PN-AAP-583
ISN: 33966

DATA, DECISIONS, AND DEVELOPMENT:

Agency for International Development
Washington, D.C.

1979

PNAAP 583

DATA, DECISIONS, AND DEVELOPMENT:

Strategy and Issues of Information Management In the Public Sector

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3134

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1979

This study is a revised version of a monograph prepared for the International Statistical Program Center (US Bureau of the Census), under RSSA arrangement with the Agency for International Development.

The judgments expressed in this study are those of the author and do not necessarily represent those of the contracting authority or any other agency of the U.S. Government.

"Data flow has become a flood, requiring the services of technical specialists, who may know how to channel, but lack the wisdom to dam."

Ida R. Hoos,
SYSTEMS ANALYSIS IN
PUBLIC POLICY: A Critique

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PREFACE

The purpose of the study is to serve as a resource for use by persons involved in improving public sector information in developing countries. It is designed to provide a guide for them that identifies basic issues and choices, advises on how to address these issues and choices in an effective way, and suggests a strategy for organizing their efforts. This strategy is designed to be adaptable to local needs and circumstances, to be incremental and divisible into manageable stages, and to be coordinated and goal-oriented, so that each stage builds on what goes before it.

One planned use of the study is to be as a framework for workshops and training for managers, administrators, and their staffs. Because of the variance in the background, skills, and experience of this group, it is written in a style which, while addressing important technical issues, is nevertheless non-technical. Numerous charts, figures, and diagrams, which can be used as visual aids in conjunction with a workshop, are therefore placed throughout the text.

The abundant footnotes that normally characterize technical monographs have been omitted. This is so for two reasons. First, much of the best work in this area remains unpublished, done by practitioners interested in making a system work rather

than in publication. It is usually only several years after the successful completion of a project, if ever, that such persons set aside the time to record their experiences in publishable form.* Second, while valuable published material does exist, it is often narrowly focused, highly technical, and targeted toward other technicians. Thus, it is not particularly suited to the needs of the audience of this study. To meet the needs of those readers who wish to pursue certain technical topics in more detail, a few selected references are suggested at the end.

Because it is anticipated that there will be multiple readerships for this study with different programmatic backgrounds, the examples and illustrations used in the text are from multiple rather than a single program area. Most are taken from health, education, agriculture, and rural development.

This study was prepared specifically for the contracting authority. It does however, take advantage of work done under two other sources of support which should be acknowledged. The first is the Woodrow Wilson School of Princeton University, which appointed me as a Visiting Fellow in the summer of 1977. This respite from

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*Because of this problem, many interesting "case studies" are not in a form that is readily usable or accessible by the public. The project files of international agencies would provide a wealth of material for persons interested in analyzing such case studies and writing them up in publishable style and format.

teaching and consulting, funded by the Faculty Research Fund of the University of Denver, gave me the opportunity to attempt to synthetize lessons from consulting experience with the growing body of technical writing in many of the areas covered in this study. Also in 1977, and 1978, the Alfred P. Sloan Foundation supported the development and teaching of a course entitled, "the management and planning of technological projects," which gave me the opportunity to experiment with various methods of teaching management information systems concepts to persons with mixed backgrounds.

As would be supposed, the judgments contained herein are those of the author and do not necessarily reflect those of the contracting authority.

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1979

I. INTRODUCTION: Information Improvement Problems

A. The Problem "With" Information Improvement

B. The Problem "Of" Information Improvement

A. The Problem "With" Information Improvement

Data - its abundance and scarcity, relevance and quality, collection and processing, communication and use - have become a priority problem for planners and administrators of development. In virtually every country in the developing world, there is some project currently underway with the objective of improving some aspects of data collection, processing, analysis, or utilization. Within the last several years, there has been a marked increase in requests to both A.I.D. and the World Bank for projects with major components directed at information improvement. These agencies themselves have placed increasing emphasis on using "hard data" in the design, execution, and evaluation of projects to which they contribute, and are investing growing amounts of resources in its collection. In the case of A.I.D., there has also been increasing congressional pressure to "document" both the justification for projects and the assessment of their success or failure.

To some extent, the new emphasis on increasing the quantity and quality of information used in development planning and administration reflects a maturing of development management and a recognition that "conventional wisdom" may be more convention than it is wise, and that the biases and prejudices upon which we base our actions ought to be more closely and frequently subject to empirical scrutiny. To some extent, however, the new emphasis reflects infatuation with the prevailing mystique of

information systems and computers as the oracles which will guide leaders through the development morass.

Whatever the motivation, the new emphasis is somewhat of an anomaly. It seems to run counter to two major thrusts in current development thought and practice. It does not at first glance appear to be congruent with the "basic needs" approach to development, which places the greatest priority on projects and programs which directly aid the "poorest of the poor." It seems at least also to have the possibility of being at odds with considerations of "appropriate technology." In practice, both conflicts are more apparent than real. Yet even their apparent existence points up potential problems with the new emphasis on data collection, processing and use, that are worth examining further.

The "basic needs" approach grew out of attempts to redress problems in predecessor approaches to development. These approaches varied considerably from country to country, but common to most was a drive toward rapid industrialization which centered on import substitution, the export of raw and semi-processed commodities as exchange for foreign capital, the development of national infrastructure (roads, bridges, dams, ports, etc.) and the building of indigenous local institutions, both public and private. Because of local production inefficiencies, fluctuating commodity prices, unfavorable trade balances, and the long incubation period for the human aspects of effective institutionalization, the record of the

"first development decade" is one of mixed success. Even in cases where increases in production were judged to be successful, however, the great disparities in wealth between the rich and the poor seemed to be aggravated rather than alleviated. The poor, particularly the rural poor, remained on the periphery of society - without adequate food, shelter, medical care, or education. The humanitarian indictment of these "trickle down" approaches to development prompted the "basic needs" approach as an alternative. The essence of this approach is to give priority in development assistance to programs and projects which directly provide services which affect the needs of the poor. The approach was adopted most quickly and thoroughly at A.I.D. in its "new directions" mandate, but has since permeated the efforts of other international development institutions, including UNDP and the World Bank.

Attempts to improve information for planning and management seems to be a classic case of "institution building," and as such, subject to the general arguments against "trickle-down" strategies of which the "basic needs" approach saw it as an example. According to this view, the principal group to benefit from an improvement of management information will be managers of the bureacratic organizations involved. They will receive more information and skills with which to fortify their own position. Indeed, in some cases where information improvement projects have taken place, this has been the case. In others underway, it may also prove to be the case. But this need not be so. Information improvement

can play an important contributive role in improving development strategies aimed at meeting "basic needs."

In this regard, it is worth recalling several points which Lester Gordon, Director of the Harvard Institute of International Development, and the principal author of the Brookings Institution's "Assessment of Development Strategies," made at last year's 25th Anniversary International Development Conference. These are as follows:

1. Support of basic human needs should itself be treated as a change in emphasis, not a new strategy.

2. Greater attention to the needs of the poor is ultimately each nation's own responsibility. A shift in emphasis toward the poor will frequently require internal reforms that many governments will be unwilling or unable to undertake. Whether and how foreign assistance might affect this process of domestic change should be a critical consideration in allocating assistance funds.

3. Restricting assistance solely to projects which directly affect the poor only provides temporary help to a smaller number than otherwise might be reached.

4. Greater emphasis on direct satisfaction of basic human needs might well start with revision of existing programs to make them more effective. This will entail continuing research and experimentation and data collection and evaluation, in the case of A.I.D., along the lines encouraged by Congress in its New Directions Legislation. *

*The text of this address is available from the International Development Conference, 1120 19th St.N.W., Washington,D.C., 20036

If the "basic needs" emphasis is conceived of in this broader way, then efforts at improving information for planning and management need not be in conflict with it. The delivery of services to the poor requires organizational instruments. The quantity and quality of services the poor will receive will be dependent not only on the amount of resources available but on the efficiency and effectiveness of these organizational instruments. Better information about who are the poor, where they are located, which of their many problems are most severe in a particular situation, and the extent to which program outputs reach them and affect them, is as necessary for the management of "basic needs" programs as for any other.

This, of course, is not to say that improved information will insure that programs will in fact benefit the poor rather than the bureaucratic elites. The policy and management elites must themselves be oriented toward helping the poor, at least as much as they are in preserving and improving their own positions within the organization. But even if this is not the case, better information can have a salutory effect in terms of "rationalizing" the decision-making process of the organization (in the sense of making judgments more informed and more reasoned). One of the most significant effects of the gathering of evaluation data at the state and local level within the United States has been such rationalization. It has forced administrators to justify their programs in ways that they previously could ignore. It has forced them to address issues

that they previously could have glossed over. Part of the problem is, of course, that the same information that can be used to "rationalize" decisions, in the sense of making them more informed and reasoned, can also be used to "rationalize" them, in the sense of devising self-satisfying but incorrect justifications. But again, even in this case, the terms of debate have changed from unchallenged assumptions toward judgments which can be more easily corroborated or refuted by "facts," however those facts are combined and interpreted.*

*In this regard it is worth noting that in every successful "muck-raking" effort, information has been critical to increasing public awareness of problems and in promoting the changes in both people and structure that were necessary for alleviation or solution of the problem.

In addition to the "basic needs" approach, the other thrust in contemporary development thinking where efforts at improving information collection, processing, and use, may not be entirely congruent is that of "appropriate technology." Here also, some discussion is in order.

"Appropriate technology" has come to represent a development strategy, a rallying call, and an international fraternity. While having antecedents that can be construed as going back to the Luddite destruction of textile machinery in England between 1811 and 1816, in the belief that it would diminish employment, its contemporary origin is the work of the late economist, E. F. Schumacher. His 1973 book, Small is Beautiful: Economics As If People Mattered, has become the recorded revelation of the appropriate technology movement, and made him a folk-hero on university campuses in Europe and North America.

Although a thorough critic of much conventional economic wisdom, Schumacher's concept of "appropriate technology" is primarily economistic. The basic continuum of appropriateness is one of labor-capital intensivity. He measures this in terms of the cost of capital to create one "workplace," i.e., one place in the work force. Within this continuum, he distinguishes three basic classes: the indigenous technology of a developing country, which he symbolically refers to as £1-technology (one pound technology); the technology of developed countries, symbolized by £1000-technology; and finally "intermediate" or

"appropriate" technology, symbolized by £100-technology. He then makes the following argument on behalf on "intermediate" technology:

> Such an intermediate technology would be immensely more productive than the indigenous technology (which is often in a condition of decay), but it would also be immensely cheaper than the sophisticated highly capital-intensive technology of modern industry. At such a level of capitalization, very large numbers of workplaces could be created within a fairly short time; and the creation of such workplaces would be "within reach" for the more enterprising minority within the district, not only in financial terms but also in terms of their education, aptitude, organizing skill, and so forth.*

What is significant in this passage is that while Schumacher defines "intermediate" in terms of the labor-capital ratio, it is also clear that there are other dimensions to "appropriateness," relating to "education, aptitude, and organizing skill." It points out the basic difficulty with the concept of "appropriate technology" - the fact that if we want to signify something more than "labor intensivity" (in which case we should call it "labor intensivity," not "appropriate technology"), it is essentially a non-operational concept which has value principally because it sensitizes us to certain problems about "high" (capital intensive) technologies.

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*E. F. Schumacher, Small Is Beautiful, Harper and Row, New York., 1973.

It is not a "criterion" of project design or choice against which we can measure projects. There are just too many dimensions to which projects can be "appropriate" whose importance will vary considerably from one setting to an another.

This again does not imply that the notion of appropriateness, as applied to information improvement technology, is without merit. It sensitizes us to looking at the labor-capital ratio. It helps makes us aware that this is a dimension across which the range of technological choice is indeed large, ranging from entirely manual to almost entirely automated systems. More importantly, however, it sensitizes us to look at the other non-quantitative dimensions of information technologies - the extent to which they are "appropriate" in terms of education, aptitude, and organizing skill. These are indeed the most important dimensions. As Schumacher relates in another passage: "Development does not start with goods; it starts with people and their education, organization, and discipline. Without these three, all resources remain latent, untapped, and potential."* It is precisely at these areas that the technology of information improvement is directed.

*Ibid, page 168.

B. The Problem "Of" Information Improvement

In the broadest sense, the objective of information improvement within an organization is "rationalization" of the decision-making process of the organization, i.e., making the actions of the organization more "rational." It involves the application of "reasoning" to choices among alternative actions. "Reasoning," according to a classic definition, is a way that the mind proceeds, on the basis of truths known (propositions) to knowledge of some new truth (consequence). Thus, rational action involves proceeding from known propositions about action alternatives to a new knowledge (more or less accurate prediction) about their alternative consequences.

From a micro-perspective of focusing on the reasoning process itself, the success of the process is a function of two factors: the accuracy of the propositions, and correctness of the inferences made. Many fairly complicated techniques (often misapplied) have been developed to assist in making inferences: cost-benefit analysis, statistical decision analysis, and linear programming - to name three of the more popular ones. The inferences made using these or any other technique are no better than the quality of the assumptions and propositions about the action situation to which they are being applied. The purpose of strategies aimed at information improvement is to increase this quality, i.e., to make these assumptions and propositions more "informed," to subject them more closely to empirical scrutiny, to make them conform more

closely to empirical reality. Complicated methodologies for making inferences (such as the three named above) without close empirical scrutiny, allow for great self-deception and disastrous consequences. The American debacle in Viet Nam, for example, was not the "fault" of inferential methods associated with "systems analysis," but of the empirical inaccuracy of the propositions on which the analysis was based.

From a macro-perspective of focusing on the institutional context of decision-making, neither sophisticated methods of making inferences nor an abundance of high quality empirical information are sufficient to ensure that a organization will in fact make better (more "informed" and more "reasoned") decisions. If we take Schumacher seriously, they will, without "education, organization, and discipline," remain "latent, untapped, and potential." These institutional-environmental factors will determine the long term effect of attempts to improve decision-making through improving information. That effect could be more informed management, more realistic decisions, better targeted programs, and more benefit to their recipients. It could also be more frustrated management, a plethora of unuseable and useless information, increased organizational rigidity and work, and the squandering of scarce resources in ways which confuse and confound rather than enlighten management decision. This is to say, in black and white terms, there are right and wrong ways of attempting to improve how an organization gathers, processes, analyzes, communicates, and

utilizes information. The opportunity is that, if done effectively, the benefits are considerable. The danger is that, if bungled, the effects are not simply neutral but damaging. The challenge is that the task is both difficult and eclectic. Yet it is do-able. Much can be learned from past successes and failures, and these lessons can be adapted to local situations in order to effectively plan and carry out activities which involve improving management information and choice.

The purpose of this study is to serve as a resource for people who are attempting to meet this challenge. It seeks to describe an approach or strategy for information improvement which is pragmatic, coordinated, and learned (cognizant of the causes of success or failure in similar efforts). It seeks to identify and explain the basic choices and options of information improvement with respect to the substance of information generated, and the way it is collected, processed, and analyzed. And, it seeks to provide guidance in making the basic choices in a way that is adaptable to the special circumstances of the particular organizational context of the reader.

PURPOSES OF THE STUDY

* DESCRIBE AN APPROACH OR STRATEGY OF INFORMATION IMPROVEMENT
* EXPLAIN BASIC CHOICES AND OPTIONS OF INFORMATION IMPROVEMENT
* PROVIDE GUIDANCE IN MAKING BASIC CHOICES

Figure I - 1

II. IMPROVING INFORMATION FOR DEVELOPMENT: Overview of an Integrated Strategy

A. The Role of Information in Development

B. Basic Factors About Improving Information

C. An Integrated Strategy for Information Improvement

A. The Role of Information in Development

The "growth" and "development" of nations has become the most significant issue facing the world community. It affects almost every other major issue from the demands for a New International Economic Order, to attempts to equate "human needs" and "human rights", to proposed codes of conduct for multinational enterprises, to the basic pattern of amity and enmity among nations. For developed countries, it is a matter affecting world stability, prosperity, and peace. For developing countries, it is a matter of life and death, both for their people and their governments.

While a powerful rallying concept, rich in connotation and emotion, "development" is less than useful as a guide to the planner or the manager charged with its accomplishment. As with many other anthropomorphic concepts, its wide use is a function of its generality as a concept, the variability of the phenomena to which it refers, and our lack of understanding of that phenomena in dynamic terms (as a process).

In most general and basic terms, "development" refers to change in the way people in a society relate to each other and to material resources. As the concept of development connotes desirability, implicit in this quite general definition is the idea that the change is a desirable or beneficial one, i.e., from one configuration of relationships among people and things to another which is perceived, on the whole, to be better. Thus, development has no meaning independent of the values of the society in relation to which it is being discussed.

This problem of differences in perception of development is further aggravated in that even within the same society, what one person may perceive as progress, another may perceive as retrogression. Thus, for some planners, "development" means agricultural growth, for others, industrialization; for some, processing of intermediate goods, for others, finished products; for some, increased trade, and for others, increased autonomy.

The existence of these differences is not to say that there are not great similarities underlying virtually everyone's notion of development. Just as there are many phenomena over which there is disagreement as to whether or not they constitute progress, there are others which are agreed upon by virtually every one as being desirable changes, hence "development". Thus, changes within a society such that more children stay in school longer, such that more people are provided with minimal food and housing needs, such that more persons have more frequent medical care, would all, of course, be within this category. And yet in the practical world of unlimited aspirations and limited resources, even here there will be different priorities and sequences for various specific development goals. The exact mix of priorities and sequences which planners and administrators will try to implement will be dependent on the problems, needs, and resources of the particular society, as these problems, needs, and resources are determined and specified in its governmental process.

While governmental institutions and mechanisms for collective choice will vary greatly from society to society, in virtually

all cases, the collective choice process will involve the interplay of various over-lapping groups: bureaucrats, industrialists, farmers, intellectuals, aristocrats, workers, peasants, and regional and ethnic goups and coalitions. If a modernizing government is to be successful in its development efforts, its development strategy (the particular problems which it has prioritized and the plans and projects it has put together to address them) must be acceptable and supported by some combination of these groups. Such a minimal combination or coalition in support of a government's strategy is not something easy to achieve, for all change involves dislocation. The economic and social change which is development will inevitably result in dislocation and increased cleavages between and among the overlapping groups mentioned. While this is true in all societies, it is probably more so in developing societies in which the gap between needs and resources is greatest.

Better information is critical to modernizing governments in carrying out their tasks in several most significant ways. First, it is critical to better definition of the real needs and problems of the society. Problems and needs are not things which exist in pure form. They must be clarified and refined. A manifestation of a health problem might be high mortality and morbidity rates (gastro-enteric diseases in particular). But is the real problem one of lack of diagnosis and treatment, caused by a shortage of physicians and village health teams, or is it an environmental health problem (poor sanitation), caused by a shortage of water in

an arid climate and a life style adapted to this shortage? Information can not only assist but is necessary for clarifying the "real" problem in such a particular local context.

Secondly, good empirical information can aid decision-makers in making better guesses as to what programs and projects will be more effective in impacting on needs, i.e., in attempting to solve problems. If the problem which they have given priority is lack of contact with medical personnel, is the solution more local clinics, or is it more mobile health teams? Even quite incomplete and sketchy information about the location of people, their attitudes, and likely responses to the two alternatives can be of great value to decision-makers in assessing the merits of these alternatives.

Thirdly, information is critical to controlling the day-to-day activities of government projects and programs. The effective management of national development implies more than being able to focus on the society's real needs. It implies more than having the creativity to design programs capable of effectively impacting on these needs. Besides the effective targeting and design of programs, it implies their efficient execution. This in turn requires control of cost, control of schedule, and control of quality. The first takes the form of information to monitor the acquisition and allocation and use of both material items and personnel. The second relates to the monitoring of the variance between the scheduled and actual start and completion dates of tasks and activities. Finally, quality control involves the setting up of more or less

arbitrary standards for performance and the collection of information related to whether or not these standards are met in executing various specific activities.

Fourthly, information is critical for development planners in evaluating and modifying their programs. The effective management of development does not end with identifying a problem and putting together a plan. It begins with it. Nor, for that matter, does it end with implementing and executing the plan efficiently. In a sense, there is no end. The nature of societies in this century is rapid change. There is no significant problem which long stays the same. Problems change as the values and behavior of people change, and as the available technologies (knowledge and combinations of material and non-material "tools") change. Both of these factors in turn change as a result of the very process of trying to solve problems.

There is no problem involving people in which attempting to solve it does not in some way change the very problem itself. Every solution in effect creates still other problems. Thus, the effective management of development in a dynamic environment requires continual evaluation not only of the anticipated effects of projects and programs, but of how both the problem and people change in response to attempted solutions.

FUNCTIONS OF INFORMATION IN PUBLIC MANAGEMENT

* PROBLEM CLARIFICATION
* PROGRAM AND PROJECT DESIGN
* CONTROL OF PROGRAM AND PROJECT IMPLEMENTATION
* EVALUATION OF SUCCESS, MODIFICATION, AND IMPROVEMENT

Figure II-1

Thus, the situation of the development strategist, planner, and manager is not unlike that of a gambler in game with very high stakes. He must make decisions with large potential gains and losses under conditions of both uncertainty and risk. Good information, even though incomplete, can help him significantly in reducing his uncertainty as to the nature of the problems he is trying to solve, as to what the expected outcomes and risks are for adopting one strategy rather than another, as to how efficiently his strategy is being implemented, and as to the difference between planned and actual results.

This is the objective and value of improving information for the development manager - reducing uncertainty so that he can make better guesses as to the probable effects of his society's collective actions. More specifically, the objective is to reduce both "fact" uncertainty, concerning the actual state of the society with respect to the things that he considers to be important (so that he can better establish priorities), and "process" uncertainty, concerning cause and effect relationships (so that he can better design and implement and control programs and projects).

B. Basic Factors About Improving Information

Because of the critical importance of information for "informed" policy-making, management, and administration, virtually all governments have some group of people with some amount of resources at their disposal whose task it is to gather, process, analyze, and disseminate information. In most governments there will be numerous groups at various levels of the organizational hierarchy concerned with various aspects of this task for different kinds of data. The collection of people and resources who are working at various aspects of this task are, in effect, the "information system" of each government.

These configurations of people and things which make up a government's information system are continually changing both by design and by accident. Changes in the things that decision-makers consider to be important (i.e., changes in goals and priorities) and changes in information technology, itself being rapidly disseminated all over the world, have given a new impetus to many government organizations (bureaus, agencies, departments, ministries) to make these changes occur more by design and less by undirected incremental or accidental change. Many government organizations have invested major resources in attempting to improve the effectiveness and efficiency of their information systems, i.e., in trying to get more relevant, more reliable, more valid information to decision-makers more rapidly.

Many of these attempts have left much to be desired. Others can only be termed, "disasters". There is much that can be learned from these efforts, both successful and unsuccessful. Thus, some attempt to summarize lessons learned in the experience of implementing information systems is in order. Very often problems were encountered because some very basic factors about the nature of information, technology, and organizations were not taken into account. Some of these basic factors can be summarized as follows:

1. Information is not a free good.

   The designers of information systems have frequently ignored or grossly under-estimated costs. Relevance, reliability, validity, and timeliness all have resource costs attached to them. Hard choices must be made. The basic question as to whether the cost of gathering, analyzing, and disseminating information is worth its value to the organization must be continually asked.

2. Information has value to the extent that it is useful in making decisions and controlling efforts to implement and improve them.

   Gathering information which is of marginal value in these terms is probably the most widely encountered shortcoming in attempts to improve information systems.

3. Improving information tends to have increasing marginal cost.

That is to say, for example, that reducing uncertainty as to the percentage of rural population who have not had medical contact in the last year will become progressively more expensive as one seeks greater accuracy. Increasing the accuracy of the estimate to within a confidence band of 5 percent will cost proportionately more than increasing accuracy to a confidence band of 10 percent.

4. Improving information tends to have decreasing marginal value.

That is to say, information that between 50 and 60 percent of a country's rural population has not had medical contact within the last year has far more value for management and planning purposes, than additional information that the actual figure is between 51 and 56 percent.

5. The variety in configurations of people and resources which comprise an information system is almost infinite.

Frequently administrators have given directives to the effect that, "I want an information system," as if one could go out and purchase one in the same way that he purchased a desk or a chair. An information system is a dynamic interaction among people, data and possibly, machines. It is to be developed and modified. It is not a product to be purchased at a computer store.

6. Alternative information systems (i.e., different permutations of people, data, and machines) cannot be determined a priori, only in relation to the needs, environment, and resources of the organization.

Without first specifying these latter factors, alternative information systems cannot be evaluated.

7. Implementation decisions tend to be reversible only at great cost.

This is a function both of what may be called "organizational inertia", which manifests itself in the tendency of organization interaction and behavior to perpetuate themselves, and of the nature of modern technology, which once acquired tends to "lock" people into its use. Thus, changes in information systems should not be implemented until the organization's needs are specified not only for the present, but are projected into the future.

8. Greater centralization of function and control in an organizational structure implies greater information needs at the top of the structure and a more elaborate system to meet those needs.

This in itself is not an argument against more centrally coordinated planning and decision-making for development. Some things can only be appreciated fully in terms of a "big

picture" of the whole society. This necessarily implies some centralization of planning and therefore of information. There may also be certain economies of scale in centralized information gathering and processing. It usually does not make sense for each ministry or department, for example, to run separate censuses (a medical census, an educational census, etc.). Separate mini-"census bureaus" in each ministry would tax not only scarce financial but also scarce expertise resources in many countries. These advantages notwithstanding, there are significant dangers and costs in the centralization of information. It implies a greater need for computerization, more expensive hardware, and more complicated software, particularly data base software. It implies placing greater emphasis on data gathering procedures, and existence of a clear, comprehensive, and uniform "data dictionary." It implies that the effect of errors at low levels of the system will be amplified by being transmitted to higher levels. It implies a persistent danger that people will uncritically accept information as being true simply because it is printed by a line-printer or terminal, or displayed on a cathode-ray tube.

9. <u>Good information systems design does not ensure an effective information system without an effective implementation strategy</u>.

Many information systems which look excellent on paper

prove to be near disasters in practice because of poor implementation stategies. Effective changes and improvements in the functioning information system of an organization require that an effective implementation strategy be worked out in advance.

10. Strategies for improving an organization's information system themselves often fail because of lack of information and communication.

It is in the nature of large and specialized organizations to resist change. The specialization of function which characterizes all large organizations implies that various actors and groups derive their power and status within the organization at least partially because of their specialized duties and expertise. Most of these people prefer the certainty of existing situation to the unknown and potentially threatening situation which might arise if there is change. If a strategy to change the content of information that passes through an organization and the channels through which it passes is to be effective, information must be communicated to all relevant parties explaining the rationale for the proposed changes, and the anticipated effects both on the organization as a whole as well as on various subgroups. All relevant parties must be convinced to help in the proposed changes rather than to be passive observers or even worse saboteurs of the proposed changes.

BASIC FACTS ABOUT AN INFORMATION SYSTEM

* IS EXPENSIVE
* HAS VALUE ONLY IF IT IS USED
* INCREASING MARGINAL COST OF ADDITIONAL INFORMATION
* DECREASING MARGINAL VALUE OF ADDITIONAL INFORMATION
* MANY DIFFERENT SYSTEMS POSSIBLE
* "BEST" SYSTEM DEPENDS ON HOST ORGANIZATION
* IMPLEMENTED SYSTEMS ARE HARD TO CHANGE
* GREATER CENTRALIZATION REQUIRES MORE COMPLICATED SYSTEMS
* SYSTEM DESIGN OF LITTLE USE WITHOUT IMPLEMENTATION STRATEGY
* IMPROVEMENT PROCESS REQUIRES GOOD COMMUNICATION

Figure II-2

The generalizations about information systems listed above are more than of academic interest. They have immediate implications for developing a strategy for information upgrading and improvement. These implications in turn may be summarized as follows:

1. While the goal of improving an information system is better decision-making, better information is only one of many factors which affect the quality of decision-making. It is a necessary but not a sufficient condition for good decisions. Thus, the contribution of improved information to decision-making takes place in the context of an environment of other factors which are also operating. The state of this environment, i.e., the composite effect of the interaction of these factors, must also be taken into account in an implementation strategy.

2. As the general goal of upgrading an information system is assisting decision-makers, detailed specification of their information needs must be the first task of any improvement strategy.

3. Costs and benefits of various information items must be eternally monitored and questioned. The question, "Is the value of this data to decision-makers worth the cost of gathering, processing, and analyzing it?", must be ever asked.

4. The organization must make basic policy decisions related to the degree of centralization of control it wishes to have and of the level of information detail that it wishes to "surface to the top." These decisions concerning information coordination and integration must be made early in the planning process because they have immediate and direct impact on the locus at which information is collected, the format in which it is collected and stored, as well as the level of detail or aggregation at which it is collected and stored.

5. While upgrading an information system implies far more than the purchase of a computer (which is often a mixed blessing), most often some degree of mechanization and computerization will play a valuable role in the overall system. To assure that any information automation is suitable to and integrated with the organization's needs and capabilities, decisions must also be made concerning how mechanization would be useful, and what form it ought to take given both potential uses and the organization's resources. This involves consideration and specification of volume and use characteristics, data base organization, basic analysis operations, and software flexibility requirements.

6. A strategy for information system improvement must be "developmental." That is to say, it must allow for maximum flexibility for evolution as an organization's needs and resources change in the future.

7. A strategy for information system improvement must include increasing the level of communication between various sub-groups within the organization so that each group is aware of the value of the contribution of its function under the proposed changes.

8. A strategy for information improvement does not take place in a historical vacuum. An effective strategy must take into account not only where the organization would like to be in terms of information and development and use, but where it is at the present time.

IMPORTANT FACTORS AFFECTING AN INFORMATION IMPROVEMENT STRATEGY

* BETTER INFORMATION IS ONLY ONE OF MANY FACTORS AFFECTING BETTER DECISION-MAKING
* NEEDS MUST BE SPECIFIED EARLY
* EVERY ITEM OF DATA HAS BOTH COSTS AND BENEFITS IN TERMS OF WHICH IT SHOULD BE JUDGED
* DEGREE OF CENTRALIZATION MUST BE DECIDED ON EARLY
* SOME MECHANIZED PROCESSING OF DATA WILL USUALLY BE PART OF OVERALL STRATEGY
* STRATEGY OUGHT TO BE "DEVELOPMENTAL" (UPWARDLY FLEXIBLE)
* STRATEGY OUGHT TO INVOLVE INCREASED COMMUNICATION
* STRATEGY MUST REALISTICALLY TAKE INTO ACCOUNT ORGANIZATIONAL CAPABILITY

Figure II-3

C. An Integrated Strategy for Information Improvement

Information has, as indicated previously, value when it aids in making decisions and directing activities. If information does not contribute in some way to doing this, the effort invested in developing the information is of marginal value. In aiding decision-making, an information system does not exist in a vacuum. It exists in an environment or context of other factors, which affect not only the quality of decision-making, but how the better information affects decision-making. Thus, upgrading the information system of a complex organization is only one of a set of interdependent factors, all of which affect each other as well as the quality of decision-making or policy-making. Given this condition, attempting to upgrade an information system will have a spillover on these other factors, and they in turn will have a spillover effect on the usability of information. Thus, a successful strategy for implementing an information system must recognize these interrelationships and take them into account. Yet, understanding this and taking it into account, does not necessarily mean that, in implementing some initial changes or improvements to the system, the entire machinery of the organization would need to be mobilized or disturbed. Needs, priorities, and available resources will be the determinants of the magnitude of the initial steps. In any event, it is desirable to examine the whole issue to be able to plan change in perspective.

There are at least five major factors which are related to improving decision-making about programs related to development. Some comments on each of these are in order.

1. An End-Results Approach to Management and Planning

As stated earlier, even the best information, if it is not used in management, is of marginal value or utility. Program managers must approach their jobs in such a way that they focus on and specify the desired end-results for their programs, and consider the gathering and using of information to monitor progress towards these results as an integral part of their management responsibility.

2. Adequate Communication and Coordination Among Intra-Organizational Units

Most organizations, especially public agencies, are organized along activity rather than programmatic lines. But the very complex needs which public organizations are attempting to meet cannot be met easily by single activities, outputs or units. The problems are complex and must be attacked from different approaches simultaneously. There is an operational need for integrated and coordinated planning, programming, and control. The channels of communication and coordination

must allow management to concern itself with important matters. They must carry management's directives and decisions in a way that facilitates their execution. Thus, information of the right quantity and quality must be communicated throughout the organization if it is to function effectively.

3. Adequate Policy Analysis Capability and Staff Support

Better information can aid in making better judgments as to whether certain conditions do or do not exist at some specific time. It cannot, in and of itself, indicate for the policy-maker that the existence of one set of conditions is in fact related to the existence of another set of conditions. This requires both better information as to the specifics of the empirical conditions, and better analysis and techniques for drawing inferences from the information, which in turn, can also be translated into policy prescriptions. In this area, the need appears to be one of both more and better trained analysts.

4. Useful Information

What is needed is not only more technically reliable (less measurement error) and valid (better correspondence between survey mechanism and variable being measured) data, but also more relevant and timely

information, and the ability to integrate information from disparate data sources. A better understanding of the nature of management information and more clearly defined purposes and objectives are required if this kind of information is to be developed.

Decisional Latitude on the Part of Policy-Makers

If all programs are inflexibly fixed, it is impossible for policy-makers, however well intentioned, to make policy. Some latitude or discretion in terms of programming and planning, i.e., the ability to create new programs and to eliminate ineffective ones, is necessary if good information and analysis is to have some impact on policy and programs.

FACTORS CONTRIBUTING TO GOOD DECISION-MAKING

* AN END-RESULTS APPROACH TO MANAGEMENT AND PLANNING

* ADEQUATE COMMUNICATION AND COORDINATION

* ADEQUATE POLICY ANALYSIS CAPABILITY AND STAFF SUPPORT

* USEFUL INFORMATION

* DECISIONAL LATITUDE ON THE PART OF POLICY-MAKERS

Figure II-4

Achieving some minimal level of capability in each of these five areas in a sense becomes the necessary conditions for achieving the ultimate, long-range goal of the improvement of policy-making and decision-making. However, an effective strategy of implementation for rethinking and upgrading an information system cannot and will not attempt to impact on all these necessary conditions, either equally or directly. Yet it is important that these elements, and their inter-relationships and feedbacks, be kept in mind throughout the process.

Stated again then, the strategy should be targeted specifically towards identifying the information requirements for effective decision-making within the organization, on how those needs and requirements are not met at the present time, and on the kinds of changes which would allow them to be met. While the immediate focus of information improvement activities is on developing the capacity to improve the quality and use of data, an effective strategy is cognizant of the fact that carrying out these activities both indirectly and directly affects a whole series of factors (what we have here called "necessary conditions") which contribute to the strategy's more general objective - the improvement of decision-making within the organization. In public sector organizations concerned with national development, these factors will hopefully result in better decisions concerning priorities, programs, and projects.

What are the information improvement activities whose direct

and indirect effects must be taken into account? Obviously, they can be specified at various levels of detail, and will vary some from specific case to specific case. One might include such activities as purchasing a computer, hiring programmers, developing software, etc. At this stage in our discussion it is probably most useful to specify these activities in more general terms. Even at this level, however, there are different ways to conceptualize, integrate and describe the broad activities that might contribute to improving an organizational information system. The way developed here is chosen both because of its conceptual and practical utility. It consists in viewing the major activities of rethinking and upgrading the information system processes of an organization as being summarized into the following five categories:

1. improving management capabilities,

2. improving data collection capabilities,

3. improving data processing capabilities,

4. improving data analysis capabilities and

5. improving the structure of communication, coordination, and control within the organization.

MAJOR ACTIVITIES FOR IMPROVING INFORMATION IN A LARGE PUBLIC SECTOR ORGANIZATION

* IMPROVING MANAGEMENT CAPABILITIES

* IMPROVING DATA COLLECTION CAPABILITIES

* IMPROVING DATA PROCESSING CAPABILITIES

* IMPROVING DATA ANALYSIS CAPABILITIES

* IMPROVING THE STRUCTURE OF COMMUNICATION, COORDINATION, AND CONTROL

Figure II-5

Again, these major activities will impact both directly and indirectly on what we have called necessary conditions for achieving the overall goal of improved decision-making. When they impact indirectly, they will do so by affecting a set of intervening factors, which in an operational sense, become intermediate objectives. There are at least seven such intermediate or operational objectives:

1. a better understanding of the nature of management information;
2. more clearly defined purposes and objectives of programs and activities;
3. a common frame of reference on problems and procedures to facilitate intra-organizational communication.
4. adequate staff data analysis and collection skills;
5. greater information relevance
6. greater information reliability and validity; and
7. an increased ability to integrate information from different data sources.

INTERMEDIATE OR OPERATIONAL OBJECTIVES OF AN INFORMATION IMPROVEMENT STRATEGY

*DEVELOPING A BETTER UNDERSTANDING OF MANAGEMENT INFORMATION

*BETTER DEFINITION OF PROGRAM AND PROJECT OBJECTIVES

*DEVELOPMENT OF A COMMON FRAME OF REFERENCE FOR INTER-UNIT PLANNING

*DEVELOPMENT OF STAFF SKILLS IN DATA ANALYSIS AND COLLECTION

*GENERATION OF MORE RELEVANT INFORMATION

*INCREASING DATA RELIABILITY AND VALIDITY

*INCREASING ABILITY TO INTEGRATE INFORMATION FROM DIFFERENT SOURCES

Figure II-6

The inter-relationships between the basic MIS*improvement activities, the intermediary factors, and the necessary conditions for good management decision are presented schematically in Figure II-7, and are discussed below.

1. Improvement of Data Collection Capabilities

It had been suggested previously that there are four general classes of information which are needed by policy-makers, planners, and managers in making decisions - information about needs, about the effectiveness of different outputs, about the control and progress of day-to-day activities, and concerning monitoring changes in both performance and problems. In terms of volume of information, the largest amount will be in the third category of control of day-to-day activities related to quality, schedule, and cost. Most of this information can and ought to be gathered as a normal part of the on-going operations of the various units. Usually this information process can be made more efficient, duplication can be eliminated, time and costs can be reduced, reliability can be increased, and better data can be put into the right hands more quickly, etc. Most attempts at improving information focus on this area of operational control,

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*MIS is a conventional acronym for "management information system."

and justly so. Yet this area of information, while being a necessary condition for effective management, is not sufficient for it. It is entirely possible to efficiently control a program which produces an output which is ineffective, or which is effective at meeting the wrong need or solving the wrong problem. Frequently, this kind of information cannot be gathered as a part of the operational information obtained in the work process of the various units. Operational information, for example, can tell a policy-maker what it costs for a rural health team to vaccinate a child. It cannot tell him the number or proportion of children who are not vaccinated. Nor, for that matter, can it tell him the extent to which the major threats to the health of most children come from causes which can be dealt with by vaccination or not. For that, additional information about the health characteristics and life style of the population must be developed. About the only way to develop this kind of information is from surveys, be they regular and recurring or specially targeted one shot surveys. This implies the development somewhere within the organizational structure of the government of a survey capability which is well integrated with its institutionalized

information system. The improvement of capabilities in this critical area represents a major part of upgrading the information system of most countries.

2. Improvement of Data Processing Capabilities

As indicated previously, one of the most frequently made and potentially disastrous mistakes in the upgrading of an information system is to equate it with the purchase of a computer. A computer and its peripheral electronic data processing machinery are only one means of processing the information which passes between people in an ongoing information system. As implied in the aphorism, "garbage in, garbage out," it is a means not an end. It cannot turn bad data into good. Nevertheless, the intelligent use of electronic data processing machinery in an information system allows levels of usability and simplicity of information presentation for the end-user which are not possible in its absence. This is, of course, the critical element in any attempt at mechanization of data processing - the machine must serve the user and not the other-way-round, which is often the case with poorly conceived and implemented attempts at computerization.

The continuing changes in computer technology have

greatly decreased the effective cost of computing power. This is true in terms of material costs, which have gone steadily down, but also in terms of labor and expertise costs, in that new languages and software systems are quicker to learn and easier to use. As the cost goes down, access to computers becomes available to more and more countries. Some form of computer technology exists even in the poorest countries, and as prices continue to decrease, the quantity and quality of available computer technology is likely to increase there.

Because of the real power of computers in allowing better operational control of costs (purchasing, payroll etc.), as well as in analysis (answering questions about the relationships among data that could never be answered by hand), they are likely to play a valuable role in virtually all information systems. Thus, some careful upgrading of the data processing capacities of an organization must be part of a coherent and integrated strategy at improving information.

3. Improving Management Capabilities

Improving management capabilities is often the most critical activity of information improvement. An effective functional mechanism to facilitate this

which concurrently raises the consciousness of department-heads and program managers in the meaning and function of information in decision-making is a seminar designed especially for planners and managers. Such a seminar can affect an over-all information improvement project in several important ways. First, it can have a sensitizing effect and contribute to the development of an end-results approach to planning and management. Second, it can aid in the coordination function by providing a common language and model for dealing with objectives and information with which policy-makers from related programs can carry on a dialogue. Third, it can provide a vehicle for staff skills development and training for those units concerned with information analysis. And finally, and most importantly, it can provide a medium through which to get the managers of programs to more clearly define their objectives and more specifically identify the kinds of information which they need to direct and monitor programs designed to achieve those objectives.

4. Improving Data Analysis Capabilities

In addition to management improvement seminars as indicated above, there is usually a need for ongoing

training and analysis support for the various operating units. Information must be analyzed and organized if it is to be useful. The analysis methodologies need not be complex. Often simple but correctly drawn inferences can be most valuable. Nevertheless, many organizations are seriously lacking in such capabilities. Technical assistance and training in these areas thus becomes essential.

5. Improving the Structure of Communication, Coordination, and Control

The management information problem is more than simply one of information, as we have seen. After information has been identified, collected, processed, and analyzed, it must be communicated in the right amount to the right people. Very often, valid, and reliable information is communicated at the wrong level of detail causing upper management to concern itself with activities which should not trouble it and which divert it from its proper problematic focus. This is true for middle and operational as well as for top management. While new advances in centralized data processing (including exception reporting) sometimes allow management to work around the problems of a poor organizational structure, improving a management information system affords an

opportunity to address basic structural issues dealing with organization and communication that would not otherwise be the case. Such structural issues ought to at least be examined in drafting a detailed MIS improvement plan.

ELEMENTS OF A STRATEGY FOR IMPROVING MANAGEMENT DECISIONS

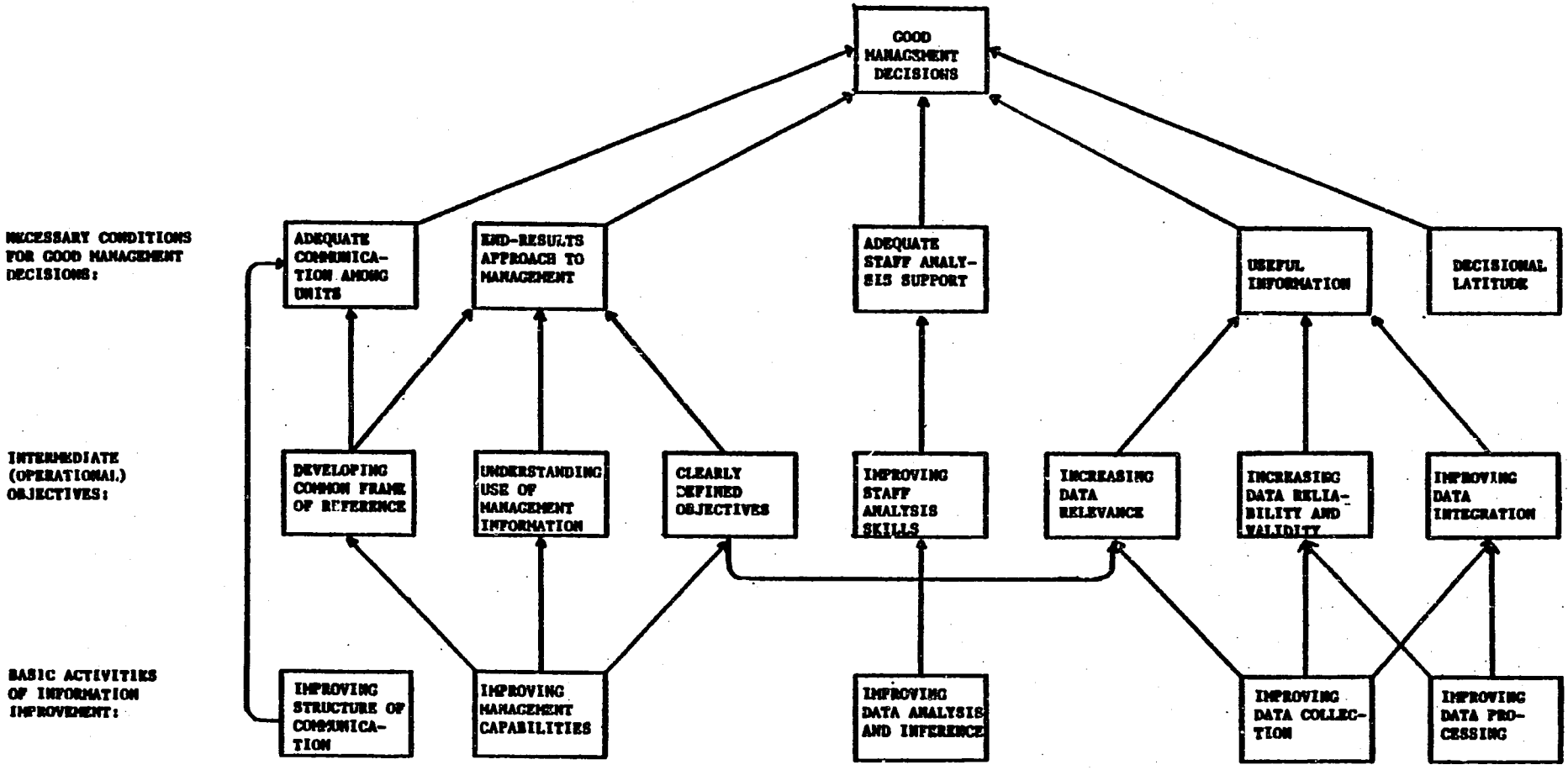

Figure II-7

This chapter has attempted to say some basic things about the role of information in the planning and management of national development, about the characteristics of information systems, and also to present a basic outline of an integrated strategy or approach to upgrading and improving information systems. It has identified some general issues, problems, and choices, but it has not discussed them in detail. In subsequent chapters, the issues and realm of choice that exist in designing an information system will be discussed in terms of four broad areas:

1. the kind of information with which management concerns itself;

2. the methods of data gathering, recording and collection;

3. the degree and nature of electronic data processing; and

4. a plan for adapting the concepts and principles discussed in this study in an efficient and effective way.*

*It is obvious that three of the four areas discussed in the study below conform to three of the general activity areas involved in information improvement. Notably absent from the list are a discussion of issues involved in changing organization structure, and choices in data analysis approaches.

The first area was omitted because the problems with organization structure usually arise not from lack of understanding of basic principles of organization but because of lack of politicial and social skill in carrying out obviously desirable structural changes. The second area, that of data analysis considerations, is the subject of a separate volume, The Analysis of Analysis, which I am preparing under a grant from the Rand Corporation and the Ford Foundation, to be published in 1980.

III. MANAGEMENT INFORMATION IN THE PUBLIC SECTOR: A Framework for Identifying Information Needs

A. Expanding Government Services, New Analysis Demands, and the Need for More Useful Management Information

B. The Role of Information in Management Decision

C. An Integrated Framework of Management Choice

D. The Information Needs for Mangement Choice: A Framework for Identifying Management Information

E. Application of the Framework: The Example of a Ministry of Education

Appendix: Management information for a Ministry of Education: Some Suggested Data Items

A. Expanding Government Services, New Analysis Demands, and the Need for More Useful Management Information

Since the demise of *l' ancien regime*, virtually all governments have publicly expressed as the justification for their existence, the promotion of the common good. Just how the common good has been promoted has varied from time to time and place to place. In the contemporary era, it has usually taken the form of attempts to directly affect public welfare through the provision of social services. The magnitude of government efforts in this area has grown exponentially in almost every country in the world, both developed and underdeveloped. Some of this growth can be accounted for by "demand pull," i.e., by the growing desire of people for the benefits of modern technology, which can only be produced on a large scale by the public sector. Yet "supply push" has also been an important factor, in that there has been a growing perception that the knowledge, skills and resources exist to affect social and economic problems which were heretofore thought to be intractable, and that since such capabilities exist, it would be gross societal negligence not to use them.

Yet the fruits of the new knowledge and growing resources have not yet been a bumper crop. Many programs designed to promote and develop the well-being of large segments of national societies have met with disappointing results. Some have even been counterproductive. In any case, there has been a backlash against the attitude that, in the name of societal development or improvement, "almost anything goes." This has led to a growing demand for better

analysis, appraisal, and evaluation both before and after the development of projects and programs. To meet this demand, a sizeable community of "evaluation researchers" has cropped up and is producing a mass of studies which are themselves greatly in need of evaluation.

There are many problems with these studies, not the least of which is the fact that many were carried out inside universities which often distorted the policy nature of the research problems for the sake of fitting them within the confines of narrow academic disciplines. In this regard it is only recently becoming recognized that policy and evaluation research and analysis, while having much in common with traditional academic research, has important differences due to its action orientation. The most basic of these is that the objective of applied research is not a contribution to disciplinary theory but information about the actual or probable effects of social action. Information has value in this context only to the extent that it is useful in aiding policy-makers and planners (managers in the broadest sense) in the making of present and future decisions.

The "utility" or "usefulness" of policy and management information is dependent on several factors. The information itself must be "relevant" to making decisions. It also ought to be "valid" (appropriately measured) and "reliable" (accurately measured). It must be "representative" of the group to which it applies. It should be "deducible" in that it should be presented in such a way that the necessary inferences can be drawn. It should also

be "integrable" in the sense that information from various disparate sources should lend themselves to combination in new analyses. Assuring "validity", "reliability," and"representativeness," imply adequate attention to measurement, sampling and statistical considerations. "Deducibility" implies that proper research design procedures have been followed. And "integrability" implies forethought in terms of data aggregation, storage, and analysis. These are all necessary and important considerations, and will be discussed in later chapters. The focus here, however, is on "relevance", the extent to which information aids public management in making decisions about programs and projects; and how one goes about identifying information which can be useful in this way.

B. The Role of Information in Management Decision

In most general terms, management consists of identifying what an organization wants to achieve and assembling, coordinating, and directing people and things to achieve it. It seeks to bridge the gap between where we are and where we want to be. It is doubly anticipatory in that it seeks to anticipate the probable effects of different means to achieve desired ends, as well as various threats or problems which may arise and ways of dealing with them. Management decision is thus, by its very nature, an uncertain enterprise. The basic function of information in management is to reduce this uncertainty in several ways: by contributing to a more accurate understanding of the long term consequences of setting different organizational goals, by enabling better predictions about the effectiveness of alternative ways of achieving organizational goals, and by identifying more accurately and more quickly problems which arise in carrying out these alternatives so that corrective measures can be well directed.

Thus, information can be thought of as the raw material which management uses to accomplish its work. As one text phrased it, "The managerial function ... consists of utilizing and analyzing information so as to organize resources to achieve specified objectives."* There are two obvious implications which flow from viewing information as the "stuff" of management in this sense. First, as with any raw material, information comes in various forms and grades which require various degrees of refining. And second, the

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* Donald Farrar and John Meyer, Managerial Economics, Prentice-Hall, Englewood-Cliffs, N.J., 1970, p. 8

specific kind of material and the degree of refining required will also be a function of how it is to be used in the production process, that is to say, the type of information and the type of processing required will be a function of the way management uses it in allocating, coordinating, and directing human and non-human resources to achieve the organization's objectives.

This is not to say that information is production material in the same way that iron ore or coal are, or that managerial decision-making is a production process the same way that steel making is. Normal production activities involve taking fairly uniform raw materials and combining them in predetermined ways to produce fixed outputs. In management decision-making and policy-making, there is great variation in the kinds of possible inputs, the mechanics of the process itself, and in the quality of the output. This is especially so in the public sector where in the absence of well-defined profit or value criteria, there is considerable disagreement as to what kinds of information are useful or necessary for making what kinds of decisions.

The existence of "useful" information is not a sufficient condition to ensure that it will in fact be used to aid judgment in making managerial choices. Likewise, "relevance" alone is insufficient to ensure that information is "useable." Yet in practice, the process of identifying what information is sufficiently relevant

to be gathered or not is often the most critical and difficult part of improving management information. There is an almost infinite number of factors that might in some way be related to the activities of a government ministry responsible for broad and inclusive social programs. Given the finite processing capacity of the human mind, as well as resource limitations, a critical task is to determine what kinds of information are needed for what purposes. This task has two aspects to it: ensuring that information critical for making decisions is included, and making sure that unimportant information is excluded. Most organizations, both private and public, make significant errors of judgment in both areas. On the one hand, this results in the absence of significant information that would be of direct use in making decisions; on the other, in inefficiency and waste and the production of huge volumes of meaningless printout. Both problems can in some ways be alleviated by a clearer understanding of the various functions and tasks of management and how they relate to each other. Such an understanding can serve as a conceptual framework and guide for identifying general categories of management information.

C. An Integrated Framework of Management Choice

Information derives its value from its contribution to management judgment and decision — whether it be before (relating to feasibility), during (relating to control), or after (relating to impact) carrying out some set of collective activities. It can focus on the resources used in (inputs) or on the results of (outputs) carrying out the activities. Cross partitioning the time and focus dimensions provides a convenient way of distinguishing among various kinds of management analysis and activity. "Financial feasibility analysis" focuses on the costing out of inputs before project initiation, while "technical feasibility analysis" focuses on examining whether the desired outputs can be produced in the stated manner. During the on-going operation of a project or program, "accounting" focuses on the control of input costs, and "monitoring" focuses on the control of the schedule of implementation and the quality of the outputs. Finally, after the completion of a project, "auditing" focuses on the adequacy of the input control process, and "impact analysis" is concerned with comparing the intended and actual effects of the project outputs. The relationships among the various categories of analysis are presented schematically in Figure III-1.

TRADITIONAL CATEGORIES OF MANAGEMENT ANALYSIS AND ACTIVITY

		FOCUS	
		Inputs	Outputs
	Before (feasibility)	FINANCIAL FEASIBILITY ANALYSIS	TECHNICAL FEASIBILITY ANALYSIS
T I M E	During (control)	ACCOUNTING	MONITORING
	After (impact)	AUDITING	IMPACT ANALYSIS

Figure III-1

One type of management analysis not specifically mentioned in the categorization made above is "evaluation." Evaluation is a term used both frequently and in different ways. It is often used as a synonym for analysis in general. Used in this way, it means the judgment or weighing or "evaluation" of two or more alternatives in any situation involving choice. "Evaluation" also, however, is frequently used in a more narrow sense referring to a specific type of analysis. In this sense, as when one speaks of "program evaluation" or "project evaluation," it usually is synonymous with what was refered to above as "impact analysis," although it sometimes also includes elements of "monitoring." Used thusly, "evaluation" focuses on the analysis of project or program outputs during and after implementation.

"Evaluation," used synonymously with "impact analysis" is an area of activity that has simultaneously become both more specialized and more generalized. It has become an area of specialized practical and academic expertise, almost a profession. In the United States, it has its own journal and its own society.* Yet it has also become an area of activity general to most programs and projects, or at least it is usually so claimed by their managers. "Evaluation" has become a necessary component of projects funded by the World Bank, A.I.D., UNDP, and other major agencies which

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* Evaluation, and the Evaluation Research Society, respectively.

assist in funding projects in developing countries. It has become part of the annual budget review and other regular "performance evaluations" in departments and ministries in developed countries, and a similar trend can be seen in developing countries. There are also numerous specific "evaluation studies" being carried out in virtually all countries for the full gamut of national, regional, and in many cases local programs (agriculture, health, population, nutrition, housing, etc.) for determining program success or failure and for identifying factors which contributed to it.

Each of these categories of management analysis activity has tended to become the domain of some special skill group: accountants, engineers, economists, behavioral scientists, and public administrators. Thus, economists tend to dominate "financial feasibility analysis", and engineers, "technical feasibility analysis". The accountants obviously are the groups mainly in control of normal project and program "accounting" as well as "auditing." "Monitoring" tends to be the function of public and business administration experts. And "impact analysis," or "evaluation" in the narrow sense of that term, most frequently is the prerogative of behavioral scientists. Each group tends to carry with it, on the junket of management analysis, the intellectual baggage of its training and expertise - the disciplinary language, concepts, and framework which give it its claim to knowledge and power. This in itself is not a bad thing, in that the knowledge and experience which form

the core of skills of each of these groups has value in its own limited context. What has been well recognized as missing is a framework for discussion which allows these different experts to communicate and a process of interaction which structures their communication in an orderly, integrated, and productive way. "Systems theory" has attempted to address the language problem, with results that have received mixed reviews; while "systems analysis" has addressed the issue of ordering and directing the process of interaction in ways that have met with notable success in areas of high technology and a more mixed record in areas where the dependent variable has been human behavior.

In attempting to identify the information needs of a project or program, it is possible to have each group performing each aspect of analysis or operational activity specify the information it requires to do its job effectively. Some of the information will be unique to the particular activity or the particular group. Many, if not most, of the information items required, however, will also be required by one or more of the other major areas of activity. What would be most useful in the process of identifying information needs is a framework which serves as a system of categories for guiding each group in identifying its own special needs, as well as provides a basis for understanding how the needs of the separate groups are linked together.

An attempt is made below to construct such a framework. This framework builds on and expands a "systems approach" to work organizations, be they *ad hoc* organizations put together to carry out a

single project, or operating agencies, departments, or ministries. The feature seen to be common to all such organizations, despite differences in size, structure, and function, is the collective performance of certain tasks. They have in common that they are units or collections of people which take certain inputs and perform the task or work of transforming these inputs into outputs, which are designed to fulfill certain functions or accomplish certain missions of the organization. In this sense, organizations are viewed as "work systems" which can be described in the terms listed and defined in Figure III-2.*

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* Discussion of "work systems" concepts is found in George Nadler, Work Systems Design: The Ideals Concept, Irwin, Homewood, ILL., 1967; Work Design, 1970; and Nadler, et. al., Design Concepts for Informative Systems, AIIE, 1975.

ESSENTIAL WORK SYSTEMS CONCEPTS

* UNIT - A HIERARCHICALLY ORGANIZED WORK FORCE

* MISSION - FUNCTION OR PURPOSE OF THE UNIT

* ACTIVITY - WORK, i.e., COLLECTION OF TASKS PERFORMED BY THE UNIT

* INPUTS - RESOURCES USED BY THE UNITS IN WORK

* OUTPUTS - THE IMMEDIATE PRODUCT RESULTING FROM THE WORK OF THE UNIT IN ATTEMPTING TO FULFILL ITS MISSION

* TECHNOLOGY - PARTICULAR PERMUTATION OF LABOR AND CAPITAL USED IN WORK ACTIVITY

Figure III - 2

The "work systems" perspective provides a basic set of concepts which stress the underlying similarity of all organizations. Viewing organizations from this perspective, as will be elaborated later, implies that all organizations will require certain kinds of information to efficiently carry out their work. But because the perspective stresses similarity at such a macro level and ignores differences, it provides little guidance in delimiting the particular information needs of specific users. It provides, to use Bronowski's language, a "first order" of concepts.* To draw further inferences, a "second order," based on further distinctions is needed.

As "work systems," organizations can vary along many dimensions. I would like to call attention to six of these possible dimensions because of the implications they have for distinguishing the information needs of organizations. While each of these dimensions is actually continuous, for the sake of simplicity in explanation, I will treat them here as if they were dichotomous. Thus, based on the six dimensions, it is possible to categorize organizations in the following terms:

1. <u>single or multiple unit organizations</u>

In practice, the work units of virtually all readers of this study will be part of multiple unit organizations. Efficiency in large organizations requires specialization and routinization of work activity. This usually involves setting up of separate units to carry out related functions: payroll, purchasing, supply disbursement, etc.

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* Jacob Bronowski, <u>The Common Sense of Science</u>.

2. single or multiple function organizations

In practice, most organizations fulfill multiple functions (usually though not necessarily through multiple units). These multiple functions may be viewed as a single overall mission or function, depending on the level of specificity required for the purpose at hand.

3. direct or intermediate output organizations

Intermediate organizations are units in multi-unit, multi-function organizations which are seen as producing an "intermediate output," i.e., one which in turn becomes an input for other units which are responsible for the "final output," which is more directly related to the overall mission of the larger organization.

4. project oriented and program oriented units

We can distinguish among units according to whether their activity tends to be recurring or idiosyncratic. The distinction here is between units which are project oriented or program oriented. This distinction, in turn, is based on the distinction between "projects," which tend to be one-time activities of short to medium duration (two to five years) with a fixed beginning and end, and "programs," which are continuing, coordinated work activities of a unit. As with any conceptual distinction, this may become muddied in practice, in that many units conduct both programs and projects. It is, nevertheless, an important one in that programs and projects tend to have different information emphases.

5. <u>fixed output and flexible output units</u>

The distinction here is in terms of the degree of flexibility which a unit has in determining the kind of output(s) which it will produce.

6. <u>fixed mission and flexible mission units</u>

Likewise, the distinction here is with respect to the degree of freedom that organization has in determining its own mission.

DISTINGUISHING CHARACTERISTICS OF ORGANIZATIONS:

* SINGLE OR MULTIPLE UNITS
* SINGLE OR MULTIPLE FUNCTIONS
* DIRECT OR INTERMEDIATE OUTPUTS
* PROJECT OR PROGRAM ORIENTATION
* FIXED OR FLEXIBLE OUTPUT
* FIXED OR FLEXIBLE MISSION

Figure III-3

The distinctions between fixed mission and flexible mission and fixed output and flexible output units can be related to common distinction among the three levels of management. So-called "top-level" or "executive level" management has in essence two degrees of freedom of choice. Their immediate organizational environment is one of flexible mission and flexible output. So-called "middle management" or "program management," has one degree of freedom of choice in that its decisional environment is essentially one of fixed mission but flexible output. And finally, for "lower" or "operational management," there are in essence zero degrees of freedom in relation to output and mission. The decision environment is essentially one of a fixed mission and fixed output in which the management task focuses on the efficient production of output.

Most modern organizations are complex work systems. Like the simple work system or unit, they carry on work activity which transforms inputs into outputs which are designed to fulfill organizational missions. But the size and volume of activity requires structural and functional complexity. That is to say, distinguishable functions will tend to be performed by separate and distinct units. Thus, a large modern organization will be a collection of sub-organizations united by a common overall function or purpose, by administrative convenience (the former Department of Health, Education, and Welfare in the U.S.), or by common administrative history. Each of these sub-organizations

or units contributes to the achievement of the overall mission. Some of these units will produce intermediate outputs; others, direct outputs. For some the work will take the form of projects; for others, that of programs. The size and volume of activity, and the resulting structural and functional complexity and differentiation, imply that the actual activity carried out by an organization will be the result of a large number of decisions made in different units at different times.

Viewing an organization as a "work system', and making the additional distinctions described above, provides a means for structuring and simplifying the many decisions which confront managers and for identifying the kind of information they need to make these decisions in an "informed" way. These specific decisions can be generalized or summarized by two questions: "What to do?" and "How to do it?". The first is the question of goals and purposes and objectives; the second is the question of the task and techniques of implementation.

The question of "what to do?" will take different forms in different types of organizations depending on the level or type of unit involved. At the most general level, that of executive management, this question becomes one of definition of the basic mission of the organization. The task of defining the mission or goals or objectives always occurs at the highest level of authority and responsibility, on a national level within the office of the chief executive, within the various ministerial or cabinet

offices, and among the collective bargaining of the legislative body. For organizations with fixed missions, on the other hand, the question of "what to do?" becomes one of what output or outputs should be produced or provided so as to fulfill the basic mission. This is the basic issue facing the managers of single programs or groups of related programs as are found in a typical ministry. For units which have not only a fixed mission but a fixed output, the question of "what to do?" in one sense has already been determined, i.e., to produce some fixed output. "What to do?" thus becomes translated into the second major question, the operational question of "how to do" whatever has been decided will be done.

Just as the first basic question of "what to do?" takes different forms depending on the type of unit, so also with the second question of "how to do it?" For units with flexible missions, the "what to do" question is what are the basic goals. The "how to do it" question now translates as "what is the best way to achieve the basic goals of missions that have been decided upon?" More specifically, what outputs should the organization as a whole produce, and how much of each output if there is more than one. For units with a fixed mission, the "what" question is what outputs to produce. The "how" question becomes one of choosing the best way to produce the outputs that have been selected. That is to say, what is the best work technique or "work technology" to be used in production (or for service organizations, in the provision of services)? Very often this relates to how labor or capital

intensive the work technology should be. Finally, for units with both a fixed mission and a fixed output, the "what" question is concerned with what we have called the "work technology." The "how" question becomes one of how to efficiently utilize the chosen mix of capital and labor resources. It relates to detailed questions of operational control such as task definition and individual work scheduling.

It is obvious in the foregoing discussion that in terms of the two basic questions or functions of management, "what to do" and "how to do it," we have a hierarchy of overlapping responsibilities and concerns. The "how" question of one level is the "what" question of the next lower level. This sharing of common function and interest among the various levels of management is the adhesive which binds a complex organization functionally together. It provides a means of identifying the basic issues which face all complex organizations. This can be seen schematically in the diagram of Figure III-4.

THE HIERARCHY OF MANAGEMENT CHOICE

LEVELS OF MANAGEMENT:	BASIC QUESTION:	CHOICE AMONG:
executive	what	objectives
	how	outputs
program	what	
	how	work technologies
operational	what	
	how	detailed work activities

Figure III-4

There are various ways to make a best choice among competing alternatives. The notion of "rational choice" implies the careful evaluation and measurement of the expected consequences of each alternative and the selection of the one which optimizes or maximizes benefit or utility to management in its role as custodians of the welfare of the organization. Perfect rationality exists only in text-books. In the world of practical decision, there are a variety of pressures and factors which imply that perfect or complete rationality can only be approximated. The decision-maker has multiple goals or values that he wants to achieve or optimize. The values are almost always in conflict. He has public welfare goals that his program is supposedly designed to achieve; agency goals, such as trying to get as large a share of the budget appropriations as possible; and personal goals of advancement and success. Making trade-offs between the various levels of goals cannot be objectively determined for the individual. It will almost always result in deviations from "optimal" strategies for the organization as a whole.

Even within each level (societal, agency, personal), there are an almost infinite number of choices of which only a minute subset can be considered. In a world of unlimited aspirations and limited resources, every "yes" implies a thousand "no's." Thus, given fixed resources, every classroom constructed means fewer teachers who can be hired to staff them and every new staff member means fewer texts. Every new village health clinic will mean less resources

for workers to staff it, and vice versa. The notion of complete rationality implies the evaluation and measurement of the expected consequences of each of these potential choices, but even in the best of circumstances, attention will only be given to a very few of these.

The decision-maker, to be totally rational, must be able to measure not only the immediate consequences but also the indirect consequences (second and tertiary impacts) on all his values, every time he makes a choice. This is objectively impossible because some of the consequences can never be completely known. There are so many overlapping and possibly conflicting goals that "fitting" them into a single common measure of benefit or utility is impossible and because the decision-maker almost always has incomplete information due to real world uncertainty and the costs of acquiring data to reduce that uncertainty.

While an ideal or a goal that can only be approximated in practice, the notion of rational or "informed optimal" choice is, nevertheless, one towards which to strive. That is to say, greater "rationalization" of decision-making (by which is meant more clearly defining and evaluating goals and objectives, and using empirical information to anticipate the consequences of alternative programs to meet these goals and objectives) is desirable. The implicit assumption here is that, over the long run, decisions made more "rationally" and in a more "measured" way will tend to be better decisions, i.e., actual results will look more like desired results.

In this regard, it is worth noting that almost all specific strategies which have been put forward with the objective of improving decision-making in either the public or private sectors (strategies associated with such names as "managemement by objectives," "program budgeting," "project evaluation and review technique") have as their goal "rationalization" of decision-making as defined here.

Thus, the approximately rational choices that a complex organization makes can be classified into four broad categories: choices among alternative objectives, outputs, work technologies, and detailed work activities. Identifying the elements required to make these choices and monitor their implementation and outcome is what ultimately enables one to identify the basic information needs of an organization.

We shall now attempt to further clarify the nature of rational or "measured optimal" choice within each of these categories. We do so by attempting to better describe and define the values or utilities we are trying to optimize and the kinds of information which will aid in more accurately measuring the consequences of alternatives aimed at maximizing values at each level.

1. Objectives

In determining general organizational priorities or objectives, the fundamental issue is where will the public receive most benefit? Again, this is not something that can be completely objectively determined. Different parts of the public will have different interests and values. While the integration of these

values is to a large extent a function of the political process, the very process of debate and deliberation can be "rationalized" by better information on how different programs designed to meet different goals will impact on various segments of the public.

Government exists to meet public needs. Objectives or goals are needs which are to be given precedence or priority over others. The public derives benefit when the output of a program in some way satisfies some public need, i.e., impacts on some given priority. Thus, for a program to provide benefit there are two necessary conditions: the need which the program is designed to meet must in some way be important, and the output of the program must achieve some minimal effectiveness in satisfying the need. In these terms, public benefit is a function of two factors: importance of needs and effectiveness of output. By implication, a program that has an important need but for which no truly effective outputs exist will not provide benefit to the public, but will in fact represent a squandering of scarce resources. Likewise, a program that effective in meeting a need of little importance or value will also tend to provide little public benefit.

In order to relate the notions of importance of need and effectiveness of output more closely to the kinds of information that will be of use in assessing them, it is useful to make further distinctions in each category between quantitative and qualitative dimensions. Thus, we may speak of quantity and quality of need and quantity and quality of output.

Quantity of need essentially refers to the size characteristics of the target population (how much of what "public" gets what benefit). Quality of need refers to the impact of meeting or not meeting the need on other social values. By way of example, consider a program in basic education. The general goal or objective might be to raise the general level of education in the populace up to some minimum. Some indicators of quantity of need would be the number of persons with education less than the desired minimum. These indicators could be for the country as a whole, as well as for different sub-populations segmented in different ways, for example, by geographic region, urban-rural dichotomy, etc. Some indicators of quality of need would be the extent to which persons in different categories of need (one year less education than desired, etc.) had other needs or values affected by the level of basic education. For example, life-time earnings for the various target groups would tell us something about how important the need for basic education is in a qualitative rather than in a simply quantitative sense. This is admittedly a difficult realm for decision. Values which are difficult if not impossible to measure (for example, in terms of basic education, the joy of being able to read a novel) can and should impact on the determination of priorities. The argument here is simply that values should be made explicit, and the implications on these values of meeting a need should be specified as clearly as possible and in as unambiguous (measurable) terms as is feasible given information gathering costs.

2. Outputs

The ability to recognize and make others aware of a previously unrecognized need is one of the most important marks of political leadership. The ability to identify or create new or alternative outputs or ways to meet needs is the most important mark of creative management. Information about the quantity and quality of output is no substitute for such creativity. It is one way to document the lack of it. It does, however, provide a way for creative managers to more accurately assess the expected results of choosing one output rather than another.

Quantity of output refers to how much of a given output can be produced for a fixed level of resources. Quality of output refers to the effect or change that producing that level of output has on the need (status of the target population).* Returning to the example of a program in basic education, quantity of output might be the number of children given instruction of various types. Quality of output might be the changes in skill levels for various groups of students which resulted from giving some number of students instruction. Given different quantity and quality for different

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*There is no standardization of terms among authors in this area. I have chosen the terms used here because of internal consistency and because of the emphasis they place on the distinction between workload and output. These coincide well with the organization theory literature but do not correspond with at least some of the evaluation literature which calls "workload," "output"; calls "quantity of output," "effect"; and calls "quality of output," "impact."

outputs, such information becomes critical for policy-makers attempting to assess, for example, how much of an instruction budget should go into full-time vs. part-time instruction.

3. Work Technology

The question of work technology relates to what is the best way to produce a given output. If it has been determined that one output of a program in basic education is to provide a certain level of classroom instruction, the question of work technology might relate to the mix of direct teacher instruction vs. televised instruction used in the process. This is the kind of "cost-effectiveness" question at which much literature has been directed in recent years. The choice will be a function of the cost of raising them the same level by televised instruction vs. the cost of raising them the same level by direct classroom instruction. Comparative cost and effectiveness data on various instruction mixes will obviously not only be of great usefulness but of necessity if an "informed" choice is to be made in this regard.

4. Work Activity

The most basic and important level of decision, the proper execution of which determines the effectiveness and costs which affect all other decisions, is that of control and execution of detailed work activities. At this level, the critical information of most value is "operations information" related to control of inventory, purchases, and personal time utilization. This data, in aggregated form, provides the basis for information related

to costs, effectiveness, and quantity and quality of output which is indispensable to higher-level programatic decisions.

D. The Information Needs for Management Choice: A Framework for Identifying Management Information

Given the basic decisions which face public management, there are definite implications for the kind of data that ought to go into a management-oriented or policy-oriented information system. For every major program, there should be information concerning the quantity and quality of need, the quantity and quality of output, the volume (workload) and schedule of work activity, and detailed expenditures for all inputs, both human and material.

BASIC CATEGORIES OF MANAGEMENT INFORMATION

* QUANTITY AND QUALITY OF NEED
* QUANTITY AND QUALITY OF OUTPUT
* VOLUME AND SCHEDULE OF WORK ACTIVITY
* INPUT EXPENDITURE

Figure III-5

The methodology for applying the above framework is somewhat eclectic. One methodology, used by the author is an evaluation training program for the upper level management in the State of New Jersey,* was to first have program managers describe their current activities and their reasons for carrying them out; second to have them identify the underlying purposes and objectives which the program existed to serve; third, to identify specific operating objectives (involving quantitative target and time schedules) for the coming fiscal year, and then finally to determine what kind of information was needed to more accurately measure the need for, effectiveness, efficiency, and quality and timeliness of implementation of their programs. In identifying specific data elements, managers were also asked to identify the desired frequency of collection, the acceptable time-lag in receiving the information, the locus or place or organization of collection, and the level of resolution or aggregation of the data itself (individual, village, region, etc.) This approach is greatly assisted in practice by using as a notational device an expanded version of a form such as that contained in Figure III-6.

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* A course entitled, "The Development and Use of Evaluation Data," was developed and taught by Peter Silvia and the author to over four hundred upper level managers in New Jersey government. The author has since carried out similar activities for ministries in developing countries, multi-national corporations, and other government jurisdictions in the U .S.

FRAMEWORK FOR IDENTIFYING MANAGEMENT INFORMATION

PROGRAM:

UNIT:

DESCRIPTION OF ACTIVITIES:

GENERAL OBJECTIVES:

OPERATING OBJECTIVES:

	INDICATORS:	Frequency	Acceptable Time Lag	Locus of Collection	Level of Aggregation
QUANTITY OF NEED					
QUALITY OF NEED					
QUANTITY OF OUTPUT					
QUALITY OF OUTPUT					
WORKLOAD					

Figure III-6

E. Application of the Framework: The Example of a Ministry of Education

Having outlined a framework for organizing management information in the public sector, I would like to show how that framework could be used to structure information for a large aggregate organization such as a ministry or a department. In this case, I shall use as an example, a ministry of education. This is obviously not intended to be a comprehensive enumeration of all information that ought to be included in a ministry of education's information system. It is intended to show how the framework outlined above could be used to structure and order the myriad of specific items that the various units of a ministry of education might be interested in, and to serve as a guide for retaining relevant and for eliminating non-relevant information.

It is difficult to speak of programmatic need and priority out of the context of a specific real setting. A society's past problems, experience, and collective sensitivities to certain problems will be critical in this regard; the higher, i.e., more general and all encompassing the level of decision, the greater the influence of these "social setting" variables. Therefore, certain assumptions must be made about some of these variables. Specifically, I would like to posit the existence of a ministry of education, responsible for all public, pre-college education and training, including adult education. Through statutory mandate, experience, tradition, and management choice, this ministry sees itself as having three basic objectives:

1) providing access to quality basic education for everyone;

2) providing additional training necessary to live and work well in society;

3) preserving and fostering the national heritage and culture.

To accomplish these objectives, the ministry conducts three major groups of activities:

1) direct basic primary education of children;

2) vocational, remedial, and adult education; and

3) non-formal education, including public broadcasting.

The ministry is organized around activity, rather than programmatic lines, into six major departments: planning; administration; curriculum development; education facilities; educational broadcasting; and general education, which in turn contains three major subdivisions: basic-primary, secondary-vocational-adult, and non-formal education. The application of the data framework to one of these departments, educational facilities, will be discussed in detail. Suggested information items for the others will be attached in summary form in a chapter appendix.

The department of educational facilities conducts the following activities:

1. It determines architectural standards for schools of various categories (primary, secondary, vocational, etc.)

2. It aids in the determination of site locations for new construction.

3. It supervises and monitors school construction and maintenance.

It carries out these activities with the explicit purpose (general objective) of producing a physical environment that is conducive to learning.

As a means of justifying its claim on the scarce resources of the ministry, the department gathers on an annual basis information about the quantity of need for its program. In particular, it gathers information about the number of students in substandard classrooms. This information is collected by school by classroom. From this particular quantitative need indicator, the department also computes an additional indicator, the number of classrooms needed to achieve various levels of standard coverage.

To indicate the quality or value or importance of the need, which has been established to be large in terms of quantity, the department computes from other data sources the differences between standard and substandard classrooms for the following variables: educational skill performance, drop-out rates, discipline problems, and teacher morale. The raw data for the first three of these come from routine data in the student and class files kept by the department of administration. The last comes from a general teacher survey conducted once annually of all teachers in all schools.

As indicators of the size or volume or quantity of output, the department uses the following information: the number of classrooms constructed, the number of classrooms reconstructed, and the number of classrooms maintained. This information comes directly from the operational control files which the division uses to monitor its work activity.

To indicate the quality or effectiveness of its output, the department also generates information on the number of children who are in fact changed from substandard to standard classrooms. This is because it is possible to locate classrooms ineffectively so that the number of students with access to standard facilities has changed little.

As a means of measuring its gross efficiency, the department also continually monitors its workload. It monitors such information as the number of separate projects going on, the number of separate purchase orders made and processed, the number of on-site construction inspections, etc. As this and so much other "management information" comes directly from the department's "operational information," something should be said about this system.

To efficiently control the cost, schedule, and quality of their work of constructing schools and classrooms, the department keeps the four files related to all construction projects: a general project file, a schedule file, an expenditure file, and a budget control file. The make up of these files is listed below:

1. Project File
    a. project number
    b. location
    c. project amount
    d. start date
    e. scheduled finish date
    f. primary contractor

2. Schedule File

   a. start date

   b. scheduled and actual start and finish dates for major activities such as foundation and footing, floors, walls, plumbing and electrical, roof, etc.

   c. number of inspections by division personnel

   d. date of last inspection by division personnel

3. Expenditure File

   a. project number

   b. purchase order number

   c. purchase order date

   d. description

   e. authorization

   f. indication of receipt of material

4. Budget File

   a. budget category (line-item)

   b. appropriation available

   c. funds expended

   d. variance of appropriated funds less expended funds

   e. funds encumbered

   f. variance of appropriated funds less encumbered funds

These files are maintained routinely as various forms (purchase order, inspection control reports, etc.) move through the department.

Given the established need for more minimally standard schools, their demonstrated importance in the education process and the estimates of costs based on past experience, the department

together with the office of the minister of education, determine certain operational objectives to serve as management guides for the department for the coming year. These objectives are stated in performance rather than simply in workload terms, and might look like the following:

1. to increase the number of pupils in standard schools by 25 percent

2. to reduce the gap between the quality of urban and rural facilities by 20 percent

3. to hold construction costs to a 10 percent increase (despite an average inflation in the construction industry of 12 percent)

4. to reduce the protracted delays that have plagued the division of construction by six months.

The elements listed above represent the kind of information that ought to be useful to managers in making better and more informed choices concerning alternative objectives, outputs, work technologies, and work activities. It is by no means inclusive. It is suggestive and it is hoped that it does identify some of the critical choice elements.

In the appendix which follows some additional examples are developed for other departments in our supposedly typical ministry of education.

APPENDIX

MANAGEMENT INFORMATION FOR A MINISTRY OF EDUCATION

Some Suggested Data Items

PROGRAM: Planning and Evaluation

UNIT: Department of Planning

DESCRIPTION OF ACTIVITIES:

1. provides planning assistance to departmental planning and budget units

2. produces one and five-year plans for the ministry

3. conducts evaluation and assessment studies on implementation of past plans and decisions and programs

GENERAL OBJECTIVES:

This unit exists to aid the ministry in anticipating needs and identifying available resources by:

1. monitoring trends related to educational needs

2. evaluating the resource implications of various goals

3. assisting program planning by evaluating existing and experimental work technologies

QUANTITY OF NEED:

1. number of surveys, evaluations, analyses, and plans requested by the ministry

2. number of departments requiring assistance

QUALITY OF NEED:

The need for this unit's output is internal rather than external and is a function of the priority placed on the need for various studies or analyses or plans by the ministry.

QUANTITY OF OUTPUT:

1. number of program plans completed/underway

2. number of program evaluations completed/underway

3. number of need studies/surveys completed/underway

4. number of departments assisted

QUALITY OF OUTPUT:

1. percent of plans judged acceptable by minister
2. percent of studies found acceptable by external reviewers
3. percent of overall budget acceptable by legislature

WORKLOAD:

1. number of surveys conducted
2. number of questionnaires written
3. number of analyses conducted
4. number of person weeks of assistance given to departmental planning unit

OPERATIONAL OBJECTIVES:

1. to complete X number of program evaluations
2. to carry out X number of major surveys
3. to provide X amount of assistance to X number of departments

PROGRAM: Admnistration

UNIT: Personnel

DESCRIPTION OF ACTIVITIES:

1. maintains records on all personnel

2. coordinates hiring, promotion and retirement processes

3. establishes and issues personnel policy

GENERAL OBJECTIVES

The general objective of this unit is to assure effective functioning of the ministry and the schools through recruitment and development of competent and creative personnel.

QUANTITY OF NEED:

1. number of persons employed directly or indirectly by the ministry

2. number of persons expected to be hired in forthcoming year

QUALITY OF NEED:

1. number of persons in organization whose performance or creativity is below expectation

2. number of persons selected for hire who have declined employment

3. turn-over rate

QUANTITY OF OUTPUT:

1. number of persons for whom records must be maintained

2. number of persons processed in special categories (new hires, promotions, retirements) on whom action must be taken

QUALITY OF OUTPUT:

1. percent of effective functioning employees

2. number of complaints raised by supervisors

3. number of complaints raised by employees

WORKLOAD:

1. applications for hire, advancement, processed

2. positions filled

3. interviews held, etc.

OPERATING OBJECTIVES:

1. to reduce turn-over rate by X%

2. to increase number of employees effectively functioning by X%

PROGRAM: Basic-Primary Education

UNIT: Basic Education

DESCRIPTION OF ACTIVITIES:

1. directs and monitors all basic-primary education
2. assigns and monitors teachers and supervisors
3. monitors student performance and progress

GENERAL OBJECTIVES:

The general objectives of this unit is to ensure that all persons have the opportunity to develop the following abilities and skills:

1. minimal literacy and quantitative skills
2. skills necessary for further study, training or employment

QUANTITY OF NEED:

1. total number of eligible children (target population)
2. total number of children not receiving services
3. percent of children not receiving services (by area)
4. number of teachers required if services were to be provided to all who are eligible

QUALITY OF NEED:

Quality of need here refers to the underlying reasons why we value or do not value education. Some of these factors will be intangible, or at least not measurable, such as the number of novels not read. Others might be the more tangible social effects of education, or the lack of it, such as lifetime income lost, lower rate of political participation, higher birth rate, etc.

QUANTITY OF OUTPUT:

1. children taught
2. teachers assigned
3. schools supervised

QUALITY OF OUTPUT:

1. percent of children promoted out of those taught
2. percent going on to further training, schooling or employment
3. percent literate on graduation or completion
4. percent not promoted
5. drop-out rate

WORKLOAD:

1. classrooms staffed
2. schools supervised
3. teacher evaluations completed

OPERATIONAL OBJECTIVES:

1. to increase the percent of those receiving coverage by X% in coming year
2. to increase the percent of those promoted by X%
3. to decrease the student/teacher ratio by X%
4. to increase the number of on-site inspections and evaluations by X%

PROGRAM: Curriculum Development

UNIT: Pedagogical Services

DESCRIPTION OF ACTIVITIES:

1. develops teaching methods and materials for primary and vocational education, etc.

2. conducts seminars and workshop for teachers concerning new materials and methods

GENERAL OBJECTIVES:

The general objective of this unit is to facilitate learning by:

1. identifying areas for instructional improvements

2. improving teaching methods and materials

3. supervising the directing and implementation of new methods and materials

QUANTITY OF NEED:

1. number of students in classes with obsolescent materials

2. number of students in classes with teachers untrained in use of new methods and materials

QUALITY OF NEED:

1. number of students not meeting minimal progress expectations

2. number of teachers registering dissatisfaction with existing methods or materials

QUANTITY OF OUTPUT:

1. number of texts of various types produced

2. number of teachers trained

QUALITY OF OUTPUT:

1. differences in progress of students who have received new material

2. percentage of teachers satisfied with new materials

WORKLOAD:

1. number of methodological evaluations conducted
2. number of separate workshops run
3. pages of finished text written

OPERATIONAL OBJECTIVES:

1. to increase by X number of students in classrooms in which new methods are used
2. to complete X more curriculum evaluations
3. to run X more in-service training workshops
4. to produce new materials for additional courses

PROGRAM: Educational Television

UNIT: Instructional Technology

DESCRIPTION OF ACTIVITIES:

1. to develop audio-visual material for classroom use

2. to provide and maintain audio visual equipment

3. to develop programs for non-classroom educational television

GENERAL OBJECTIVES:

The general objectives of this program are to increase the availability and quality of education by:

1. providing quality, inexpensive non-classroom access to education and training

2. providing an efficient means of introducing new and more uniform teaching methods

QUANTITY OF NEED:

1. number of persons desiring further training who cannot attend formal classes

2. number of children in schools without proper audio-visual materials

QUALITY OF NEED:

The need for this program is the same as for other forms of education. The only thing different is the efficiency and effectiveness of the means.

QUALITY OF OUTPUT:

1. number of schools supplied with equipment

2. number of programs developed for classroom use

3. number of non-classroom programs developed

QUALITY OF OUTPUT:

1. number of persons watching non-classroom programs

2. differences in mean progress scores of students in classrooms with and without classroom TV

3. number of adults receiving literacy through educational television

WORKLOAD:

1. number of equipment purchases made

2. number of pieces of equipment maintained

3. number of films made ready for final dissemination

OPERATIONAL OBJECTIVES:

1. to increase coverage of students in classrooms with educational television by X%

2. to increase the topics covered in non-classrooms instructional television to include the following topics:

3. to purchase X number of additional pieces of audio-visual equipment

4. to maintain X number of pieces of audio-visual equipment

PROGRAM: Facilities and Construction

UNIT: Department of Educational Facilities

DESCRIPTION OF ACTIVITIES:

1. to determine architectural standards for schools of various categories
2. to aid in determination of site selection
3. to coordinate and monitor school construction and maintenance

GENERAL OBJECTIVES:

To produce a physical environment conducive to learning, via:

1. the establishment of standards
2. planning and controlling construction and maintenance activities aimed at ensuring that standards are met

QUANTITY OF NEED:

1. number of pupils in substandard classrooms
2. number of classrooms needed to achieve X% coverage

QUALITY OF NEED:

1. difference in education performance
2. difference in drop-out rates
3. difference in discipline problems
4. difference in teacher morale

between standard and substandard classrooms

QUANTITY OF OUTPUT:

1. number of classrooms constructed
2. number of classrooms reconstructed
3. number of classrooms maintained

QUALITY OF OUTPUT:

1. number of children changed from substandard to standard classrooms

2. number of children in classes who were previously not enrolled

WORKLOAD:

1. number of construction projects

2. amount of material purchases

3. number of on-site inspections, etc.

OPERATIONAL OBJECTIVES:

1. to increase percent of pupils in standard schools by X% in coming year

2. to reduce rural/urban unbalance by X% in coming year

3. to reduce cost/constructed classrooms by X% in coming year

4. to reduce construction delays by X% in coming year

IV. DATA COLLECTION: Choices and Issues

A. Design Criteria for Data Collection

B. Two General Data Sources

C. Operations Information

D. Surveys

E. Validity

F. Reliability

G. Integrability

H. Deducibility

I. Representativeness

A. Design Criteria for Data Collection

The raison d'etre of management information is that it be useful in making decisions. To be useful to managers, planners or policy-makers, it must be relevant to the decisions which they have to make or to the issues which they have to address. More specifically, it must be related to the importance of the needs that they are trying to meet, to the effectiveness of the outputs (products and services) that they are producing or providing, or to the efficiency of the way people who work with and for them combine resources and skills to produce the outputs. In addition to relevance, usefulness implies that the information must be usable by managers in their process of analysis, deliberation, or decision. Usability, in turn, depends on certain technical qualities or characteristics of the information, which are determined by the manner in which it is gathered, recorded, and stored. There are five such characteristics:

1. validity

This refers to the extent to which data in fact measures the concepts or categories of things which it is supposed to measure.

2. reliability

This refers to the accuracy or consistency in the measurement process by which the data is obtained.

3. integrability

This characteristic pertains to the extent to which data sources (project records, interviews, surveys, etc.) can be combined

in analysis.

4. <u>deducibility</u>

This refers to the extent to which data lends itself to making inferences about relationships which the manager, planner or policy-maker is unsure about, and about which he would like to know more.

5. <u>representativeness</u>

This refers to the extent to which partial or incomplete data reflects the whole from which it is drawn.

HIERARCHY OF DESIRABLE INFORMATION CHARACTERISTICS

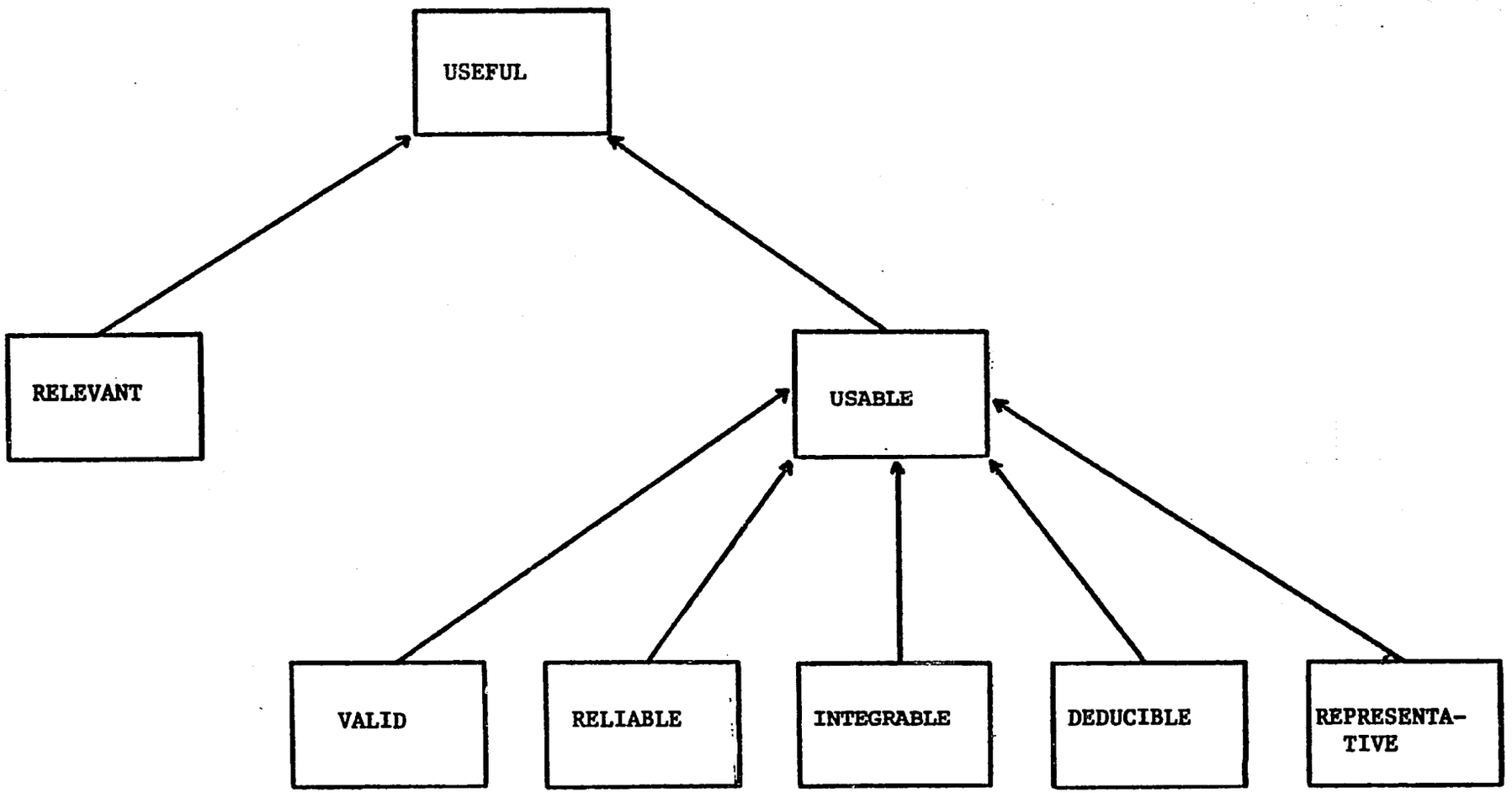

Figure IV-1

Each of these characteristics are at once a dimension across which collected data will vary, as well as a criterion or norm for guiding the creation and improvement of data collection procedures. Each has a body of technical knowledge on which it is based: "validity" and "reliability" on measurement theory; "deducibility" on experimental and quasi-experimental design; "representativeness" on classical statistics; and "integrability" on the theory of data bases. The purpose of the discussion which follows is not to make the reader a technical expert in all, or for that matter even one, of these areas. It is rather to give an understanding of the basic concepts and choices concerning each of the technical dimensions so that managers, who are not only the decision-makers which use information but makers of decisions about what information will be used, have the terrain mapped so that they can better plan their information strategy. It is to facilitate an understanding of how and when to use technical experts. It is also to provide some practical and pragmatic suggestions for making it more likely that collected data will in fact have the desired characteristics. These suggestions are often over-looked by technicians who want to practice their craft in a pure and uncorrupted way. This, in itself, is not unnatural given their considerable learning and professional investment in their craft. It can, however, lead to an information system, which while meriting an "A" in a graduate design class, in practice represents "information over-kill," and results in a system which is too costly, too cumbersome, and too complex to use.

B. Two General Data Sources

There are two general sources of information for public management: operational records, and surveys. Operational records are simply the records that an organization develops and maintains in the process of carrying out its work. They are the records that tell who is doing what activity with what inputs at what time. They describe the characteristics of an organization's people, of its durable and nondurable material resources, and how and when people and resources interact. They can and often do provide information about the status of the clients, recipients, or beneficiaries of the services which the organization provides. Surveys are activities whose sole purpose is to gather information, via direct contact with people - the "subjects" or "respondents" of the survey. Surveys can provide information about the attitudinal and behavioral status of people, be they tenant farmers, village leaders, local entrepreneurs, or the workers and staff of one's own organization. They can provide information on groups which are not involved in a project or program so that comparisons can be made.

Whatever the generic source of information, it must be valid, reliable, integrable, deducible, and representive if it is to be usable and useful to management in the making of decisions.

C. Operations Information

Operations information has traditionally been focused on controlling and monitoring the cost, schedule, and quality of day-to-day operations. As such it will minimally involve generating information in the following areas: cost control, resource control, schedule control, and quality control. A word on each of these is in order.

1. cost control

In any organization, public or private, it is minimally necessary to control expenditures and costs. This will normally entail the setting up of a budget which attempts to see to it that adequate resources are available for programmatic activities as well as to set limits on amount of such resources. This involves breaking down the myriad functions and activities carried on in an organization into a set of identifiable activities which are used as the basis for control. The level of "breakdown" ought to bear some resemblance to the pattern of managerial responsibility - e.g., by clinic, region, project phase, etc. There are two broad areas which require budgeting and control in this way: human (payroll) and material (purchasing). It is necessary to know what people, receiving what amounts of pay, are performing what tasks. It is necessary to know what resources are being purchased for use in what tasks. Thus, for each unit in an organization there will normally be a list of people with their rates of pay, benefits, and how much they have been paid to date for the fiscal period. Likewise, there

will be records (purchase orders) that describe all purchases that have been made by or for the unit.

2. resource control

In addition to controling the amount of cost of human and material resources, it is necessary to know something about their status in terms of quality, quantity, and location. In terms of people (the most valuable resource of any organization), it is important to have personnel records which contain information about the people who do the work, where they live and work, their backgrounds, skills, training, and experience. Likewise, for the material resources which an organization uses as inputs, it is important to know what has been purchased, what has been used, how fast it is being used, how much is on hand, etc. - which implies maintaining inventory records.

3. schedule control

Most programs and projects involve several distinct groups performing multiple tasks. Management must be able to coordinate and schedule the work of these various groups. To do this it must have a plan which identifies the major tasks and activities of a project, the groups which are responsible for performing each task, the resources required, and the times that distinct tasks should start and finish. It should also have information on how well the schedule is doing, i.e., how far ahead or behind are the start and finish of each task as the project progresses.

4. quality control

Not only is management interested in seeing to it that a job is done on time and within budgeted cost, it is interested is making sure that job performance meets a certain minimum quality. This requires management to set up certain standards aganist which to evaluate the results of each activity. It must monitor performance on a schedule which allows for problems to be identified early and for mistakes to be corrected before they are amplified.

Virtually all organizations will routinely collect information in each of these areas, so that dav-to-day operations can be monitored. The information is recorded on the various standard forms that pass through the organization: budget statements, time-sheets, payroll lists, requisitions, purchase orders, inventory lists, work schedules, inspection reports, etc. This information should tell much about the status of an organization. For example, it should be able to identify for management in a ministry of health how many health clinics it has, where they are located, how health personnel of various skill categories are distributed across the clinics, what the payroll and supply costs are for each clinic, how much supplies are on hand, the last time each clinic was visited, and the judgment of the visiting team, etc. Analyzing this information should allow the ministry's management to clearly identify both

operational problems and possibilities for improvement, such as a poor balance of skilled personnel (too few physicians in comparison to other personnel, or too many), long delays in receipt of drug supplies, etc. To the extent that records are also kept on clients or beneficiaries, management can also start to make some more informed judgments about whether people are in fact utilizing clinics, the problems they are bringing to them, etc.

USES OF OPERATIONS INFORMATION

* COST CONTROL
* RESOURCE CONTROL
* SCHEDULE CONTROL
* QUALITY CONTROL

Figure IV - 2

D. Surveys

Surveys are used to describe who does what, how, why, and when. They are used to gather data on the values, attitudes, and behavior of people through direct contact. The kind of contact can vary considerably in how it is structured, from the almost unstructured interview to the completely structured (no open-ended responses) written questionnaire. The subjects of surveys can be workers in ones own program (e.g., agricultural extension agents, village health workers), the recipients of the services provided by one's program, or any group in which one is interested. Surveys can involve direct contact with all of a group of subjects (a "census"), or they can involve contact with only part of a population (a "sample").

The principal values of surveys as means of data collection are as follows:

1. They allow the gathering of data on groups which are not recipients of services provided by the organization's programs and projects.

2. When applied to project recipients or beneficiaries, surveys can serve as a means for gathering information not gathered through project implementation channels.

3. When applied to project recipients, surveys can serve as a means of cross-checking against data obtained through project records.

The principal problems with surveys is that they are expensive and difficult to do well. Their effective design and

execution requires a high level of technical skill in designing the survey instrument, testing it, identifying the particular "subjects" or "respondents", conducting the actual interviews, and in processing and analyzing the results.

USES OF SURVEYS IN GATHERING INFORMATION (ON VALUES, ATTITUDES, AND BEHAVIOR)

* GATHERING DATA ON PERSONS NOT INCLUDED IN OPERATIONS DATA

* FILLING GAPS IN OPERATIONS INFORMATION

* AS A CHECK AGAINST OPERATIONS INFORMATION

Figure IV - 3

E. Validity

In textbook treatments of research design, much attention is given to "validity", which describes the extent to which empirical indicators and scales reflect the concepts of the research hypothesis that they are supposed to measure.* Some methodologists, such as Kerlinger, even attempt to develop quantitative measures of validity**. While validity is a desirable characteristic of any data one intends to collect, the purist approach of behavioral science methodologists to validity is not useful in the applied context. The applied setting of generating data from and for development projects and programs is so different from the problems addressed in the methodological texts that the supposedly sophisticated techniques currently in vogue are marginally useful. Yet validity is nevertheless an important consideration for both operations data and surveys.

At first glance, for operations data, "validity" seems to be so straightforward as to be trivial. At the level of a particular local unit, it is, at least, not difficult to achieve. For example, the "drug costs" for a local clinic might be determined simply by

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* The term "validity" is actually used in at least two different ways in the methodology literature. It is used to mean "construct validity," referring to the correspondence between concepts and their empirical referents or indicators. It is also used to "design validity," which refers to structural issues of the research design concerning the use of control groups. In this paper, "validity" refers to "construct validity," as defined above.

** Kerlinger defines "validity" as "the ratio of common factor variance to total variance." Vida, Foundations of Behavioral Research, p. 469.

summing the count of drugs shipped to the clinic times their purchase price. But even here, it can become complicated. Does one take into consideration the indirect costs of a "central drug dispensary?" If one wants to determine the total cost of operating the entire clinic system, it becomes even more arbitrary. Does one apportion "overhead costs" such as administration and training equally among all clinics or is this done on a clinic by clinic basis? For such traditional monitoring functions, standard accounting practices have been developed and adapted to most organizations, so that although still somewhat arbitrary and subject to local variation, the "construct validity" of such information is not a major problem.

This is not the case with need and output indicators which are gathered as a part of operations data, however. For example, there is far less agreement on the way to measure the "health status" of clients of a local clinic. Yet even here, within functional areas such as health, education and agriculture, some standardization is taking place. There are a variety of general lists of variables or indicators to describe such concepts as "health status," "educational performance," and "agricultural productivity." This is not to say that the problem of validity is by any means solved. It means that these framework can guide toward a solution of the "validity" problem. Most of these frameworks are in essence inventories of concepts about which specific data items should be collected from on-going

projects.* They are checklists of categories of information which are thought to be interesting. Such general lists (or more detailed lists related to programs rather than sectors, which would flow from using a framework such as that presented in Chapter III) are useful tools in identifying specific data items. What is essential is that these inventories be in fact used in some way to identify the specific data items to be gathered.

How can this be done? One sensible and workable way is to use the list or inventory as a frame of reference for discussion aimed at identifying the specific items to be collected. Such discussions should take place on a project-by-project basis. It is most important that they be a collaborative effort, being the product of the interaction, knowledge, and experience of both persons with specific project involvement and expertise as well as of persons with data collection and management expertise. The result of such discussion and interaction, effectively carried out, will be a list of very specific data items that will be gathered, by what group, at what time and interval, during project implementation, for each relevant category of information. It will in effect be a "data dictionary" which defines relevant categories

*E.g., Ralph Cummings, "Minimum Information Systems for Agricultural Development," Agricultural Development Council, 1977.

of information operationally, i.e., in terms of specific data items to be collected.

Validity is, of course, as important for surveys as it is for operational data. Here it refers to how well the specific questions asked of respondents in fact measure the basic concept or category information which has been determined to be relevant. This is a most difficult task. Fortunately, however, much work has been done and much is known concerning the problems of framing valid questions in particular local contexts. A group which has had experience in such surveys, such as a national statistics organization ought to be able, in conjunction with persons knowledgeable about the particular project or sector, to effectively design such a questionnaire. This group together with project personnel, ought to develop a "data dictionary" which defines the concepts of the basic inventory in operational terms, in this case as a list of specific questions to be asked of rural-household or farm respondents, of health clinic clients, parents of school children, or whatever the target group.

VALIDITY

* REFERS TO THE EXTENT TO WHICH DATA REFLECTS THE CONCEPTS IT IS SUPPOSED TO MEASURE

* REQUIRES THAT CONCEPTS ARE CLEARLY DEFINED IN TERMS OF UNAMBIGUOUS MEASUREMENT CATEGORIES

Figure IV - 4

F. Reliability

Reliability has to do with consistency in measurement. As with validity, there are a variety of technical definitions (e.g., the ratio of the difference between of total variance and error variance to total variance) which are next to useless in the present context. In a more practical sense, reliability is the opposite of ambiguity in measurement. To the extent that our categories, ranks, intervals or ratios are ambiguous, to that extent our measurement is unreliable. If we have difficulty identifying an individual as rich, poor, or middle class, our measurement of wealth cannot be very reliable. If one of the data items being gathered as a part of a farm credit project is "size of land holding," we need to have a clear (unambiguous) definition of what "size of land holding means" if it is to be reliable as a data item. Does it include family holdings? For what relatives? Spouse? Parent? Siblings? Or does it refer strictly to the holding for which the head of household has direct title or lease? If the answers to these questions are left open to the interpretation and judgment of different people at various local credit agencies, the variable, "size of land holding," is not likely to be very reliable or therefore very usable in analysis.

To generate reliable data it is important that the measurement procedures and practices for gathering each item of data be clearly defined and unambiguous. In this regard, it is worth

remembering that as a way of facilitating validity, it was suggested that a "data dictionary" be constructed which attempted to clearly define each variable and how it was to be operationalized in terms of specific data items. If these procedures are identified in a way which is clear and unambiguous, this same "data dictionary" can also serve an important reliability function. It can serve as a device for routinizing and standardizing the judgment of the persons who actually record the data. This will increase consistency of data recording both of the same person over time, as well as among a group of people at the same time. It reduces the likelihood that inconsistency will enter because of the biases of the persons recording the data.

While reliability is always a concern with operational data, it is even more so with survey data. If the data of a survey are to be reliable, the questions themselves must be unbiased in their design and phrasing, and they must be asked of respondents in a consistent and unbiased way. In this sense, a survey is like the proverbial chain that is no stronger that its weakest link. The results of a survey are no better than the quality of the questions which compose it, and the consistency and lack of bias in how responses to those questions are solicited and recorded. Enumeration, the asking and recording of questions of respondents, is an art, albeit one that can be taught. The training of enumerators, therefore, must be of critical importance if a survey is to generate data which is reliable.

RELIABILITY

* REFERS TO CONSISTENCY IN MEASUREMENT

* REQUIRES THAT PERSONS RECORDING DATA MUST HAVE A COMMON UNDERSTANDING OF WHAT IS BEING MEASURED AND HOW TO MEASURE IT

Figure IV - 5

G. Integrability

Integrability refers to the extent to which data from different sources can be combined together in the same analysis. It is one of the main advantages, purposes, and results of a "systems approach" to information problems. According to the mythology of "systems theory," the whole is greater than the sum of its parts. The benefit from integration is that the ability to combine data from different sources allows questions to be asked and inferences made which could not be asked or made even if the very same data were available but not combined.

Integration is a critical characteristic to be addressed in designing the data collection mechanisms for both programs and projects being implemented as well as for surveys. Implicit in this criticality is the judgment that the really interesting issues and questions go beyond the scope of any single project. There are issues of major interest and relevance which are inter-project within traditional sectors, as well as inter-sectoral. Information from different particular sources must be integrable if it is to be useful in addressing these inter-project and inter-sectoral questions.

Integration is one of the most widely discussed and poorly understood aspects of information systems. Most authors ignore that it is a multi-faceted concept and focus only on one aspect of it. As integration is so important to the usability and usefulness of any information system, some attempt must

be made to order our understanding of it in such a way that it can provide some guidance in setting up an information system.

"Integrability" is a characteristic of data pertaining to its ability to be combined in analysis. "Integrated" describes data which exhibits this characteristic to some extent. "Integration" is somewhat ambiguous in that it is often used both to refer to the process of designing an "integrated" information system as well as to the process of combining data within an "integrated" system. "Integration" will be used here in the latter of these two ways. In any case, whether we are referring to the ability, the characteristic, or the process, various aspects or types are involved. Thus, it is possible to speak of the following types of "integration:"

1. vertical or hierarchical

This pertains to the integration of data across different levels of analysis (levels of aggregation). It might involve "integrating" from the level of the individual to that of the village, or from that of the village to that of the province or from that of the province to that of the country as a whole. To some extent "summarization" may be used as a synonym for vertical or hierarchical integration.

2. horizontal

This pertains to the integration of data from different sources at the same level of analysis. It might involve com-

bining or "integrating" information about an individual's health status with other information about his education or about his income.

3. temporal

Temporal integration involves the combining of information about the same individual from different observations or points in time. It might involve combining information about a farmer's daily work schedule before and after his purchase of a tractor.

Each type of integration involves two distinguishable operations: extraction of the basic data items to be integrated from their respective data sources, and combination ("matching") of the various extracted items together in a meaningful (usable) way.

INTEGRABILITY

* REFERS TO THE EXTENT THAT DATA FROM DIFFERENT SOURCES CAN BE COMBINED IN THE SAME ANALYSIS

* THREE DIFFERENT TYPES OF INTEGRATION:

    * VERTICAL - COMBINATION INTO HIGHER LEVELS OF AGGREGATION (E.G., INDIVIDUALS TO VILLAGE)

    * HORIZONTAL - COMBINATION ACROSS SAME LEVEL OF ANALYSIS (E.G., DIFFERENT SURVEYS FOR SAME INDIVIDUAL)

    * TEMPORAL - COMBINATION OF INFORMATION ON SAME KIND OF INFORMATION ON SAME INDIVIDUAL OVER TIME (E.G., AS IN "PANEL" STUDIES)

Figure IV - 6

The way that data can be extracted is obviously dependent on the characteristics of the thing from which it is being extracted, i.e., on the medium of its storage. Some media of storage facilitate extraction more than others, so it is important to specify in advance how data is to be stored so that it may later be extracted in a way conducive to combination or matching.

Data may be defined as an organized set of characters (including numerals) which describe some aspect of something in which one has interest. Such data can be stored in a fairly haphazard and random way, as when I take notes on the various meetings which I attend. Other than time, date, and list of participants, which I put on the top of the page, there is little structural similarity in the data which I copy down on the content of the meetings. I could, of course, order in some way my meeting information by standardizing the format in which I record it. For example, I might have a journal for recording data about various meetings, in which there is a particular place to record place, time, participants, subject matter, major points discussed, issues resolved, issues unresolved, and follow-up. Organizing my meeting notes thusly would both speed my own review of them and facilitate use by someone else if I needed to show my notes on a regular basis.

This somewhat trite example illustrates some basic concepts about data storage. A record is defined to be a set of data about an individual or event, as when the notes on each separate meeting are thought of as separate records. Records are standardized by ordering the location in which information is placed. A file is defined to be a collection of records. That section of my notebook reserved for my meeting notes is thus a meeting file in this sense. Files are ordered or standardized by affecting the sequence of their constituent records. This order can simply be chronological by entry, as in a journal. (In fact a journal as used in accounting is simply a chronological listing, by order of entry, of financial events, such as purchase orders, disbursements, etc.) If a different physical medium of storage is used, such as a card file instead of my composition notebook, the order of storage of the records could be arranged in some other way - alphabetically by topic, by country, or some other variable or category of interest.

DATA ORGANIZATION CONCEPTS

* DATA - AN ORGANIZED SET OF CHARACTERS WHICH DESCRIBE SOME ASPECT OF SOMETHING IN WHICH ONE IS INTERESTED

* RECORD - SET OF DATA ABOUT AN INDIVIDUAL OR EVENT

* FILE - A COLLECTION OF RECORDS (USUALLY ON SAME SUBSTANTIVE TOPIC)

Figure IV - 7

The physical medium of storage sets constraints on the flexibility with which information can be extracted. In a manual file (and certain types of computer files) information can only be accessed according to the principal sequence according to which the records are placed. In this case, determining the category according to which one will most often wish to access the records is critical.

Most automated information systems provide a deus ex machina solution to the problem of how to sequence a file to facilitate access because they can search out the records of a file for relevant information regardless of the principal sequencing. (Certain sequences may be more internally machine efficient than others, but this is of little concern other than to the programmer.) There are other considerations, however, that must go into the design of the format of the data (record), if it is to be usable by such a flexible access system. These considerations are different from, but not incompatible with those of good manual systems, so that it is possible to design a data collection, recording, and storage procedure which facilitates manual use but which is upwardly flexible in that it also facilitates conversion to an automated system. This is important because even if information is orginally recorded and stored by manual means, it will need to be aggregated, tabulated, and analyzed at some point. This will usually imply some form of computer access. Almost every country has some such access at the present time and as costs continue to drop sharply, computer access will not in itself be a problem, though it may still cause problems, as well be discussed in the next chapter. In any case, increased access implies that data ought to be stored in an upwardly flexible manner, facilitating possible automation at a later date.

There are many ways to classify and divide computer files, depending on the purposes at hand. In this case, it is useful to do so according to type of data, of which there are two basic

types: times series files and line-item files. A time series file can be thought of as a rectangular arrangement of data in which each line is some indicator or variable, and each column is the value of the variable at some period in time (year, quarter, month, week, day, etc.) A line-item file can be thought of as a rectangular arrangement of data also. In this case, each line represents the data on some particular item. It could be villages in a village information file; borrowers in a farm credit file; or farm, in an input-purchase file or in an output-production file. The various columns of the rectangle represent variables or categories of data - "fields" in computer terminology. These fields may contain descriptive or numeric information. In some systems. these fields can be of variable length, though in most systems, they have a maximum size. An example of such a file might be a village description file, which could contain the following fields:

1. village name (30 characters)
2. region (20 characters)
3. name of local leader (50 characters)
4. miles from major access road (integer)
5. population (integer)
6. number of separately farmed parcels (integer)
7. etc.

Most project data is of this line-item variety. The original form in which data is recorded need not look anything like the line-item

file to which it may be converted. Physical format can differ greatly. What is important is that the raw data be capable of being represented as fields. It is also desirable that data be recorded in such a way that there is a fixed maximum size for each field or variable. This can be done by identifying a fixed set of categories, which is used to classify the data in some meaningful way. For example, in a medical records system for local clinics, while allowing the examining physician or physician's assistant to describe the patient's ailment in detail, it might be useful to have him or her identify the particular class of disease or problem from an inclusive list of twenty or thirty most common illnesses. A file coded in this way could be converted to machine readable form for analysis without much difficulty.

In addition to extraction, which is primarily a function of record and file format, the other factor critical to integration which has yet to be discussed is that of coupling or matching. If information is to be integrated, there must be some capacity to combine or couple or match the specific data items of different files.

The process by which the data items of two or more collections of data are combined centers around linking together their respective files. This process, referred to in computer jargonese as "chaining," involves having the same field appear on the several files that are to be "chained." The field, that appears on the separate files for the purpose of linking them, is called a

"key" field. The items within these key fields are used to cross-reference and match themselves up on variables which were previously matched with the key fields but are now also matched with each other.

An example is in order. A "farmer's cooperative" file might include the following fields:

1. region or province
2. village
3. name of client-farmer
4. amount borrowed
5. amount outstanding
6. etc.

Similarly, an agricultural mechanization project might have a file which includes the following fields:

1. region or province
2. village
3. name of client-farmer
4. type of equipment (tractor) obtained
5. date of lease-purchase
6. etc.

Having the first three fields appear on both files would enable matching up of clients of the two projects by province and village so as to determine if the same people tend to take part in both programs.

Of course, the "matching" that takes place will usually be both more complex and more significant than in this simple

example. But the essential process will be the same. What will differ will be the type of field on which the matching takes place. For horizontal integration, as in the current example, the matching will be via an individual identification field across files that pertain to different individual attributes. For vertical integration, the matching will usually be done across individual attribute files, but instead by an aggregate class field such as village or region. For temporal integration, the matching will take place using an individual field, only in this case the files will usually be identical except that the variables on each pertain to different times of observation.

"Matching" can also be used to combine project information files with survey information files. This requires that the survey be stored in a format similar to that which we have described for projects. The survey also must be represented by a rectangular arrangement of data. In this case, each survey can be viewed as a rectangular array of data in which each row represents the responses of a single person surveyed and in which each column represents the responses for a given question. In terms of the vocabulary we are using to describe files, each line-item is an individual respondent and each question is a variable.* The process of matching is now structurally identical to that for

* Technically it is possible to have multiple questions reduced to a single variable or field (component or factor) through some data reduction process such as factor analysis.

matching any other array (line-item-field file).

If the benefits of integration for examining cross-project and cross-sector issues are to accrue, it is important to use, as standards for the format of data collection and storage, the rectangular array, line-item-field formats described in this section. It is also important that data be collected at the lowest possible level of analysis, allowing for maximum links among files, using clients as key fields. Aggregations can easily be made later to the macro-level desired for more general levels of analysis.

H. Deducibility

"Deducibility" is related to the extent to which data allows drawing conclusions about relationships among concepts, categories or variables. More specifically, it is concerned with the ability to make causal inferences (causal guesses) about relationships. The basic question relates to whether the data lends itself to distinguishing between spurious (accidental) and genuine (causal) relationships. This is the underlying rational for all basic and most applied research. It is particularly important in the present context because of the desire to make more informed judgements about whether a project intervention in fact "caused" an intended effect, or whether it was spurious. Or in another case, whether, despite the fact the intended result did not materialise, things would have been even worse had there been no project intervention.

The issue of "deducibility," of course, focuses on classical considerations of research design and the use of control and treatment groups. The purpose of such research design is, not only to measure changes in variables of interest and concern ("dependent variables") but to maximize the variance or difference in other variables ("independent variables") which might account for these changes, so that inferences might be made as to what is causing what.

The basic technique of scientific research is the controlled experiment, in which differences in independent variables are maximized by administering some treatment to one of two similar groups (groups that are matched on certain characteristics), but not to the other (the "control group"). Very nice if you can do it. But it can hardly ever be done perfectly in an applied setting for at least a dozen reasons that are beyond the scope of this paper to discuss.* Nevertheless, the idea of examining differences between groups which are subject to some project intervention and groups which are not is certainly desirable where possible; and it is possible in the case of most development projects. As Hirschman phrased it, "Projects are the privileged particles of the development process." Resource limitations almost always dictate that such "particles of privilege" be limited both in function and geography. This implies the existence of natural control groups - groups similar to the project recipients in characteristics other than the specific intervention.

Thus, almost all projects involve functionally limited interventions directed at geographically restricted populations of beneficiaries. This has important implications for the

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* The classic discussion of these reasons (of "internal" and "external" impediments to validity) is Donald T. Campbell and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research, Rand McNally, Chicago, 1963.

inferences to be drawn concerning the separate and additive effects of different project interventions. For either single or multiple surveys, allowing for maximum variation across project interventions ought to be taken into account in the design of the survey. Such design considerations would provide an important testing ground for development projects and strategies.

Given the difficulties of conducting a valid and reliable survey in a developing country situation, conducting either a single or multiple surveys is no mean task. A reliable sample frame must be found or be created. A survey instrument must be developed, pretested and modified, and re-pretested and re-modified, several times. Enumerators must be trained and supervised. Provision must be made for encoding of raw data, tabulation, and analysis. Given this considerable task, it is frequently better to develop or to use existing institutional capabilities rather than to bring in a contractor to do a survey sui generis. In this regard, A.I.D. is a good example in that it has had fairly successful experiences in working with and utilizing indigenous survey and data collection institutions in Latin America, such as local census bureaus, and national statistical offices. For not much more than it would cost for a contractor to carry through a survey, it might be possible, with periodic and regular technical assistance from

groups such as the U.S. Bureau of Census, USDA, USPHS or WHO, to conduct the multiple, small, but well targeted surveys such as those suggested above. Whether this is possible will be a function of the capabilities of local institutions, a situation that can be clarified without much difficulty.

If the requisite capabilities exist and/or can be augmented easily, working with local institutions will usually not increase the cost of surveying or delay the time of the first survey results. It will, however, usually increase the extent to which the data obtained is used by local organizations. It also has the additional positive externality of upgrading skills at local institutions.

DEDUCIBILITY

* REFERS TO THE EXTENT TO WHICH DATA ALLOWS DRAWING INFERENCES ABOUT RELATIONSHIPS AMONG CONCEPTS, CATEGORIES OR VARIABLES

* FOCUSES ON CLASSICAL CONSIDERATIONS OF RESEARCH DESIGN AND THE USE OF CONTROL AND TREATMENT GROUPS

Figure IV - 8

I. REPRESENTATIVENESS

Representativeness refers to the extent to which partial data reflects the larger universe from which it is drawn. If the "larger universe" is some target population, and the "partialness of the data" refers to the fact that it applies only to a sample of that population, describing "representativeness" is a fairly straightforward mathematical operation. The whole body of classical statistics is in fact devoted to addressing the bounds of "representativeness" by specifying clearly the confidence we can have that a sample statistic in fact really represents the corresponding population statistic.

The random sampling on which classical statistics is based is extremely powerful. For example, if we want to know some statistic about the 10,000,000 plus people living in some region, we could sample out a group of 500, compute the desired statistic on that group and be 95 percent certain that the actual statistic for the 10,000,000 was within 4.7 percent of our sample statistic based on the 500. This, of course, assumes that each of the 10,000,000 had an equal chance to be picked as one of the 500. In practical terms, this means that to do such a random sample, there must be some list (called a frame) from which we can randomly draw the 500 persons for the sample survey. The problem is that if we do not have such a list, we cannot really draw randomly and therefore, will have very little confidence in the results of the sample.

Practically speaking, the existence and quality of such lists is a major factor in assuring representativeness. Where accurate frames do exist, they, of course, ought to be used. Where they do not, some alternative method of selecting respondents must be found. One alternative is to develop "area frames," using satellite mapping techniques. This is reliable but costly. Another alternative is to choose some small group, thought to be typical of the larger population (such as some village or group of villages) and to randomly select respondents from this group, or if it is very small, to survey all members of the group. The burden of the argument of representativeness in this instance falls on how strong a case can be made for similarity between the selected village(s) and the larger region. This alternative, while not meeting statistical criteria for representativeness, often is a feasible modus operandi for surveys when accurate sampling frames do not exist, or are not reliable because of poor updating or some other reason, and the development of "area frames" is not feasible because of resource and/or time constraints. An additional compromise alternative, which combines elements of area sampling and respondent sampling is a two-stage sample in which a list of geographical jurisdictions (villages, towns, cities, etc.) is developed. A group (usually including at least thirty such jurisdisctions) is sampled from the list. Respondents are then selected randomly in each of the jurisdictions which has been selected. Such two-stage samples are

very useful alternatives for assuring a predictable level of statistical representativeness in the absense of a comprehensive enumeration frame or a comprehensive area frame.

REPRESENTATIVENESS

* REFERS TO THE EXTENT TO WHICH PARTIAL DATA REFLECTS THE LARGER UNIVERSE FROM WHICH IT IS DRAWN

* CONVENTIONALLY BASED ON CLASSICAL STATISTICS, BUT CAN ALSO BE ARGUED FOR ON OTHER THAN CLASSICAL STATISTICAL GROUNDS

Figure IV - 9

V. DATA PROCESSING: CHOICES AND ISSUES

A. The Computer - An Information Processing Machine

B. Elements of Electronic Data Processing

C. The Basic Choices

A. The Computer - An Information Processing Machine

In this study, we have taken a broad view of an "information system." We have viewed it as a pattern and process of interaction among people, and possibly machines, in which an organization identifies, collects, saves, analyzes, and disseminates the information it uses to set goals, design programs, and control day-to-day operations. There are many ways the machines can be used in such an "information system." The purpose of this chapter is to explain some things about information processing machines and how they can help (or can not help) make an organization's information system more effective.

A machine is a tool used to do work, i.e., to move or change the material things which we find around us into different things that are more to our liking and use. A machine can be very simple, like Archimedes' "water screw," which is used to do

the work of raising or changing the level of a quantity of water; or it can be very complex such as a petroleum refinery which does the work of changing crude oil, with its chemical properties, into gasoline, with its more desirable properties. Similarly, a computer is a machine which does the work of sorting, combining, and selecting information so that the information is more useable and meaningful.

Simple machines, such as Archimedes' water screw, involve only a small number of steps. Complex machines, such as a petroleum refinery, involve literally thousands of steps, and can best be thought of as processes which take certain inputs (crude oil, in the case of a refinery) and perform the work or task of transforming these inputs into outputs (gasoline). Thought of as a process, the computer is a machine which takes as inputs, combinations of data, and processes (selects, sorts, and combines) them into the output of a new combination of data.

As with any machine, in the case of the computer, the quality of the output will depend on both the quality of the input and the quality of the process. Yet here the similarity between computers and other machines begins to break down. Virtually all other machines use their inputs only once, i.e., they expend their inputs in the process of production. The computer, on the other hand, can re-use the same inputs again and again, i.e., it can recombine the same

data in many different ways for many different uses over and over again. It can take information about worker's pay rates and how long and on what tasks they have worked to determine weekly or monthly payrolls. It can take information from purchase orders to determine what has been bought for a project. It can combine the same information it used to do payroll and purchase orders and use it again determine how much has been spent to date on various projects and then compare this to the amount budgeted.

Besides having an almost inexhaustible capacity to combine information and to use the same information over and over again, the computer has a speed and accuracy that is almost difficult to comprehend. It can do thousands of calculations, which would have taken an entire office staff weeks to do by hand, in a matter of seconds. Further, so long as the data and the instructions of what to do with it were input into the computer correctly, it can calculate without any mistakes, while if done by hand, there inevitably be at least some percentage of error.

SOME CHARACTERISTICS OF COMPUTING MACHINES

* CAN USE THE SAME DATA OVER AND OVER AGAIN
* CAN EASILY COMBINE DATA FROM DIFFERENT SOURCES
* GREAT SPEED
* GREAT ACCURACY

Figure V - 1

These factors - the capacity to combine data from different sources and to use the same data over and over again, with great speed, and great accuracy - give the computer its value, and explain why tens of thousands of computers are in use today. These factors imply that computers are useful in at least four types of cases. The first type is the case where common information will be combined and used multiple times in different ways as is done in a generalized accounting system where payroll, purchasing, inventory all use at least some common data. The second, is where there is a large volume of information which must be processed and where doing so by hand would be too time consuming or would greatly reduce accuracy. A typical example is insurance claims for a health insurance plan. A third area is where the information is needed without delay if it is to be useful. The classic case in this regard is the use of computers to determine flight availability in making reservations and advance ticketing at airline offices in major cities around the world. A fourth area in which computers are useful is where there is a need to do complex calculations which are difficult to do by hand. In this case the calculations are routinized and tested on the computer where they are referred to as "packages." These packages can be then used easily by anyone. Linear programming, as used in industrial production or in analyzing alternative agricultural cropping patterns, is a classic example. Many

computer applications are, of course, combinations of all four of these areas - where there is the need to combine large amounts of information from different sources, several times in different ways, and to perform involved analysis and to do so quickly and accurately.

TYPICAL COMPUTER USES:

* SAME DATA MANY TIMES
  (E.G. PAYROLL, PURCHASING, INVENTORY FOR COST CONTROL)

* LARGE VOLUMES OF DATA WHICH WOULD TAKE TOO LONG TO PROCESS ACCURATELY BY HAND
  (E.G. INSURANCE CLAIMS)

* IMMEDIATE RESPONSE REQUIRED
  (E.G. AIRLINE RESERVATIONS)

* COMPLEX CALCULATIONS
  (E.G. LINEAR PROGRAMMING)

Figure V - 2

B. Elements of Electronic Data Processing

Thus far, we have spoken of the computer as if it were a "black box" which processes information. We will now, in a very general way, attempt to "open the black box," and say something about the goings-on inside a computer that give its inexhaustible capacity to combine, and its great speed and accuracy.

Physically, a computer is made up of connected electronic circuits. A circuit is set of electronic switches which allow or stop the sending of electrical current, i.e., are "on" or "off", respectively. The circuits structure the way the high and low pulses ("ons" and "offs") of electrical current passing through the computer combine. If we think of the pulses of current as binary numbers (base power of 2 instead of 10), it is possible to design circuits which combine pulses in ways which simulate addition and the other arithmetic processes. In fact, that is all the first experimental computers were - simple circuits which added, subtracted, multiplied, and divided binary numbers. Obviously, the technology of computers has advanced very much in the last thirty years, yet they are still essentially connected circuits. The circuits have become more complex, the frequency and encoding of the electronic pulses has changed; the physical medium of which the circuits are made has changed (from vacuum tubes, to transistors, to glass chips scratched by lazers) - yet they are still essentially masses of circuits which combine pulses of electrical current.

Thus, computers are machines made up of interconnected circuits, which take data as input and process that data into some new format which is the output. The data itself must be input into the computer, or retrieved if it has already been input and stored; the computer must be instructed about what to do with the data; and the results of the processing must be output in a form which is useable. Thus, there are multiple elements involved in the electronic data processing cycle. These are as follows:

1. data, or the basic information to be processed,

2. the input medium or mechanism by which the data is put into the computer,

3. hardware, or the collection of circuits which make up the machine part or the computer proper,

4. software, or the instructions which tell the computer how to processes the data and what the output should look like,

5. the output itself, or the physical results of the processing of the data,

6. auxiliary storage or the way of keeping and accessing data not immediate or directly input.

The nature and role of each of these elements in the data-processing cycle is discussed briefly below.

ELEMENTS OF COMPUTING MACHINES

* DATA
* INPUT MECHANISM
* HARDWARE
* SOFTWARE
* OUTPUT
* AUXILIARY STORAGE

Figure V - 3

1. Data

In the last chapter, we defined data as an organized set of characters or numbers which describe some aspect of something in which one is interested. There is a hierarchy of complexity in which these characters or numbers can be organized in the computer. The most basic is the bit, which is a single "on" or "off" pulse of current in the computer. It takes a sequence of four such bits to form a byte or character in a computer. A set of characters or bytes which are logically related and physically contiguous is a field, i.e., a variable or category or information. For example, children in school, location of a health clinic, crop yield per land parcel, would all be variables or fields. The next level in the hierarchy is that of the record. A record is simply an organized collection of fields related to some specific item or time period. In turn, a file is an ordered (sorted) collection of records. And finally, in terms of the concepts introduced in the last chapter, a data base is a set of files which are "chained" or "linked" together.

For very small computer applications, it is possible to have the computer work with "fields" as the highest level of data. For most administrative or management applications, however, the data on which the computer will operate will minimally be organized as files, and today, with growing frequency as "chained" files, i.e., as a data base.

DATA HIERARCHY

* BIT
* BYTE OR CHARACTER
* FIELD
* FILE
* DATA BASE

Figure V - 4

2. Input Mechanism

While a computer can do hundreds of thousands of calculations in seconds, in many ways, it is a very "stupid" though "obedient" machine. It cannot interpret and does only exactly what it is told. Therefore, its instructions and data must be precise. For example, if on a computer personnel file, my name is input as "Romagne" instead of "Romagna," and the computer is instructed to find my record in the file, it will not be able to do so. It will return a statement to the effect: "RECORD NOT IN FILE." The results of the processing of a computer are no better than the accuracy of the instructions and of the data.

There are basically four ways that information (instructions or data) can be put into the computer:

1. by "key-to-card" or "key-punching," in which the information is typed on a machine which represents it as holes in a small card, which are then read by a "card reader" which translates the holes into electrical impulses,

2. by "key-to-tape," in which the information is typed on a machine which converts it to magnetic patterns on a recording tape, which are then translated by a "tape-drive" into electrical impulses,

3. by "key-to-disk," in which the information is typed on a machine which converts it to impulses on a disk similar

to a phonograph record, which are then translated by a "disk pack" into electrical impulses, and finally,

4. by "key-to-core," in which, usually only for small specialized applications, information typed on a typewriter, CRT-type display terminal (TV or cathode-ray tube terminal), or on a computer console, is translated directly into impulses in the computer's main core of circuits.

"Key-punch" is the oldest form of mass data entry and "key-punch" machines, which are fairly sturdy and reliable mechanical devices, are found scattered around most countries. The decks of cards which are the physical product of key-punching information are slightly less convenient to use, and slightly more prone to damage, and take up more physical storage space than disk or tapes. Also, the "card readers" which translate the cards into impulses for the computer are more prone to require maintenance than the newer solid-state disk and tape units, yet such maintenance is usually much simpler to diagnose and perform than for disk or tape units. In any case, "key-punching" certainly can do the job of data input adequately. The critical factor in a developing country in deciding what medium is most appropriate for a particular application will often be determined by what is locally available and maintainable and its costs.

INPUT MECHANISMS

* KEY-TO-CARD
* KEY-TO-TAPE
* KEY-TO-DISK
* KEY-TO-CORE

Figure V - 5

3. Hardware

As discussed earlier, the hardware of the computer machine is a set of connected electronic circuits which simulate calaculations on data by combining electronic impulses in predetermined ways. This hardware of circuitry has seven basic capabilities. First, it can read information from some external medium such as a card-reader or an electronic typewriter. Second, it can write information out to some external device such as CRT (TV) display or to a typewriter or line-printer. Thirdly, it can transmit information internally, i.e., it can move information from one location in the computer to another. Fourth, it can compare information to see whether certain data are equal to, less than, greater than (etc.) each other. Fifth, it can do simple arithmetic computations, namely addition, subtraction, multiplication, and division. Sixth, it can "branch," i.e., it can control the order or sequence in which it does operations, or for that matter whether or not it does certain operations. (For example, in evaluating personal medical records to identify persons requiring vaccination, if it finds a "yes" pertaining to whether the person had certain immoculations, it can ignore the remainder of that individual's file and go on to examining the next person's records.) Finally, a computer can control peripheral devices, i.e., it can send signals to other machines as is done in using computers to controll a wide variety of complex industrial processes.

HARDWARE CAPABILITIES

* READ DATA
* WRITE DATA
* TRANSMIT DATA INTERNALLY
* COMPARE DATA FOR IDENTITY AND EQUALITY
* DO ARITHMETIC COMPUTATION
* BRANCH (CONTROL SEQUENCE OF THE OPERATIONS)
* CONTROL PERIPHERAL DEVICES

Figure V - 6

4. Software

If the computer could only process information in a predefined sequence, a separate and unique combination of circuits would have to be built for each application. Indeed, there are certain computer manufacturers which do this; they have designed special circuit boards to do different jobs - one for accounts receivable, one for payroll, one for inventory, etc. When the operator of the computer wants to do a different set of operations, he pulls out one circuit board and inserts another. If this were the only way that computers could operate, they would of course, still be useful, but their flexibility would be greatly reduced because every different application would involve changing some of the hardware, and every new application would involve in essence building a new piece of hardware. The great flexibility of computers arises from the fact that not only can data be input into the computer, but so also can instructions as to what particular operations are to be performed on the data. These instructions need not be in the "hardware" of the computer, they can be in the messages sent to it, in the "software."

Software is the instructions which tell the computer what operations to perform on data. Groups of such instructions which define a particular logical task or program are called "programs." As with data, the software, programs, or instructions

must be presented to the computer in a way in which the computer will understand them.

The changes in the "languages" used to give the computer these instructions have been no less revolutionary than those which have taken place in hardware. The first experimental computers could only understand instructions in their own language - "machine language." Machine language has only two characters, the only two which circuits understand, "on" and "off" or "1" and "0." Machine language programs were series of instructions which were translated into 1's and 0's and thereby made understandable by the computer's hardware - a nice medium of communication for the computer but not very pleasant for the person giving the instructions. This led to the development of symbolic languages in which basic operations could be represented by words instead of numbers. Such languages are called "assemblers," as they assemble each symbolic statement into a corresponding machine language statement. Assembly languages, though far superior to machine language coding, still leave much to be desired because, while words like ADD, SUB, DIV, and MULT could be used to represent basic operations, the operations themselves still had to be thought of in terms of how the computer would do them - one small step at a time. To do simple calculations would take literally hundreds of assembly language statements - hardly worth the effort for small applications.

This led to the next stage in the evolution of computer languages, the development of compiler driven languages, or "compilers." The special feature of compilers is that one statement can be "complied" or translated into multiple statements or lines of machine language instruction. This greatly reduced the time required for programming and thereby increased the number of applications for which computer processing was economically feasible. The most widely used compiler languages are COBOL, which stands for "common business oriented language;" FORTRAN, which stands for "formula translator;" and BASIC, which stands for "beginner's all-purpose symbolic instruction code." Most of the instructions used to control computers today are written in these three compiler languages.

In using a compiler language, the instructions written in the language, called the "source program," are input into the computer and then "compiled" into the corresponding set of machine language instructions, called the "object program," or "object deck," if they are physically represented on a deck of punched cards. This compilation of the source program into the object program need be done only once unless changes are made to the source program. The object program then becomes the instructions which are used to direct the computer to do routine work. This leads to considerable efficiency in terms of use of the computer's hardware, in that the source program need not be

compiled everytime that a program is run. If the job that the computer is being asked to do is not routine, however, as in a research or planning environment, the use of compilers can be inconvenient in that everytime a change is made, the programmer must wait for the program to be recompiled before he can evaluate the results. It has led to the development of interactive languages or "interpreters," in which each line of a program is compiled or interpreted as the program is being run, allowing the programmer to interact directly and immediately with the computer, or even to interrupt it in the middle of a program and to decide to change instructions which the computer has not yet executed. Both FORTRAN and BASIC exist in such interactive forms.

The newest, and in some ways most controversial major computer language is APL, which stands for "a programming language." It was developed as an extension of mathematical notation, rather than with the computer execution in mind, by Dr. Kenneth Iverson, formerly of Harvard University. APL is an interpretative language, which is very powerful in terms of conciseness of notation, requiring on the average 10 to 20 times fewer statements than FORTRAN of BASIC and 80 to 100 times fewer statements than COBOL. It's main disadvantage is that, until recently, APL could only be run on a very large computer with the capacity to the store

hundreds of thousands of statements which made up the APL interpreter. Thus, APL, while very efficient for the qualified programmer, was very inefficient for the computer hardware. As hardware costs have shrunk and hardware capabilities have increased, this has changed in that APL now exists on several mini-computers. While APL has become the principal language for management, planning, and research use for several large organizations, such as the U.S. National Aeronautics and Space Administration, IBM and most of the airline industry, it stills remains controversial among traditionally trained programmers. Some objections are that good APL programmers are difficult to find and train, and that the ability of APL to do sophisticated operations far beyond the standard operations found in other languages (e.g., the rotation of three dimensional arrays of data), make it difficult for anyone other than the original programmer (and the machine) to understand what is being done and why.

EVOLUTION OF SOFTWARE

* MACHINE LANGUAGE
* ASSEMBLY LANGUAGES
* COMPILERS
* INTERACTIVE LANGUAGES
* INTERPRETERS

Figure V - 7

There are two general types of software: systems software and applications software. Systems software is the basic software that is usually supplied with any computer. It programs the computer to accept other programs, schedules the order in which it does operations, and contains the compiler or interpreter for whatever languages can be used. Applications software are those specialized programs, written in a way that is consistent with, and takes advantage of systems software, which are directed at doing some specific job such as producing a payroll, listing the names of respondents in a survey, etc. Applications software can involve single programs and groups of related programs called "packages."

TYPES OF SOFTWARE

* SYSTEMS SOFTWARE - CONCERNED WITH GENERAL COMPUTER OPERATIONS (FILE MAINTENANCE, INTERNAL MACHINE CLOCKING AND ACCOUNTING, ETC.)

* APPLICATIONS SOFTWARE - CONCERNED WITH USER JOBS (PAYROLL, SURVEY ANALYSIS, ETC.)

Figure V - 8

There are ten principal steps in the development of applications software. These are as follows:

a. Problem definition

A computer program is a way of solving someone's data manipulation or calculation problem. As with solving any problem, the first step is to clearly define just what that problem is.

b. Algorithm design, testing, evaluation, and choice

An "algorithm" is a regularized procedure (sequential set of operations) for solving a mathematical or data manipulation problem. Usually several different ways to solve a problem (such as combining the information from different survey instruments) exist or can be created. In any case, one must be found or selected before a program can be written.

c. Flow charting

This involves using a visual graphics technique to specify the details of the algorithm so as to serve as a guide in writing a program or programs.

d. Coding

The is the actual writing of the program in the language used, based on the algorithm and flow-chart.

e. Conversion to machine-readable form

This involves either key-punching the program or typing it into the computer using a typewriter-terminal or a CRT-terminal.

f. Running of the program

This will involve assembly or compilation if an interpretive language is not used.

g. Debugging

This involves correcting mistakes in the coding of the program or if necessary in the algorithm.

h. Documentation

The program is then described so that future problems which may arise can be easily fixed, or desired changes made.

i. Operational use

This, of course, involves using the program for the work for which it was intended.

j. Maintenance

This involves making the adjustments needed to keep the program functioning either because of changed circumstances or unforeseen "bugs," i.e., "mistakes" which did not originally appear in routine processing but which since have become apparent.

STEPS IN PROGRAM DEVELOPMENT

* PROBLEM DEFINITION
* ALGORITHIM DESIGN
* FLOW CHARTING
* CODING
* CONVERSION TO MACHINE-READABLE FORM
* RUNNING OF PROGRAM
* DEBUGGING
* DOCUMENTATION
* OPERATIONAL USE
* MAINTENANCE

Figure V - 9

5. Output

The output of the result of data processing is information which has been generated either by summarizing, combining, or projecting other information. Physically the form of the output can be a picture on a CRT or it can be "hard copy," i.e., standard "computer printout." While some futurists are projecting an eventual "paperless organization" in which management receives only the information it needs, as it needs it, from CRT terminals, this is unlikely to ever be the case in the public sector where overlapping patterns of responsibilities and interests dictate that multiple copies of duplicative forms be generated, signed and filed. Thus, for all practical purposes, for the foreseeable future, when we speak about computer output, we are speaking about hard copy printout.

Functionally, there are two basic kinds of hard copy documents which the computer generates: transaction forms and summary reports. Transaction forms are the specific detailed documents which are generated in the work of an administrative department, such as requisitions, purchase orders, bills of lading, etc. Summary reports are, by definition, those summaries of detailed transaction documents (or individual surveys) which summarize for management the status of work (or in the case of surveys, the status of their target group). The form of transaction reports will obviously vary greatly, depending on

the type of transaction. Almost all summary reports, however, will take a form which is structurally similar in format. They all are matrices or rectangular arrays of data with appropriate verbal description and identification, both for rows and columns. Some rows and columns will usually be simple arithmetic functions of other rows and columns, but not necessarily. By way of illustration, the following figure contains a quarterly financial summary report for a village health clinic.

QUARTERLY HEALTH CLINIC FINANCIAL SUMMARY

	(Second Quarter 1979)			(Year to Date)		
	(1) Budgeted Amount	(2) Expected Amount	(3) Variance (1)-(2)	(4) Budget Amount	(5) Expected Amount	(6) Variance (4)-(5)
(1) Physicians	000.00	000.00	000.00	000.00	000.00	000.00
(2) Nurses	000.00	000.00	000.00	000.00	000.00	000.00
(3) Other	000.00	000.00	000.00	000.00	000.00	000.00
(4) Total All Personnel	0000.00	0000.00	0000.00	0000.00	0000.00	0000.00
(5) Overhead	000.00	000.00	000.00	000.00	000.00	000.00
(6) Pharmaceuticals	000.00	000.00	000.00	000.00	000.00	000.00
(7) Transportation	000.00	000.00	000.00	000.00	000.00	000.00
(8) Total Supplies	0000.00	0000.00	0000.00	0000.00	0000.00	0000.00
(9) Total Expenses ((4)+(8))	0000.00	0000.00	0000.00	0000.00	0000.00	0000.00

Figure V-10

This report summarizes financial information both for the current quarter and for the fiscal year-to-date. It contains information on the amount budgeted, the amount expended, and the variance, or the difference between them. It lists information for various categories of medical personnel, for supplies and expenses, as well as subcategory totals, and a grand total.

Structurally, this report is a simple 9 by 6 matrix, with row and column titles, in which two columns are linear functions of other columns, and in which three rows are simple sums of other rows. In most other summary reports on operations data, the numbers will vary, the titles will vary, and so will the arithmetic relations among the columns and rows. The basic structure, however, will be the same - a matrix of data with row and column titles.

A similar situation exists with survey data. In this case, however, the rows will usually be response groups (e.g., those answering "yes," those answering "no") for some question, and the columns will usually be either frequency counts, percentages, or some other descriptive statistic.

In most applications packages, the details (titles, and relations among rows and columns) of reports are fixed, (i.e., they cannot be changed without reprogramming). Recently, however, several "generalized reporting packages" have been developed which allow the user, in response to questions asked by

the computer terminal, to custom design the format of his report, and to change this format as his needs change. The flexibility of such packages is a valuable asset in most uses, but particularly in an environment characterized by dynamism and change, and in one in which there is a shortage of programming skills. This is precisely the situation in most public sector applications in most developing countries. Management priorities and skills are both undergoing continual change, and the demand for programmers is growing faster than the ability to train them, with the best-trained ones usually leaving for higher salaries in the private sector.

6. Auxiliary storage

As we have seen, one of the important characteristics of electronic data processing machines is that data need only be input once and that it can then be stored and used over and over again. Physically, there are two basic ways to store data: on tape and on record-like disks. Tape storage used to be cheaper than disks, but the cost of disk-reading machines ("disk packs") has gone down sufficiently that this is no longer necessarily the case. Disk storage also greatly facilitates "interactive" data access, in which the computer asks the user questions about what data he wants to access and then proceeds to get the data which the user specified.

In terms of systems software, there are many different ways to access data stored on disk and tape files. Many manufacturer's representatives extoll the virtues of their system's method of access as compared to others. The critical variable for the user is not whether vender's file system or data-base access system is a few thousanths of a second faster than another, but how to get data on and off them after they have been set up.

C. The Basic Choices

We have seen that computers can be thought of as somewhat remarkable electronic machines, which can vary greatly in the content and method of their input, the complexity of their hardware, the simplicity of their software, the medium of their storage, and the format of their output. We shall now attempt to recast some of our previous discussion in terms of how one decides how best to use computers (if at all) in a specific situation.

The basic premises of the strategy of Chapter II with respect to electronic data processing are that computers are only one factor making for useful information, which in turn is only one factor contributing to good decision-making. Following from these premises, the proper way to evaluate whether and how to use computers is to focus on management's information problems, at each stage asking critically whether those problems can be better solved by electronic data processing. This can be done by following a plan similar to that outlined in the next chapter, which attempts to identify information needs based on management decisions, and to base collection and processing methods on information needs.

In attempting to identify problem areas where electronic data processing is likely to be appropriate and effective, several problems seem to be most common: problems arising from inaccuracies of hand processing, problems arising from lack of timeliness, and problems arising from the inability to integrate data from different sources. How the computer can be useful in each of these areas ought to be somewhat obvious from the discussion of computer capabilities. Nevertheless, a further

word on these areas is in order.

1. problems arising from information being processed inaccurately by hand

People make mistakes. Tabulations are done incorrectly. Decimal points are misplaced. Totals are incorrectly printed, etc. While these problems exist in almost all organizations, normal clerical procedures usually assure that they are corrected before they become critical. Gross errors are usually deleted by accounting practices which require periodic trial balances and numerous cross-checks across totals from various accounts. Given effective controls on data collection, transcription, entry, and software development and use, electronic data processing can virtually eliminate most of these "routine" errors. However, even in this simple problem area, it is not a panacea. A organization's ability to control routine hand processing of data is usually a good indicator of its ability to effectively control computerized data entry and processing.

2. problems arising from lack of timeliness

Lack of timeliness in the processing of data can be a problem for operation data, but in practice this is not usually the case. The necessity of paying workers and vendors on-time (for morale and goodwill reasons, if for no other) imply that, while there often is not much lead-time, results are usually computed as required. This is far from being the case with regard to surveys, particularly large surveys such as censuses, which in many countries literally take years to process. Thus, the processing of survey data is frequently an

early and important use of EDP equipment and resources in most countries.

3. problems arising from the inability to integrate data from different sources

Frequently, the most compelling reason for introducing or upgrading electronic data processing in an organization is the inability to integrate data from different sources. This problem occurs most vividly in operations data. It is in the nature of operations that effective control requires information integration. Control of quality and cost requires control of people, schedule, purchasing and inventory at a fairly low level of detail (that of separate activities or tasks within projects). The necessarily separate activities payroll, purchasing, inventory and schedule management must be combined at this level. It is in this area that computerization can have greatest impact. In fact, in large systems, it is a necessity for centralized control.

A fourth problem area for examination for potential use of electronic data processing, which cuts across the others just mentioned, is that of the inefficiency of hand processing. As computer costs decrease and labor costs increase, computerization often can be cost-efficient in narrow economic terms. Often an entire payroll section of ten people can be replaced with two or three people plus a mini-computer. While not intending to argue for deliberate inefficiency, there are good arguments for proceeding cautiously in terms of introducing electronic data processing strictly for purposes of efficiency. The first relates to appropriate technology" arguments discussed in Chapter I. There may be good external (non-

cost-benefit analysis) reasons why more labor intensive processing configurations ought to be continued or introduced. (These reasons will vary greatly from situation to situation). Secondly, the total costs of computerization are often underestimated, both in terms of direct hardware and software costs, as well as in terms of the personnel required to run the system once in place. Applications which were predicted to be cost-effective often end up being more expensive in actual use.

In addition to the basic choice area of the problems to which electronic data processing is to be applied, two other choice areas are that of the specifications of hardware and software, and that of the physical format of the desired output. While not enabling a generalist manager to make such choices on his own, the ideas discussed in this chapter ought to assist him in using technical support staff and consultants in making these choices in an effective way.

VI. CONCLUSION: A Simple Plan of Action

A. Plan for a Plan

B. Outline of a Plan for Management Information Analysis

A. A Plan for A Plan

This study has attempted to order and explain the choices and issues involved in improving data for decision-making. The substantive context has been that of developing countries, from which all examples have been drawn, although much of what has been discussed is equally applicable to public sector organizations in developed countries. The approach taken throughout, while attempting to be intellectually rigorous, has been pragmatic. It has focused on the choices that will of necessity be made (whether consciously or by default) in attempting to improve how an organization identifies, collects, processes and uses information in an environment of changing problems, goals, and activities. This chapter will attempt to integrate information and ideas discussed in previous chapters into a simple plan designed to serve as a "cook-book-like" guide for those concerned with the actual task of improving and adapting an organization's management information system.

A plan is a description of the steps which take us from where we are to where we want to be. There can be, by definition, no plan without knowing where we want to go, without specifying goals and objectives. With improving management information, as we have seen, the general goal is the making of better decisions. While necessary to be ever kept in mind when dealing with management information issues, this goal in itself is so general as to be of little guidance in drafting a <u>detailed</u> plan of action.

A detailed plan will depend on the nature of the decisions and concerns which face management in a given organization, on the quality and quantity of its human and material resources, and on the extent to which the kinds of issues and choices described in this study are adequately addressed in drafting such a plan. The chapter does not seek to outline a detailed plan of action for improving management information, per se. As indicated, this cannot be done independently of a specific organizational context. It seeks instead to outline a plan for developing a plan, i.e. a plan for applying, in an organized way, some of the ideas and insights described in this study.

B. Outline of a Plan for Management Information Analysis

In doing management information analysis, experience has shown the following sequence of steps to be useful:

1. Putting together an analysis team

No analysis will be better than the quality of the people who do it. Because of the importance of information to the work of an organization, it is extremely important that the people involved be the best people available, with someone having knowledge in each of certain basic areas: management, administration, data collection, data processing, and knowledge of the substantive areas of operation of the organization (health, education, agriculture, etc.). A single person ought to have responsibility for the group's results. The group itself ought to be as small as feasible, making it desirable to have persons with expertise in more than one area, where possible.

2. Determining whether to continue with a detailed analysis

Before investing major amounts of time and energy, the project team must make a preliminary decision as to whether the anticipated consequences make doing a management information analysis worthwhile. They must address the question as to whether management's current decision problems can be affected by better information or not. Does the organization meet certain minimal levels in the areas we had called "necessary conditions" in Chapter II: an end-results orientation on the part of management, an organization structure which allows for coordination in the execution of decisions, adequate staff capability for analyzing information, and decisional latitude to utilize information in addressing the organization's problems. If these conditions do not minimally exist, is there a reasonable expectation that they might be changed? If so, their change can be part of an improvement plan. If not, they ought to be changed before proceeding with the analysis.

3. Doing a "macro" analysis of the organization in terms of its major missions and activities

Such a macro-analysis will specify, for the organization as a whole, the following categories of information:

a. the major goals, purposes, and functions of the organization,

b. its major problems and concerns,

c. the broad options and decisions that would have to be made to address these problems effectively.

d. the information needed to approach the decisions in an informed and rational manner,

e. the information actually available and its status,

f. the gaps between information required and the information available.

4. Doing a "micro" analysis of each major unit within the organization

This micro-analysis will ask the same kinds of questions at the unit level that the macro-analysis asked from the perspective of the whole organization, with one significant addition. It will also attempt to identify ways of bridging the gaps between required and actual information.

5. Doing a "linkage analysis" of the individual units

This involves specifying how each unit interacts with other units in the organization. It involves identifying what information and directives are passed from who to whom.

6. Doing a "resource analysis"

If a plan is to succeed in getting us from where we are to where we want to be, it must assure that actual or developable resources are sufficient to last the journey. The organization's management, administrative, data collection, data processing, and data analysis capabilities must be specified. This, in some cases, will involve identification of external support resources available such as computer hardware support, programming support, and other forms of technical assistance.

7. Prioritization and grouping of suggestions from the micro-analyses

The numerous improvement suggestions made in the micro-analyses of the individual units need to be prioritized. This prioritization will depend on several factors: management's critical information needs (based on the macro-analysis), the human and material resources available, linkage patterns, and on the economies of scale which might accrue from grouping and coordinating certain data collection, processing, or analysis activities.

8. Integration of suggestions into a plan

The specific recommendations must themselves be managed. A schedule must be set up, as well as procedures for monitoring the cost and quality of each activity.

9. Effective presentation of the group's findings and suggestions

The process described in the preceding eight steps is a communicative process which generates continual feedback. It serves to keep the entire organization aware of the planning group's activities and thoughts so that its recommendations, report, and plan ought not contain many surprises. Nevertheless, the recommendations must be presented to top management as if it were hearing them for the first time, both in terms of concept and approach, as well as of implementation details. Costs and advantages of various options should be presented in a forthright manner (e.g., alternative levels of data processing). Once top

management has agreed to the details, the plan should be communicated to all relevant persons in the organization (i.e., anyone who will have to do something differently as a result of the proposed changes). The most effectively implemented plans are those which have not only commitment from top management but also support throughout all levels of the organization.

STEPS IN A PLAN FOR MANAGEMENT INFORMATION ANALYSIS

* PUTTING TOGETHER AN ANALYSIS TEAM
* DETERMINING WHETHER TO DO DETAILED ANALYSIS
* DOING A "MACRO" ANALYSIS
* DOING "MICRO" ANALYSES OF MAJOR UNITS
* DOING A "LINKAGE" ANALYSIS
* DOING A "RESOURCE" ANALYSIS
* PRIORITIZATION OF SUGGESTIONS FROM MICRO ANALYSES
* INTEGRATION OF SUGGESTIONS INTO PLAN
* PRESENTATION OF FINDINGS AND SUGGESTIONS

Figure VI-1

BIBLIOGRAPHY

The term bibliography, as applied here is a misnomer. What are presented here are simply some suggestions for further reading. Many of the works themselves contain large bibliographies, which can then be consulted.

For the topical areas of the "basic needs approach" and "appropriate technology," discussed in chapter one, the reader would do well to read such "source documents" as E.F. Schumacher, Small is Beautiful: Economics As If People Mattered," Harper and Row, New York, 1973.

For general issues involved in upgrading information systems, Jerome Kanter, Management-Oriented Management Information Systems, Prentiss-Hall, Englewood Cliffs, N.J., 1972, is a most comprehensive and readable volume.

For a discussion of the information requirements of project and program management, a clear and incisive treatment is found in N. Imboden, A Management Approach to Project Appraisal and Evaluation, Organization for Economic Cooperation and Development, Paris (and Washington), 1978.

For further reading in the topics of data collection discussed in chapter four, two old standards are still worth consulting: Fred N. Kerlinger, Foundations of Behavioral Research, 2nd Edition, Holt, Rheinhart, and Winston, New York, 1973; and Donald T.

Campbell and Julian Stanley, Experimental and Quasi-Experimental Designs for Research, Chicago, Rand McNally, 1963.

For additional reading on data processing issues, a good beginning is Jerome Kanter, Management Guide to Computer Selection and Use, Prentiss-Hall, Englewood Cliffs, N.J., 1970.

Finally, for reading in general management concerns which pervades entire study, Dick Carlson, Modern Management: Principles and Practices, O.E.C.D., Paris, 1962, still remains a work which should be on every development manager's book-shelf.

THE AUTHOR

John Romagna is currently Social Science Advisor to the Agency for International Development with special responsibilities in the area of management information systems and analysis. For the past three years, he has also been on the faculty of the Graduate School of International Studies of the University of Denver, where he has taught courses in systems and policy analysis, the management and planning of technological projects, social science theory and research methods, and advanced statistics. He has been a consultant in management and information systems to the U.S. and foreign governments particularly related to social services, health and rural development, and to international corporations, particularly in the areas of electronics and telecommunications, and large project management.

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