	LS3	LS4	LS5
External Affairs (EF)	EF1	EF2	EF3	EF4	EF5

National Values: Respect for manual work, Foresight, Responsibility, Leisure, Interdependence and Pluralism

P1. Since the population is increasing, Jordan will need more schools. But primary basic education is the priority need rather than schools of general secondary education, especially since resources are limited.

P2. As students enter work early, they need some kind of training or apprenticeship. There can be "work and learn" centers, where young men go once or twice a week to learn skills related to their work.

P3. Growing population needs agricultural products. The demand raises the prices of such goods, which attracts young men to work on the land and produce to the market.

P4. People need housing, and construction absorbs a great deal of unskilled labor, which can also go into small industries, after acquiring basic tool skills.

P5. If the policy of expanding secondary education continues, high-school graduates will increase, adding to the army of the educated unemployed, and vice versa.

E1. It is not good that the national economy depends on thousands of foreign laborers who will transfer hard currency outside the country, while thousands of high-school leavers are idle. General secondary education must change.

E2. The transfer of preparatory-school leavers to the labor market as unskilled labor increases the importance of apprenticeship and informal vocational education.

E3. Agriculture is an important component of the economy which produces for the local market, and can produce for exports and to substitute for imports. If more land is brought under cultivation, corn production can increase and reduce imports, help the country's balance of payments, reduce debt, and increase savings and investment.

E4. Materials for construction, such as steel, timber, aluminum, and other commodities, are now imported because they are not available in the country. Unskilled labor is also imported, even when it is abundant in the country.

E5. There is unmet manpower demand in some sectors, while unrequired supply in other sectors. We must work to match supply and demand by changing the education policy, so that it trains for needed occupations. But new demand must also be created.

W1. The work market is growing and requires more labor. This has to be drawn from secondary schools or, more precisely, from preparatory-school graduates.

W2. The work market welcomes unskilled labor, which will learn the job through apprenticeship and informal vocational education.

W3. In agriculture a great deal of basic infrastructural works (irrigation, leveling) are needed to prepare unused land for cultivation to produce agricultural products which are in great demand.

W4. Construction works are full of Koreans, Pakistanis, and workers of other nationalities. This is because young Jordanians go to secondary schools and seek white-collar jobs, although it is difficult to find a bricklayer, a plasterer, a pointer, or a plumber.

W5. As a result of the policy of mass secondary education, high-school graduates and leavers are produced in thousands. Unfortunately, they have no demand in the work market. In spite of that, they are not ready to go to blue-collar jobs or manual work.

Wo1. Women have proven themselves equal to men in many fields of economic activities. Despite limited opportunities after high school, they will turn increasingly to paid jobs, because social customs encourage it and household budgets require it.

Wo2. There are many jobs that require skills that apprenticeship or on-the-job training can provide. There is no need for formal vocational education.

Wo3. Villagers need their children--both boys and girls--to work on the land and on their farms with them. This kind of work should start early before children get accustomed to idleness.

Wo4. Light and small industries take women as well as men. There are food and oil factories, cloth and clothing factories, tailor shops and dairy works that give good opportunities for women.

Wo5. If these alternatives are not taken, and all girls go to the secondary schools after finishing the preparatory stage, they will eventually join the army of educated unemployed.

Women with good-paying employment can help themselves, their parents, their spouses, and their children.

L1. The complications of life and its pressing demands make it uneconomical for the parents to wait for the children to finish high school, unless they are sure that they will find work afterwards. This is not now certain, so secondary education is no longer attractive to many families.

L2. Apprenticeship and vocational training are more secure, as they ensure some kind of work where the worker can be productive and earn his living earlier, and thus reduce dependency.

L3. Life's necessities have become many and expensive, not only in towns but also in villages. Peasants need the hands of their children to increase their product and add to their income.

L4. The same can be said about townspeople who will send their children, after compulsory education, to workshops and construction works where the pay is high.

L5. People cannot afford under these pressing needs to send all the children to secondary schools, on the slight hope that they will be the lucky ones among the educated unemployed.

EF1. People in the past assumed debts to send their children to high school, and thence to go to Saudi Arabia or any other Gulf oil state to work and get money. This market no longer exists, which reduces the enthusiasm for such kind of education.

EF2. Therefore, a new course should be taken by preparatory-school graduates, to go to the labor market earlier and learn jobs through apprenticeship and nonformal vocational education.

EF3. Those in the villages will join agricultural works on their farms, or someone else's farm.

EF4. In towns people send their children to workshops and construction works, to learn occupations which may help them to go outside the country, where skilled workers and craftsmen are more in demand than workers with general education.

EF5. The reduction in the outside market for secondary graduates discourages the people and stops the drive and rush to these schools. In the long run, this will reduce the number of educated unemployed.

Summary

The societal trends will affect education in Jordan by directing students to the labor market after they finish the third preparatory class, leaving the general secondary education to those who have the capability for that sort of education.

As a result, reducing the number in secondary schools will free resources to improve quality. The fewer and better high-school graduates will be absorbed by higher-education institutions instead of being unemployed, and different sectors of the economy will be provided by unskilled labor.

STAGE IV:

POLICY-MAKING MATRIX FOR VALUE SHIFTS

Matrix Two shows the impact of value shifts, one by one, on the sectors mentioned in Stage III.

Matrix Two

	1	2	3	4	5
Sector	Academic Secondary Education	Nonformal Voc.Ed.& Apprent.	Agricul. Works	Construct. Work/Small Industry	Educated Unemployed
National Value					
Respect (R)	R1	R2	R3	R4	R5
Manual w. Foresight (F)	F1	F2	F3	F4	F5
Responsi-bility (Ry)	Ry1	Ry2	Ry3	Ry4	Ry5
Leisure (L)	L1	L2	L3	L4	L5
Interdepen-dence & Pl. (I)	I1	I2	I3	I4	I5

National	Population	Economy	Work
Trends	Women	Lifestyle	External Affairs

R1. People in the past did not respect manual work, so they rushed to secondary schools in order to prepare themselves for mental work. Now, secondary education is not so much in demand, because it does not lead to employment and increased earnings. Skilled manual work does, so it is more desirable.

R2. As a result of this change of attitude, manual work is sought through apprenticeship with informal vocational education, which will prepare people for a craft or occupation.

R3. Those in villages will go into agriculture and farm on their family land. This work does not need great skill, and can be learned through father-son work/learning arrangements.

R4. Construction works and small industries attract a number of school leavers, who want to start earning a living.

R5. In this way there will be no addition to the great number of unemployed high-school graduates. On the contrary, some of them may go to manual work earlier.

F1. People used to prefer government jobs where they felt secure, as they gave them pension. They rushed into secondary education, which was the path to these jobs. Now, they have realized that the private sector has many good opportunities, especially in crafts. The rush to secondary education is slackened.

F2. The alternative is apprenticeship and informal vocational education, to qualify for an occupation or a trade.

F3. Villagers will not permit their lands to lie unused, either completely or partly, while they see their children go and finish high school and sit around. They must encourage the children to share farm work and the income. There is a demand for market garden produce.

F4. Wise people consider the situation of the market around them. If the high school does not give children the chance to have a job, why spend three years for nothing. Construction works and small industries are open.

F5. No one with vision wants his child to sit idle after finishing school, so less education with a craft is better than full education with no trade.

Ry1. Responsible people do not force their children to go to high school when these children are not capable of success in academic education.

Ry2. Parents send children to search for crafts through apprenticeship and nonformal education. In this way young men become productive and satisfy their interests.

Ry3. Responsible people do not leave the land idle because their is no labor to work on it. They must encourage their children to work there. Holding on to family land is one of the strongest social values, and it will not change in the future with population growing and landholdings shrinking.

Ry4. Construction works and workshops are another kind of place of learning for young men to work and learn in after they finish preparatory schools.

Ry5. Responsible people will not allow their children to join the force of educated unemployed.

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L1. Parents want to enjoy some leisure time, and children must work and contribute to family income.

L2. As a result, youth enter the labor market and seek a trade through apprenticeship.

L3. In the village children will go to the land to help their parents, and become good farmers.

L4. Construction works and small industries will receive these newcomers who want to earn their living.

L5. In this way, the number of high-school graduates will be reduced. Only capable students will go to higher education.

I1. The father as the head of the family can no longer provide alone for the family. Other members of the family must share this burden with him as early as possible. In secondary schools, as the quantity is reduced, the quality will be improved.

I2. Those who will not go to high school will go to the labor market and qualify for a craft.

I3. Village way of life should center on the land.

I4. In small towns and villages there are also construction works and small industries.

I5. With the smaller number of high-school graduates absorbed by higher-education institutions, dropouts will be minimized. Waste will be reduced.

<u>Summary: Value Effects</u>

New values will influence general secondary education to reduce enrollments, graduates, and dropouts. Preparatory-school graduates will go to the labor market to supply the demand of industries.

STAGE V:

FORMULATION OF THE NATIONAL GOAL AND OBJECTIVES

The changes in the nation will bring changes in secondary education. The policy of expansion of secondary education must end.

The alternative will be a moderate policy where academic secondary education will be limited to those capable of finishing and succeeding in college afterwards. This will improve the quality of secondary and higher education, and provide the economy with the number of workers who are needed in agriculture, construction works, and small industries.

GOAL: Improve the life of the people of Jordan, and the national economy, through improved basic and intermediate education and more job-relevant training.

OBJECTIVES:

1. Reduce general secondary education, and improve its quality.
2. Focus attention on literacy programs and primary education.

3. Provide labor for agriculture, construction works, and small industries.

4. Reduce the number of educated unemployed.

STAGE VI:

DETERMINING THE COMPATIBILITY OF OBJECTIVES WITH OTHER OBJECTIVES AND VALUE SHIFTS

Matrix Three

Testing Compatibility of Objectives with Other Objectives

Objectives	Reduce general sec. education and improve its quality.	Focus on primary education and literacy program.	Provide labor for agr. const. works & small industries.	Reduce the number of educated unemployed.
1. Reduce general secondary education and improve its quality		A	A	A
2. Focus attention on primary ed. and literacy programs			A	C
3. Provide labor for agriculture, construction works, and small industries				A
4. Reduce the number of educated unemployed				

Code: A. Compatible; B. Neutral; C. Incompatible

Matrix Four

Testing Compatibility of Objectives with Value Shifts

Objectives	Change/Respect for manual work.	Foresight	Responsibility	Interdependence and pluralism	Leisure
1. Reduce general secondary education and improve its quality	A	A	A	A	A
2. Focus attention on primary ed. and literacy programs	B	A	A	A	
3. Provide labor for agriculture, construction works, and small industries	A	A	A	A	
4. Reduce the number of educated unemployed	A	A	A	A	

Code: A. Compatible; B. Neutral; C. Incompatible

Summary

a. Objectives compatibility matrix: All the objectives are compatible with one another except one which calls for focus on primary education and literacy, with reducing the number of educated unemployed. These objectives are incompatible when primary education leads more students to go on to secondary education, and some of them will become unemployed. But under the new policy, limited numbers will go to secondary education to satisfy the needs for higher education, taking into consideration that educated unemployed will be brought to a minimum.

b. Objectives-value shifts compatibility matrix: All are compatible except the objective emphasizing focus on primary education and literacy programs, which is unrelated to the value of respect for manual work and leisure.

STAGE VII:
FUTURE SCENARIOS

Future scenarios are projected, using the IFPS Model, in Annex A.

Optimistic Scenario

The ministry of education has realized the need for a major change in the education policy at the secondary stage, because thousands are graduated each year and the number is increasing year after year. At the same time educated unemployed are becoming a problem. One promising step taken by the ministry is diversification of the secondary education, especially giving more attention to vocational branches within the means of the country.

A second step expected is to put a ceiling on promotion from the third preparatory class to the first secondary class.

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This will not exceed 50%. IFPS Model results are shown in Table 1.

Under this policy, academic secondary school population will stop growing and start decreasing, from 94,008 this year (1986) to 88,188 in 1990. High-school graduates will be 24.9 thousand, down from 27.5 thousand. Most of them can find places at the higher-education institutions in Jordan, where community colleges have places at present for 14,440 freshmen (in 1990 they will have 15,626 places), and the two universities in the East Bank have places for 6,061 (in 1990 they will have 6,198 places). Remaining graduates will join foreign institutions.

In this scenario there is less pressure on higher-education institutions, and universities will be able to use their resources to develop needed research and post-graduate studies instead of horizontal expansion to accommodate more high-school graduates.

A reduced number of secondary students will facilitate better education qualitatively. There will be surplus in the budget of JD 1,146,943, as expenditure will be less than the present-day allocations. This can go to needed salary increases. The additional allocations of the budget, which are increasing every year, will help to make improvements in the equipment and facilities needed for the secondary schools. A part would go to consolidate primary education, and literacy programs.

Table 1

IFPS Secondary Student Enrollment (New Scheme)

	1986	1987	1988	1989	1990
1st level sec.	35,310	27,171	28,204	30,000	32,427
2nd level sec.	29,142	34,067	26,562	27,308	29,017
3rd level sec.	29,556	28,566	33,274	26,166	26,739
Total secondary	94,008	89,804	88,039	83,474	88,183
Secondary grads.	27,487	26,566	30,944	24,334	24,867

Table 2

Teacher, Expenditure Forecasts

	1986	1987	1988	1989	1990
SCTOTTEACH (Total Teachers)	4599	4394	4307	4084	4314
SCTOTINC (Total Income)	18515081	18515081	18515081	18515081	18515081
SCTOTEXPEND (Total Expend)	18515370	17687354	17339767	16440575	17368138
SCBALANCE	-289.5	827727	1175314	2074506	1146943

Note Decrease in expenditure

Poistive Balance is achieved from second period on

Table 3

Statistical Summary of Enrollment Projection (New Scheme)

Year Grade	85/86	87	88	89	90
3rd Prep.	51517 d 23183	54235 d 24406	57746 d 25986	62456 d 28105	65459 d 29456
1st sec.	35310 d 706	p 25759+ r 1412 27171 d 543	p 27117+ r 1108 28204 d 564	p 28873+ r 1128 30001 d 600	p 31228+ r 1200 32428 d 649
2nd sec.	29142 d 291	p 33191+ r 874 34066 d 341	p 25541+ r 1022 26563 d 266	p 26512+ r 797 27309 d 273	p 28201+ r 819 29020 d 290
3rd sec.	29556 d 1478	p 27976+ r 591 28567 d 1428	p 32703+ r 571 33274 d 1664	p 25500 r 665 26166 d 1308	p 26217 r 523 26740 d 1337
t.sc/enr.	g 27487 94008	g 26566 89804	g 30944 88039	g 24334 83474	g 24867 88183

p.promotion r.repetition d.dropouts g.graduates

	p	r	d	g
3/prep	50%	5%	45%	-
1/sec	94%	4%	2%	-
2/sec	96%	3%	1%	-
3/sec	-	2%	5%	93%

Note: Enrollments Projected Using EDMODEL(Davis,mainframe variant,1984)
Promotion/Repetition/Drop-out tables not shown to conserve space

Table 4

Freshmen Seats at Community Colleges and Universities

(New Scheme)

	1986	1987	1988	1989	1990
GRADSC	12,371	11,957	13,927	10,952	11,192
TOTCOSCFR	5,504	5,779	6,068	6,372	6,690
TOTUSCFR	2,577	2,611	2,644	2,679	2,714
GRADART	15,116	14,610	17,017	13,382	13,675
TOTCOARTFR	8,936	8,936	8,936	8,936	8,936
TOTUARFR	3,484	3,484	3,484	3,484	3,484
SECGRAD	27,487	26,566	30,944	24,334	24,867
TOTHIGHSFR	20,501	20,810	21,133	21,470	21,824
TOTCOFR	14,440	14,715	15,004	15,308	15,626
TOTUNFR	6,061	6,095	6,128	6,163	6,198

Teachers, Income, Expenditures, Balance

	1986	1987	1988	1989	1990
COINC	9138400	9193440	9251232	9311914	9375629
TOTCOEXPFR	8664000	8829120	9002496	9184541	9375688
COBALANCE	474400	364320	248736	127373	-58.56
UINC	6156900	6166950	6177131	6187445	6197892
TOTUEXPFR	6061000	6094501	6128438	6162815	6197640
UBALANCE	95900	72449	48694	24629	252.1

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Students who will finish the third preparatory class and not be promoted to the first secondary class, will go to the labor market. Village students will work with their parents on their land. They can also work at agricultural development projects in the Jordan River Valley, where there are big corporate forms. Town students will join construction works and small industries. They will become productive members of the society as soon as they leave school and join the labor force.

In spite of the policy of restricting general secondary education, the average enrollment ratio will be 38% of the total population at the age of 15-19 in 1990 (shown in Tables 5A, 5B). (Note: School-age Population Tables shown in Annex B.)

Pessimistic Scenario

If things go off the track and the ministry of education sticks to the old policy of expanding secondary education, following the classical pattern and promoting 85% of preparatory-school graduates to high school, the future will look worse than the present. Every year will bring increasing numbers of high-school graduates. The number of secondary-school population will jump from 94,008 to 157,089 in 1990. The enrollment ratio will climb to .67 (Table 5B). High-school graduates will be about 49,000 (Table 6).

Table 5

Secondary Enrollment Ratio

New Scheme and Old Scheme Compared

5A: New Scheme (Optimistic)

	1986	1987	1988	1989	1990
SCTOTENRL	94,008	89,804	88,039	83,474	88,183
POPSCAGE	200,000	108,000	216,320	224,973	233,972
POPRATE	1.040	1.040	1.040	1.040	1.040
SCENRLRATIO	.4700	.4317	.4070	.3710	.3769

5B: Old Scheme (Pessimistic)

	1986	1987	1988	1989	1990
SCTOTENRL	94,008	107,830	126,883	144,445	157,089
POPSCAGE	200,000	208,000	216,320	224,973	233,972
POPRATE	1.040	1.040	1.040	1.040	1.040
SCENRLRATIO	.4700	.5184	.5866	.6421	.6714

Table 6

Secondary Student Enrollment (Old Scheme)

	1986	1987	1988	1989	1990
FSTSCENRL	35,310	45,200	50,096	53,612	57,939
SNDSCENRL	29,142	34,064	43,513	48,396	51,841
TRDSCENRL	29,556	28,566	33,274	42,437	47,309
SCTOTENRL	94,008	107,830	126,883	144,445	157,089
SECGRAD	27,478	26,566	30,944	39,466	43,997

Secondary Level Teachers,Income,Expenditure,Balance

Teachers, Income, Expenditures, Balance

	1986	1987	1988	1989	1990
SCTOTTEACH (Total Teachers)	4599	5275	6208	7067	7685
SCTOTINC " INCOME	18515081	18515081	18515081	18515081	18515081
SCTOTEXPEND	18515370	21237743	24990180	28449196	30939509
SCBALANCE Balance	-289.5	-2722662	-6475099	-9934115	-12424428

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Complications of This Policy

1. To accommodate for this great number of secondary population requires an extra amount of JD 12,424,428. Total expenditure will be 30,939,509; while the ministry can allocate only 18,515,081 (Table 6).

2. If we impose tuition fees, each student has to pay JD 79.10 in order to make total income equal to total expenditure (Goal Seeking, Table 7). This could cause unrest, as people are not used to paying fees at public schools. The money may have to come at the expense of other responsibilities.

3. There is no place for this number of graduates at universities and community colleges, and the number of graduates will far exceed demand for university-educated manpower.

4. If, in spite of these disadvantages, the growth of community colleges and universities is vastly increased to take in these numbers, we would need in 1990 about 24,496 places for freshmen at community colleges, and 10,445 places for university freshmen (Table 9). This means 12,000 additional places over Table 4 totals. Since the government cannot increase subsidies, tuition will be increased from JD 200 to 344.8 at the community colleges, and from 300 to 584.6 at the universities (Table 10), increases of 74% and 95% respectively.

5. This means quantity, without quality, college students so poorly equipped that they are graduates on paper only.

6. Consequently, the army of the educated unemployed will become bigger and bigger, to the detriment of the national

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Table 7

Goal Seeking Tuition Necessary in Secondary Education to Cover Expenditure

Enter Name of Variable(s) to be adjusted to achieve Performance

.sctuition (secondary tuition)

Enter 1 Computational Statement(S) for Peformance

.sctotinc = sctotexpend (secondary total income equals total expenditure

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	1986	1987	1988	1989	1990
SCTUITION (Secondary tuition fee)	.0031	25.25	51.03	68.77	79.09

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Table 8

Statistical Summary of Enrollment Projection (Old Scheme)

Year / Grade	85/86	87	88	89	90
3rd prep.	51517 d 2576	56811 d 2841	60715 d 3036	65641 d 3282	68900 d 3445
1st sec.	35310 d 706	p 43789+ r 1412 45202 d 904	p 48289+ r 1808 50097 d 1002	p 51608+ r 2004 53612 d 1072	p 55794+ r 2144 57939 d 1159
2nd sec.	29142 d 291	p 33191+ r 874 34066 d 341	p 42490+ r 1022 43512 d 435	p 47091+ r 1305 48397 d 484	p 50395+ r 1452 51847 d 518
3rd sec.	29556 d 1478	p 27976+ r 591 28567 d 1428	p 32703+ r 571 33274 d 1664	p 41771+ r 665 42437 d 2122	p 46461+ r 849 47310 d 2365
	g. 27487	g.26568	g. 30945	g. 39466	g. 43998
t.sc/enr.	94008	107830	126885	144445	157089

p. promotion r. repetition d. dropouts g. graduates

	p.	r.	d.	g.
3/prep	85%	10%	5%	-
1/sec	94%	4%	2%	-
2/sec	96%	3%	1%	-
3/sec		2%	5%	93%

* Projected using Davis EDMODEL(mainframe variant,1984)

Table 9

Freshmen Seats at Community Colleges and Universities (Old Schemes)

	1986	1987	1988	1989	1990
GRADSC	12371	11957	13927	17763	19802
TOTCOSCFR	5504	6605	7926	9511	11413
TOTUSCFR	2577	3092	3711	4453	5344
GRADART	15116	14610	17017	21704	24195
TOTCOARTFR	8936	9830	10813	11894	13083
TOTUARFR	3484	3832	4216	4637	5101
SECGRAD	27487	26566	30944	39466	43997
TOTHIGHSFR	20501	23359	26665	30495	34941
TOTCOFR (Entering cohort Com Col	14440	16434	18738	21405	24496
TOTUNFR Entrant cohort university	6061	6925	7927	9090	10445

Community College Balance Sheet

	1986	1987	1988	1989	1990
COINC	9138400	9537280	9998064	10531346	11149658
TOTCOEXPFR	8664000	9860640	11242992	12842837	14697775
COBALANCE	474400	-323360	-1244928	-2311491	-3548117
UINC	6156900	6416040	6716556	7065678	7471977
TOTUEXPFR	6061000	6924800	7926520	9090260	10444592
UBALANCE	95900	-508760	-1209964	-2024582	-2972614

Table 10

Goal Seeking Tuition -- Community Colleges
and Universities (Old Scheme)

Enter Name of Variable to be Adjusted to Achieve Performance
.cotuition (community college tuition)
Enter 1 Computational Statement for Performance
.coninc = totcoexpfr (community college income = total community college expensesF:

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	1986	1987	1988	1989	1990
COTUITION	167.1	219.7	266.4	308.0	344.8

Enter Name of Variable to be Adjusted to Achieve Performance
.ututlon (university tuition)

Enter 1 Computational Statement for Performance
.uinc = totuexpfr (university income equal total university expenditure

	1986	1987	1988	1989	1990
UTUITION	284.2	373.5	452.6	522.7	584.6

economy, and the frustration of the young men and their families, who were looking forward to seeing them start work and earn their living. Many parents will be burdened with debt in order to send their children to the secondary school, hoping to repay that debt as soon as their children finish high school or college. The high-school graduates, unwilling to go to manual work after being conditioned physically and psychologically to academic and white-collar work, will avoid "demeaning" jobs. A recent study made by the ministry of agriculture finds that one of the great problems facing this sector is lack of manpower. This has already led to rising wages.

7. Agricultural work on development projects, or small private plots, either cannot expand or must depend on foreign labor. There are now 39,744 paid workers from outside Jordan (Table 11).

8. Construction works suffer a shortage in unskilled labor, so the shortage is made up for by Egyptians, Pakistanis, and Koreans. About 6,500 non-Jordanians work in this sector.

9. The loss is then doubled. There are thousands of unemployed, despite jobs available for those who are qualified or ready to do them. The nation depends on foreign labor, which transfers part of the money outside the country. With 39,744 agricultural laborers receiving JD 90 a month and transferring 70% of their pay; 6,500 construction workers earning JD 120 and trasnferring 60% of their wages; and 3,500 laborers in small industries earning JD 150 and transferring 50% of their pay, the

total annual wages will be JD 58,583,520; while annual transfers are 38,812,464. Wages in 1990 will be 70,493,792, while the transfers will be 46,776,645 (Table 11).

Table 11

Foreign Labor in Jordan -- Wages and Transfers

	1986	1987	1988	1989	1990
PREPDROPOUTS	23182	24573	26047	27610	29267
FAGRLAB (NUMBER AG WORKERS)	39744	41731	43818	46009	48309
FCONLAB (CONSTRUCTION WORKERS)	6500	6760	7030	7312	7604
FINDLAB (INDUSTRIAL WORKERS)	3500	3640	3786	3937	4095
TOTFWAGES TOTAL WAGES	4881960	5113008	5355086	5608726	5874483
TOTTRANS	3234372	3388786	3550628	3720258	3898054
ANTOTFWAGES (TOTAL WAGES)	58583520	61356096	64261037	67304710	70493792
ANTOTTRANS (Total TRANSFER)	38812464	40665427	42607532	44643096	46776645
TOTUNSKLAB	166000	174400	183244	192555	202360

STAGE VIII

STRATEGIES AND POLICIES

Trends and value shifts have helped to frame our objectives, which center on reducing the number of educated unemployed. To attain this end, means reducing the general secondary-education population. This will provide labor for agriculture, construction works, and small industries, because preparatory-school graduates not promoted to the secondary school will go to the labor market. The money saved will help to give a better secondary education, and will go to consolidate primary education, or literacy projects.

The scenario comparisons show the benefits from the new policy of putting an end to expanding secondary education, and the disadvantages of sticking to the old unwise policy.

a. <u>The Strategy</u>

Four years under the "new" alternative will bring a stable situation. The number of high-school graduates will match the needs of the country and the seats available in higher-education institutions. Agriculture, construction works, and small industries will receive preparatory-school graduates to fill needed jobs.

In 1990 there will be 24,867 high-school graduates instead of 43,997 (Table 6). The number will be moderate and reasonable, so that most of the students will be absorbed by higher-education institutions (in 1986 places for 20,501, and in 1990 about 21,824 freshmen); and the rest will go to some jobs that do not necessitate special skills.

On the other hand, from preparatory school 23,182 graduates will go to the labor market instead of 2,576. They will go to work in agriculture, construction works, and small industries and workshops. They will first replace foreign labor of 49,744 at agriculture, construction works, and small industries. They will also join the unskilled labor of 166,000 which will grow to 202,360 in 1990 (Table 12) to meet the needs of the five-year plan as the table shows. This plan has provided for many projects in different sectors of the economy where skilled, semiskilled, and unskilled labor are needed.

Table 12

Unskilled Labor in Jordan (Five-Year Plan Data)

Economic Activity	1986	1990
Agriculture	60,000	72,930
Industry	20,000	25,250
Mining	5,000	6,312
Electricity and water	1,000	1,262
Construction	35,000	44,187
Trade, restaurants, hotels	15,000	18,233
Transports, communications	9,000	10,940
Financial services, insurance	1,000	1,170
Administration, defense, others	20,000	22,076
Total	166,000	202,360

a. Forestry, JD 7 million.

b. Agricultural projects, 214.8 m.

c. Pastures, 4 m.

d. Roads and transport, 545 m.

e. Housing, 118 m.

f. Municipality projects, 156 m.

g. Cooperative societies, 20 m.

The plan aims to achieve an annual rate of increase in gross domestic product by the attainment of the following annual sectoral growth rates:

Table 13

Plan Growth Rates, Key Sectors

Agriculture	5%
Mining and manufacturing	6%
Electricity and water	6%
Construction	6%
Trade	5%
Transport and communication	5%
Administration and defense	2.5%
Finance and insurance	4%

The table of development in labor productivity shows that it was JD 1,865 in 1981, while in 1985 it became 2,536, and the percent change in average productivity is 35.9 (Table 15).

Table 14

Labor Force in Jordan

Economic activity	1981	1985	Increase	Unskilled
Agriculture	62,012	66,341	7%	60,000
Industry	33,440	41,984	25%	20,000
Mining	3,982	8,966	125%	5,000
Electricity and water	5,176	5,545	7%	1,000
Construction	44,151	47,788	8%	35,000
Trade, restaurants and hotels	37,123	39,634	6%	15,000
Transport and communications	33,048	36,522	10%	9,000
Financial services and insurance	9,556	10.409	9%	1,000
Administration, defense, & others	168,177	171,083	2%	20,000
	396,671	428,772		166,000

Table 15

Development in Labor Productivity (JD m/81 price, 1981-1985)

Economic activity	1981		1985		
	net product	productivity/w.JD	N/product	Av/pro. JD	% change in av/producti.
Agriculture	73.5	1185	131	1975	66.6
Industry	104.5	3124	167.4	3987	27.6
Mining	30.5	7659	34.9	4896	-36.1
Electricity/water	11.2	2163	19.9	3590	65.9
Construction	63.8	1445	86.3	1806	24.9
Trde,rest.&hotels	131.9	3554	180.8	4564	28.4
Transport/communi.	69.8	2112	120.4	3296	56
Financial s/insur.	101.2	10590	123.8	11902	12.3
Administration,	151.3	900	203.5	1190	32.2
Total real prod.	737.7	1865	1077	2536	35.9

The ministry of education will no longer be under pressure to find places in secodary schools for the growing numbers of preparatory-school graduates, or places in universities and community colleges for increasing numbers of high-school graduates, already beyond its means. On the contrary, it can concentrate on general primary education, literacy projects, and improving the quality of secondary education to produce well-informed students who will perform in higher education easily and efficiently.

The national economy will benefit. Now, there are thousands of educated unemployed while thousands of jobs are waiting for people to take them, so that unskilled labor has to be imported from outside.

b. <u>The Policy</u>

In order to facilitate the strategy that will help the attainment of our objectives, we have to follow a policy which will go into effect after three years. As the secondary cycle lasts three years, enrollment in the first year of secondary can only be changed next year. The second and third classes will not be influenced by the new policy, which will put a ceiling of 50% of those taking the secondary entrance examination, instead of 85%.

With 51,517 students at the third preparatory class, 25,759 of them will go to the first secondary next year instead of 43,789 under the old system. Next year, the first secondary class will be affected by the new policy, making the total

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enrollment at the secondary stage 89,804 instead of 107,830. Graduates of the third secondary will not be affected by the new policy. In the following year, the first and second secondary classes only will be affected, making the general enrollment 88,039 instead of 126,883. In the third year, all the three classes will be affected (the graduates included). In 1990 the intake at the first secondary class will be 31,228, while the graduates of the third secondary class will be 24,867, and a total enrollment of 88,183 students.

STAGE IX

FORESIGHT

After deciding to implement the new policy of limiting the promotion in the secondary entrance examination to 50%, let us assess the impact of such policy on our objectives by asking the following question:

Matrix Four

How will the Policy Affect Objectives in the Matrix Effects:	General secondary education	Primary education and literacy	Labor for agr. const. works & small indust.	Educated unemployed
	Reduction & Improvement	Increase attention	Increase	Reduction

We see that the impact on the different objectives will be positive, and this will be clarified by referring to the effects, consequences, and results of the policy.

a. <u>Effects</u>

The primary and direct effects will be shown by the number of adults directed to agriculture and other sectors of the economy immediately after the application of the policy. Instead of 2,576, we will have 23,182 going to the labor market next year (Table 11). There will be no effect on high-school graduates in the first year, as intakes of first secondary will affect the third secondary after two years. Besides, there will be partial effect on the total number of secondary-school students.

b. <u>Consequences</u>

In three years the policy will have clear-cut consequences: the intakes of the three secondary classes will have been affected by the new policy. The number of secondary students will be reduced considerably; instead of 157,089, we shall have 88,183 (Table 1), which means a good impact on the budget, where the surplus of JD 1,146,943 (Table 2) will be available for improvements, and giving more attention to primary education and literacy projects.

c. <u>Results</u>

The immediate effects mean providing labor to different sectors of the economy, especially agriculture and construction works; while the medium-term consequences mean a real reduction in the secondary-school population. Finally, the far-reaching results will be a drastic reduction, if not elimination, of educated unemployed, as the number of high-school graduates will be limited, leading to a limited number of college graduates to meet the needs of the market.

In addition, there will be stability in the secondary-school population, which will have an annual increase of 5-6%, not far from the growth of the population in the country.

STAGE X
FEASIBILITY

It is time to examine the feasibility of the policy and what constraints might hinder its implementation.

Matrix Five

		Reducing secondary school population	Improving secondary education	Reducing educated unemployed	Providing labor for agriculture
Change in population structure	P	P1	P2	P3	P4
Continuing aspiration, expectation of social equity	A	A1	A2	A3	A4
Prevailing value system among population groups	V	V1	V2	V3	V4
National legislation	L	L1	L2	L3	L4

P1. Any change in total population will be reflected on the secondary-school population. We have seen that three years after implementing the policy there will be stability, and the increase in the secondary students will be similar to the growth of the population.

P2, 3, 4. The change in population will not hinder any parts of the policy, whether improving the secondary education, reducing the educated unemployed, or providing labor for agriculture.

There may be some conflicts:

A1. Some people aspire to see their children doctors or engineers, even if they do not show any sign of academic excellence. They believe that since they have the money, they can support them even in foreign institutions, if they have no place in local schools or colleges.

A2. These people put the blame on poor education if their children fail, so they support better secondary education.

A3. They encourage getting rid of educated unemployed without knowing how.

A4. They may not mind providing labor for agriculture, but not their children.

V1. There are some groups that will still prefer white-collar jobs for their children, even if they get low wages.

V2. They want better secondary education.

V3. They would like to have all the educated get employment, including themselves.

V4. They do not want their children to go to blue-collar jobs.

L1. Some legislators and members of the government may think a great deal before they take a step to reduce the secondary-education opportunities. There is need for brave members to bear the responsibility.

L2. They may prefer to keep the status quo.

L3. They resort to the policy of giving the chance of employment to graduates of previous years, as a kind of superficial solution for the problem of educated unemployed, but without reducing the number.

L4. They may encourage high-school graduates to go to agricultural and construction works.

We see that in spite of the encouraging circumstances--trends and values that support a change in the policy of secondary education, to make it realistic and meet the needs of the society and the national economy--there are some constraints on such a policy. Two kinds of people may oppose this new system: rich people whose children are not good at school, who may drop out; and some traditional groups that prefer mental work of the lowest level to manual work. Government officials may be influenced by reaction of these groups, to an extent that they prefer to keep the status quo and leave the conflict for others to deal with.

These constraints may be dealt with wisely, and with patience:

1. It must be explained to the public how much enrollment is required in each education cycle.

2. The education system cannot be improved at any stage without getting rid of excess expenditure on unnecessary things.

3. Labor offices must be very active in getting information about available jobs, and recruiting for them from among third preparatory classes in the school vacation.

4. It should be made clear that all will have a fair chance at the best education they are capable of utilizing.

We have a start toward implementing the policy, just like the boy who found a horseshoe and said: "All I need now is three more horseshoes and a horse, to be a horseman." Someone must make the first move to implement a sensible but unpopular policy, but it is like the mice who decided that it would be a good idea to hang a bell on the cat, so they could hear him coming. They can all agree on the goal of the policy, but it is harder to decide who will make the sacrifice to implement it.

I hope that politics will be realistic, and not only based on emotions and trying to please the people irrespective of what is hidden in the future. There is nothing better than facts, although sometimes they are bitter. But they say, "You must be cruel to be kind."

Mohammad Omar Yousef

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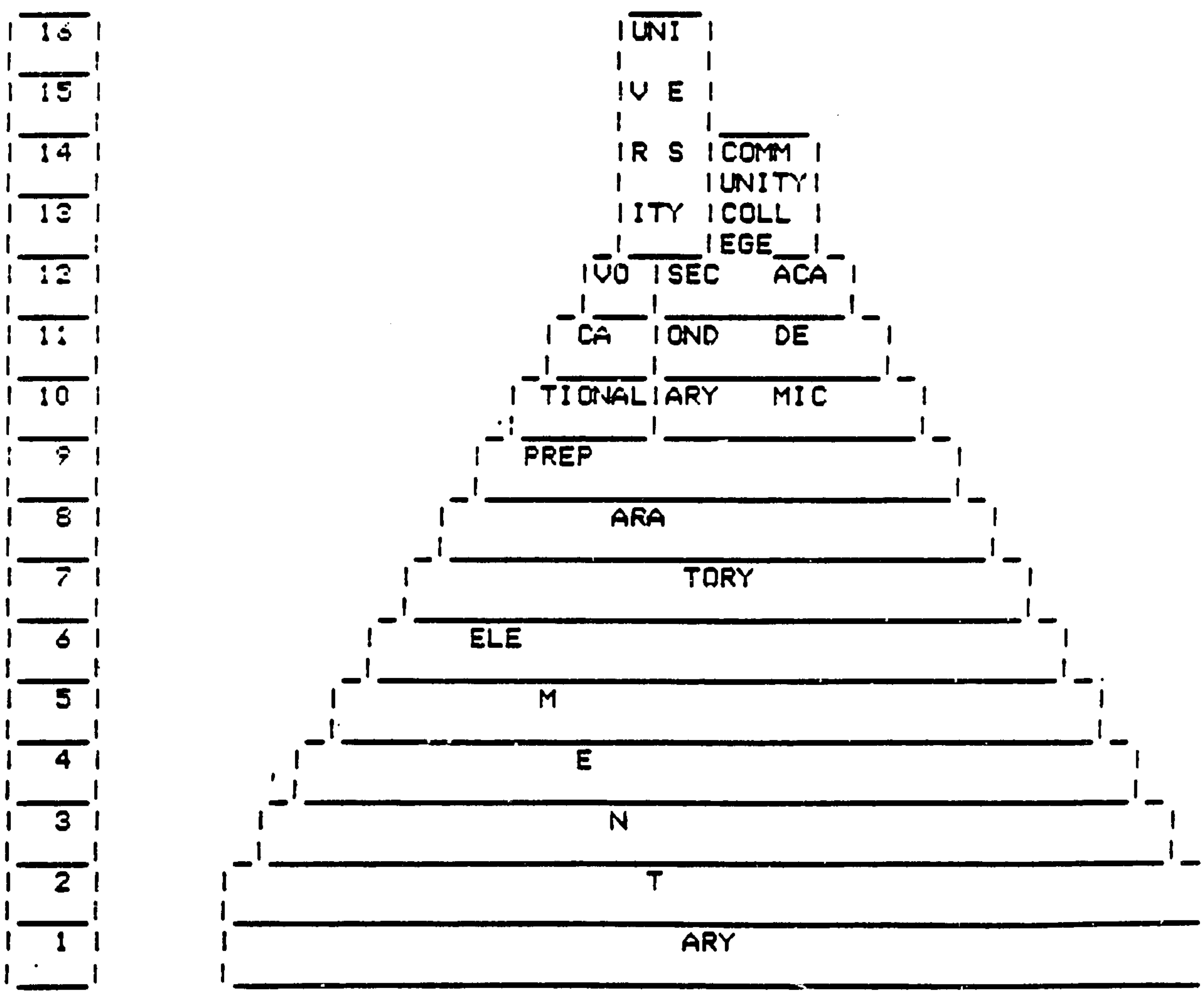
EDUCATIONAL STRUCTURAL SYSTEM



ANNEX A

THE IFPS MODEL EDJORDAN

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.list

MODEL EDJORDAN  VERSION OF  04/26/86  09:34
1   COLUMNS 1986,1987,1988,1989,1990
2   FSTSCENRL=35310,PREVIOUS FSTSCENRL*FSTSCRATE      1st secondary enrollment
3   SNDSCENRL=29142,PREVIOUS SNDSCENRL*SNDSCRATE      2nd    "        "
4   TRDSCENRL=29556,PREVIOUS TRDSCENRL*TRDSCRATE      3rd    "        "
5   GRADSC=12371,PREVIOUS GRADSC*GRADSCRATE           sec. graduates /science
6 GRADART=15116,PREVIOUS GRADART*GRADARATE             "     "         arts
7   FSTSCRATE=1.0,0.7695,1.038,1.0637,1.0809
8   SNDSCRATE=1.0,1.169,0.7797,1.02808,1.0626
9   TRDSCRATE=1.0,0.9665,1.1648,0.78638,1.0219
10  GRADSCRATE=1.0,0.9665,1.1646,0.78638,1.0219
11  GRADARATE=1.0,0.9665,1.1648,0.78638,1.0219
12  SCTOTENRL=FSTSCENRL+SNDSCENRL+TRDSCENRL          sec. toal enrollment
13  SECGRAD=GRADSC+GRADART                            "  graduates
14  SCTEACHLOAD=20.44                                 "   teacher' load
15  SCTOTTEACH=SCTOTENRL/SCTEACHLOAD                  "  total teachers
16  SCTEACHSAL=1333                                   "   teacher salary
17 SCTOTSAL=SCTEACHSAL*SCTOTTEACH                     "  total salaries
18  FUR=SCTOTENRL*5                                   furniture
19  STA=SCTOTENRL*2                                   stationary
20  LIB=SCTOTENRL*3                                   library
21  LAB=SCTOTENRL*5                                   laboratory
22   ART=SCTOTENRL*2                                  art
23  SPOR=SCTOTENRL*2                                  sport
24  TAID=SCTOTENRL*2                                  teaching aids
25  SCCAPITOUTL=FUR+STA+LIB+LAB+ART+SPOR+TAID         sec. capital outlay
26  SCADMEXPEND=SCTOTENRL*10.74                       " administrative expenditu
27  SCSPACE=SCTOTENRL*100                             "      "          "
28  SCTOTEXPEND=SCTOTSAL+SCCAPITOUTL+SCADMEXPEND+SCSPACE  sec. total     "
29  SCTUITION=0                                           "  tuition
30  SCTOTTUIT=SCTUITION*SCTOTENRL                         "  total tuition
31  SESUBSID=18515081                                     "  subsidy
32  SCTOTINC=SCTOTTUIT+SESUBSID                           "  total income
33  SCBALANCE=SCTOTINC-SCTOTEXPEND                        "  balance
34  COEDART=3355,PREVIOUS COEDART*COEARATE     community college education art
35  COSOS=581,PREVIOUS COSOS*COSOSRATE            "        "   social studies
36  COCOMART=5000,PREVIOUS COCOMART*COCOMARATE "       " commercial stud. art
37  COEDS=1500,PREVIOUS COEDS*COEDSRATE           "       "  education sciences
38  COCOMS=1150,PREVIOUS COCOMS*COCOMSRATE        "   Commercial studies sciences
39  COENG=2051,PREVIOUS COENG*COENGRATE           " college engineering profession
40  COMED=786,PREVIOUS COMED*COMEDRATE            "    "     medical          "
41  COAGR=17,PREVIOUS COAGR*COAGRATE              "    "     agriculture
42  COEARATE=1
43  COSOSRATE=1
44  COCOMARATE=1
45  COEDSRATE=1.05
46  COCOMSRATE=1.05
47  COENGRATE=1.05
48  COMEDRATE=1.05
49  COAGRATE=1.05
50  TOTCOARTFR=COEDART+COSOS+COCOMART         total commu. college arts freshmen
51  TOTCOSCFR=COEDS+COCOMS+COENG+COAGR+COMED "    "     "     scinces  "
52  TOTCOFR=TOTCOARTFR+TOTCOSCFR               "    "     "     freshmen
53  ULAN=800,PREVIOUS ULAN*ULANRATE          university languages
54  USOS=415,PREVIOUS USOS*USOSRATE              "
55  UEPS=289,PREVIOUS UEPS*UEPSRATE                     social studies
56  UAD=945,PREVIOUS UAD*UADRATE                 "  education & psychology
57  UREL=192,PREVIOUS UREL*URELRATE              "  administration
58 ULAW=93,PREVIOUS ULAW*ULAWRATE                "  religion
59  UPE=179,PREVIOUS UPE*UPERATE                 "  law    physical education
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UFIN=103.PREVIOUS UFIN*UFINRATE                university fine arts
UPR=466.PREVIOUS UPR*UPRATE                        "      Private studies
ULANRATE=1
USOSRATE=1
UEPSRATE=1
UADRATE=1
URELRATE=1
ULAWRATE=1
UPERATE=1
UFINRATE=1
UPRATE=1
TOTUARFR=ULAN+USOS+UEPS+UAD+UREL+ULAW+UPE+UFIN+UPR total uni. arts/freshman
UNAT=1326.PREVIOUS UNAT*UNATRATE            "  natural sciences
UNUR=215.PREVIOUS UNUR*UNURATE              "  nursing
UAGR=265.PREVIOUS UAGR*UAGRATE              "  agriculture
UMED=55.PREVIOUS UMED*UMEDRATE              "  medicine
UMES=62.PREVIOUS UMES*UMESRATE              "    "     sciences
UENG=654.PREVIOUS UENG*UENGRATE             "  engineering
UNATRATE=1.013
UNURATE=1.013
UAGRATE=1.013
UMEDRATE=1.013
UMESRATE=1.013
UENGRATE=1.013
TOTUSCFR=UNAT+UNUR+UAGR+UMED+UMES+UENG     total uni. freshmen sciences
TOTUNFR=TOTUARFR+TOTUSCFR                     "     "      "
TOTHIGHSFR=TOTUNFR+TOTCOFR                    "   higher education freshmen
PREPDROPOUTS=23182.PREVIOUS PREPDROPOUTS*DROPRATE  preparatory dropouts
DROPRATE=1.06
FAGRLAB=39744.PREVIOUS FAGRLAB*FAGRATE  foreign labor in agriculture
FCONLAB=6500.PREVIOUS FCONLAB*FCONRATE     "      "     " construction works
FINDLAB=3500.PREVIOUS FINDLAB*FINDRATE     "      "     " small industries
FAGRATE=1.05
FCONRATE=1.04
FINDRATE=1.04
WAGAGR=90                                wages/labor in agri.
WAGCON=120                                  "    "     " const. works
WAGIND=150                                  "    "     " small indust.
FWAGAGR=WAGAGR*FAGRLAB                   foreign wages/agri.
FWAGCON=WAGCON*FCONLAB                      "      "    const.
FWAGIND=WAGIND*FINDLAB                      "      "    small indus.
TRANAGRATE=0.70
TRANCONRATE=0.60
TRANINDRATE=0.50
TOTTRANAGR=FWAGAGR*TRANAGRATE total transfers of foreign labor/agri.
TOTTRANCON=FWAGCON*TRANCONRATE "     "      "    "     "     const.
TOTTRANIND=FWAGIND*TRANINDRATE "     "      "    "     "     small indust.
TOTFWAGES=FWAGAGR+FWAGCON+FWAGIND " foreign wages
TOTTRANS=TOTTRANAGR+TOTTRANCON+TOTTRANIND  total transfers
ANTOTFWAGES=TOTFWAGES*12          annual total foreing wages
ANTOTTRANS=TOTTRANS*12               "      "   transfers
AGLAB=60000.PREVIOUS AGLAB*AGRATE unskilled labor inagriculture
INDLAB=20000.PREVIOUS INDLAB*INDRATE    "      "     " Industry
MINLAB=5000.PREVIOUS MINLAB*MINRATE     "      "     " mining
EWLAB=1000.PREVIOUS EWLAB*EWRATE        "      "     " electricity & water
CONLAB=35000.PREVIOUS CONLAB*CONRATE    "      "     " construction
TRLAB=15000.PREVIOUS TRLAB*TRATE        "      "     " trade,rest. hotels
TCLAB=9000.PREVIOUS TCLAB*TCRATE        "      "     " transport & communica.
FLAB=1000.PREVIOUS FLAB*FRATE           "      "     " finance & insurance
DSLAB=20000.PREVIOUS DSLAB*DSRATE       "      "     " defense and services
AGRATE=1.05
INDRATE=1.06
MINRATE=1.06
EWRATE=1.06
CONRATE=1.06
TRATE=1.05
```

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127. FRATE=1.04
128 DSRATE=1.025                                                                        total/unsk:
129 TOTUNSKLAB=AGLAB+INDLAB+MINLAB+EWLAB+CONLAB+TRLAB+TCLAB+FLAB+DSLAB -ed labor
130 COTUITION=200                                    community colleges tuition
131 TOTCOTUIT=TOTCOFR*COTUITION       total           "          "        "    /freshmen
132 COENDOWMENT=2000000                              "           "      endowment
133 COSUBSID=4250400                                  "           "      subsidy
134 COINC=TOTCOTUIT+COSUBSID+COENDOWMENT              "           "      income
135 COSALFR=TOTCOFR*300                               "           "   salaries/freshmen
136 COADMEXPFR=TOTCOFR*100                            "      " Administr. expend/freshmar
137 COCAPITOUTFR=TOTCOFR*200                          "      " capital outlay/ freshmen
138 TOTCOEXPFR=COSALFR+COADMEXPFR+COCAPITOUTFR        "      " total expenditure/freshmar
139 COBALANCE=COINC-TOTCOEXPFR                        "      "  balance
140 UTUITION=300                                     universities tuition
141 TOTUTUIT=TOTUNFR*UTUITION               total  "               "
142 USUBSID=2338600                                   "            subsidy
143 UENDOWMENT=2000000                                "            endowment
144 UINC=TOTUTUIT+USUBSID+UENDOWMENT                  "            income
145 USALFR=TOTUNFR*500                                "     salaries/freshmen
146 UADMEXPFR=TOTUNFR*200                             "     administrative expenditure/'
147 UCAPITOUTFR=TOTUNFR*300                           "     capital outlay/freshmen
148 TOTUEXPFR=USALFR+UADMEXPFR+UCAPITOUTFR      total "     expenditure/freshmen
149 UBALANCE=UINC-TOTUEXPFR                           "     balance
150 HIGHSUBSID=COSUBSID+USUBSID                      higher education subsidy
151 GOVSUBSID=SESUBSID+HIGHSUBSID                    Government subsidy
152 INFLATION=1.0
153 POPSCAGE=200000.PREVIOUS POPSCAGE*POPRATE  population secondary age groups
154 POPRATE=1.04
155 SCENRLRATIO=SCTOTENRL/POPSCAGE                   secondary enrollment ratio
END OF MODEL


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MODELS AND REPORTS SAVED ON FILE MODEL
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ANNEX B: POPULATION OF JORDAN (Excludes West Bank)

THE HASHEMITE KINGDOM OF JORDAN
POPULATION AND HOUSING CENSUS-1979

TABLE -5- JORDANIAN POPULATION LIVING IN EAST BANK BY AGE GROUP, SEX, AND RELIGION.

الجدول ٥ — توزيع السكان الاردنيين المقيمين في الضفة الشرقية حسب العمر والجنس والديانة

AGE GROUP IN YEARS AND SEX فئة العمر والجنس		TOTAL PERSONS مجموع السكان	TOTAL المجموع			URBAN حضر			RURAL ريف		
			MOSLEM مسلم	CHRISTIAN مسيحي	OTHER اخرى	MOSLEM مسلم	CHRISTIAN مسيحي	OTHER اخرى	MOSLEM مسلم	CHRISTIAN مسيحي	OTHER اخرى
EAST BANK		الضفة الشرقية									
TOTAL	المجموع	2,031,059	1,952,999	77,946	114	1,120,261	63,032	84	812,738	14,914	30
MALE	ذكور	1,027,309	989,728	37,527	54	574,398	30,332	38	415,330	7,195	16
FEMALE	اناث	983,742	943,263	40,419	60	542,863	32,700	46	397,400	7,719	14
"0"		83,285	81,482	1,889	2	44,835	1,500	1	36,567	381	1
MALE	ذكور	42,668	41,733	933	2	23,032	744	1	18,709	189	1
FEMALE	اناث	40,617	39,669	948	-	21,803	756	-	17,866	192	-
1-4		302,952	293,701	7,244	7	162,383	5,708	6	133,318	1,536	1
MALE	ذكور	156,303	152,581	3,718	4	83,528	2,969	4	69,053	749	-
FEMALE	اناث	146,649	143,120	3,526	3	78,855	2,739	2	64,265	787	1
5-9		351,478	342,006	9,460	12	193,645	7,288	10	148,361	2,172	2
MALE	ذكور	181,668	176,739	4,928	1	99,863	3,757	1	76,076	1,163	-
FEMALE	اناث	169,810	165,267	4,540	11	93,782	3,531	9	71,485	1,009	2
10-14		300,506	290,447	10,042	17	170,775	7,832	14	119,672	2,210	3
MALE	ذكور	156,393	151,333	5,053	7	88,722	3,920	6	62,611	1,133	1
FEMALE	اناث	144,113	139,114	4,989	10	82,055	3,912	8	57,061	1,077	2
15-19 *		225,408	216,351	9,037	20	132,012	7,380	16	84,339	1,657	4
MALE	ذكور	116,372	111,957	4,405	10	68,414	3,577	7	43,543	828	3
FEMALE	اناث	109,036	104,394	4,632	10	63,598	3,803	9	40,796	829	1
20-24		142,709	136,798	5,903	8	82,709	4,933	6	54,089	970	2
MALE	ذكور	70,837	68,409	2,424	4	41,672	2,038	4	26,737	386	-
FEMALE	اناث	71,872	68,389	3,479	4	41,037	2,895	2	27,352	584	2
25-29		102,843	96,782	5,252	7	57,292	4,387	2	39,580	865	5
MALE	ذكور	49,375	47,053	2,316	6	28,069	1,941	1	18,984	375	5
FEMALE	اناث	52,466	49,729	2,936	1	29,135	2,446	1	20,594	490	-

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ANNEX C

NEW SCHEME

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	1986	1987	1988	1989	1990
FSTSCENRL	33310	27171	28204	30000	32427
SNDSCENRL	29142	34067	26562	27308	29017
TRDSCENRL	29556	28566	33274	26166	26739
GRADSC	12371	11957	13927	10952	11192
GRADART	15116	14610	17017	13382	13675
FSTSCRATE	1	.7695	1.038	1.064	1.081
SNDSCRATE	1	1.169	.7797	1.028	1.063
TRDSCRATE	1	.9665	1.165	.7864	1.022
GRADSCRATE	1	.9665	1.165	.7864	1.022
GRADARATE	1	.9665	1.165	.7864	1.022
SCTOTENRL	94008	89804	88039	83474	88183
SECGRAD	27487	26566	30944	24334	24867
SCTEACHLOAD	20.44	20.44	20.44	20.44	20.44
SCTOTTEACH	4599	4394	4307	4084	4314
SCTEACHSAL	1333	1333	1333	1333	1333
SCTOTSAL	6130757	5856586	5741494	5443756	5750888
FUR	470040	449020	440196	417368	440916
STA	188016	179608	176078	166947	176366
LIB	282024	269412	264117	250421	264549
LAB	470040	449020	440196	417368	440916
ART	188016	179608	176078	166947	176366
SPOR	188016	179608	176078	166947	176366
TAID	188016	179608	176078	166947	176366
SCCAPITOUTL	1974168	1885882	1848821	1752947	1851846
SCADMEXPEND	1009646	964494	945540	896507	947087
SCSPACE	9400800	8980392	8803911	8347365	8818316
SCTOTEXPEND	18515370	17687354	17339767	16440575	17368138
SCTUITION	0	0	0	0	0
SCTOTTUIT	0	0	0	0	0
SESUBSID	18515081	18515081	18515081	18515081	18515081
SCTOTINC	18515081	18515081	18515081	18515081	18515081
SCBALANCE	-289.5	827727	1175314	2074506	1146943
COEDART	3355	3355	3355	3355	3355
COSOS	581	581	581	581	581
COCOMART	5000	5000	5000	5000	5000
COEDS	1500	1575	1654	1736	1823
COCOMS	1150	1208	1268	1331	1398
COENG	2051	2154	2261	2374	2493
COMED	786	825.3	866.6	909.9	955.4
COAGR	17	17.85	18.74	19.68	20.66
COEARATE	1	1	1	1	1
COSOSRATE	1	1	1	1	1
COCOMARATE	1	1	1	1	1
COEDSRATE	1.050	1.050	1.050	1.050	1.050
COCOMSRATE	1.050	1.050	1.050	1.050	1.050
COENGRATE	1.050	1.050	1.050	1.050	1.050
COMEDRATE	1.050	1.050	1.050	1.050	1.050
COAGRATE	1.050	1.050	1.050	1.050	1.050
TOTCOARTFR	8936	8936	8936	8936	8936
TOTCOSCFR	5504	5779	6068	6372	6690
TOTCOFR	14440	14715	15004	15308	15626
ULAN	800	800	800	800	800
USOS	415	415	415	415	415
UEPS	289	289	289	289	289
UAD	945	945	945	945	945
UREL	192	192	192	192	192
[illegible]	93	93	93	93	93

NEW SCHEME

UFE	179	179	179	179	179
UFIN	105	105	105	105	105
UFR	466	466	466	466	466
ULANRATE	1	1	1	1	1
USOSRATE	1	1	1	1	1
UEPSRATE	1	1	1	1	1
UADRATE	1	1	1	1	1
URELRATE	1	1	1	1	1
ULAWRATE	1	1	1	1	1
UPERATE	1	1	1	1	1
UFINRATE	1	1	1	1	1
UPRATE	1	1	1	1	1
TOTUARFR	3484	3484	3484	3484	3484
UNAT	1326	1343	1361	1378	1396
UNUR	215	217.8	220.6	223.5	226.4
UAGR	265	268.4	271.9	275.5	279.1
UMED	55	55.72	56.44	57.17	57.92
UMES	62	62.81	63.62	64.45	65.29
UENG	654	662.5	671.1	679.8	688.7
UNATRATE	1.013	1.013	1.013	1.013	1.013
UNURATE	1.013	1.013	1.013	1.013	1.013
UAGRATE	1.013	1.013	1.013	1.013	1.013
UMEDRATE	1.013	1.013	1.013	1.013	1.013
UMESRATE	1.013	1.013	1.013	1.013	1.013
UENGRATE	1.013	1.013	1.013	1.013	1.013
TOTUSCFR	2577	2611	2644	2679	2714
TOTUNFR	6061	6095	6128	6163	6198
TOTHIGHSFR	20501	20810	21133	21470	21824
PREPDROPOUTS	23182	24573	26047	27610	29267
DROPRATE	1.060	1.060	1.060	1.060	1.060
FAGRLAB	39744	41731	43818	46009	48309
FCONLAB	6500	6760	7030	7312	7604
FINDLAB	3500	3640	3786	3937	4095
FAGRATE	1.050	1.050	1.050	1.050	1.050
FCONRATE	1.040	1.040	1.040	1.040	1.040
FINDRATE	1.040	1.040	1.040	1.040	1.040
WAGAGR	90	90	90	90	90
WAGCON	120	120	120	120	120
WAGIND	150	150	150	150	150
FWAGAGR	3576960	3755808	3943598	4140778	4347817
FWAGCON	780000	811200	843648	877394	912490
FWAGIND	525000	546000	567840	590554	614176
TRANAGRATE	.7000	.7000	.7000	.7000	.7000
TRANCONRATE	.6000	.6000	.6000	.6000	.6000
TRANINDRATE	.5000	.5000	.5000	.5000	.5000
TOTTRANAGR	2503872	2629066	2760519	2898545	3043472
TOTTRANCON	468000	486720	506189	526436	547494
TOTTRANIND	262500	273000	283920	295277	307088
TOTFWAGES	4881960	5113008	5355086	5608726	5874483
TOTTRANS	3234372	3388786	3550628	3720258	3898054
ANTOTFWAGES	58583520	61356096	64261037	67304710	70493792
ANTOTTRANS	38812464	40665427	42607532	44643096	46776645
AGLAB	60000	63000	66150	69458	72930
INDLAB	20000	21200	22472	23820	25250
MINLAB	5000	5300	5618	5955	6312
EWLAB	1000	1060	1124	1191	1262
CONLAB	35000	37100	39326	41686	44187
TRLAB	15000	15750	16538	17364	18233
TCLAB	9000	9450	9923	10419	10940
FLAB	1000	1040	1082	1125	1170
DSLAB	20000	20500	21013	21538	22076
AGRATE	1.050	1.050	1.050	1.050	1.050
INDRATE	1.060	1.060	1.060	1.060	1.060
MINRATE	1.060	1.060	1.060	1.060	1.060
EWRATE	1.060	1.060	1.060	1.060	1.060
	1.060	1.060	1.060	1.060	1.060

OLD SCHEME

USOS	415	456.5	502.2	552.4	607.6
UEPS	289	317.9	349.7	384.7	423.1
UAD	945	1040	1143	1258	1384
UREL	192	211.2	232.3	255.6	281.1
ULAW	93	102.3	112.5	123.8	136.2
UPE	179	196.9	216.6	238.2	262.1
UFIN	105	115.5	127.1	139.8	153.7
UPR	466	512.6	563.9	620.2	682.2
ULANRATE	1.100	1.100	1.100	1.100	1.100
USOSRATE	1.100	1.100	1.100	1.100	1.100
UEPSRATE	1.100	1.100	1.100	1.100	1.100
UADRATE	1.100	1.100	1.100	1.100	1.100
URELRATE	1.100	1.100	1.100	1.100	1.100
ULAWRATE	1.100	1.100	1.100	1.100	1.100
UPERATE	1.100	1.100	1.100	1.100	1.100
UFINRATE	1.100	1.100	1.100	1.100	1.100
UPRATE	1.100	1.100	1.100	1.100	1.100
TOTUARFR	3484	3832	4216	4637	5101
UNAT	1326	1591	1909	2291	2750
UNUR	215	258	309.6	371.5	445.8
UAGR	265	318	381.6	457.9	549.5
UMED	55	66	79.20	95.04	114.0
UMES	62	74.40	89.28	107.1	128.6
UENG	654	784.8	941.8	1130	1356
UNATRATE	1.200	1.200	1.200	1.200	1.200
UNURATE	1.200	1.200	1.200	1.200	1.200
UAGRATE	1.200	1.200	1.200	1.200	1.200
UMEDRATE	1.200	1.200	1.200	1.200	1.200
UMESRATE	1.200	1.200	1.200	1.200	1.200
UENGRATE	1.200	1.200	1.200	1.200	1.200
TOTUSCFR	2577	3092	3711	4453	5344
TOTUNFR	6061	6925	7927	9090	10445
TOTHIGHSFR	20501	23359	26665	30495	34941
PREPDROPOUTS	2576	2576	2576	2576	2576
DROPRATE	1.100	1.100	1.100	1.100	1.100
FAGRLAB	39744	41731	43818	46009	48309
FCONLAB	6500	6760	7030	7312	7604
FINDLAB	3500	3640	3786	3937	4095
FAGRATE	1.050	1.050	1.050	1.050	1.050
FCONRATE	1.040	1.040	1.040	1.040	1.040
FINDRATE	1.040	1.040	1.040	1.040	1.040
WAGAGR	90	90	90	90	90
WAGCON	120	120	120	120	120
WAGIND	150	150	150	150	150
FWAGAGR	3576960	3755808	3943598	4140778	4347817
FWAGCON	780000	811200	843648	877394	912490
FWAGIND	525000	546000	567840	590554	614176
TRANAGRATE	.7000	.7000	.7000	.7000	.7000
TRANCONRATE	.6000	.6000	.6000	.6000	.6000
TRANINDRATE	.5000	.5000	.5000	.5000	.5000
TOTTRANAGR	2503872	2629066	2760519	2898545	3043472
TOTTRANCON	468000	486720	506189	526436	547494
TOTTRANIND	262500	273000	283920	295277	307088
TOTFWAGES	4881960	5113008	5355086	5608726	5874483
TOTTRANS	3234372	3388786	3550628	3720258	3898054
ANTOTFWAGES	58583520	61356096	64261037	67304710	70493792
ANTOTTRANS	38812464	40665427	42607532	44643096	46776645
AGLAB	60000	63000	66150	69458	72930
INDLAB	20000	21200	22472	23820	25250
MINLAB	5000	5300	5618	5955	6312
EWLAB	1000	1060	1124	1191	1262
CONLAB	35000	37100	39326	41686	44187
TRLAB	15000	15750	16538	17364	18233
TCLAB	9000	9450	9923	10419	10940
FLAB	1000	1040	1082	1125	1170
DSLAB	20000	20500	[illegible]	[illegible]	[illegible]

OLD SCHEME

AGRATE	1.050	1.050	1.050	1.050	1.050
INDRATE	1.060	1.060	1.060	1.060	1.060
MINRATE	1.060	1.060	1.060	1.060	1.060
EWRATE	1.060	1.060	1.060	1.060	1.060
CONRATE	1.060	1.060	1.060	1.060	1.060
TRATE	1.050	1.050	1.050	1.050	1.050
TCRATE	1.050	1.050	1.050	1.050	1.050
FRATE	1.040	1.040	1.040	1.040	1.040
DSRATE	1.025	1.025	1.025	1.025	1.025
TOTUNSKLAB	166000	174400	183244	192555	202360
COTUITION	200	200	200	200	200
TOTCOTUIT	2888000	3286880	3747664	4280946	4899258
COENDOWMENT	2000000	2000000	2000000	2000000	2000000
COSUBSID	4250400	4250400	4250400	4250400	4250400
COINC	9138400	9537280	9998064	10531346	11149658
COSALFR	4332000	4930320	5621496	6421418	7348888
COADMEXPFR	1444000	1643440	1873832	2140473	2449629
COCAPITOUTFR	2888000	3286880	3747664	4280946	4899258
TOTCOEXPFR	8664000	9860640	11242992	12842837	14697775
COBALANCE	474400	-323360	-1244928	-2311491	-3548117
UTUITION	300	300	300	300	300
TOTUTUIT	1818300	2077440	2377956	2727078	3133377
USUBSID	2338600	2338600	2338600	2338600	2338600
UENDOWMENT	2000000	2000000	2000000	2000000	2000000
UINC	6156900	6416040	6716556	7065678	7471977
USALFR	3030500	3462400	3963260	4545130	5222296
UADMEXPFR	1212200	1384960	1585304	1818052	2088918
UCAPITOUTFR	1818300	2077440	2377956	2727078	3133377
TOTUEXPFR	6061000	6924800	7926520	9090260	10444592
UBALANCE	95900	-508760	-1209964	-2024582	-2972614
HIGHSUBSID	6589000	6589000	6589000	6589000	6589000
GOVSUBSID	25104081	25104081	25104081	25104081	25104081
INFLATION	1	1	1	1	1
POPSCAGE	200000	208000	216320	224973	233972
POPRATE	1.040	1.040	1.040	1.040	1.040
SCENRLRATIO	.4700	.5184	.5866	.6421	.6714

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TRATE	1.050	1.050	1.050	1.050	1.050
TCRATE	1.050	1.050	1.050	1.050	1.050
FRATE	1.040	1.040	1.040	1.040	1.040
DSRATE **NEW SCHEME**	1.025	1.025	1.025	1.025	1.025
TOTUNSKLAB	166000	174400	183244	192555	202360
COTUITION	200	200	200	200	200
TOTCOTUIT	2888000	2943040	3000832	3061514	3125229
COENDOWMENT	2000000	2000000	2000000	2000000	2000000
COSUBSID	4250400	4250400	4250400	4250400	4250400
COINC	9138400	9193440	9251232	9311914	9375629
COSALFR	4332000	4414560	4501248	4592270	4687844
COADMEXPFR	1444000	1471520	1500416	1530757	1562615
COCAPITOUTFR	2888000	2943040	3000832	3061514	3125229
TOTCOEXPFR	8664000	8829120	9002496	9184541	9375688
COBALANCE	474400	364320	248736	127373	-58.56
UTUITION	300	300	300	300	300
TOTUTUIT	1818300	1828350	1838531	1848845	1859292
USUBSID	2338600	2338600	2338600	2338600	2338600
UENDOWMENT	2000000	2000000	2000000	2000000	2000000
UINC	6156900	6166950	6177131	6187445	6197892
USALFR	3030500	3047251	3064219	3081408	3098820
UADMEXPFR	1212200	1218900	1225688	1232563	1239528
UCAPITOUTFR	1818300	1828350	1838531	1848845	1859292
TOTUEXPFR	6061000	6094501	6128438	6162815	6197640
UBALANCE	95900	72449	48694	24629	252.1
HIGHSUBSID	6589000	6589000	6589000	6589000	6589000
GOVSUBSID	25104081	25104081	25104081	25104081	25104081
INFLATION	1	1	1	1	1
POPSCAGE	200000	208000	216320	224973	233972
POPRATE	1.040	1.040	1.040	1.040	1.040
SCENRLRATIO	.4700	.4317	.4070	.3710	.3769

ENTER SOLVE OPTIONS

OLD SCHEME

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***** WHAT IF CASE 3 *****
31 WHAT IF STATEMENTS PROCESSED
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	1986	1987	1988	1989	1990
FSTSCENRL	35310	45200	50096	53612	57939
SNDSCENRL	29142	34064	43513	48396	51841
TRDSCENRL	29556	28566	33274	42437	47309
GRADSC	12371	11957	13927	17763	19802
GRADART	15116	14610	17017	21704	24195
FSTSCRATE	1	1.280	1.108	1.070	1.081
SNDSCRATE	1	1.169	1.277	1.112	1.071
TRDSCRATE	1	.9665	1.165	1.275	1.115
GRADSCRATE	1	.9665	1.165	1.275	1.115
GRADARATE	1	.9665	1.165	1.275	1.115
SCTOTENRL	94008	107830	126883	144445	157089
SECGRAD	27487	26566	30944	39466	43997
SCTEACHLOAD	20.44	20.44	20.44	20.44	20.44
SCTOTTEACH	4599	5275	6208	7067	7685
SCTEACHSAL	1333	1333	1333	1333	1333
SCTOTSAL	6130757	7032181	8274677	9420016	10244602
FUR	470040	539151	634413	722225	785445
STA	188016	215661	253765	288890	314178
LIB	282024	323491	380648	433335	471267
LAB	470040	539151	634413	722225	785445
ART	188016	215661	253765	288890	314178
SPOR	188016	215661	253765	288890	314178
TAID	188016	215661	253765	288890	314178
SCCAPITOUTL	1974168	2264436	2664533	3033344	3298869
SCADMEXPEND	1009646	1158097	1362718	1551339	1687136
SCSPACE	9400800	10783029	12688252	14444496	15708902
SCTOTEXPEND	18515370	21237743	24990180	28449196	30939509
SCTUITION	0	0	0	0	0
SCTOTTUIT	0	0	0	0	0
SESUBSID	18515081	18515081	18515081	18515081	18515081
SCTOTINC	18515081	18515081	18515081	18515081	18515081
SCBALANCE	-289.5	-2722662	-6475099	-9934115	-12424428
COEDART	3355	3691	4060	4466	4912
COSOS	581	639.1	703.0	773.3	850.6
COCOMART	5000	5500	6050	6655	7321
COEDS	1500	1800	2160	2592	3110
COCOMS	1150	1380	1656	1987	2385
COENG	2051	2461	2953	3544	4253
COMED	786	943.2	1132	1358	1630
COAGR	17	20.40	24.48	29.38	35.25
COEARATE	1.100	1.100	1.100	1.100	1.100
COSOSRATE	1.100	1.100	1.100	1.100	1.100
COCOMARATE	1.100	1.100	1.100	1.100	1.100
COEDSRATE	1.200	1.200	1.200	1.200	1.200
COCOMSRATE	1.200	1.200	1.200	1.200	1.200
COENGRATE	1.200	1.200	1.200	1.200	1.200
COMEDRATE	1.200	1.200	1.200	1.200	1.200
COAGRATE	1.200	1.200	1.200	1.200	1.200
TOTCOARTFR	8936	9830	10813	11894	13083
TOTCOSCFR	5504	6605	7926	9511	11413
TOTCOFR	14440	16434	18738	21405	24496
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]