Lessons Learned from the Administration of the Rand Health Insurance Experiment

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Rand

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PREFACE

This report summarizes major lessons learned from the administration of the Rand Health Insurance Experiment, a large-scale social experiment designed to investigate the effects of alternative health insurance plans on the use of health services and on health status. The Experiment involved the design, administration, and processing of numerous data collection documents, and the management of several substantial subcontracts. This report presents conclusions that can be drawn from this body of operational experience about issues that will face managers of future large, complex, social science research projects and suggests ways by which those issues might best be resolved.

Additional administrative issues are addressed in R. W. Archibald and J. P. Newhouse, *Social Experimentation: Some Whys and Hows*, The Rand Corporation, R-2479-HEW, May 1980.

This report should be particularly useful to inexperienced managers or sponsors of large, complex social science research projects. It should also be of interest to experienced managers and students of social science research.

The author was associated with the project in a managerial role for nine years, beginning as a member of the operations staff and ending as Director of Administration. (See the organization chart on page 6.)

The analysis reported herein was performed pursuant to Grant No. 016B-80 from the U.S. Department of Health and Human services, Washington, D.C. The opinions and conclusions expressed are solely those of the author and should not be construed as representing the opinions or policies of any agency of the U.S. government.

SUMMARY

The Health Insurance Experiment (HIE) was an extraordinarily large and complex research project. It lasted 15 years and cost approximately $80 million. The experience of running the HIE yielded a wealth of knowledge about problems that arise on large, complex projects and the most favorable approaches to solving them. This report summarizes these lessons learned from the administration of the Health Insurance Experiment.

Because of the nature of the research conducted and the way the project was organized to conduct it, the lessons learned pertain to the following five subjects: general project management (organization, communications, scheduling, and cost control), data collection and processing, management of subcontracts, program administration, and management with an operations staff.

GENERAL PROJECT MANAGEMENT

On large projects, substantial effort can go into work not directly related to analysis of data and publication of the results. This work may include budgeting, scheduling, design and implementation of data collection and processing systems, and the administration of an experimental program. Under these circumstances, employing a staff whose sole responsibility is to carry out these tasks (an "operations" staff) can have many benefits. The benefits will be maximized if the project is bureaucratically organized, that is, if job responsibilities and lines of authority are defined in detail.

The management of communication processes should be a top priority on large, complex projects. Channels of communication should be established and adhered to; systems to control written communications should be developed.

DATA COLLECTION AND PROCESSING

Data collection and processing systems should be developed and implemented in a standardized and orderly fashion. The development process should include preliminary feasibility studies, creation of schedules and budgets, development of detailed descriptions of what the system is to achieve and how it will do so, and reviews of these descriptions by the appropriate persons. The systems should be tested before being put into full-scale operation. These steps should be carried out for all parts of the system--e.g., the data collection documents, and clerical and machine processing procedures--as part of a unified development effort.

Once a system is in place, changes to that system can cause many problems. Revisions must, therefore, be carefully managed. In particular, all ramifications of contemplated changes should be thoroughly explored before the changes are implemented. Detailed documentation should be created for any system revisions.

In fact, we found that it is very important to document *all* data collection and processing procedures as well as any exceptions that are made to these procedures by the operations staff. Creation of such documentation should be a routine part of developing and operating data collection and processing systems. Project managers should take steps to insure that this documentation is used properly by the research staff.

System development should also be accompanied by the creation of a quality control policy for that system. Besides describing the specific quality control measures to be taken, the policy should make explicit what those measures are expected to accomplish. Staff responsible for designing and implementing the policy should have the appropriate qualifications.

MANAGEMENT OF SUBCONTRACTORS

Development of good standards by which to evaluate subcontractor performance can make the difference between smoothly run operations and problem riddled operations. The standards adopted must be acceptable to the subcontractor as well as to the prime contractor. They should be formally documented before work actually starts.

As work proceeds, it should be continuously measured against the standards. When a variance is detected, corrective action should be taken.

PROGRAM ADMINISTRATION

Research-related programs entail the rendering of various treatments to a sample population. Specific program activities obviously vary from project to project. However, in all cases, rules of operation--guidelines governing the ways in which program activities are carried out--need to be developed and formally documented. These rules should be carefully constructed to balance the need to preserve the research design with the need for operating efficiency. Project management should encourage research staff to use the rules documentation as an aid to the interpretation of research results.

Often in a program, administrative data are collected for which there is no initially recognized analytical use. However, problems can occur if a need for these data arises at a later stage of the project. These problems will be minimized if such a need is anticipated when administrative systems are designed and the administrative data preserved.

PROJECT MANAGEMENT WITH AN OPERATIONS STAFF

Although, as stated earlier, there are many benefits to be gained from using a staff devoted entirely to carrying out project operations, the existence of such a staff does require some special consideration from management. Attention must be paid to the integration of the operations staff and the research staff. Also, steps should be taken to insure that the research staff participates adequately in project operations.

CONTENTS

I. INTRODUCTION

The Rand Health Insurance Experiment (HIE) was conducted over a 15 year period. Total project expenditures were approximately $80 million. This report summarizes the major lessons learned during the Experiment about the administration of large, complex research projects. In Sec. I, I discuss subjects essential to the reader's understanding and appreciation of these lessons: the intended audience for and purpose of the report, the Health Insurance Experiment experience from which the lessons are drawn, and the way the lessons were selected and are presented here.

AUDIENCE AND PURPOSE

As the budget, number of goals and objectives, and staff size of research projects increase, so do the challenges presented by project management. Yet those in charge of large, complex projects may be unprepared to meet those challenges. Often they have excellent academic backgrounds, strong analytic skills, and a good deal of experience managing social science research. But they have little formal training in management. Furthermore, the administrative issues and problems faced by managers of large, complex projects are often very different from those encountered on the smaller, simpler projects more typical of social science research.

Less frequently, persons with managerial expertise, but no previous experience with research endeavors, assume managerial positions on large projects. The need for experienced managers on such projects is recognized and people with those skills are sought to fill them. But, without guidance, it can be difficult for these people to adapt lessons they have learned in other environments to research management. Groundrules in the research world differ in important ways from those in the commercial business world.

For both these groups--researchers without managerial experience and managers without research experience--on-the-job training in the administration of large, complex projects can be very expensive.

Documentation and analysis of the experience of others in similar endeavors can lower the costs. The purpose of this report is to provide such documentation and analysis. In doing so I hope to give inexperienced research project managers practical information about some significant issues they will face and ways they can deal with them effectively.

The information and suggestions should also be of interest to sponsors and experienced managers of large, complex projects as well as to students of social science research. Sponsors need to be aware of circumstances that will confront project managers to adequately specify the work to be done, choose those who are to do it, and evaluate their performance. Experienced managers can build on their own experience by comparing it to ours. And for students, the material in this report should supplement their understanding of the theory of social science research by illuminating some of the realities of its practice.

My objectives in writing this report limit its scope in important ways. Readers should understand these limitations, otherwise their expectations may not coincide with my intent.

Because the report is based on the experience of one research project, it should not be regarded as a complete guide or "checklist" for project management. We obviously did not encounter every problem that might arise on large, complex projects. Moreover, issues that were minor for us may, for many reasons, loom large for others and vice versa.

I intended the report to be a summary of significant lessons learned (or brought home, as the case may be). I did not intend to cover all subjects with which project managers should be familiar. Neither did I intend to provide a thorough description of the HIE experience or of the HIE. Some issues that arose during the administration of the Experiment were not significant enough to discuss here; some were not readily generalizable to other projects. HIE administration and operations are described only enough to make my points.

The recommendations I make for managerial action are meant to be expedient and practical and to recognize constraints imposed by limited time and money. This is in no sense a theoretical management text and I do not pretend to add to that literature.

Managerial issues on research projects can be divided into three primary categories:

1. Issues related to management of research per se, e.g., the analysis of data and the publication of the results of that analysis.
2. Issues related to the management of project tasks other than research, such as budgeting and cost control and the collection and processing of data.
3. Issues related to management of the interface between the project and its external environment--the larger research institution, the sponsor, and the public.

This report focuses on the second set of issues. Obviously, lessons learned about these issues have implications for research management and the relationship between the project and its environment, and vice versa. However, to discuss all these implications is beyond the scope of this report. My intention is to describe what we learned about sound management of specific project operations. What makes excellent sense from this perspective is not always optimum when other factors--the sponsor's preferences or expectations, for example--are taken into account.

This caveat is especially true for cost control, scheduling, and subcontract management. Under some circumstances efficiency and administrative ideals must bow to political realities. The reader should keep this in mind when reading about these subjects in this report. For example, a subcontractor's connections to the sponsor must be considered when selecting and working with the subcontractor. The nature of the relationship may affect the feasibility of some of the suggestions made in Sec. IV. Similarly, the sponsor's expectations may influence the scheduling process in general and the amount of slack built into the project schedule in particular.

THE HEALTH INSURANCE EXPERIMENT EXPERIENCE

At this point the reader is doubtless asking, "so what was this HIE experience from which so much can be learned?" In the following paragraphs I attempt to answer that question by describing the HIE--its goals, organization, and major activities. The reader should then be able to draw conclusions about both the validity of the lessons and their relevance to his or her interests and concerns.

The following description of the Experiment is key to an appreciation of the "lessons learned." The discussion in the remainder of the report assumes a knowledge of this material. Additionally, as with any endeavor, managerial concerns on the HIE were shaped by the project's objectives, the way the staff was organized, and the steps that were taken to meet those objectives. Hence, an understanding of HIE objectives, organization, and operations provides the reader with insight as to the origins of the lessons by placing them in context.

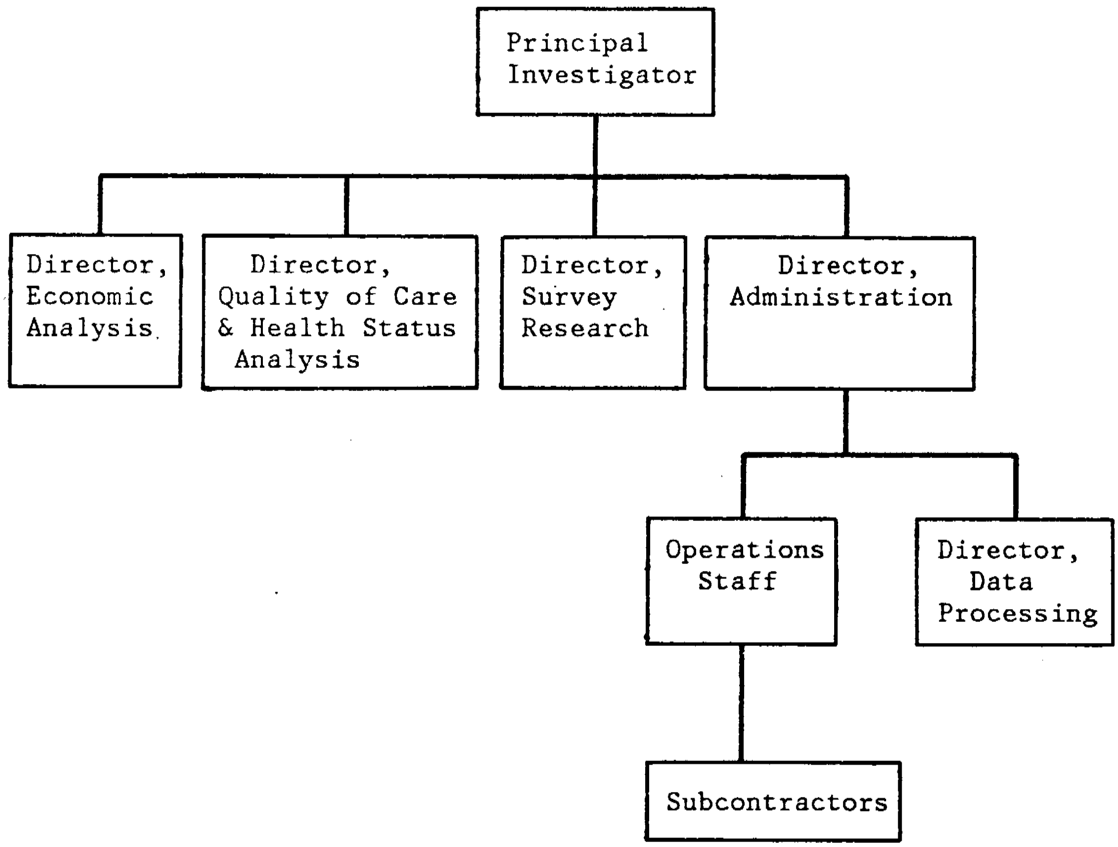
The major objectives of the HIE were:

1. To estimate how alternative cost-sharing arrangements affect the demand for health care services. If several groups of similar individuals have insurance coverage for the same health care services, but if the cost of these services is varied from group to group (different amounts of coinsurance, deductibles, or maximum out-of-pocket payments), how will the demand for health services vary across groups? The relationship between cost sharing and the quantity, timeliness, appropriateness, and convenience of the services used was examined. Health services were defined broadly to include services frequently not covered by existing insurance, such as dental, vision, hearing, mental health, and pharmaceutical services.
2. To assess the impact of varying the cost of health services on the health status of individuals. If people differ in the degree to which they use health services as a result of cost variation, what effect (if any) does this have on their level of health?

3. To determine whether cost-sharing arrangements affect poor families more than higher-income families (and by how much).
4. To ascertain how the ambulatory care system can accommodate to varying levels of demand or stress.
5. To gain familiarity with the difficulties of administering health insurance plans that place a ceiling on out-of-pocket payments by the family, the ceiling being defined as a fraction of annual family income.
6. To learn how the quality of medical care received differs (if at all) among individuals who have various insurance plans and to evaluate different methods of quality assessment, in comparison with each other and with known outcomes.
7. To compare use, quality of care, health status outcomes, and consumer satisfaction in an existing prepaid group practice with the fee-for-service system.

The HIE experimental program was designed to meet these objectives. As part of that program, 7,706 individuals in six sites--Dayton, Ohio; Seattle, Washington; Fitchburg and Franklin County, Massachusetts; and Charleston and Georgetown County, South Carolina--were enrolled in 14 health insurance plans operated by the Experiment and one Health Maintenance Organization. The plans had different coinsurance requirements and caps on the insured's out-of-pocket expenditures for medical care. The health care claims filed with the Experiment provided data on health care use and its costs to the user. We also collected information on enrollees' income, family composition, demographic characteristics, employment, employment-related sick leave benefits, health status, and satisfaction with health care throughout the Experiment. Lessons learned from these activities are discussed in Secs. III and V of this report.

The following chart shows how Rand staff were organized to accomplish all this. Research responsibilities were divided along topical lines. Analysts were assigned to one or more of three groups--economic analysis, health status and quality of care analysis, or survey research--depending upon their skills and interests. Leaders of the three groups reported directly to the Principal Investigator.



Health Insurance Experiment Organization Chart

The research staff was responsible for the design of the experiment and the analysis and publication of the results. All other project activities were under the purview of the Director of Administration. These included financial management of the project, the collection and processing of data, and the implementation and administration of the experimental program. Secs. II and VI discuss considerations stemming from this division of responsibility.

The bulk of the data collection and reduction as well as the administration of the experimental program were done by three organizations under subcontract to Rand. One organization was responsible for survey administration and a second one for giving medical screening examinations to Experiment enrollees at the beginning and end of the Experiment. The third ran the experimental program. This included the administration of the various health insurance plans, operation of local site offices, sample maintenance, collection of health and employment-related information from participants and their employers, and making certain payments to enrollees to provide them with an incentive to participate in the Experiment.

The subcontractors were supervised by an "operations staff," composed of five or six Rand staff members. They were responsible for, among other things, task specification, contract negotiations, design of data collection and processing systems, and oversight of their implementation. They monitored subcontractor performance and acted as liaison between these organizations and other Rand staff. Section IV summarizes lessons learned about subcontract administration.

Three characteristics of the Experiment bear on the subject of this report and should give credibility to the lessons presented; its duration, its size, and the variety of operations activities (data collection, processing, and program administration) involved.

In July 1971, the first grant was awarded for work that subsequently became "The Health Insurance Experiment." Enrollment of the sample began in the fall of 1974. The last families left the Experiment in January 1982. Analysis will be completed in 1986. All in all, the HIE will last approximately 15 years.

As stated earlier, total HIE expenditures will be close to $80 million by the time the Experiment is completed. Of this amount roughly 40 percent was for analysis and administration at Rand and 40 percent for subcontractors' work. The remaining 20 percent went to participants in the form of health care claim reimbursements or participation incentive payments. The HIE employed as many as 80 full-time equivalents (FTEs) at Rand during its peak. At the height of subcontractor operations the program administrator had a staff of approximately 70 individuals, the survey administrator, 350, and the screening examination subcontractor, 15 to 20.

The HIE included the following major undertakings apart from the analysis and publication of Experiment results.

- The selection of the sample and their enrollment in the experimental program.
- The operation of the experimental health insurance plans.
- The administration of medical screening exams to the sample population.
- The collection of approximately 10,000 family years[1] of data. During the Experiment over 500 different documents were used to gather a wide range of information from a variety of sources. (The following table summarizes the types of data collected, sources, and methodologies employed.)

All of the processes, procedures, and documents necessary to carry out these activities were designed, implemented, and managed by HIE staff at Rand or the subcontractors.

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[1]The "family" was a primary unit of analysis on the HIE. A "family year" is one year's worth of data about one family unit.

SUMMARY OF MAJOR HIE DATA COLLECTION EFFORTS

SOURCE	METHODOLOGY	DATA
Study enrollees and control groups	Personal interviews; self-administered questionnaires; telephone interviews; health care claims; physical screening examinations.	Demographics; family composition; income and income taxes paid; assets and debts; employment; health insurance coverage; medications taken; health care (medical, mental, and dental) use; health care expenditures; health status; satisfaction with health care received; health habits; physical health measures; knowledge of health insurance coverage; evaluation of the Experiment; assistance payments from state, local, federal government.
Physicians, Dentists, Osteopaths	Self-administered questionnaires; health care claims; telephone interviews.	Services rendered to enrollees; charges for services; office staffing levels; appointment procedures; medications prescribed.
Pharmacists	Health care claims.	Medications supplied to enrollees; cost of medications.
Hospitals	Self-administered questionnaires; health care claims; telephone interviews; medical records collection and abstraction.	Patient census; services rendered enrollees by hospital staff and attending physicians; charges for hospital services; staffing levels, salaries, and fringe benefits.
HMOs	Medical records abstraction; membership records abstraction.	Services rendered and medications and supplies provided enrollees and control group; premiums paid by control group.
Health insurance carriers	Self-administered questionnaires; telephone interviews; brochure collection and abstraction.	Health insurance coverage available to enrollees; group rating information.
State agencies	Self-administered questionnaires; records collection and abstraction.	Medicaid use and eligibility of Experiment enrollees; birth and death certificates.
Employers	Personal interviews; self-administered questionnaires; telephone interviews.	Health insurance and sick leave benefits available to enrollees; premiums paid by enrollees.
Local retailers	Personal interviews.	Prices of selected products and services.

The volume and range of HIE endeavors provided a wealth of opportunities to learn do's and don'ts of managing large, complex projects. In a sense, we had a chance to experiment with running an experiment.

PRESENTATION AND SELECTION OF THE LESSONS

The findings or "lessons learned" are grouped into five sections entitled:

- General Project Management,
- Data Collection and Processing,
- Management of Subcontractors,
- Program Administration, and
- Project Management with an Operations Staff.

The subjects covered begin with those that are of concern to all managers of large, complex projects (Sec. II) and move through those that arise from particular characteristics of projects such as primary data collection or an experimental program.

Each section is divided into several topics. For example, a topic in the Data Collection and Processing section is "data base revisions." A topic in the Program Administration chapter is "communications with participants."

For each topic, the major related conclusions that can be drawn from our experiences, e.g., the "lessons learned," are summarized. The discussion that follows these lessons elaborates on that experience and the reasoning that led to the conclusions.

Each lesson presented met four criteria.

1. It is generalizable to and useful for other projects.
2. The topic of the lesson was crucial to HIE ability to meet its objectives.
3. The topic fell under the purview of senior-level project managers and received a substantial amount of their attention.

4. Actions suggested as part of the lessons are those that project managers have responsibility for taking.

II. GENERAL PROJECT MANAGEMENT

This section covers topics of interest to all managers of research projects--project organization, communication, scheduling, and cost control. In keeping with my objectives, however, the discussion emphasizes those issues that acquire greater significance for project management as project size and complexity increase. My focus is on management of tasks other than data analysis and publication of research results.

PROJECT ORGANIZATION

Lesson(s): Net benefits can be gained from a relatively bureaucratic project structure that includes a staff solely responsible for project operations. The benefits of these organizational features are substantial; several steps can be taken to minimize their costs.

The Bureaucratic Project Structure

A bureaucratically structured project is one where tasks, particularly those pertaining to administration, data collection, and data processing, have been identified at a fairly detailed level. Responsibility for their performance has been allocated to particular individuals as has the authority for making various kinds of decisions. Lines of authority and channels of communication have been defined and project staff members are expected to adhere to them. Staff will not act without direction from the "correct" party. Examples of bureaucratic rules might include restrictions on who is "allowed" to communicate with subcontractors or the sponsor, or allocation of responsibility for the content of particular questionnaires.

All project structures have bureaucratic elements. But on large, complex projects the opportunities for precision in job definitions and the possible links in command chains are many times greater than for the average research project. Hence, structures can be developed that limit the staff's freedom of action far more than can the collegial, egalitarian organization of smaller projects.

Our experience indicates there are many benefits from devising more bureaucratic structures for large, complex projects. These benefits accrue largely because each staff member has his own agenda, set of special interests, and ways of looking at things. Each will place a unique set of demands upon project resources. The sum of these demands will exceed the resources available to fill them. Although this problem is present to an extent on any project, it tends to grow with staff size. The sheer number of demands increases as does the chance that there will be little convergence among them.

A bureaucratic structure allows project management to control the allocation of resources, to coordinate multiple objectives, and to meet staff demands in a way that benefits the project as a whole. Without control, resources tend to be allocated on the squeaky wheel principle, an allocation that rarely reflects management priorities.

A bureaucratic structure will also contribute to a smooth communication process thereby enhancing task performance. It will minimize the number of conflicting instructions conveyed to project staff and avoid the need for reconciliation of such instructions by those ill-prepared to do so. This, in turn, will promote efficiency and high staff morale and help insure that instructions are accurately and clearly imparted.

A good example of the benefits of a bureaucratic structure is the questionnaire design process on the HIE. Many of our questionnaires were developed by a subcontractor using specifications from the Rand research staff. If we had not carefully controlled channels of communication to the subcontractor and developed a chain of command within Rand, that subcontractor could have received instructions about questionnaire content from at least a dozen members of the research staff. Given the wide variety of staff backgrounds and specialized analytical interests, many of the instructions could have conflicted. The subcontractor would have been faced with resolving these conflicts without knowing project management's true priorities. Ultimately the Principal Investigator would probably have had to assume a major role in transmitting specifications for our 500 data collection documents to the subcontractors, a less than optimum use of his time.

The major drawback to a bureaucratic structure, as I have defined it, is that the staff, particularly those with previous experience on smaller research projects, may not like it. It may be very different from what they are used to. They may resent limitations on their authority and restrictions on their ability to directly alter activities they see as having a significant effect on their analysis. In particular, it may be hard for them to entrust the completion of certain tasks to others. Finally, it may seem to them that the bureaucratic aspects of the project organization unnecessarily increase the time it takes to get anything done. For time will be consumed in examining process as well as substance and in conveying information through communication channels. Staff members will long to shortcut the process.

Project leaders who elect a fairly bureaucratic structure for their projects must be prepared for objections from project staff. As part of dealing with these objections, they should make it clear that they support the structure and that the bureaucratic elements were adopted for sound reasons. Staff dissatisfaction will be heightened if bureaucratic procedures appear to be the result of arbitrary decisions by individual staff members.

Project structure, procedures, and roles should be explained to potential staff members before they join the project, so that they will not be unpleasantly surprised when they begin work. By the very act of joining the project they will have tacitly accepted its structure.

Staff complaints about project structure will be reduced if the project is well run to begin with. For example, the more staff are otherwise pleased with and well rewarded for their work, the less they will feel threatened by bureaucratic limitations upon their role and authority. Assuring that staff performance meets certain standards will increase the staff's acceptance of delegation and enhance their trust and confidence in one another. If the project operates efficiently, the time required to get things done will be minimized.

The Operations Staff

To appreciate the discussion that follows, the reader must understand what is meant by the terms "operations" and "separate" operations staff. Throughout this report, operations will refer to project tasks associated with financial and grant management, data collection and processing, and administration of an experimental program. Essentially "operations" includes all tasks not directly associated with analysis of data or "research." The exact tasks covered by the term will of course vary with the nature of the project.

Typical projects involve proposal preparation, budgeting, and data processing. But larger, complex projects may also need staff to translate research requirements into plans of action, design the resultant data processing and data collection systems, and monitor their implementation. Under these circumstances operations responsibilities cover the full range of activities necessary to accomplish these tasks--from the most abstract to the most detailed. To use the HIE as an example, our operations staff created general plans, schedules, and budgets; decided on site office locations, staffing, and procedures; helped design questionnaires; established document coding rules and reviewed precolumning and program specifications; defined follow-up algorithms and procedures for missing data, monitored the follow-up, and instituted procedural changes if needed; designed forms to record queries from the field and got answers to them; dealt with the hundreds of special situations that arose as the 7,706 individuals in the Experiment lived their unique lives. And as the data began to be analyzed, the operations staff answered numerous questions from researchers about sample composition and how the data had been collected and processed. Often, extensive research was required on the details of events that transpired several years before.

Financial management can also entail substantial effort on larger projects. To use the HIE again as an example, costs incurred by four organizations outside Rand had to be estimated and monitored in addition to expenses by several cost centers within Rand and consulting organizations and individuals. Arrangements for use of our data by or collection of data for other institutions were frequently made and the

resulting financial implications had to be dealt with. And costs for the experimental program had to be forecast and closely monitored. Cost reporting systems, tailored to a variety of accounting practices and organizational needs, had to be negotiated and implemented.

A "separate" operations staff is a group of people whose *sole* responsibility is to perform these operations and administrative tasks. This is in contrast to the "typical" research project where this kind of work is done by the research staff. The scope of operations activities on larger projects makes such a division of labor feasible. There was a separate operations staff on the HIE and the benefits gained far outweighed the costs.

The primary benefit is the enhancement of overall project productivity made possible by specialization. Operations work as I have defined it requires expertise in one or more of the following fields: finance, accounting, contract negotiation and management, survey management, and data processing--as well as general administrative ability. Persons most qualified to conduct research are usually not experts in these fields nor do they want to be. There is no reason to expect research skills to coincide with administrative ability. Having a separate operations staff frees research staff from performing tasks in which they have little expertise and even less interest and allows the work to be done by persons with appropriate skills and enthusiasm, thus improving overall project productivity. Also, it can be argued that the project as a whole profits if operations are managed by persons without a special interest in any of the many issues the project is attempting to address. Decisions may be made more "objectively," with the goal of maximizing the overall well being of the study as opposed to enhancing progress in one particular research area. Finally, there can be additional benefits when outside organizations with little previous experience in research are doing operations work under subcontracts as they were on the HIE. Contractual matters will often be viewed by analysts as unappealing and needlessly time consuming. Additionally, the subcontractor may more easily relate to someone performing a purely administrative role, perceiving him or her as better able to understand their problems and view of reality than someone from the research staff.

The primary disadvantage of a separate operations staff is that it will complicate project administration to the extent that efforts are necessary to ensure effective communication between operations and research staffs. There must be adequate input from the research staff into operations activities and vice versa. Neither group can make good decisions independently. Without adequate interaction researchers can become committed to analysis plans that are operationally infeasible, while decisions made by the operations staff can badly compromise the experimental design. Additionally, by definition, the interests, skills, and goals of operations staff members will differ from those of other professional staff on the project. The reward structure of the company employing the staff may favor research skills rather than administrative ones. Hence, an operations staff may require special support from project management to insure that an insulated, uninterested, demoralized group does not emerge.

As with a bureaucratic structure, any negative effects of a separate operations staff can be substantially mitigated by sound management. There are several actions project managers can take to integrate research and operations staffs, assure adequate research staff participation in operations, and maintain operations staff morale. For interested readers, these are discussed in detail in Sec. VI. Briefly, they include providing opportunities for routine interaction between research and operations staff, assuring that all staff members have a common understanding of one another's job responsibilities and project priorities, promulgating guidelines for research staff participation in operations tasks, providing researchers with the time and incentives to participate, and building a strong team spirit among members of the operations staff.

COMMUNICATIONS

> Lesson(s): Good communications are essential for a well-run project. Communication processes should include all relevant parties at the appropriate level of involvement. Formal channels of communication and other methods of communication control should be established.

One of the most significant lessons brought home by the HIE is the overriding importance of high-quality communication to the success of the project. This is the implicit theme of most of the discussion in the remainder of this report. It cannot be overemphasized. In fact, most problems I point out here arose from poor communications between parties involved in running the Experiment. Thus, our experience indicates that developing ways to assure problem-free communications among all groups should be one of project management's highest priorities. Below I report steps that can be taken in pursuit of this important goal.

Involvement of the "Right" People

Be sure all relevant parties are involved in any communications. This takes a lot of thought on a large, complex project like the HIE. It is very easy to confine interactions to a select group, regardless of whether others should be involved. This can occur through habit or because only a few staff members appear to be enthusiastic about a subject or because staff members are simply ignorant of each other's roles, skills, and interests. But, whatever the reason for it, when it happens, there can be severe repercussions. The two areas related to HIE operations that were especially problematic in this regard were the inclusion of data processing personnel in communications about data collection systems and the inclusion of the research staff in communications about operations activities in general. The former topic is discussed in detail in Sec. III, the latter in Sec. VI.

The Means of Communications

Select appropriate means of communication for each party to be involved. This is as important as selecting the correct parties and deserves as much thought. The means may range from memo copies to meetings and usually determine the individual's level of involvement in whatever decisions are being made. It is useless to involve the right parties at the wrong levels; this can actually impede progress.

Furthermore, "important information" should be communicated to each party by at least two means. What information is important will obviously depend on the particular project but, for two reasons it should include at a minimum task specifications, schedules, and budgets. First, important information should always be put in writing for well-known reasons. Second, writing is not sufficient to guarantee the correct communication of important information and should be supplemented by meetings or phone calls. There are many arguments against large meetings and multiperson phone calls. They can be expensive and many participants will object if material discussed seems irrelevant to them. This latter objection will be especially true for data processing personnel asked to attend meetings on clerical systems and vice versa. But the sad truth, which was painfully brought home to us on several occasions, is that people rarely pay close attention to memos particularly if the subject matter appears to be irrelevant. Unfortunately where complex task specs or schedules are concerned, many important items can be buried on the last page. And, while feedback is relatively easy to obtain in meetings or over the phone, people receiving numerous memos on a myriad of detailed subjects are slow to volunteer comments.

As an illustration of these points consider the communication process surrounding the development of a questionnaire on a project with 25 researchers and a separate operations staff. Say the data collected will be analyzed by only five analysts and that 10 others are peripherally interested in the research questions that the five will address. At least one meeting to discuss the questionnaire between those five and the operations personnel that will be developing the questionnaire is probably in order. For reasons given above, a memo to the five describing what was decided by the operations staff alone about the questionnaire (or vice versa) is likely to be insufficient.

Inviting the entire research staff to that meeting would be highly counterproductive and wasteful of valuable staff time. And I would argue that the costs of attendance at the meeting outweigh the benefits even for the peripherally interested 10. Their contribution would probably be marginal, yet their presence would complicate communications

and slow down the decisionmaking process. It would be best to send them a memo summarizing the meeting and leave it to the truly interested five to discuss the questionnaire with the peripheral ten or others they felt could make a contribution.

Channels of Communications

Establish formal channels of communication and take steps to ensure that project staff adhere to them.

I have already described our project organization and the way we tried to control communications. Each subcontractor also had an established chain of command that we tried to honor. Rand operations staff usually communicated instructions directly only to the highest level of managers and tried to avoid, for example, calling department heads or site office managers.

The costs and benefits of a relatively bureaucratic project structure and my reasons for recommending it were discussed earlier. But I would like to emphasize that failure to control communication channels and thus to restrict the number of persons passing on orders or information can be particularly damaging to subcontractors. They are usually physically removed and unfamiliar with all other project staff and thus will have a more difficult time figuring out who to believe than will employees of the prime contractor. And it will be harder to detect when they do go astray by taking instructions from the wrong person.

However, although set channels should be the general mode, the real managerial skill comes in spotting situations where this mode should be abandoned. On the HIE there were three general sets of circumstances, common to many projects, where optimum task performance called for direct contact between parties that would normally not interact. In these cases operations staff members ceased performing their usual liaison role and became facilitators of discussions between others. One such situation arose when actions were being planned that had to be carried out in concert or were in other ways highly complementary. This typically involved two or more subcontractors or a subcontractor and the Rand data processing staff. A second was when complex data processing or collection specifications, the details of which could be easily lost

in translation, were formulated. The third occurred when an effort required expertise not possessed by the liaison. Again, these situations could involve discussions between subcontractor personnel and Rand data processing staff or, frequently, members of the research staff. In all three of these situations, however, the operations staff maintained responsibility for assuring that communication took place and was subsequently acted upon.

Control of Written Communication

Develop a formal system for keeping track of and preserving written communications. On a large, complex project such a system will greatly improve the quality of communications and prove well worth the time involved.

On the HIE, for example, over 20,000 memos were written. These memos were our major means of communication within Rand, among Rand and the subcontractors, between Rand and the sponsor, and among subcontractors. The information they contained was invaluable. It included documentation of the experimental design and the reasoning behind it, instructions for selecting the sample, specifications of all tasks to be performed, and records of operations activities. These memos were thus a key documentation device. (See Sec. III for a discussion of documentation-related issues.)

We found that a formal policy for control of the memos was an essential management tool. We are extremely pleased with the results of the policy we developed. Hence, I describe it briefly here as a model for other projects.

At Rand written communication of any significance was required to be issued as an "official" HIE memo. That is, it was assigned a unique control number, entered into a project log, and filed in our central files. Each memo was filed in three ways--by subject, by author, and by date issued.

All Rand professional staff and their secretaries followed this policy. The numbering system and logs were controlled by the secretary to the Director of Administration, who also maintained the files.

Each subcontractor set up a similar system to identify and track memos written to Rand or other subcontractors. These memos were also logged and filed at Rand.

The Principal Investigator and the Director of Administration reviewed every memo written. The Director designated the subject file in which they were to be placed. Together the Principal Investigator and the Director selected the memos to be copied for the sponsor. It should be evident that besides controlling communications, this system provided the Principal Investigator and the Director with an excellent means of monitoring project activities.

THE SCHEDULE

> Lesson(s): Promulgation of formal, "official" schedules is one of the best ways for management to control events on large projects. A schedule is most effective when it is comprehensive, realistic, closely monitored, and revised in a timely fashion. Meetings can be very useful scheduling mechanisms.

The Schedule as a Management Tool

A good schedule summarizes management priorities and project goals clearly and in concrete terms. Hence, it allows staff to keep track of what come to be highly complex and voluminous data on large projects. It provides benchmarks against which progress can be measured. It allows small deviations from plans to be caught and checked before they become large ones. A well-prepared schedule is a great aid to delegation. It clearly assigns responsibility for task completion. Also, it establishes a framework, incorporating project priorities, within which the staff can largely determine their own actions. This kind of freedom makes for happy employees. People like to know what they are supposed to be doing in advance so they can plan their own work. They resent getting daily, or ad hoc, marching orders from project management.

The Effective Schedule

A schedule should be comprehensive. That is, even the smallest task should be included in a schedule. It is dangerous to assume that some step in a process will occur automatically. There is a good chance that unscheduled items will be "forgotten" as efforts are naturally directed toward the scheduled activities. Also, the greater the number of tasks scheduled the more things will appear to run themselves.

To be useful over the long run, schedules should be realistic. The major deadlines should be reachable given the nature of the tasks, the skills of the individuals performing them, and the resources at their command. And the time interval between tasks on the schedule should reflect all relevant parties' best assessment of the time actually required to do the work. This may sound obvious, but if the project is under great pressure to produce results, as is usually the case, wishful thinking may lead to schedules that reflect the ideal rather than the possible. Then, the artificially foreshortened schedules are not met, thus causing a lot of unhappiness: project staff and the sponsor must constantly revise their plans; staff members will come to resent being trapped in a cycle of preordained failure; and the quality of their work will suffer as they strive to meet their impossible deadlines. No matter how desirable these deadlines may be, it does no one any good to stubbornly pretend that they will be met despite overwhelming evidence to the contrary. It is better to face reality and provide staff and sponsor with dates they can rely on, no matter how much they may dislike them.

The Scheduling Meeting

It is also important that all parties whose actions will materially affect the progress of scheduled events be adequately represented in the scheduling process. A good schedule is really a carefully negotiated consensus among these individuals as to how the work will be done. It is here that the power of a schedule to control events lies. The formation of a true consensus increases the chances that the deadlines in the schedule will be met. For people will strive harder to honor commitments they have made themselves than commitments made for them or forced upon them by others.

Meetings can be very effective in this regard. Face to face give and take increases the chances that the schedule will be regarded as a joint effort, incorporating the concerns of all involved. Additionally, commitments made in a meeting are sometimes stronger for having been made to a *group*. There is peer pressure both to make commitments that aid the group effort and to meet them. Meetings also facilitate the exchange of pertinent information.

And finally, a scheduling session is the perfect forum for verbally working through the tasks to be accomplished. To determine *when* something will be done, one usually has to think through *how* it will be done. Many a hidden flaw in task specifications can be exposed in the process. And if something is wrong it is obviously better to find out early than halfway into the job.

Running a scheduling meeting requires strong interpersonal skills. Ideally, besides producing a schedule, the leader must induce participants to commit to it. That is, they should leave the meeting feeling that it is possible for them to meet the deadlines and intending to try as hard as they can to do so. To "buy in" in this fashion, the meeting's participants must feel that their opinions have been respected and that the constraints they face have been adequately taken into account.

Monitoring and Revising the Schedule

Finally, once a schedule has been produced it must be closely monitored. Information systems should be developed that allow management to compare the scheduled events to actual events. Proper monitoring data should be reviewed regularly so that problems can be detected as they occur and corrective actions undertaken in a timely fashion. Also, the pressures created when commitments are made during the scheduling process must be sustained or the schedule will not be taken seriously. Hence, deviations from the schedule should not go unacknowledged by project management.

Management should expect numerous deviations during the early phases of project operations or whenever any nontrivial new tasks are added. One of the most common reasons for this is that it takes time to

learn what completing scheduled activities actually involves. Initial project schedules are often unrealistic because little is known about the details of the work to be done and how long it will take. Some tasks may be new to the staff charged with performing them. Even when the staff has experience with similar projects, differences in the nature of the data or the population about or from which the data are collected may limit their ability to apply that experience. Once work is under way, the originally promulgated schedule can quickly become obsolete.

Another reason for obsolescence is that project plans may change. Research designs are often revised during initial phases of a project as knowledge is gained about pertinent research questions and approaches to answering them. Furthermore, initial analysis of data or experiences in the field can cause design changes well into the life of the project.

Under such circumstances schedules will need revisions if they are to be useful management tools. By causing staff and sponsors to act on false assumptions about project activities, out-of-date schedules can sometimes be equally if not more harmful than no schedule at all. If schedules are generally out of date, staff soon lose respect for them, and the schedules, in turn, lose effectiveness as mechanisms for behavior control.

Project managers should carefully consider the nature and timing of schedule revisions. Failure to update schedules in a timely fashion to reflect substantial changes in plans can lead to such problems as those mentioned above. On the other hand, issuing a new schedule whenever there is *any* change in plans no matter how trivial can also cause a lot of confusion and waste valuable staff time. As soon as feasible an equilibrium schedule for revisions should be developed. Thus, changes can be accumulated. The frequency of revisions will depend on the nature of changes that are anticipated and the resources available to revise the schedule. On the HIE, for example, during the height of operations a new schedule was issued monthly. As the work declined, we rescheduled quarterly.

COST CONTROL

Lesson(s): Effective cost control depends on comprehensive budgeting, good management information systems, and the cost consciousness and spending restraint of project staff.

Comprehensive Budgeting

To effectively control costs the project manager must have a clear idea of what project costs *should* be, given the work that is planned. This means that a comprehensive budget must be developed. That is, the budget must include estimates for all tasks requiring the expenditures of project monies. Although this is true, of course, for any project, creating and maintaining a comprehensive budget is much more challenging for larger projects than it is for small ones. This is because of both the sheer number of tasks involved and the number of individuals that can make expenditures. The budgeting process can be further complicated if the project continues for the substantial period of time typical of larger projects.

Comprehensiveness is often emphasized in the initial budgeting effort for any undertaking but given short shrift thereafter. Over time new tasks are added. Others, included in the original budget are never completed. The budget must be revised frequently to reflect these changes if managers are to have accurate perceptions of probable expenditures. In other words, on large, long-term projects comprehensive budgeting means *continual* budgeting. The initial project budget should not be filed away once it is completed, to be dusted off when time for the next funding request/proposal rolls around.

Cost estimation should be a routine component of planning for new tasks. Unfortunately, budgeting will often be tedious and appear to hold things up needlessly when fast action is demanded. But there is a great danger in undertaking work without first estimating its cost. Failure to do so only delays making choices that *must* be made sooner or later. Typically, there is not enough money available to add even the smallest task, without giving up something else. This fact is better faced before the additional expenditures are incurred than afterward. Management needs the opportunity to weigh the importance of the proposed action not only against that of ongoing tasks but against tasks being

contemplated for the future, of which other staff members are unaware. Money must be spread out over the funding period in line with management's priorities. There is a great temptation to add on tasks without examining tradeoffs during the early phase of the project when money appears to be relatively unconstrained. This can result in the sacrifice of tasks of much higher priority in the later phases when money gets tight.

"Nits"--apparently trivial, close to zero-cost undertakings--can be a particular problem when it comes to maintaining comprehensive project budgets. It can be hard to resist pressure from the staff to launch these small efforts as soon as they are conceived of without bothering with the usual cost-estimation formalities. But this can result in a misuse of project funds. Expenditures can balloon quickly, especially if the task is unique as many research tasks tend to be. If time could not be accorded for budgeting, chances are the job was begun in a rush and was not planned very well. What appears to be simple at the outset can become enormously complicated halfway through after all the implications have become clear. Complications can be compounded if people do not put their best efforts into performing these nits, which will increase mistakes and, hence, costs. And, of course, nits add up. While one nit may be almost free, 100 nits can amount to the financial equivalent of an entire questionnaire, for example. And if the staff realizes that "small" jobs can be added to the project's agenda without cost justification they will add a multitude.

Management Information Systems

In addition to knowing what costs "ought" to be, project management must know what they actually are. Although obtaining information on incurred costs may be relatively straightforward on small projects, it can be very difficult on larger ones. Information must be gathered from many different sources, sometimes from a variety of organizations.

For ease of analysis, these data should be in compatible formats. Also little effort should be needed to match actual costs from invoices to cost estimates. Without affirmative action by project management, there is no guarantee that the cost information available from various sources of project expenditures will meet these standards. Yet if it

does not, the cost data will be extremely difficult to work with at best and, at worst, the data will be useless. Lack of timely information about actual expenditures will severely restrict management's ability to control costs. Therefore, managers of large projects should put considerable effort into diagnosing their needs for cost information and developing management information systems capable of filling those needs.

Information about costs will be even more critical for projects like the HIE, where many of the tasks have not been undertaken before by the organizations charged with performing them. Under those circumstances, it is very hard to create accurate budgets initially. As experience is gained, the results of that experience must be recorded for use in subsequent budgeting exercises. By analysis of actual costs, cost estimations can be improved.

Cost Consciousness and Spending Restraint

On larger projects, authority to spend project funds may be fairly widely dispersed. Typically, this will be true for items, such as data processing costs, that are a function of the way an analyst chooses to conduct research. Concern about academic freedom and the promotion of creativity may foster a tendency toward a "laissez faire" approach in these areas. That is, project management may hesitate to impose the strict, centralized expenditure controls on analytical design decisions that might be imposed upon, say, decisions to purchase supplies. Under these circumstances the staff's level of cost consciousness and spending restraint become major determinants of management's ability to manage expenditures.

At times the levels of cost consciousness and spending restraint may be less than optimum. This problem can have both philosophical and logistical roots. In the research environment, the profit maximization/cost minimization objective takes a back seat to product quality concerns. Typically analysts are rewarded for excellent, not low cost research. A desire for perfection in data collection and analysis can obscure the need for tradeoffs in the face of scarce resources. While this may be an entirely appropriate order of priorities for participants in a research project, it can make project fiscal management challenging.

The logistical problem is to match pertinent information about financial matters with authority to spend. Unless the effort is made to make analysts aware of the relevant cost factors and financial constraints, their expenditures will not always reflect project priorities.

Thus, it becomes important to include research staff members in project fiscal planning. Among steps that can be taken are regular meetings where the project financial status and special issues, such as computer budgets, are reviewed, and one-on-one budget planning sessions. The staff should be provided with feedback on costs incurred either by them directly or by others in their behalf. Specific techniques used will depend on project structure and the personalities involved, of course. The important point is that making the staff conscious of and subject to expenditure constraints is crucial for true control of project resources. Expenditures should be based on priorities set by project management, looking at the project as a whole. High-priority data processing and data collection activities should not have to be cut in the face of cost overruns caused by research staff's uncontrolled spending on lesser-priority items.

III. DATA COLLECTION AND PROCESSING

The lessons presented in this section draw on the HIE experience with the creation, implementation, and management of numerous data collection and processing systems. By "system" I mean the complete series of steps necessary to gather a defined dataset and to transform it into machine-readable files. Hence, a system consists of the full range of manual and data processing procedures entailed in instrument development, survey administration, and data reduction. Typically a system will be questionnaire (or data collection document) specific. That is, where there is one questionnaire (or other data collection document), there is one system.

Some of the lessons will be useful for projects involving only one or two such systems. But, because many of the lessons arise from our attempts to coordinate and control large numbers of systems and actors, they will probably be most relevant for projects collecting and processing data on a greater scale.

The topics covered are the systems development process, system revisions, database revisions, participation by data processing staff in the development of data collection systems, documentation, quality control, accounting for the sample, and system comprehensiveness/ complexity.

THE SYSTEMS DEVELOPMENT PROCESS

Lesson(s): A prototype of the ideal systems development process has been identified in the business systems literature. This prototype can be usefully applied to the development of research data collection and processing systems. There are, however, good reasons why it cannot be followed for all such systems. But even then, the ideal model suggests certain steps that management can take to improve the systems development process.

The Prototype

On a project like the HIE, careful management of the data collection and processing systems development process is essential for successful completion of the research. Systems development costs are a large part of total project expenditures and the research depends on the outputs of the systems. Bad management of the process is costly in terms of both dollars and data quality.

Much has been written about the systems development process and certain key steps have been identified. The terminology may vary from author to author but there is a general consensus among most that those steps include preliminary feasibility studies, development of schedules and budgets for the process, specification development, system design, design review, installation, and testing (followed by modification and retesting as needed). Additional review points that depend on the nature of the system and participants in the process can be specified. Generally, a system should be reevaluated after it has been operating for a suitable period of time. The "ideal" or prototype system development process is one where each of these steps is carried out in sequence for the *entire* system as part of a unified development effort. "Entire" system means all parts or subsystems of the system. For data collection and processing systems, these would include instrument development, survey administration, and data reduction.

Although the literature focuses on the development of data processing systems with commercial applications, the general approach applies equally well to development of both manual data collection and machine processing systems in a research setting. In other words, the nature of the data or the manner in which it is manipulated does not affect the principles upon which sound management of the process is based.

The following illustration from the HIE should clarify how these rather abstract concepts can be applied to research project operations as well as what the "ideal" or prototype process entails. Our systems development process typically involved the following 10 steps which I describe in terms of one specific data collection system we implemented.

1. The identification of a research question and information required to answer it. For example, we were interested in discerning the effect of the experimental health insurance plans on the enrollees' health. We believed that knowing the exact cause of death of individuals in our sample who died during the Experiment would help us understand this effect.
2. Examination of alternative data sources; selection of "the best." Possible sources for information on cause of death included the participants' remaining family members, their doctors, or Certificates of Death filed by their doctors with state health agencies. After calling a few state agencies, exploring the quality of data they might provide, and what it would take to get it from them, we decided they were the best source.
3. Development of initial plans for collecting and processing data. Identification of actors for various roles. In this instance we decided the best way to collect the data would be for one of our subcontractors to call the state agency and request a copy of the Death Certificate. Upon receipt, subcontractor staff would abstract exact cause of death onto a coding form. The form would be sent to Rand for data processing.
4. Creation of rough cost estimates based on initial plans. On the basis of these estimates, a determination can be made as to whether the data are worth pursuing, given project priorities.
5. Development of detailed schedules and budgets for the activity. This was done simultaneously with the creation of step-by-step plans for collecting and processing the data. Steps would include phone calls, logging in of Certificates as they were received, follow-up actions if they were not received after a specified period of time, abstraction of the data, batching and transmittal of forms to Rand, etc. Additionally, responsibility for each step was assigned to particular individuals.

6. Development of detailed descriptions of how each step will be carried out. This material includes protocols for the phone calls and follow-up contacts, guidelines for screening and abstracting the data, and the design of data processing programs.
7. Review of the output of steps 5 and 6 by the appropriate parties. These parties might be members of the research staff or operations or subcontractor personnel who had not created the outputs themselves.
8. Implementation of procedures; review of results. For example, we had a subcontractor make a few phone calls and send reports on the outcomes to Rand. When Certificates began to arrive, we had copies sent to Rand where they could be examined by the analysts to be sure the data were what they had expected.
9. Correction of system as indicated by reviews in step 8. In this case, we discovered it was necessary to change the phone protocol to emphasize that we wanted cause of death. Otherwise, in some circumstances, we would get only a cover sheet containing demographic information about the deceased.
10. Completion of steps 8 and 9 periodically, after the system is operating routinely.

In the more formal systems development terminology used above, steps 2, 3, and 4 constitute a feasibility study; step 5 includes development of budget, schedules, and specifications; step 6 is the design process; step 7 the design review; step 8 is installation and testing; step 9 illustrates a system modification based on the test results; and step 10 is a type of reevaluation.

This example also demonstrates the thorough approach inherent in the prototype process. Each step is important and should not be omitted. Staff should not rush directly from step 4 to step 6 or overlook step 7. It should also make clear the complex interrelationships between subsystems and why it is important that they be developed in conjunction with one another. In the ideal process, for instance, the creation of guidelines for abstracting the data and the

design of the systems to process the data would proceed simultaneously. Development of follow-up rules would be timed so that the rules could be finalized shortly after the start of data collection.

Because system development has been explained so thoroughly elsewhere, I will not attempt to justify each step in this ideal system development process here. It will suffice to urge that those responsible for the development of data collection and processing systems become familiar with the systems development literature and apply the concepts to their work. ("Success and Failure...," 1980; Brown, 1977; and Smith, 1978.)

When the Prototype Cannot Be Followed

Failure to follow the approach toward system development outlined above may seem simply "bad management," but sometimes--for reasons of time constraints or limited resources--it is often difficult to do so.

Because of time constraints on research projects, it becomes impossible to proceed through the prototype system development steps sequentially. Deadlines from research sponsors foreshorten the process so that each step cannot be completed before the next is begun. Hence, for example, design and design review may occur simultaneously with installation or testing. This happened often on the HIE when a subcontractor was put under extreme pressure to deliver a file of processed data to Rand. We would find that they had finished the program and were testing it before the program design had been reviewed by the appropriate people.

Time pressure can also mean that modification and retesting of the system will occur after the system is in full-scale production. Many times, for example, we made changes to questionnaires after they had been administered to a substantial proportion of the population. This will happen most when little is known about the phenomenon about which the data are being collected. Under these circumstances, ideally, several iterations of testing, modification, and retesting of data collection instruments should occur to ensure that the information collected meets research requirements. Frequently, time limits preclude this. Full-scale data collection begins after a single pretest. Discoveries will be made in the field that have significant implications

for research results. If it is decided to modify the survey instruments or procedures as a result, these modifications may be implemented while data collection is ongoing. A case in point is a questionnaire that was administered to the HIE sample twice a month throughout the Experiment. Although we tested that questionnaire as part of a pilot study, we changed it numerous times over the years, largely because we discovered gradually and in a piecemeal fashion that respondents were misinterpreting questions.

Also, time constraints can combine with staffing constraints to preclude following the prototype development process for all "subsystems" within a given system as part of a unified development effort. Turning again to my earlier example regarding cause of death data, there may not be enough staff available to simultaneously develop protocols for telephoning state health agencies, instructions for following up when Death Certificates are not received, and procedures for abstracting the data for data entry. And time pressures may be such that waiting for staff to complete these tasks one at a time is simply not feasible. In such situations management must adopt a more reactive mode--dealing with problems that arise, allocating time to tasks of the greatest perceived urgency at a given time. Usually this means getting data collection activities "up and running," e.g., starting the telephone calls to the state agencies, with little thought given to subsequent clerical and machine processing activities that must take place before the data can be analyzed. Unfortunately this can mean that after all the subsystems are eventually completed, they will not integrate as planned to produce the expected outputs.

Failure to design a subsystem in a timely fashion can cause a variety of problems all of which can lead to high costs or poor data. For example, if the design of the data processing system is put off until after the questionnaire to be processed has been fielded, high processing costs may be incurred to solve problems that could have been inexpensively handled by minor changes in the document. Or if coding specifications are not developed soon enough, important decisions about data transformation will be made by default in the field. These decisions may result in data very different from those anticipated by designers of the data processing programs. This can mean that the programs must be changed, which will increase costs.

Even under these circumstances, when the ideal process is not feasible given time and staffing constraints, there are certain things management can do to improve the system development process. These actions are inspired by the prototype.

First of all, although the process is foreshortened or development of some subsystems may be put off, the basic steps of the prototype can still be taken for those parts of the system that are developed. In particular, specification development, reviews, and testing should not be omitted just because the project is under pressure to get into the field. These steps are essential safeguards against the collection and processing of unusable data or the revision of systems once they are in operation--expensive events in terms of both time and money. Instead management should focus on streamlining and expediting the process--making the specification development, reviews, and testing efficient. The review process should be scrutinized especially closely, for this can be a major cause of delays in the system development process. For example, staff members given questionnaires to review should be encouraged to proceed quickly and not to let days pass.

Second, revisions of systems after they are in production can be strictly controlled. (See the next subsection for a detailed discussion of the management of system revisions.) This will reduce the number of times steps in the development process occur out of sequence.

Third, the reactive mode used to deal with urgent, short-term objectives can be abandoned and the more systematic prototype approach adopted for the long run. Project staff must understand that this is the preferred mode. They should not make a habit of switching from design and administration of one data collection instrument to another without adequately refining machine editing or data retrieval procedures for either of them, simply because they find the first two tasks more exciting than the last two.

Fourth, if development of certain subsystems is omitted because of time constraints, management can be sure the staff is diligent about completing the system design as soon as time permits.

Finally, at least one thorough follow-up evaluation can be conducted for all systems after they have been in operation for some time. They should be evaluated in terms of the original specifications and the needs they were intended to fill when they were designed and in terms of the staff's current needs and perceptions of what the system is, in fact, accomplishing. As we learned the hard way, these two sets of expectations may have some important differences because of changes in research objectives over time. The follow-up evaluations can also be used to verify that the design of the entire system has been completed.

SYSTEM REVISIONS

Lesson(s): System revisions, though inevitable, cause many problems. The problems can be minimized by following the prototype development process discussed above for changes to the system, documenting the changes well, incorporating flexibility into the original design of the system, and evaluating the cumulative effects of proposed changes.

No matter how efficiently the original system development process is managed, on a large, long-term project numerous reasons will arise to change systems after they are in operation. Unpredictable complications may develop in the field. Or perhaps the initial analysis of the data uncovers methodological problems that will confound study results and additional data are needed to analyze the problem. Or the sponsor becomes interested in new research questions. But no matter how valid the reason for making them, revisions of ongoing systems will cause problems, including loss of comparability of results, over time or from site to site; loss of ability to replicate or reconstruct collection or processing activities; and an increase in error rates. Additionally, the way the revisions are implemented may cause further problems. For example, one subsystem may be changed without appropriately supporting changes being made to other subsystems. The managerial challenge, therefore, is not to eliminate change, because there may be benefits to be gained, but rather to identify and refrain from making changes for which costs exceed benefits and to manage the implementation of beneficial changes well. In the following paragraphs, I discuss four steps that we found helpful in meeting this challenge.

The Prototype Approach

The systematic approach to initial system development discussed above can be beneficially applied to the design and implementation of system revisions. Methodically evaluating the effects of a contemplated change on *each subsystem* can be helpful in understanding the true costs of a change and all the steps that will be necessary to implement it. Often when changes are contemplated the focus is solely on that particular part of the system that is going to be revised. Ramifications of the change for other parts of the system are overlooked. For example, a change in fielding procedures for a certain questionnaire may affect the way the questionnaire is coded which will, in turn, have implications for data processing programs. To accurately evaluate and plan for the change, each of these effects must be understood.

Also, the same basic process recommended for the development of the system--feasibility study, design, design review, etc.--can be followed during the design and implementation of change. Changes made in an informal manner often do not reflect the original intention when the change was decided upon and do not accomplish the desired results. Unfortunately, it is tempting to skip some of the steps, since changes can often appear deceptively simple and are made under great time pressure.

Documentation

Documentation of revisions is very important. If changes are not adequately documented, users of the system and its outputs will act upon incorrect assumptions about the way the system operates. This can lead to much wasted time during analysis and, in the worst case, a misinterpretation of results.

Yet if changes are made to a system, simple documentation of each change may not be sufficient. It is very easy to lose track of the final form of the system. Users find themselves confronted with a stream of constantly updated documentation. Similar confusion can arise when specifications for revisions must be communicated to others for implementation. Hence, large projects with frequently changing systems

will need more than documentation of each change, which in itself is often difficult to come by. A system for summarizing documentation and identifying *final* changes will be necessary.

Flexibility

Changes can be made more smoothly if the original system was designed to accommodate them. Flexibility is therefore a key design feature of many data collection and processing systems. Generally, in any activity that will be carried out more than once, some room for change should be provided. The extent of flexibility and exactly where and how it is built into a system will depend on, among other things, the number and type of revisions that are contemplated. An example of what I mean by flexibility is reserving space for additional data items on questionnaires and computer files.

The Cumulative Effect of Changes

A complicating aspect of controlling system revisions is that for any one change examined in isolation the benefits may exceed the costs. But if several such seemingly beneficial changes are made, the cumulative effect on the system can be disastrous. The root of the problem is that changes rarely simplify systems. Usually they increase their complexity. With enough changes, a system can become so complex to operate that its original, highest-priority objectives are abandoned, error rates increase to unacceptable limits, or the burden on the respondents escalates far beyond the optimum.

Ideally, therefore, decisions about each change should be made in light of all other changes contemplated. Also, on a project as inherently complex as the HIE, it is important to examine not only the impact of change on the specific system for which it is intended, but also the impact of changes in one system on all the other systems. With resource limitations, increasing the complexity of a system draws resources toward it and away from other systems. Such resource shifting should be done consciously and should reflect project priorities.

Problems with understanding the cumulative effect of changes seem to be especially great for continuous, as opposed to discrete, data collection activities. That is, it is harder to control revisions made

to a questionnaire administered every two weeks for five years, for example, than to one administered once a year. One reason may be that, in the case of the latter, changes are not implemented as soon as they are decided upon. They are accumulated until the next administration of the questionnaire, which allows review of all proposed changes at one time, and thus their cumulative effects are more apparent to decisionmakers. In the case of ongoing systems, there is no such chance to review a series of proposed changes together and to select those of the highest priority. Unless organization is artificially imposed where feasible--e.g., allowing changes to be made only at regular intervals--changes are apt to be made one by one as they are suggested by project staff, with little examination of cumulative effects and priorities.

Understanding cumulative effects of revisions requires real efforts at collection and communication of information. Data about the effects of changes have to be gathered and analyzed. This may be particularly difficult if activities are unique or are carried out by subcontractors, as they were on the HIE. Also, on a large project with many actors, and as many points of view, it becomes a real challenge to see that staff are aware of and appreciate the ramifications not only of the changes they are proposing, but also of those being proposed by others.

PARTICIPATION BY THE DATA PROCESSING STAFF

Lesson(s): Data processing staff should participate in the development of data *collection* systems.

"Data processing staff" is a general phrase that includes individuals performing a wide range of tasks. Obviously, data processing personnel are involved in the development of data processing systems. But their involvement in the development of data collection systems--systems that gather and prepare data for processing--is not always automatic. Under pressure to get field activities started, data processing systems development is sometimes postponed. This focus on the "front end" can result in the exclusion of data processing people from any role in the development process. This can, in turn, result in expensive adjustments to the system when data processing plans are finally developed. Data processing capabilities constrain data

collection systems. These constraints have to be taken into account eventually and it is usually cheapest to do so while data collection activities are being designed. Expert data processing staff can contribute greatly to questionnaire design or data editing/coding procedures. In fact, without their review, forms can be designed that unnecessarily complicate keypunching, for example, or data collected without the required identifying information.

DATABASE REVISIONS

Lesson(s): Under certain circumstances it may become desirable to change data after they have been added to the database. If systems are developed to do this:

- They should be implemented in a timely fashion,
- They should be accompanied by stringent controls,
- The staff and sponsor should be made fully aware of the implications that the use of such a system has for the progress of the analysis.

On the HIE, the capacity to add to or change computer files of data after they had been archived--incorporated into the database--became vital. This need arose from several circumstances that may be found on other research projects. The following are four of the most common.

1. Scheduling concerns required the imposition of cutoffs on field activities. Questionnaires not returned by a certain point were not processed. Hence, they were excluded from the database. Eventually it became important that these questionnaires be added to the database so that they could be included in the analyses.
2. During analysis it was discovered that errors had been made during data reduction such that the data were incomplete or inaccurate.
3. For various reasons data had been associated with invalid identifying information and could not be added to the database in a timely fashion. Later the error was corrected and it became desirable to analyze the previously inaccessible data.

4. During the study, changes in their circumstances caused people to be added to or dropped from the HIE sample. Additionally, it was important for analytical reasons to identify on an ongoing basis persons living with members of our sample. (Clasquin and Brown, 1977.) Our automated Family Tracking System kept track of this information. Occasionally there was a tremendous lag between the time a member of the sample experienced a change in circumstances that resulted in an addition to or subtraction from the sample or a change in living arrangements and the time the event was reported to the Experiment. Sometimes this delay meant a change in Family Tracking files that had already been archived.

If, given the nature of a project, similar situations can reasonably be expected, there is much to be gained from incorporating updating capabilities into the initial design of the database management system. Delaying development of updating mechanism until the need for updating actually arises allows a backlog of potential database changes to accumulate while the system is designed and implemented. This can cause important deadlines to be missed or can mean that analyses must be duplicated after the updates have been made.

When the system is implemented it is important to have the appropriate control procedures in place. Mechanisms should be developed to keep track of various versions of both raw data files and analytical files, the differences between them, and the various analyses for which they were used. If there are more than a few files involved, without a control system things can get quickly out of hand.

Use of a database updating system can interfere with the progress of the analysis. Changes made to the database may alter the conclusions that can be drawn from the data. This can be troublesome if conclusions have been drawn and publicized before the changes are made. Dealing with this situation will be easier for all involved if the sponsor and the research staff have known from the outset that this could happen. As part of planning for database revisions, project management must make the possibility of the revisions and their implications clear to all relevant parties.

DOCUMENTATION

Lesson(s): Three types of documentation about data collection and processing systems will prove useful--description of standard operating procedures, justification/rationalizations of those procedures, and exceptions to the procedures. Creation of documentation should not be put off. Getting it used once it is created can be a problem, but certain steps can be taken to facilitate and encourage its use.

Documentation Requirements

Generally, three kinds of documentation about data collection and processing proved valuable on the HIE. These are:

1. Detailed descriptions of procedures for each activity. These include generation of labels and logs for questionnaire mailout (or interviewer instructions), clerical editing, coding, missing data retrieval, machine cleaning, and the creation of archived files.
2. Descriptions of "exceptions," e.g., instances where these procedures were not followed for one reason or another. Exceptions could result from actions by either project staff or respondents/study participants. (It was neither feasible nor desirable to capture information about every such instance. Guidelines defining those exceptions of significance from a research or administrative perspective were established.)
3. Justifications and explanations of choices made during the system development process that define the database and hence constrain and shape the analysis. For example, it was important that analysts understood the reasons why certain questions had or had not been included on questionnaires or why a particular sample was selected. The HIE was so long and complex, this information was easily lost if not documented.

This kind of documentation will be useful for many projects for a variety of reasons. For one thing, the way the database was created, including some of the exceptional occurrences, has implications for analytical methods and interpretation of the results. When analysis

begins, the research staff will have numerous questions about operations. If there is insufficient documentation, analysts will be forced to rely on the memories of those involved in operations work, if they are still around. Or they will have to conduct their analyses without the benefit of the information they desire. This can lead to misunderstandings about and misuse of data.

Also, the existence of documentation will enhance analysts' and others' confidence in the data and, hence, in the research results by supporting replication of data collection and processing methods and verification of the data. In general, if analysts believe they are using clean, accurate data files, it will reduce the number of elaborate, detailed checks for data integrity they may feel compelled to make before proceeding with their analyses. In particular, if there is clear and complete documentation of the quality control, editing, and cleaning procedures followed in the field and during data reduction, inadvertent replications of these steps during analyses can be avoided and intentional replication can be minimized.

Finally, documentation of data collection and processing activities also performs important administrative functions. In fact, documentation is crucial if high staff turnover or turnover of key staff members is expected. It is a major way to assure that the specialized knowledge of the departing staff is passed on to their replacements and it can be an invaluable tool for managing and controlling operations. Essentially, the kind of documentation I am referring to here incorporates agreements between all parties about what is to be accomplished and how. Thus, it provides a frame of reference for performance evaluation and the analysis and implementation of proposed revisions to procedures.

The Importance of Timeliness

Creation of documentation should not be put off--it should be an integral part of system development and operation. Realistically, if it is to be done at all, creation of documentation must be treated like any other ongoing, routine work assignment. It should be included in job descriptions and taken into account in performance evaluations. Staff must be given the time necessary to complete it. Documentation of

procedures and design decisions should be a by-product of system development. Exceptions should be documented as they occur. If the creation of documentation is not handled in this fashion, chances are it will never be done or will be done very poorly.

Ultimately, on a project like the HIE, putting off documentation means that once data collection and processing activities have begun to wind down, some jobs will consist of little else but documentation, an overwhelming task. It will become difficult to induce key people to remain in the project under these circumstances. Even if they do stay, their memories are bound to be faulty, which will hamper their documentation efforts. This latter point is particularly true for exceptions to standard operating procedures. It is practically impossible to reconstruct these special situations after the fact.

Encouraging Usage

Actually, the benefits of documentation described above do not stem from the existence of documentation alone but from its use by the right people. On a project with as many complex systems operating over as long a period of time as on the HIE, getting the documentation used may be at least as much of a challenge as getting it created. Staff members may not realize that documentation pertinent to their work exists. Or locating it, obtaining it, and understanding it may involve so much time that the staff often decides that using it is not worth the trouble. Our experience suggests that the following steps can reduce some of the more substantial barriers to use of documentation.

1. The ultimate users of the documentation should be borne in mind when it is created. Select a format and language that will facilitate their use of the documentation. Remember that while technical phrases and specialized acronyms can be clear to the authors, they may be incomprehensible to others. This is a particular concern for the documentation of exceptions to standard operating procedures. Without careful attention to the appropriate format and language, descriptions of these situations tend to be difficult to understand in retrospect. Establishing formal, standardized systems for routine

documentation of exceptions will promote uniformity and clarity, and, hence, usefulness.

2. Develop a simple mechanism for tracking updates and revisions. This is especially important on a project where numerous changes to procedures are made. If it is difficult to account for revisions and to identify reliably the most current version of the documentation, only the most persistent and highly motivated staff will try to use it.
3. Store documentation so that it is readily accessible to the intended user. Minimize the specialized knowledge needed to find it. Keep the number of storage locations to a minimum. Use bookshelves and file cabinets as opposed to sealed boxes placed on top of each other. Organize and file material in a logical manner that does not require an in-depth knowledge of project operations to comprehend. For example, on the HIE it was much easier for staff to find documentation on questionnaire administration if it was filed by document title and site rather than by the particular subcontractor that administered the questionnaire.
4. Develop "pointer" mechanisms: guides and indexes. While these kinds of user aids are handy under any circumstances, they can be the key to productive use of documentation on large projects. To be truly useful the guides and indexes should contain a good deal of detail. Substantial cross indexing is probably desirable. In fact, use of an automated information management system may be cost effective and should definitely be considered for long-term, large projects.
5. Inform project staff of the existence and location of the documentation. This will need to be done several times on longer projects, because staff may forget what they have been told, there will be staff turnover, staff interests will change, and the documentation will be updated. A major challenge in this regard is dissemination of information about exceptions to standard procedures. By their very nature, exceptions are often unexpected and hence easily overlooked during analysis. Careful thought should be given to

appropriate ways of flagging data or otherwise indicating that standard assumptions about procedures followed may not always be valid. Information on where to find documentation of deviations from usual procedures should be readily available.

6. "Train" staff to use pointers and to access documentation either with clearly written materials or personal instructions. In other words, make it easy for them to find out how the system works.
7. Perhaps the greatest aid to use is employment of one or more "librarians" to supplement the pointer system and retrieve and interpret documentation. This would greatly reduce time involved for other staff members. However, librarians may prove cost effective for only the largest projects.

QUALITY CONTROL

Lesson(s): Projects should develop a quality control policy. Effective implementation of the policy will depend upon appropriate timing and thorough training and monitoring of project staff.

The Quality Control Policy

For purposes of this discussion, I have chosen a broad definition of quality control, covering a wide variety of activities. These activities have several common features and the points I wish to make apply to all of them. Essentially, the term quality control as I use it includes all steps taken to insure that the data added to the project database meet certain standards. By definition, they are activities that are carried out *before* analysis: interviewer validation, validation coding, clerical and machine editing, missing data retrieval, key verification, review of marginals, checks for completeness/consistency across documents and over time, and data control procedures as well as the reviews during system development and general subcontractor or data collector monitoring activities discussed at length elsewhere in this report.

There were three characteristics of the HIE that had a significant impact on our approach to quality control. First, much of the data collection and processing, and hence, the implementation of our quality

control systems were done by subcontractors. Some of the subcontractors had little or no experience in research. Second, there was a wide variation in depth of research experience within the operations staff itself. Some individuals were very knowledgable about quality control issues, others had no previous exposure. Third, there was a large research staff with many different backgrounds, skills, and interests and, hence, many different approaches to quality control.

Under these kinds of circumstances management's deliberate promulgation of a quality control *policy* for the project can have many benefits. Before discussing these benefits, I need to be more specific about what I mean by quality control policy. A policy is a conscious articulation of project management's philosophy toward quality control and the establishment of guidelines for use by staff members responsible for designing and implementing quality control measures. Essentially, the policy should specify what measures are to be employed, by whom, and at what point in the process. Depending upon the nature of the data collection activities and project management's attitude toward the imposition of uniformity, policies can be developed for each data collection and processing system separately or for the project as a whole.

The following are examples of subjects that should be covered in a quality control policy.

- For each quality control activity, what are the kinds of errors or problems it is designed to detect? Why are they significant, i.e., what are their implications for project goals and objectives?
- I stated earlier that the purpose of quality control activities was to insure that data met certain *standards*. These standards should be made explicit for each quality control activity. In particular, what are "acceptable" rates for various kinds of errors? What are "acceptable" rates of missing data?
- What are the *limits*[1] for each quality control activity, that

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[1]Note that there is an important logical relationship between what I have called "limits" and "standards," which must be preserved when limits are specified. The two must be consistent. If the standards are

is, when should it stop? For example, how many attempts should be made to retrieve missing data? Or suppose it is decided to verify certain variables, for example, respondent birthdate. How far should the verification effort be taken--back to the respondent? Or will a cross check among various data files be sufficient? How tight should edit specs be? Should they check for every conceivable inconsistency within a document? If not (and most likely not), where should the cutoff be? Which possible inconsistencies should be ignored?

Who is responsible for the selected quality control activities? By this I mean, at what stage in the process will the activity occur? What staff and which computer will carry it out? On the HIE, possibilities included data collection/clerical staff at the subcontractors, data processing staff or facilities at the subcontractors, or various data processing groups at Rand. In some cases, once the activity is defined, the responsibility for it is obvious. Keypunch verification is an example. But in other cases, this is not so clear. For example, on the HIE a check for sensible questionnaire completion dates could be made in a variety of ways by a variety of actors. Under these conditions a decision has to be made as to which group or groups will perform the check and that decision conveyed to all groups. In other words, the various quality control activities have to be *coordinated*. Otherwise the check might not be made. Or, if each group individually sets their own quality control policy, the check might be duplicated unnecessarily.

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higher than the limits allow, they cannot be met. For example, a standard of a 5 percent missing data rate may not be achievable if retrieval is limited to one follow-up call. Such unmet standards cause unhappiness for all. This particular disparity can occur more frequently than might be supposed. Standards are often based on perceived research requirements and reflect the ideal. They are usually set either implicitly or explicitly by the research staff and may not be communicated clearly to operations people. Limits, on the other hand, arise from practical considerations, particularly cost constraints. Without careful thought and planning, they can be established ad hoc or even by default as a result of realities in the field. On the other hand, limits that lead to data quality higher than the standards indicate miscommunication somewhere along the line and a probable waste of resources.

Allocation of responsibility and coordination of activities is a necessary part of the development of a quality control policy on any project with multiple actors performing similar functions.

For those quality control systems designed to detect errors, what is to be done with the errors that are detected? It makes little sense to have elaborate error identification systems if no action (or inappropriate action) is taken when errors are discovered. Hence, a complete quality control policy should include specifications for error disposition and other actions. These plans should be laid as thoroughly and thoughtfully as plans for the quality control task itself. This may appear to go without saying. Yet, as I have emphasized in other sections of this report, for various reasons, the "front end" of systems (in this case, the error detection activity itself) often gets much attention while the latter stage, "follow-up" type tasks such as error disposition, get too little. Possible error follow-up includes one or more of the following.

- distribution of reports about errors to appropriate persons
- flagging of data elements or adding special codes to data files
- changing/correcting data
- staff retraining/reassignment
- questionnaire redesign
- respondent education

As with other quality control tasks, specifications should designate persons responsible for taking the selected actions.

Articulating a quality control policy as I have defined it will prevent these kinds of decisions from being made in an ad hoc uncoordinated fashion by the wrong people, as may happen in the absence of guidelines. It gives project management *control* over quality control activities. Resources can be allocated to them in light of overall

project priorities. Decentralized decisions about quality control activities are likely to reflect the specialized interests and view points of the staff members who participated in the decisions. Also, because they so directly affect data quality, which is supremely important to the research staff, without managerial control quality control activities can be carried to the point where costs greatly exceed benefits. The conscious setting of limits and definition of standards can guard against this.

At the same time defining specific quality control procedures will help to ensure satisfactory, adequately documented quality control. This will be particularly important where data collection and processing are carried out by persons having no previous experience with research data. Also, through a policy, project management can promote uniformity and consistency across data collection efforts, if desired.

Finally, establishing a quality control policy will help reduce or avoid duplication of effort, which can be costly on a large project. Centralized decisions about what is to be done plus clear designation of responsibility help prevent operations people from redoing what others have done. The very existence of well thought out quality control plans together with precise documentation of what was done will constrain researchers from redoing it during analyses.

Timing Consideration

Quality control activities can be classified as either continuous or discrete. Continuous activities are those meant to continue as long as the related data collection or processing activity is ongoing. Computerized data editing is an example. Discrete quality control activities are not intended to continue as long as that. They can be designed as unique, "one-shot" efforts like some interviewer validation or they can be periodic, for example, reviews of marginals. Most quality control tasks can be either discrete or continuous depending upon the needs of a particular project.

The key timing consideration for continuous activities is that they be designed and implemented so they are operational when the related activity begins. Delays in implementation of quality control systems result in inconsistent treatment of data and overlooked errors, which in

turn lead to lack of confidence in the database. The chances that expensive double checking will take place are increased. In the absence of "official" guidelines from project management, those actually collecting and processing the data (for example, the subcontractors on the HIE) may develop their own systems. This is a waste of money if these systems are determined to be inadequate once guidelines are finally developed. I recognize that setting the standards and limits for quality control is often an iterative process that depends on feedback from the field. I am not arguing that gradual development processes be abolished. I am simply saying that those aspects of a quality control policy that can be defined a priori should be. Those making decisions about standards and limits should be aware of data collection and processing schedules and should make decisions in a timely fashion. Otherwise, they are likely to be made by default.

For discrete activities, the key timing concern on long term projects is that they are carried out often enough. Discrete checks are often used to examine personnel-related errors rates, like those in coding, to be sure they are within acceptable ranges. If the rates are deemed acceptable, quality control is discontinued on the assumption that the rates will continue to be within that range. These kinds of assumptions are not necessarily valid when there is personnel turnover or when the data collection or processing activity occurs over a long period of time. Errors can increase dramatically if checking is infrequent. Personnel changes should be watched closely so that validation activities can be carried out as needed.

Training and Monitoring of Personnel

Project managers should be sure that staff members charged with carrying out the project's quality control policies are adequately trained to do so. Designers and managers of quality control systems (in our case, the operations staff) should be aware of various quality control options and the theory behind them. They must thoroughly understand project policies. Quality control is not simply "common sense"; the ability to develop quality control systems does not necessarily "come naturally" to operations managers or research staff members, no matter how good they are at other aspects of their work, if

they do not have appropriate backgrounds. Often, specialized survey research skills are required to develop, implement, and monitor quality control systems. And, of course, those actually performing the quality control functions (primarily the subcontractors on the HIE) should be appropriately trained and retrained. Again, particular training efforts will be important if they have no previous experience with research data. A serious, rigorous approach to quality control may be new to them. They will need to be educated as to its significance for project objectives and the importance of performing quality control tasks with at least the same care as other tasks.

No matter how well trained the staff is, constant management diligence will be important to see that the project's quality control policies are effectively implemented. The establishment of quality control systems can have a lulling effect by creating a false sense of security. But lack of managerial interest sends all the wrong signals to data collection/processing personnel, causing performance lapses. Hence, quality control systems should be implemented for quality control systems themselves. The quality control activities should be monitored as closely as the tasks they are monitoring or there is little to be gained from their implementation.

ACCOUNTING FOR THE SAMPLE

> Lesson(s): Activities designed to account for either individuals or data should be carried out in a timely fashion. Responsibility for accounting tasks should be centralized as much as possible.

Accounting in a Timely Fashion

As with the term quality control, I use the phrase "accounting for the sample" to cover a wide range of activities with similar objectives and to which the points I wish to make equally apply. In this case, I use the term "accounting for the sample" for tasks that seek to answer three questions about either specific kinds of data or individuals in the sample. The questions are:

1. How many should there be?
2. How many are there?
3. What explains the difference, if any?

Answering these questions usually involves some sort of reconciliation process, for example, checking questionnaires received against logs listing the sample or a current list of the sample against an earlier listing, and the collection of information to explain the difference. Typical information might include the number of questionnaires returned "addressee unknown" or the various reasons people dropped out of a study.

Projects will differ with respect to what is accounted for and the accounting methods used. The degree of precision and detail sought in explanations of differences will also vary. Possible items to be accounted for include individuals enrolled in an experimental program or panel survey, a single administration of a questionnaire, or a continuous flow of data, such as the health care claim forms submitted by participants in the HIE. Methodologies range from standard survey administration techniques to routine data control activities to elaborate mechanized systems to track samples over time. Reconciliations can involve sample listings, transfers of data among organizations, and comparisons of various data files.

In general, if there is to be an accounting as I have defined it, it is best done sooner rather than later. Ideally, both reconciliation and collection of explanatory information should occur just as soon as possible. Timeliness is crucial because the successful performance of these tasks depends on the availability of special information--the whys and hows behind sample selection and data collection and processing, the reasons for sample loss, identification and location of inputs to the reconciliation process, etc. The source of this information is usually people: research subjects or project employees. If the information is not captured or taken advantage of when it becomes available, it will be very hard to gather later. The right people will become difficult or impossible to locate or, if locatable, their memories of events will be inaccurate or incomplete. As time passes, the information it is

possible to obtain will become more and more expensive and of lower and lower quality.

For some types of data or samples, timely accounting can often be more difficult to accomplish than it sounds. Before reconciliations can take place or information be collected, reconciliation needs (which samples, which file) and the information to be captured must be specified and the necessary procedures designed and implemented. On a long-term project there will be problems getting these tasks completed in the earlier phases of the project to the extent they depend upon fairly thorough development of plans for analyses that will occur several years later. Changes in analyses plans can mean changes in accounting needs. Samples of little interest initially may become central foci later on.

Because of the possibility of changes and because early analytical plans may be relatively vague, project managers must try to *anticipate* accounting needs, that is, to carry out reconciliations and collect information in a timely fashion in the absence of any current request from the research staff, in the belief that there will eventually be a need for it. Often this can be done for little extra cost. As an example, suppose a group of individuals are to get a medical exam at the beginning of a five-year study. Research plans do not call for data on why certain people fail to take the exam, and there is no apparent interest in the subject. Yet, if the study employees administering the exams come across this information during the routine performance of their jobs, it is simple to write it down. It can be added cheaply to the medical exam data files, and it would be wise to incorporate the procedures to do so into routine exam data collection and processing. If this information becomes important later on, trying to recapture it--reconciling the sample selected for exams with data files and tracking down explanations of the difference five years later, for instance--will be relatively expensive and very frustrating.

Centralization of Accounting Activities

Our experience indicates that on large, complex projects there are advantages to having most accounting activities be a *project*-level responsibility. That is, there are reasons to centralize the accounting function as much as possible rather than leaving it up to individual researchers to do as part of their analyses. In terms of HIE organization this means having the operations staff, the subcontractors, and the project data processing group design and carry out reconciliations and prepare explanations of differences *before* releasing data to researchers. For example, say seven members of the research staff all want to use files that contain different kinds of data but for the same sample. We found it most efficient to have project staff account for that sample once rather than each researcher doing it himself in his own way.

For many activities, such as standard data control or survey administration procedures, this kind of centralization will occur naturally as part of the project's division of labor. Certain administrative accounting activities are unambiguously project-level, operations responsibilities. But responsibility for other activities like the example given in the previous paragraph will not be so obvious. Project management may need to step in and *enforce* centralization. This can prove an unpopular policy. It can mean the imposition of uniformity and placement of limits on analytical procedures.

However, there are major benefits to be gained in exchange. One obvious benefit is the reduction of duplication of effort. A second is that sample reconciliation procedures can often be built into data collection/processing tasks. Hence, they can be done in a more timely fashion than if they are put off until analysis. Third, proper accounting usually requires knowledge about what happened during operations activities that is not possessed by the research staff. Thus, centralization can improve the accuracy and efficiency of accounting activities. Finally, centralization of responsibility promotes uniformity in the presentation of analytical results, since each analyst starts from the same base.

COMPREHENSIVENESS/COMPLEXITY

Lesson(s): Comprehensiveness and complexity are characteristics of data collection and processing systems that deserve a good deal of attention from management. Beware of tendencies that lead to insufficiently comprehensive, highly complex systems.

I will address the topics of comprehensiveness/complexity together because both are important dimensions of data collection and processing systems and involve concepts of burden and overload and the perennial question of when is enough enough.

Comprehensiveness is a function of the amount of information collected by any one data collection document or contained in any one computerized file in the data base. It is a measure of the thoroughness with which a particular subject is covered. First name of respondent is less comprehensive than first and last name; year of birth is less than month, day, and year; taxable income is less comprehensive than gross income, deductions, and exemptions.

Complexity is a characteristic of a data collection/processing system as a whole. It measures the number of functions the system is designed to perform or the number of goals it is expected to meet. A questionnaire designed to collect data to measure one or two explanatory variables is a very uncomplicated system. That same system can be made highly complex by adding procedures to use it to monitor sample loss, to validate or monitor other types of data being collected simultaneously, and to test various survey methodologies.

On the HIE, management, research, and operations staffs were constantly concerned with calculations of the costs of increasing the comprehensiveness and complexity of our data collection and processing systems. These are always difficult calculations to make primarily because the necessary information is not available a priori. But with 20/20 hindsight, it appears that, in general, our systems probably suffered most often from too little comprehensiveness and too much complexity. Put another way, when discussing data collection and processing "problems" in the HIE, most staff members cite instances where too little data were collected by a particular instrument or

contained in a particular file, or a system was assigned so many goals that it failed to adequately accomplish a large number of them.

Problems related to comprehensiveness stemmed largely from penny wise/pound foolish thinking. Decisions to forgo doing things that can be done relatively cheaply now in the interest of saving resources or simplifying procedures should be made cautiously if there is a possibility that this will lead to more expensive, cumbersome undertakings in the future. There are many variations to this theme and its applications will be different for different projects. The following example illustrates my point and may help the reader apply it in other circumstances. Suppose a questionnaire is being designed for administration to a particular sample. Suppose also that there are certain pieces of information needed for analysis that could be collected directly from the sample and incorporated in the computerized file of questionnaire data for little extra cost, in terms of the project's overall budget. Say these same pieces of information already exist on other project data files or could be inferred from other data from the questionnaire or other data files. Our experience has demonstrated that it is almost always wisest and cheapest in the end simply to collect the information on the questionnaires rather than to rely on linking files later on or on inference, even if this means that information is duplicative or can be seen as "unnecessary." Somehow linking and inference were usually more time consuming and expensive than originally predicted.

Too much complexity is often the result of making changes to an existing system without examining the effect the changes will have on the system as a whole. Instead, the focus is on the implementation of the changes and the quality of the performance of the new tasks. This problem was discussed above--see System Revisions. I will not repeat the discussion here except to reiterate the importance of thorough analysis of all ramifications of proposed changes.

In some cases highly complex systems will be consciously developed. Management will be fully aware of the risks but believe potential benefits to exceed the potential costs. These costs can be minimized if such systems receive special managerial attention. In particular priorities should be assigned to the various goals of the system and

their order made clear to those overseeing system performance. If this is done, in the event it becomes evident all goals cannot be met, steps can be taken to insure that top priority goals are not sacrificed in favor of those of lessor priority.

IV. MANAGEMENT OF SUBCONTRACTORS

In this section I present lessons learned from our experience in managing organizations that collected and processed data and administered the HIE experimental program under subcontract to Rand. Thus, the lessons will be most applicable for subcontractors performing similar functions. Throughout the text, I will use the term prime contractor to refer to the organization receiving the funding for and conducting the research. The term subcontractor will refer to a separate organization paid by the prime contractor to collect or process data or administer an experimental program.

The lessons are grouped into three main topics: role definition, performance standards, and managerial commitment.

ROLE DEFINITION

Lesson(s): The prime contractor and the subcontractor should have a mutual understanding of the role each is to play *before* work begins. Two attributes of those roles are particularly deserving of attention: the allocation of power and decisionmaking authority between the organizations and the extent to which the prime contractor is going to participate in the day-to-day operations of the subcontractor.

The Importance of Advance Agreement on Roles

By role I do not mean which tasks each organization will perform. I mean the manner in which the two organizations are going to interact during the performance of those tasks. In other words "role" is, among other things, a function of the structure and nature of the relationship between the prime contractor and the subcontractor, their attitude toward one another, and their views of the contributions they make toward each other's performance and the overall goals of the project. The formal roles are obvious--one is the prime contractor, one the subcontractor. But there are several other roles that can be assumed informally and which govern staff actions to an equal or greater degree than the formal roles. These include partners, teacher-student, professional-peer reviewer, or supervisor-employee.

Problems begin not necessarily when these other roles are taken on, but when the parties do not *agree* as to which ones should be adopted and by whom. When staff members of the two organizations begin their joint efforts with different sets of expectations about their own and each other's behavior, they are apt to be continuously disappointed. Frustration sets in; power struggles develop. Problems with interpersonal relationships become the central focus rather than achievement of project objectives. Solving those problems takes management time away from what should be higher-priority tasks. Unchecked, the friction between organizations can increase to the point where continuation of the contractual relationship is no longer feasible.

The managerial challenge is to *prevent* these problems by reaching agreement on roles before work begins rather than trying to solve them only when they begin to severely disrupt project operations. It is unrealistic to suppose that the prime contractor and the subcontractor (and each staff member) will always agree completely on all facets of their roles. However, to avoid a deterioration of working relationships, they should see eye to eye (or at least have views that are reasonably similar) about the most significant characteristics of their roles.

Senior management at both organizations can do a lot to accomplish this ideal if, during contract negotiations, they clarify role expectations. Potential sources of major disagreement over roles can be identified and steps can be taken to reconcile dissimilar points of view. Compatibility of perceptions of organizational roles should be considered during the subcontractor selection process. Once management has determined the groundrules, clear and consistent signals can be sent down the line. Thus provided with the framework within which to form their own relationships, staff will be better able to work together smoothly and cooperatively.

The possible and most likely roles will vary from project to project. The ease with which the characteristics of the roles can be articulated and the issues related to them can be formulated and communicated to others will also vary. There are, however, two role

characteristics that are common to all contractual relationships: the division of power/decisionmaking authority and the extent to which the prime contractor becomes involved in the work of the subcontractor. These characteristics are discussed in the next two subsections. They are good examples both of what I mean by "most significant characteristics" about which agreement ought to be reached and of how abstract concepts like "role characteristics" can be translated into concrete issues that can be raised during contract negotiations.

The Division of Power/Decisionmaking Authority

In practical terms this boils down to such questions as: who is going to have the final say on what? When will mutual agreement be required before action is taken? Under what circumstances will the subcontractor interact directly with the research sponsor? The basic issue underlying all these questions is whether the two organizations are going to deal as partners or whether they are going to assume the traditional prime contractor/subcontractor roles. Essentially the classic "prime contractor" issues marching orders and the subcontractor marches accordingly. The prime creates the task specifications. In case of disputes over what tasks are to be done, the prime is entitled to the last word. Partners, on the other hand, *negotiate* about these things. In case of disputes, as a last resort, a partner will refuse to do another partner's bidding.

There are some advantages to the partnership approach. It can sometimes help to foster subcontractor project loyalty and productivity and to improve decisionmaking ability. The subcontractor staff may feel isolated both from the prime and their own organization. Their future after the project ends may be unclear. A strong, friendly, peerlike relationship with staff at the prime contractor may give them a sense of support and help them identify with project objectives. An egalitarian approach to task planning often makes good use of people's knowledge and ideas and increases their commitment to carrying out the plans.

But the cost of these benefits--the surrender of some of the prerogatives of the prime contractor--can be high. The subcontractor's responsiveness may decrease. In some cases, much time can be consumed in getting them to "agree" to do even the smallest of tasks and in

arguing about how it should be done. Under these circumstances friction between prime and sub will increase. The prime contractor's staff will become frustrated and bitter about having to beg people to do something they are actually being paid to do. And subcontractor staff will become angry at being given what they see as arbitrary orders. As persuasion becomes more and more the rule, personalities interject themselves and relationships become less businesslike and more exhausting for all to sustain.

I am not arguing here for subcontractor/prime contractor relationships built exclusively around the authoritarian imposition of will. Participatory management can be an extremely important tool. But it can get out of hand on research projects (as well as in other situations) for the reasons mentioned above. There is a fine line between the two approaches, different for each set of circumstances and personalities, which cannot be crossed without causing severe management problems. Before a contract is signed, project managers should define in concrete terms where that line best lies for their project and do whatever is necessary to be sure the subcontractor understands and accepts those terms. As work progresses, signs that the line is being crossed should be watched for and when or if they appear, steps should be taken to stay the course.

The Level of Involvement

Choice of level of involvement with the subcontractor's task performance deserves a good deal of attention from project management. Both over and underinvolvment can cause severe problems.

Level of involvement can be measured on a continuum. For purposes of this discussion I will refer to one extreme as the classic prime contractor role and the other as the classic "supervisor" role. A "prime contractor" sets forth tasks at a high level of abstraction and agrees on a budget figure and major milestone dates. For example, a prime contractor might specify that a questionnaire asking about family income should be administered to the HIE sample in Dayton, Ohio, with a clean data tape to be delivered in June for $25,000. A "supervisor" looks at tasks, budgets, schedules in a highly disaggregated fashion and involves himself in the details of how and when each subtask is

completed and analyzes each cost item. Using the previous example, a supervisor would, among other things, review the drafts of the questionnaire, check pre-columning, participate in developing coding rules, and review field edit specs and processing specs. He would develop and monitor a schedule showing these and other steps and who would perform them. And he would understand and monitor cost components such as printing, editing, and CPU time.

How far to move toward the supervisor end of the scale when dealing with subcontractors is a key management decision. The right level will depend, of course, on the organizations and the tasks being performed. Too little involvement results in a lack of control over what is being done by subcontractors that can limit the usefulness of the analyses. It is common knowledge that decisions made in the field can compromise experimental design and the quality of data that reach the analyst. The danger may be particularly acute if the subcontractor is new to the research business, as were some of ours. Actions that make good administrative sense do not always make good sense from a research standpoint. Therefore, it can be argued that the best protection against bad decisions in the field arising from misunderstandings about research aims or data collection principles is for the organization conducting the research to make them. Similar reasoning can be applied to the management of other aspects of collecting and processing data and operating an experimental program.

Close involvement by the prime contractor in scheduling and budgeting subcontractors' activities can provide the prime with a greater understanding of the constraints and problems faced by the sub and can lead to more realistic schedules and budgets. This, in turn, will create smoother relationships and improve the prime's ability to manage the project. Potential trouble spots--items that are likely to run under or over budget or bottlenecks that may slow down scheduled activities--can be identified in advance. Should more than one subcontractor be involved, coordination among them, especially in cases where the prime is acting as a go-between, will be closer.

Also, closer involvement may allow prime contractor staff to supplement subcontractor staff in skills where they are weak.

However, after some point, which again, varies with the situation and the actors, intense participation leads to a lot of friction between organizations. Too much second guessing and close monitoring by the prime implies distrust of and lack of confidence in the sub and causes much resentment by them. It also results eventually in a vicious cycle of management default. Making decisions for or changing/criticizing decisions made by management of the subcontractor will discourage them from making decisions at all. So the prime contractor will make more and more decisions for them, be drawn much further into orchestrating day-to-day happenings at the subcontractors than they had ever intended, and wonder the whole time why the subcontractors "cannot think for themselves." The decisions made under these circumstances are rarely good ones. The prime will often be unaware of pertinent information in the possession of the sub. If the prime does not understand the correct question to ask to elicit the information, the sub probably will not volunteer it. This can be either because of resentment or because, being left largely out of the process, they do not realize the importance of information to the decision being made.

As with the allocation of power, project managers should carefully weigh the costs and benefits of different levels of involvement and select the level most appropriate for their projects. Then during contract negotiations, their expectations about which tasks they want to participate in and the degree of participation must be made clear to the potential subcontractor.

PERFORMANCE STANDARDS

Lesson(s): Design and implementation of an effective system of performance standards is the key to control of the subcontractor's performance. To be effective, performance standards must be established and agreed to before the tasks to which they apply are begun. They should be objective and easy to measure, comprehensive, and realistic. They must be supported by good performance monitoring mechanisms and specified recourses in the event of poor performance.

The Standards

By performance standards I mean any criteria by which the subcontractor's performance is to be guided and evaluated. These include everything from schedule milestones and budget ceilings to missing data rates and keyboard verification requirements. Performance standards are at the heart of subcontract management. Disagreements between prime and subcontractors are often rooted either explicitly or implicitly in performance standards. In fact, many of those interorganizational conflicts sometimes referred to as style or personality clashes can be viewed as lack of common perception of what the standards are or should be.

Reaching agreement among prime and subcontractor staff members about performance standards is difficult, especially if tasks are complex and there are as many different skills and world-views as there were on the HIE. It will be even more difficult if the two organizations have adopted a partnership relationship or there is disagreement between them about their roles. The ease with which standards can be articulated will increase with the age of the project. During initial phases, when relatively little is known about the nature of the work to be performed by the sub, fewer standards can be developed than during later stages of the project. In most situations, however, the problems of negotiating standards will not be totally insurmountable. With perseverance, the prime can, and I would argue should, see that some standards are formally recognized. We found them to be an essential subcontract management tool. We also found that the following guidelines can make them easier to administer.

First, performance standards should be established and agreed to by all relevant parties *in advance*. "In advance" means before the contract is signed for major tasks and before work begins on lesser ones that would not be called out separately in the contract Statement of Work. Write any that apply to Statement of Work tasks into the contract. By making performance standards explicit early on, many unpleasant surprises can be avoided. Subcontractor staff will know how their performance will be judged and friction from Monday morning quarterbacking by the prime will be reduced. Goals and priorities set

by the subcontractor will be more compatible with those of the prime and their performance will be better from the prime's viewpoint than if there had been no discussion of standards. Additionally, such discussions will make the sub's views on performance clear and will indicate where they need to be reconciled with those of the prime. Writing performance standards into the contract highlights their significance, shows that the prime takes them seriously, and demonstrates a commitment by the sub. It also provides documentation of the commitment in the event of subsequent performance shortfalls.

Where possible, the standards should be *objective and easy to measure*. This will reduce the conflict over their meaning and whether or not they have been met. Ideally, performance evaluations should not be clouded by personality or world-view differences.

In some cases, establishing concrete standards is quite straightforward. A contract can specify delivery dates, processing turnaround times, or error rates. Others are less simple to define. A desire that the sub be "responsive" to changes in specifications might seem impossible. But it can be translated into measurable standards in many instances by attaching implementation dates to specification changes as they occur. However, there are some standards--very important to the prime contractor--that defy translation. The ability to "ask the right questions" is an example. Even in cases where the prime's criteria are as nebulous as this, though, there are benefits to be gained from making them explicit. Often through discussion, it becomes clear how to refocus or redefine standards so compliance can be more readily measured. In this example, perhaps "ask the right questions" could be redefined to include regular managerial reports on selected topics. While this does not cover everything implied in the criteria, it does at least move some aspects into the realm of the measurable. At any rate, so much has been written elsewhere about quantifying performance objectives that I will not further belabor the point.

Performance standards should also be *comprehensive*. Like any set of incentives, formalized standards will focus effort on the tasks to which they apply, particularly if they appear in the contract. Tasks without standards may suffer from lack of attention. Although, it may

not be feasible to hammer out standards for each task, standards should be agreed to for all tasks considered significant. Important tasks often overlooked include data processing and clerical system documentation, and development of related procedure manuals, documentation of exceptions made to general procedures, and creation of management information (performance monitoring) data.

Perhaps most important, performance standards should be *realistic*. That is, they should be possible for the subcontractor to meet given staff capabilities, resources available, and the other requirements they are expected to fulfill. The conscious use of standards set at slightly higher levels is sometimes recommended to create incentives to strive, somewhat the way the rabbit is dangled perpetually ahead of the racing greyhounds. This policy can have serious drawbacks on long-term projects. It places the subcontractors into a cycle of failure, since most of the time their performance will fall short of expectations. This is damaging to morale at both organizations. Those responsible for managing the sub find themselves in a no-win situation. They must either ignore the standards that are not being met or constantly criticize the sub's performance. Control is surrendered when unmet standards are ignored. Yet constant criticism is hardly a basis for supportive, productive relationships. Eventually the power of performance standards as a management tool is eroded completely as the subcontractor learns that attempts to conform to them are usually futile. Meanwhile project management, the research staff, and the sponsor are making their plans on the assumptions that performance specifications will be adhered to by the sub. When they are not, these plans must be adjusted accordingly. Adjustments cost money and lead to frustration and recriminations.

In fact, nothing caused more trouble for HIE operations than subcontractor's failure to meet standards. Of course, unrealistic expectations were not behind every failure, but they were definitely a contributing factor, for several reasons. Some of these reasons warrant examination here because they involve tendencies we doubtless have in common with others managing similar endeavors. Recognition of these tendencies is a first step to controlling them. Controlling them will facilitate the development of sound performance standards and a smoothly run project.

First of all, there is the natural drive for perfection that can blind both prime and sub to reality. Typically subcontractors will not have resources available to them to carry out all the data collection tasks imaginable to the degree of perfection that can be specified for a big and complex project. Choices have to be made. But recognition of constraints/limitations can be hard to come by, as the research staff may be loathe to make data quality tradeoffs.

And then there is the "If I can do it, you can do it" syndrome. People have a tendency to project their own characteristics onto others in an attempt to understand and relate to them. This creates the expectation that what is easily or well done by oneself should be easily or well done by others, an assessment that is not always accurate. A related syndrome is "If I *think* I could do it, you should be able to do it," the logic of which is self-evident. There are many variations of the basic theme. A common one is based on an extrapolation from past experience that appears to have been like the one currently faced by the subcontractor. If that situation was successfully handled then the subcontractor is expected to handle the current one in similar and equally successful manner. Such reasoning can lead to unrealistic standards where, as is often the case, the two situations are not as similar as they seem or the capabilities of the people involved are very different.

Finally, impossible goals were often set when scheduling and planning of tasks were conducted in isolation. That is, we often found ourselves in the position of agreeing to task specifications without precisely understanding the impact on the subcontractor of the other activities that the subcontractor was expected to perform. These other tasks or actions by other organizations would then prevent the subcontractor from meeting its goals. We, of course, realized this could happen and tried to take these factors into account. But it was not easy for us, just as it would not be for other like research projects. The tasks were relatively unique, there were a large number of tasks and actors, and little money was available for sophisticated scheduling and information management systems, given project priorities.

Monitoring Mechanisms

An aspect of standards design that sometimes gets overlooked is the provision for monitoring devices to determine whether the standards are being met. Simply agreeing upon standards may bring some of the benefits described earlier by clarifying both parties' expectations. However, our experience has been that when the prime does not have means to compare the sub's achievements to the standards, the standards become impotent.

Monitoring devices can be categorized in several ways. Information about a subcontractor's performance can be gathered indirectly, by observation, or directly through some form of report. Reports can be verbal (meetings or phone calls), or written (produced by hand or machine). They can be very formal, with set formats and schedules, very informal with neither, or somewhere in between these two extremes. The contents of the reports can be specified by the subcontractor or by the prime or worked out together. They can be of varying degrees of sophistication. They can simply set down what was done. They can contain data that allow the reader to make comparisons with other data such as past performance or performance target. They can contain transformations of the data, for example, statistical averages. And they can contain some sort of analysis of the information presented.

The particular monitoring methodologies employed will depend on, among other things, the task being monitored, the resources available for monitoring, and management's personal preferences. However, when at all feasible, formal written reports should be considered.

A report is preferable to observation for several reasons. For one thing, it involves the sub in the process. Preparing reports will focus them on their performance and make them aware of the prime's perception of how they are doing. Information about performance is usually more accurate and complete if provided by the subcontractor rather than gathered by observation. Furthermore, although there will still be arguments about the interpretation of that information, at least there will be little disagreement over what the performance actually was. Similarly, written reports usually leave less room for ambiguity than do verbal reports. Two-party phone calls are particularly troublesome in

this regard since there are no witnesses to the conversation and a lot of information and important shades of meaning can get lost in the retelling. Additionally, with written data the prime can more easily build a data base for subsequent analysis.

Formalized content greatly aids the efforts to analyze trends and make comparisons as well as increases the chances that the prime will get the needed data. Formalized schedules help insure that the data will arrive when needed. Somehow, reports without due dates just never get done.

The contents of reports or other monitoring devices should be jointly specified. Devices designed exclusively by the prime are often more expensive and less likely to be used than the ones put together with input from the sub. This is a key point. The subcontractor will have more intimate knowledge of his own systems and, thus, how the information desired by the prime can best be generated. Often this has implications for report content. For example, say the prime contractor arbitrarily specifies that it wants a certain piece of data at six week intervals, although really any time less than ten weeks would be acceptable. Generating the data at six weeks will take massive amounts of clerical time, but it would be readily available at eight weeks if a subroutine were added to a program routinely run by the sub bimonthly. If the prime fails to consult the sub and demands the six-week interval, the information will be much more expensive than if the subcontractor had been encouraged to participate in the design process. Then, the subroutine idea would doubtless have surfaced in the discussion.

Another key point is that the provision of monitoring data should be treated just like any other task. That is, the work involved should be specified in advance and, if it is fairly expensive, should be written into the Statement of Work and budgeted for specifically. Obvious as this sounds, the focus can be so intently on the "real" data collecting, processing, and program administration efforts that monitoring tasks are overlooked, particularly when it comes to paying for them. It may be assumed that they will be a by-product of the activity being monitored at no additional cost. Usually, this is just not true, or is true only for the most simplistic, least sophisticated devices. Adding on complex reporting requirements without seeing that

there will be resources available to fulfill them will have one or both of two unhappy outcomes. The reports will not be done or be done badly or the activity being reported upon will suffer. The free lunch concept is no more valid here than anywhere else.

Recourse for Nonperformance

After objective, realistic, comprehensive performance standards have been specified and monitoring devices defined, agreement must be reached between prime and sub as to what happens if the standards are not met. Two types of actions need to be considered--setting corrective mechanisms in motion and imposing sanctions. It is the latter activity I wish to discuss here. Like monitoring devices it can be easily overlooked in the heat of battle. The omission can make entire standard/monitoring structures meaningless.

Sanctions or penalties for nonperformance can be associated with one or more specific tasks and can apply to any related performance standard--schedule, budget, error rates, etc. They are usually monetary--reduction of fees or nonpayment of certain costs.

Sanctions should be agreed upon during contract negotiations and incorporated into the language of the contract. Lack of formally agreed-upon sanctions will limit options to deal with severe performance problems. Of course, management will not be precluded from imposing penalties after the fact. For example, one can refuse to pay for poorly executed work or reduce fees when crucial data are not delivered on time. But working out these problems with the contractors after the fact will be a messy process. Productivity of staff at both organizations will suffer while everyone focuses on the conflict. Reaching agreements before the contract is signed with the management of the subcontractor about the penalty to be imposed for specific failures to perform will not eliminate conflict about nonperformance, but it can reduce it. Negotiations about the nature and amount of penalties are bound to go more smoothly before the nonperformance has occurred than afterwards, when conflicts already exist and the atmosphere is emotionally charged.

MANAGERIAL COMMITMENT

Lesson(s): The degree of "managerial commitment" of the subcontractor is a determinant of the degree to which performance standards will be met. Research projects may face special obstacles in obtaining sufficient commitment. These can be at least partially overcome if the issue is dealt with during contract negotiations.

The degree of the subcontractor's *managerial commitment* to the project is a significant determinant of the extent to which performance standards will be met. The phrase managerial commitment means many things to many people. I use it to refer to the lengths to which the organization's top management is willing to go to see that the prime is pleased. The issue usually comes to the fore when the demand for the subcontractor's resources, both human and nonhuman, begins to exceed the supply. For example, what happens when the project and another of the sub's clients both "urgently" need data processed on the same equipment at the same time? Does the project win out over the other client or does the schedule slip?

Another way commitment is demonstrated is through the quality of management provided for the project. Will the sub pay enough to attract well-qualified managers to the project? Will it designate a particular individual as project manager and encourage him or her to form a vested interest in the project? What if other clients want the same person for their work? Do key employees have any incentive for performing well on the project? Will their performance affect subsequent raises and promotions?

These questions can become very important on large, long-term projects and may too frequently be answered in the negative. Because research projects are essentially one time efforts, they can be regarded by subcontractors as an aberration, a contract that will provide sure dollars in the short run, but will do little for them in the long run. This will be particularly true for those that foresee no further research related undertakings. Their internal reward structure will reflect these beliefs. So when "push comes to shove," the project's work will come out second best.

Clearly these kinds of issues should be raised with an organization before the contract is signed. However, much has been said about where good intentions can lead. Something more than verbal assurance is desirable. The contract itself can be a tool for increasing managerial commitment. Key personnel and equipment and minimum time or other forms of commitment can be specified. Incentives can be added to counter disincentives within the subcontractor's reward system. Negative incentives, sanctions, were touched on earlier. If permitted by the sponsor, positive ones can also be employed.

V. PROGRAM ADMINISTRATION

A significant portion of HIE operations involved the administration of an experimental program. The program is described in some detail in Sec. I. Essentially, it entailed the enrollment of some 7,706 individuals in health insurance plans operated by the Experiment. In this section I present lessons we learned in the process of administering this program. Out of the numerous possibilities, I have chosen only those general enough to be helpful to other research projects with a program component. The topics covered are administrative data, the rules of operation, communications with participants, and participation incentive payments.

ADMINISTRATIVE DATA

Lesson(s): Administrative data may eventually be required for analysis. Managers should anticipate this possibility and be sure that it is taken into account when administrative data collection systems are designed. Administrative data should be preserved until the conclusion of the project and a well-documented quality control policy for this type of data should be developed.

"Administrative" data will be collected as part of the performance of each program function. It is distinct from "research" data in that, although it consists largely of information about program enrollees, their behavior, and their interactions with program administrators, its collection is not called for in initial research plans. Rather, administrative data are collected as a by-product of administrative operations. When the analysis is designed no plans are made to add it to the project data base. Development of administrative data collection and processing systems does not require input from the research staff. Instead, they are regarded as purely administrative territory and left in the hands of program administrators. Examples of administrative data from the HIE are the number of times a participant called with questions on claim forms and what the questions were, complaints received about incentive payments, or the fact that a participant traveled to Europe for the summer.

Most of the considerations listed in Sec. III apply to the collection of administrative data. There is also an important special consideration which is the reason I have chosen to discuss administrative data separately: the possibility of its eventual use in analysis.

Although there is no intention to use administrative data for this purpose at the time it is collected, it may subsequently become critical to the interpretation of research results. It may be discovered that certain events and behaviors of participants that were captured by administrative data collection systems shed light on key analytical findings. Thus, in later phases of a project, managers may be faced with the task of locating particular administrative data and getting it into the database or at least into a form usable by the research staff. Often, at this point, there is a good deal of time pressure because analysis is being held in abeyance until the data are readied.

Two situations that arose on the HIE will serve as examples of this point. The first involves information about Experiment participants' eligibility for Medicaid. This information had been collected as a by-product of program administration operations but no plans had been made to add it to the database. Initial analysis of the claim data made it clear that information about Medicaid status would improve our understanding of the data. In particular we wanted to know whether participants eligible for Medicaid were using Medicaid instead of their experimental insurance. Identification of Medicaid eligibles was a necessary first step in the investigation of Medicaid usage. Therefore late in the Experiment, clerical records had to be searched and new machine-readable files created.

The second example also stems from the analysis of the claim data. For several reasons, it became necessary to review administrative records maintained by a subcontractor to determine where everyone who had moved during the Experiment had moved from and to. Again, the need for this information arose late in the Experiment and entailed the creation of additional computer files that had not been planned for by the operations staff.

The capture of administrative data under these kinds of circumstances will go relatively smoothly if the situation has been *anticipated* from the outset of program operations. Routine addition of administrative data to the database as they are generated is probably not feasible for several reasons, cost among them. However, fairly inexpensive steps can be taken to make adding them easier, should a real need arise toward the end of the project.

For one thing, administrative data can be kept rather than discarded before analysis is complete. On the HIE we made it a rule to save all unique administrative information whenever possible, even if no need for the information was foreseen. At the end of the Experiment, we were repeatedly grateful for instances where the rule had been followed and chagrined about those where it was not. Second, it helps if designers of administrative data collection and processing systems *realize* that the data may eventually be used by others. Often, they can incorporate design features that facilitate this use. Or, at least, they can refrain from doing things that will make it impossible to use. For example, clerically maintained logs can be designed for easy data entry. Standardized forms for recording telephone calls can be used at all site offices; identifiers needed for analysis can be added to the forms. Finally, quality control procedures can be designed, applied uniformly and consistently, and documented in detail. Although these procedures may differ from those that would have been selected for research data, at least analysts will be able to learn what was done.

RULES OF OPERATION

Lesson(s): In the design of program rules of operation, zeal to preserve and perfect the experimental design must be tempered by administrative considerations. Changes to the rules are inevitable and should be carefully managed. Managers should be sure that project staff members make appropriate, optimum use of rules.

Design of the Rules

The administration of a research-project-related program requires the development of detailed guidelines or "rules of operation." These rules typically cover enrollment in and disenrollment from the program, the treatments to be rendered program participants, fiscal responsibility, and data collection. The HIE rules of operation covered the following subjects, among others. (For a more detailed description and a justification of the rules, see Clasquin and Brown, 1977.)

- Criteria for grouping people into families; criteria for determining whether the families and the individual family members were eligible for enrollment in the Experiment.
- Standards the families and individuals had to meet to remain enrolled in the Experiment.
- Procedures for handling changes in family composition over time.
- Methods by which the income-related expenditure ceilings built into the HIE plans would be determined.
- Types and methods of payments to family units.
- Coverage and payment implications of changes in family unit composition.

It is apparent that many of the rules reflected and were constrained by the experimental design. This will be true of other projects as well. One of the main functions of rules of operation in fact is to translate experimental design into specific administrative actions. Thus, one of the goals of designers of rules of operation is to specify actions that will preserve the design. From this perspective the operational guidelines in the rules should incorporate research ideals.

At the same time, those guidelines should make good administrative sense. That is, they should lead to efficient operations.

At times these two goals--preservation of experimental design and development of sound administrative operations--will be incompatible. Ideally, the rules should represent a balance or compromise between them

that reflects the philosophy and values of project management. Achieving the desired balance consumed large amounts of managerial time on the HIE and was a central concern in the design of the rules.

Two issues--case-by-case vs. uniform treatment of individuals and simple vs. complex procedures--are typical of those that will call for thoughtful compromise between research and administrative concerns. Ease of administration increases with uniformity. The greater the number of individuals that can be treated the same way, in accordance with a common set of procedures, the less error prone and less costly it will be to administer the program. The same is true for procedural simplicity--it will save money and increase the quality of the program administrator's performance. Yet specialized, individualized treatment of sample members will sometimes be desirable from a research point of view. Similarly, fairly complex procedures may best achieve research aims. The following example should illustrate both of these points.

The HIE enrolled families on the basis of and as part of personal household interviews. Sometimes a member of the family would be temporarily away from home at the time of the interview and the enrollment process, perhaps because of business trips, vacations, jail terms, or hospitalizations. It was desirable that these people be included in the sample if they returned within a "reasonable" period of time. Administrative efficiency would be enhanced if a single waiting period, say 30 days, was adopted and the burden to report the individual's return was put on the family. If no notification of the return was received within 30 days, they would not be eligible for enrollment. But treating each situation independently, establishing expected return dates for each person, deciding if the date was "reasonable" given the circumstances, having study employees check to see if the individual had indeed returned, and making a decision to enroll case by case would probably maximize the number of "the right people" eventually enrolled. Hence, the crux of the dilemma for rules designers: this maximization cannot occur simultaneously with a minimization of administrative costs and error rates. The challenge is to define a compromise between these two goals that satisfactorily reflects project priorities and budget constraints.

A second important administrative consideration in rules design is realism or "reasonableness." Rules need to recognize and accommodate real life events and human nature, even if they are inconvenient given the study design. Sample loss in a program like the HIE is, in part, a function of the reasonableness of the rules of operation. The burden associated with participation in the study must not be so weighty nor the administrative procedures so impractical that participation becomes unbearable. Also, unreasonable rules will have a strong negative impact on the morale of those responsible for administering them. This may be a particular problem when they are being administered by staff with scant research background and with a strong administrative orientation.

The concept of reasonableness is highly abstract and subject to interpretation. The HIE eligibility standards provide some good examples of what it can entail. The design of the HIE required that individuals in the sample be grouped into families. So rules specifying how the grouping should be carried out were created. One fairly obvious criterion was that family members should live together. Thus, families could change over time. New people could move in; original family members might leave. Our rules had to deal with these eventualities in ways that the analysts, the participants, and the program administrators all could live with.

For example, divorce and its probable effect on family relationships had to be taken into account when we decided whether to treat divorced or separated individuals as a single unit for insurance purposes. The effects on sample loss of the extension or refusal to extend health care coverage had to be carefully considered when rules for treatment of newborns, new spouses, and other added family members were designed. And the burden on family heads and the relative awkwardness of alternative procedures had to be evaluated when we determined what to do about enrolled children who left their parents to live with grandparents or other adults. In each of these instances, research ideals had to acknowledge the real world. Practical considerations had to play a role in shaping the rules if they were to be administratively feasible.

Updating the Rules

Even if a great deal of care is taken to anticipate events when rules are first designed, things will occur that were not foreseen and the rules will need to be revised as a result. For example, we thoroughly explored possible changes in family unit composition as described earlier. Yet, we overlooked the possibility that two people, enrolled in two separate family units and assigned to two different health insurance plans, would divorce their respective spouses and marry each other. Farfetched maybe, but it happened and new rules had to be developed to cover the situation.

Changes and updates to rules of operation raise two major concerns, accountability/control and dissemination of information. Rules essentially document the implementation of experimental design as well as the contract between the study and the people enrolled in it. Hence, it is very important to keep track of changes and dates when changes were implemented. Great care should be taken to preserve various versions and information about the time periods that the versions were in effect. Our experience indicates that documentation of the reasons behind changes will also prove valuable over time.

Also, because of the valuable functions of the rules, it is crucial that appropriate persons are informed of changes. This should include analysts, those responsible for implementation of the rules, and study participants.

Promoting Proper Use of the Rules

An even bigger concern than getting information about the rules to the right people is getting them to make the best possible use of it. If such information is ignored or used improperly, there is not much point in making an effort to develop dissemination systems. To properly use material on the rules, staff must be aware that it exists, understand it, and refer to it while making analysis plans and administering the program. This applies to both the original version of the rules and the updates.

One reason usage problems develop is that by their very nature the rules are many things to many people. For analysts and others interested in experimental outcomes, they provide a description of significant aspects of the experimental design. For study participants they spell out what they can expect from the study and what the study expects of them. For program administrators, they serve as basic procedure manuals and guidelines for operations. It is difficult to select a style and format for documentation of the rules that is appropriate to such a wide range of purposes and that facilitates usage by such diverse individuals. We found it helpful to create different versions of the rules. We had a formal, tightly written, legalistic document for distribution to participants or others who were not on the staff. And we had an abstracted, simply worded version for use by the program administrator's staff, who needed to be thoroughly familiar with the rules.

It is also helpful to devise a way to keep interpretive, detailed explanatory material out of the official rules document. A simpler document is usually easier for analysts and participants to use. Also, this allows interpretative material to be written in the style that most facilitates use by the administrative staff.

Finally and most important, project management should see that all project staff are educated appropriately about the rules and their significance and are trained to use them as part of their work. It is essential that the program administrators--from the most senior to the most junior level--thoroughly understand the rules that pertain to the functions they perform and apply them as intended by project management. Also, we found that many difficulties experienced during analysis were caused by misunderstanding or igorance of the rules on the part of the research staff. It is dangerous to assume that the significance and implications of the rules of operation are obvious to all and that they will be used properly as a matter of course. This assumption is probably least valid for large projects where decisionmaking about experimental design and rules content is relatively centralized. Additionally, the need for staff training increases with the number and complexity of the rules.

PARTICIPATION INCENTIVE PAYMENT

Lesson(s): Incentive payments should be as simple as possible to calculate, based on information for which a neutral, reliable source is available, and have a stable basis.

As part of many research projects some sort of payments are made to the subjects to reward or reimburse them for their participation in the research. Such fees are often not variables of analytic interest. Usually the algorithm used to determine the amount of the payment is fairly straightforward and is based on factors that are easily measurable. For example, it can be a flat fee or be based on number of questionnaires completed or time taken in interviews.

The participation incentive payments made to families enrolled in the HIE were like these kinds of payments, in that they were designed to encourage participation, not as an experimental variable. However, unlike "typical" incentive payments, the payment algorithm was highly complex. Not only was the calculation itself relatively complicated, but the underlying concepts were extremely so. For the manner in which these payments provided an incentive was to insure that participants were not made *financially worse off* as a result of their enrollment in the HIE.

The possibility of financial loss arose because as part of their enrollment people agreed not to use their regular health insurance coverage and accepted one of the experimental plans which may have been less generous. In other words, in certain cases, for any given medical treatment, a person could have paid more out of their own pocket under our plans than under the plan that covered them before they enrolled in the Experiment. Calculating a participation incentive payment, therefore, involved comparing the payments made by the two plans.

We were also concerned that participants in the HIE not terminate their other insurance, because of the possibility that they might become uninsurable during the course of the Experiment. To encourage them to keep it in force, we reimbursed them for the amount they paid out of their own pockets for premiums. This amount was factored into their participation incentive payments.

This may sound highly complex, but it is a simplification of the actual method of calculation. Special rules had to be developed for, among other things, cases where the participant had two plans covering the same or different services, hospital indemnity policies, premiums that were paid by someone outside the family unit, premiums that covered some family members who were not eligible for coverage by an experimental plan, and situations where all or part of the family was eligible for Medicaid. And, of course, changes in family composition and insurance coverage further compounded the complexity.

This complexity was introduced into our incentive payment system for good reasons. (See Clasquin and Brown, 1977, for a detailed description and explanation of the HIE participation incentive payments.) However, from a purely administrative standpoint, the complexity was highly undesirable. The best advice I can give someone planning an incentive payment system for a research project on the basis of the HIE experience is, if at all possible, *keep it simple*! The participation incentive system is a perfect example of the tension that can arise between experimental design and administrative efficiency that I discussed in the previous section of this report.

The major dangers of complex systems are twofold. First, the staff administering payments will have trouble understanding the algorithms and the purpose behind them. This will cause misinformation to be conveyed to participants, lack of confidence on project management's part in judgments made by the administrative staff, and fairly high error rates. Proper management will require the development of detailed guidelines, extensive staff training, and thorough quality control measures. This can result in the devotion of resources to management of the payment system out of proportion to its contribution to project objectives. In general, the amount of management time taken up by purely administrative matters, such as payment administration, should be minimized; the amount given to collection and processing of data and insuring the integrity of the experimental design should be maximized. Complex payment systems will shift resources in an unproductive direction.

Also, participants are not likely to understand complex algorithms or, even if they do understand them, to remember them for very long. In addition to raising issues of informed consent, a poor understanding of the payment algorithm by participants in a research project can be a particular problem when the accuracy of the calculations depends on inputs they supply.

This was the situation on the HIE. The participants were our primary source of information on their insurance. If they did not report changes in that insurance or premiums in a timely manner or if they conveyed incorrect information to us, large under- or overpayments could accumulate. These caused a lot of administrative difficulties and friction in our relationships with participants when they were subsequently discovered. (We verified our records of participants' insurance and premiums with employers and carriers from time to time.) Chances of misreportings or failures to report information were obviously increased when participants did not understand their payments were related to their insurance.

Payment administration problems will be minimized if payments are based on data for which a reliable, neutral source is available. The reasons for this should be evident from the previous paragraph. In particular, avoid using the payee as the source. We had to rely on the participants to act against their own interests to obtain information about loss of coverage and premium decreases. When we discovered overpayments had been made, prudent management usually dictated that we attempt to get the participants to return the funds. This often led to discord which was exacerbated by the fact that the participants' compliance with their reporting obligations to the Experiment was often also an issue. Thus, the conflict was further personalized.

A final related caution is, if possible, select a stable basis for payment. Our participation incentives were sensitive to changes in family composition, income, health insurance coverage, and insurance premiums--all of which change relatively frequently in a 3- to 5-year study involving over 7,000 individuals. The majority of the administrative problems we experienced were due to these changes. Not only was information about them difficult to collect, but by their very

existence, they added tremendously to the number of rules and interpretations of rules and, thus, to the operational complexity of the system.

COMMUNICATIONS WITH PARTICIPANTS

Lesson(s): Communications with program participants should be managed as carefully as any other administrative task. Managers should be concerned with both the quantity and quality of interactions between program administrators and participants.

Administration of the program required frequent communication with participants about a variety of subjects. Some contacts were initiated by participants, some by the Experiment staff. The contacts could be by phone, mail, or personal visit. They ran a gamut from highly structured, formal instructions for completing questionnaires to personal interviews to informal, unscheduled phone calls about the completion of claim forms. The overriding "lesson" that can be distilled from this experience is that communication flows must be "managed" just like any other administrative task.

The outgoing flow, e.g., from the program to the research subjects, needs to be planned, controlled, and coordinated both within and among organizations. Good management of the process will prevent duplication of effort by project staff and avoid confusing the participants while minimizing the burden upon them. On the HIE, there were eight different departments within the organization administering the program that could potentially contact participants on any given day. In addition, they might also receive a communication from the survey and screening exam subcontractors. Without planning, they could easily have been overwhelmed with mail and phone calls from the HIE. This problem is not hard to prevent. Standard techniques and common sense can go a long way toward keeping contacts to a reasonable level. Responsibility for communications can be specifically assigned. Contacts can be aggregated or batched so, for example, four issues can be taken care of in one phone call. Timing of contacts can be synchronized so that, to use an HIE example, two organizations did not mail questionnaires to the same people on the same day. These arrangements do require an initial

investment of managerial effort. But once the necessary communication systems within and among organizations have been established, they usually run smoothly without extraordinary supervision.

The hard part seems to be *recognizing* the need for coordination of outgoing flows. Project management's attention is sometimes more readily drawn to the mechanics of specific tasks, particularly during the design and implementation phases. What is needed also is an examination of the implications of those tasks for communication patterns. The combined effects of all tasks must be understood, for only this will reveal the true impact of program activities on participants.

Incoming flows--from research subjects to the project--must also be managed. On a project with the scope and number of actors of the HIE, channeling becomes an important concept. Channeling involves setting up systems and educating project staff so that participants initiating contact with the Experiment are directed toward those employees who can best handle their concerns. This kind of direction is necessary if gains from delegation of responsibility and specialized training are to be fully realized.

Project management should also be concerned with the quality of communications between enrollees and project staff. The degree of concern and resultant involvement of management in the communication process will vary with the project. As with other aspects of operations, even though the actual interactions were carried out by our subcontractors, Rand staff chose to become very involved. We wanted to ensure as much as possible that the information conveyed to our participants was accurate, clear and, perhaps most importantly, did not influence enrollees behavior in inappropriate ways. Similar considerations would probably dictate close oversight of those interacting with participants by project management on other research projects.

Verifying that written materials meet certain standards is fairly easy. These materials can be reviewed or, as a last resort, drafted by senior-level management or, on a project structured like the HIE, by the prime contractor operations staff. We did establish a system of mandatory review by Rand of questionnaires and other key materials prepared by the subcontractors.

Controlling the nature of verbal exchanges between participants and program staff is much more difficult. This is particularly true in a situation where those actually talking to enrollees are junior-level employees of other organizations like the subcontractors on the HIE. Less obtrusive means such as development of training protocols and detailed written procedures or even periodic site reviews reveal little about what really takes place during phone calls or personal visits. Yet more obtrusive monitoring devices such as phone call tapes can be expensive, raise confidentiality concerns, and be deeply resented by subcontractors. Nevertheless, because personal interactions can have such an impact on research subject behavior under circumstances like those we faced, their management deserves a good deal of thought. The choice of methodology will depend on the nature of the project, the personalities involved, and the money available.

VI. PROJECT MANAGEMENT WITH AN OPERATIONS STAFF

In Sec. II, I discussed the benefits to large, complex projects from employing a "separate" operations staff, that is, a staff distinct from the research staff whose sole responsibility is the management of project operations. I defined operations as all project tasks not associated with data analysis. These tasks can include financial management, subcontract administration, data collection, and data processing. In this section I discuss topics that our experience indicates will be of special concern to managers of projects that do have a separate operations staff. These are staff size, the ideal characteristics of an operations staff, operations staff morale, integration of the operation and research staffs, and participation of the research staff in operations.

Some of the issues raised here are also very relevant to projects that involve a nontrivial amount of operations work but do not have a separate operations staff. Typically, some members of the research staff are also responsible for operations tasks. Lessons we learned about staff size will be useful for any project managers who must make decisions about the share of project resources to be devoted to operations. Ideal characteristics of the operations staff are ideal for anyone doing operations work. And managers generally must be concerned about adequate/appropriate research staff participation in operations.

STAFF SIZE

Lesson(s): Selection of the size of an operations staff amounts to a decision about the lack of perfection that can be tolerated in operations work. Management must be prepared to live with the consequences of this decision.

The share of project resources to be devoted to operations work as I have defined it here is a question that requires a good deal of thought. The level of staffing is an important determinant of how "perfect" the data will be and how smoothly its collection will proceed. It will constrain the speed with which the experimental design can be

implemented or changed and, often, the pace of the analysis. It will also mold the research staff and others' perceptions of how well the project is being managed.

Managers should not expect to have an operations staff big enough to fulfill all the demands that will be placed upon its time. Given the nature of research project staff's expectations about the product of operations work, these demands can be unlimited. There will almost always be one more thing that can be done to create a more "perfect" data base, i.e., there will almost always be another use for staff time. It may sound ridiculous to suggest that data collection should produce a "perfect" product, but that is what often comes to be implicitly expected by both the research staff and the data collectors and operations staff themselves.

As an illustration of what I mean consider a self-administered questionnaire mailed to a sample population. During development of the instrument, a draft can be reviewed once by analysts, changes incorporated on the basis of this review, and the questionnaire sent to the printer. Or the analysts can review it again before it is printed. Inevitably, more changes will be made, which can be reviewed again, resulting in more changes and so on ad infinitum as everyone strives for the perfect questionnaire. Each of these review rounds takes operations staff time away from other questionnaires.

After the questionnaires are mailed and begin to be returned, they will be edited. Follow-up for missing items can be implemented--for all missing items, for some missing items, for inconsistent responses. Any number of follow-up contacts can be attempted. In theory, everyone realizes that endless, complete follow-up is very expensive, if not impossible. Yet in practice, decisions to reduce retrieval attempts are hard to come by. When each questionnaire is taken separately, analysts find it difficult to agree to allow missing or inconsistent data. Hence, pressures on projects are toward complete, logical data which translates into fancier and more thorough follow-up and greater demands on operations staff time.

A final example arises when responses on questionnaires are coded. If there are open-ended responses, a different code can be assigned for each response to capture the nuances of the way each individual

respondent chose to express himself. Or more aggregated codes can be created to capture some but not all of what was said. Again, the decision to forgo information is very hard to make. Pressures will be toward finely distinct codes which require more time to create and monitor.

Desires for perfect data that manifest themselves in these and other ways can create unlimited demands for operations staff time. Such desires are not necessarily "bad" and should not necessarily be eliminated, but they mean that the decision about the operations staffing level amounts to a decision about the lack of perfection that can be tolerated. Compromises and tradeoffs must be made.

Once these decisions and compromises have been made, they must be *lived with*. Management must realize that perfection is not possible, understand the degree to which it is possible given the operations staffing level, and be prepared to defend the resultant lack of perfection to the research sponsor and the research staff. In other words, the *expectations* of project staff and others as to what operations can accomplish must be *adjusted* to match the resources available. Expectations that are out of line with capabilities will damage both operations and analytical staff morale and can cause serious problems with the sponsor.

Additionally, if project management fails to acknowledge that the operations staff cannot possibly meet all the demands for its time, and fails to establish priorities for its use, the allocation of that time will be made ad hoc and will probably not reflect management's priorities. Instead, it will reflect the wishes of whichever analyst, subcontractor, etc., is most successful in attracting operations staff attention to their needs. Thus, living with the level of staffing chosen means making tradeoffs, establishing priorities, and communicating these priorities to all relevant parties.

STAFF CHARACTERISTICS[1]

Lesson(s): Ideally, members of an operations staff should possess the following characteristics:

- ability to get along well with others,
- good communications skills,
- ability to cope with change and ambiguity,
- research sensitivity, and
- appropriate entrepreneurial skills.

Once the staffing level is set, personnel can be selected. The specific technical skills required will vary with the project. We have learned, however, that there are certain general characteristics staff members should have in common.

First, and perhaps most important, they must not only be able to get along with people but must *be willing to work at it*. The operations staff must see working well with other project members as an obligation--a central part of their role on the project. While this ability improves any job performance, it is particularly important for operations people. They must work with individuals whose backgrounds, priorities, and world views differ greatly from each other and in many cases from their own. By way of example, on the HIE, the staff had to interact with, among others, Rand management, individuals representing the accounting, data processing, contracts, personnel, and purchasing departments, the health sciences program management, the subcontractors, the sponsor, state and local government agencies, attorneys, physicians at the sites, public accounting firms, organizations wishing to use HIE data, and research personnel with medical, economic, statistical, and psychological backgrounds. They worked intimately with analysts on the project, all of whom had distinct areas of interest, to design and implement data collection and processing programs that would suit their needs. "Getting along" greatly facilitated their ability to communicate appropriately with these diverse groups, a key job requirement.

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[1]The ideal characteristics of an administrative director or chief of the operations staff are discussed in Archibald and Newhouse, 1980.

In fact, good communication skills, particularly oral, are a second important characteristic to look for in operations staff. Because one of their major roles is to relay information and instructions between parties, they must be able to understand what is said and to accurately reconstruct it for others. In many cases, communications from individuals with specialized backgrounds will be somewhat arcane and will have to be "translated" before being passed on. If the right data are to be collected and processed in the right way, those doing the collecting and processing must comprehend what they are being told to do. Additionally, system design and implementation call for clear descriptions of ideas and the effective presentation of plans and arguments.

Operations personnel must also be skilled at coping with change--they must be able to handle ambiguity, be flexible, and be very patient. Data collection and program administration are inherently dynamic processes, particularly on a longer-term project. Even with a pilot program and routine system pretesting, adjustments will be made on the basis of field experience. New research staff members will have different interests from those that began the project and priorities will shift as a result. New systems will be added, and old procedures dropped or altered. Initial data analysis will change project foci as new research questions arise. The sponsors' interests may shift or funding levels may be reduced or increased from those originally planned.

The operations staff will have to be prepared to handle the resulting frustrating, disappointing, tense situations. Systems they worked long and hard to create will be abandoned. They may be told on one day that a questionnaire will be added, make arrangements with a subcontractor to hire additional personnel, and then be told three weeks later that the document will not be fielded after all. Projected funding levels may change daily, thereby changing plans for any or all systems. Not only should the operations group be sympathetic to the causes of such changes and be able to cope with them, but, depending on the project organization, they may be called upon to support others who bear the brunt of the change and ambiguity. Their ability to do this will depend in large part on their understanding of the analytical

process in general and the project's mission in particular--a quality we often referred to as "research sensitivity." In other words, it helps if staff members have appropriate academic training or previous experience with research projects.

Research sensitivity is important for other reasons. First decisions made by the operations staff can have a significant impact on the data quality and experimental integrity. There is less danger of "bad" decisionmaking if the staff understands the objectives of the research and the nature of the questions being asked. But even with a well-versed staff, there will be some issues only the research staff should deal with. Operations people have to be able to recognize their own limits--to spot issues that should be brought to the attention of the research staff. Usually definite guidelines such as budget impact cannot be established for identifying these issues. Rather, they are selected for their effect on the research. Hence, the ability to spot them depends on research sensitivity.

Also, the operations group should be capable of advising researchers when they are developing data collection and processing specifications, and again when they are analyzing the data. Often, especially on a large project like the HIE, operations people will have a better overview of the project operations than does the individual researcher. Hence, researchers may be acting in a void--unaware of factors that will alter the outcome of their decisions. Additionally, on a large-scale, long-term project, the operations staff may be much more conversant with constraints imposed by fieldwork during the early phase of the project when data collection and processing systems are being designed. The analysts may still be working on important conceptual problems in the design. Sometimes the operations staff will be pressing them for detailed questionnaire specifications when they have not yet outlined their analysis plans. For these reasons operations staff may need to scrutinize instructions they are given. They need to identify complicating ramifications and discuss them with the research staff. They must be able to recognize situations where further thought, inputs from others, or peer review would be beneficial and to point them out. In a sense, they must play the role of gatekeeper to the database.

To play the role, the staff must have credibility with and the respect of the analysts. They must have enough self-confidence and faith in their own judgment to not be overwhelmed and intimidated by the research staff. These characteristics arise from many factors, one of which is research sensitivity.

A final characteristic we found to be of importance in administrative personnel is entrepreneurship. Some people are highly creative, generate new ideas freely, would rather look at the forest than keep track of the trees, like a lot of action, and are easily distracted from routine tasks. Others thrive in routinized, stable environments, and are good at working with details. Most people lie somewhere in between these extremes.

Different phases of research projects often call for different mixtures of these skills/characteristics. This was true of the HIE and we found that things went most smoothly when operations staff were well matched to the project phase. For example, during the design and pretest phases, operations responsibilities included creation of the organizational structure, selection of subcontractors, and designing the data collection and processing systems. Successful completion of these tasks required imaginative entrepreneurs. After the participants were enrolled and most systems were up and running, we needed people with the patience to closely examine and refine these systems, solve detailed problems with participants and data, and conduct precise monitoring, follow-up activities with the subcontractors.

Ideally, as the nature of the project changes, the entrepreneurial characteristics of the staff should change correspondingly. In reality, this is easier said than done. I am certainly not recommending that a well-trained staff be jettisoned once the design phase is over. My point is simply that turnover need not be viewed with the great alarm it often is. Change can be very positive, even if class knowledge is lost. People who have become bored and dissatisfied with their jobs and worried about their careers can be replaced with people with a different attitude and a fresh perspective. In other words, when new people are hired, trying to duplicate lost staff members may not be the best approach. New and different skills may be desirable. If there is no

opportunity to hire new staff, managers should be aware that people strong in one phase of the project may be weak in another and may need more supervision, support, or training as the project enters a new phase.

STAFF MORALE

Lesson(s): Operations staff may have little in common with other members of the organization by which they are employed. Managers should be cognizant of this fact and take steps to minimize any resulting staff morale problems.

By definition, there is a good chance that members of the operations staff will have little in common with the project's research staff. Their training, interests, and job descriptions gave them a different focus. Because they perform largely administrative tasks, often not seen as central to a research project's mission, they may be regarded, or at least feel themselves to be regarded, as second-class citizens.

This sense of alienation can extend to the entire organization if its primary business is to conduct and publish research. The corporate reward and support structures for professionals will be derived from this process. The recognition accorded administrative professionals who are not publishing research results may not always be adequate--in kind or amount. There may be no clear career path for operations people and much of their knowledge may not be readily transferable to other organizational environments. As a result, the operations staff will feel not only isolated but insecure.

The managerial challenge is to keep morale high and to foster loyalty to the project and high levels of productivity under these circumstances. One way to do this is to build a strong "team spirit" among staff members. The operations group can provide much support and recognition for each other. They will develop reward and incentive structures of their own; empathize with each other's problems; appreciate each other's accomplishments.

Formation of a cohesive group can be facilitated by the selection of compatible individuals and by taking action if it becomes clear that someone does not fit in or is not holding up his end of the work. In

the extreme, this means letting them go. Sometimes project managers are loathe to do this because it is unpleasant, and research projects are relatively short term and they fear loss of class knowledge and high training costs for new staff. But the cost of keeping on poor performers can be even higher because of the low morale and decrease in productivity of the other staff members.

Additionally, management can make it clear that the operations staff is expected to perform as a team and to help each other to meet common goals. Their evaluations can emphasize their contributions to the group. Frequent staff meetings can be held to provide a forum for joint problem-solving and open discussions of the stresses inherent in their job. Work can be structured to allow them to appreciate each other's roles and skills.

In addition to creating a team spirit among operation staff members, project management should strive to create a smooth operations staff/research staff interface. Smooth interactions between the two groups is very important. It does wonders for the operations staff's morale to feel that researchers understand and appreciate their role. The more relationships formed with the analysts, the less the operations staff's sense of isolation and alienation from the project. Ways to promote positive interaction between these two groups are discussed in the following subsection.

INTEGRATION WITH THE RESEARCH STAFF

Lesson(s): Research and operations staffs must work well together. Their working relationship will be enhanced if project management takes steps to insure they have a common understanding of priorities and one another's job responsibilities and provides opportunities for routine interaction among all members of both staffs.

Not only is a sound, cooperative relationship among the operations and research staff members important to operations staff morale, it is essential if project operations are to further research aims and if the results of those operations are to be correctly interpreted. For these two things to occur, the two groups must be able to communicate well. The operations staff must understand what the research staff wants and the research staff must understand the progress of the budget, data

collection, data processing, the experimental program, etc. Also, the operations staff must be motivated to do a good job. In a sense, the operations staff works very hard producing a product for which they get no direct credit. Credit and recognition go to the researcher upon publication. If the operations staff has a good relationship with the research staff, it will be easier for them to "give their all" to seeing researchers get the best possible data to work with than if the relationship is characterized by hostility, contempt, rivalry, or misunderstanding.

We have found that the following specific actions by project management can foster good relationships between these two groups.

- Be sure all members of the project staff--both operations and research people--have a common understanding of priorities and budget constraints. In the section on staff size I said that the operations staff will probably be faced with more demands for their time than they can possibly fill. The same is true of project funds. If these scarce resources are to be used efficiently, operations staff must have an idea of the time and effort to be devoted to any particular task--e.g., how "perfect" to make any one data collection effort, given that all of them can not be perfected. They have to understand how to make tradeoffs among the things the research staff will want them to do. Problems arise when research staff and operations staff have different views of the importance of a task. For example, researchers may become upset if they feel operations people are not spending enough time to fulfill a request; operations staff will become extremely frustrated if research staff members appear to be uninterested in a questionnaire that has to be out in the field immediately. Since neither person really "reports" to the other, the resolution of these issues will rest with the project director. It is much easier on everyone if research and operations staff have the same understanding of how much time and money is to be spent on a task before it is begun than to have the Principal Investigator resolving conflicts after the fact.

- Be sure all members of both the research and operations group have a common understanding of each other's job responsibilities. In general "research" tasks are fairly distinct from "operations" tasks but there are some gray areas. A lot of friction and wasted time result when it is not clear who should do what. This is particularly true when "less desirable" work like reviewing detailed data edit specs or going through a large number of memo files to answer questions about the sample is involved. These are often seen as operations tasks by the research staff, since they are quasi-clerical and related to operations activities. On the other hand, from the operations staff point of view, the research staff should be involved, since they have specialized knowledge. In the two examples cited above, for instance, only the researcher really understands how the data will be analyzed, which affects edit specs, and only he understands exactly what information he will want to pull out of the memos on the sample. Because no one wants to perform such tedious tasks, they will not be done well unless they are clearly made part of someone's job. And this can only be done by project management. Leaving it up to the operations and research staff to work it out themselves will cause hard feelings. As with priorities, it is better to reach agreement a priori, than to wait until friction develops.
- Create opportunities for routine interaction across all levels of both staffs. Knowing one another will reduce the operations staff's sense of isolation from the project, will facilitate clear communication and a "team spirit," and will engender sympathy for the other's role. Be sure it is not just the most senior staff members that get to know each other well. Toward this end tasks can be assigned to give the two staffs a chance to solve problems together. Meetings to discuss project-wide issues should include both groups as much as possible.

PARTICIPATION OF RESEARCH STAFF IN OPERATIONS

Lesson(s): Special care must be taken to be sure that research staff participate adequately in the design and operation of data collection and processings systems and the experimental program (if any). That participation can be facilitated by making sure the research staff has the time available and the incentives to do so and promulgating guidelines for research staff participation in operations.

Encouraging Research Staff Participation

The researchers are the ultimate users of the primary product of operations activities--the database. As such, they must provide input into those activities sufficient to insure that the database will be adequate for their purposes. This will be true for any project. The existence of a separate operations staff makes the participation of researchers in operations of greater concern than on "typical" projects. Without careful management, the operations staff can become an impermeable barrier between the research staff and creation of the database. Both researchers and operations staff may act as if the operations staff can run operations independently. Letting this happen is a mistake. On the HIE, insufficient researcher input into operations inevitably led to subsequent problems with the data that surfaced during analysis. It would have been cost-effective to have prevented or at least ameliorated many of these problems by having the analysts participate in the development of data collection and processing systems and monitor their implementation.

Two anecdotes from the HIE demonstrate the kind of problems that can arise when researchers are not adequately involved in operations decisions. The first involves the creation of the HIE "provider file." This computer file was assembled by the program administrator with some input from the Rand operations staff. For a variety of reasons, some of which are described below, researcher input into the design of the file was minimal. Yet the file would prove important to many analyses. It contained information about persons who provided health care to HIE participants.

In the absence of detailed specifications from Rand, the subcontractor staff proceeded to make their own decisions about the information to be put on the file. Naturally they concentrated on the information most useful to them in running the program. This was primarily provider name and address, which were important for processing claims. Later, when analysts attempted to use the file, it was deemed inadequate for their purposes. Information important to them--provider's specialty, for example--was sketchy and sometimes questionable. As a result, the file had to be revised--a tedious and time-consuming task that greatly disgruntled the subcontractor.

A second case in point is the process by which the system to collect and process sick leave data was designed and operated. Our objective was to generate a computer file containing information about sick leave benefits provided to members of the sample by their employers. We did this by sending questionnaires on the subject to the employers. These questionnaires were designed almost entirely by the operations staff and the subcontractor that would administer them. There was little involvement of the research staff. Questions from employers about how to complete the forms and rules for coding and interpreting the data once it was collected were handled similarly. Predictably, decisions made by the operations and subcontractor staffs did not result in the best possible database, given the analysis plans that were subsequently developed. For example, no distinction had been made between short-term employer paid sick leave days and days of coverage under longer-term disability plans. Unfortunately, this distinction was analytically significant. When these kinds of problems become evident during analysis of the data, the hard copy questionnaires had to be exhumed and much of the data recoded.

Research staff may leave operations entirely to the operations staff because they lack the time or the incentive to get involved. The lack of time may be the result of the flow of the operations and analysis work. Design and implementation of data collection and processing systems and the intensive operation of those systems usually precedes most of the analytical work. Therefore, the optimum staffing pattern for the analysis does not guarantee that the research staff will

be available to provide input to operations when it is needed most. Sometimes the appropriate analysts may not yet be on the project. In other instances other commitments can prevent them from devoting the necessary time. Project management should be aware of this problem and consider operations needs as well as research needs when assembling the research staff.

But adequate staffing alone will not guarantee an optimal level of participation by the research staff. Staff members must have an incentive to get involved. They must see the benefits to themselves as outweighing the costs. These costs can be fairly high in terms of time taken away from other work. In particular, analytical plans need to be developed in some detail if research staff contributions are to be truly useful. And if data collection and processing systems are complex, there will be meetings to attend and much material requiring thorough review. On a project with a large research staff there are likely to be many potential users of any one data set. Hence the benefits to individual members of the research staff from spending time to oversee the collection and processing of that data can be unclear. Researchers may receive no direct credit for such work. Their careers generally depend much more on the quality of their analytical work. "Letting the other fellow do it" can seem very appealing under these circumstances.

If this attitude develops, it can become a real problem. Not only can data quality suffer but the morale of operations staff and those researchers who are trying to help with systems development will suffer as well. Project management should consider preventive action designed to control the costs of and to create incentives for research staff participation in data collection and processing.

The operations staff may also need encouragement to get the research staff involved in their domain. Management can provide encouragement to all staff members by articulating "guidelines" for research staff participation in operations. The guidelines should clarify management's expectations about their participation and translate these expectations into actions to be taken by the members of both staffs. Both the enunciation of management's general philosophy and guidelines specific to each data collection and processing system are helpful.

Guidelines for Research Staff Participation in Operations

These guidelines should address the issues of who should be involved and what the nature of that involvement should be.

To decide *who* should be involved, both the commitment of individual research staff members to a system and the effects of the number of people involved on the process should be considered.

Obviously, it is important to include analysts with a real stake in the outcome of a particular system. It is equally important to exclude those without one. Demanding input from uncommitted analysts usually leads to pro forma reviews and a lot of "shooting from the hip." This can be worse than no guidance at all because it is so misleading. It is preferable for those designing/managing data collection and processing systems to know they are doing so without input from the users than for them to believe they are getting well thought out input when they are not.

The number of analysts involved can be as important to the success of the system as their commitment to it. On a large project, having too many can become a problem, particularly if their commitment is weak. Each additional person further complicates communications and increases the number of opinions that must be reconciled. The more people involved, the more time it takes to reach decisions. Delays in reaching decisions can wreak havoc with schedules and severely constrain operations. When activities--for example, experimental program activities--cannot be halted until decisions are reached, failure of the appropriate persons to make timely decisions often means that they will be made by others by default. The results can be quite contrary to research interests.

In contrast, too few analysts involved is also a cause for concern when the system will collect data to be used by several people. The system can be tailored to the desires of one or two and be of little use to the others. This is a particular danger on longer projects where turnover on the analytical staff is to be expected.

In addition to determining which analysts should be involved, the nature of their involvement should be specified. By "nature" I mean the specific data collection and data processing issues where instructions

from the analytical staff are deemed appropriate and useful and the content of those instructions. Nature can become an issue because of the distinction between the responsibilities of the operations staff and those of the analytical staff. It is sometimes difficult to structure interactions so that sufficient input is received from analysts yet the operations staff is given leeway to exercise their expertise. (For example, there is a significant difference between commenting on the content of a questionnaire and specifying exactly how it should be designed and printed.) Thought and direction from project management are necessary for an optimum balance of these two objectives. Failure to strike such a balance can lead to misuse of valuable resources and a lot of friction among staff members.

Also, especially where ongoing operations are concerned, it can be hard to determine exactly which situations require analytical input. On larger projects there can be so much going on in the field and so many layers in the communication chain--for example subcontractor's field staff, subcontractor's home office management, the operations staff, and the research staff--that clear guidelines will be essential if the right problems are to be solved by the analysts.

The nature of analysts' involvement with operations will vary from project to project. It will depend on, among other things, the type of data collection and processing systems developed, the skills and interests of the analysts, and the funds available to pay for their involvement. However, a description of those areas of operations where we found research staff input to be essential may be useful to those developing guidelines for other projects.

For purposes of this discussion, HIE operations can be divided into two primary categories--program administration and data collection and processing. Regarding program administration, obviously researchers must be involved in the creation of the rules of operation for the program. (See Sec. V for a description and discussion of the HIE rules of operation.) Our experience indicates that it is important that they also participate in the ongoing implementation of the rules when exceptions to the rules arise.

Program administrators will deal with many exceptional events during the operation of a long-term, complex program. The original rules of operation will not cover every eventuality as people do not always act in predictable ways. Assumptions about how they will behave that are incorporated into the study design will not always hold. Ad hoc accommodations will have to be made by program administrators, new rules designed. For example, as part of the HIE, some families were enrolled in a prepaid group practice (HMO). Provisions were made for assigning them to a fee-for-service insurance plan should they move out of the HMO service area. Our general assumptions were that families would move as a group (unless there was a divorce or separation) and that the move would be permanent. Then we discovered that some fathers had taken jobs in another state, which meant they would be out of the service area during the week and back in it on weekends. This violated both our assumptions and required new rules.

Some of these exceptions will be interesting from an administrative standpoint only. But some can have an impact on the study design and research outcomes. Those in the latter category should be brought to the attention of the research staff. Decisions about how to deal with them should not be made in the absence of input from the analysts. To insure against this, appropriate channels of communication must be in place and the operations staff must be sensitized to the need for researcher review of exceptional cases.

Regarding data collection and processing, on the HIE analytical participation proved crucial at three main points in system design and operation.

1. Design of the data collection instruments. Obviously analysts should specify the information to be gathered. They should also follow through and review data collection instruments to be sure their specifications have been followed. Additionally, during the data collection process decisions will be made that affect the nature of the information gathered. To use my earlier example of sick leave data collection, after the questionnaire was mailed to employers many of them asked us

exactly what we meant by "sick leave." As we learned the hard way, researchers should be involved in handling these kinds of issues. As with exceptions to the rules, information flows must be set up and staff must be trained to be sure this happens.

2. Creation of the quality control policy as defined in Sec. III of this report. These policies determine the quality of the database and the validity and significance of the conclusions that can be drawn from it. Hence, it is essential for the analytical staff to be represented when the policy is developed. Key areas that require their participation are determinations of the kinds of errors and problems that quality control activities should be designed to detect, the *limits* for each activity, and the *standards* that the data should meet. (See Sec. III for definition and discussion of limits and standards.) Also, they should decide whether errors and problems discovered should result in changes to the data or the addition of flags or special codes to the data base.
3. Development of specifications for data transformations. If the data are to be altered in any way before they are added to the project database, analysts should be aware of or help design the alterations. Clerical coding that involves interpretation of respondents' remarks is a prime example of what I mean by this. On the HIE such coding was frequently required and we found that it was very important for analysts to participate in the development of coding instructions. Using the sick leave data as an example again, during analysis it was discovered that when the data were coded for data entry, the same code had been assigned to plans that allowed employees to accrue sick leave days from year to year, and to plans that provided a fixed amount of days per given time period. This distinction turned out to be very important to the analysts, but had seemed of no special significance to those who designed the coding rules.

There is an additional area, implicit in both data collection activities and program administration, where analytical involvement is of the utmost importance--sample selection. The reader is undoubtedly well aware of this. Research staff make sample selection decisions as a matter of course at the outset of most studies. But what may get overlooked on a large, complex project are the many decisions made case by case during ongoing data collection and program operations that have an effect on the sample. Such decisions include who should or should not be enrolled in the first place, who should or should not complete particular questionnaires or, in the case of the HIE program, whose health care claims should or should not be paid. Often operations staff (or subcontractors), under great pressure to keep things moving, make these decisions on administrative grounds alone. For example, they might decide on their own to excuse an individual from completing an annual questionnaire because they were going to be in Europe during the survey period. Or a sample change might be an unintended by-product of an administrative decision. On the HIE, sample loss could stem from attempts to collect claim overpayments. Ideally, the research staff should be aware of and involved in these kinds of decisions.

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