Scholars As Managers

or

How Can The Managers Do It Better

Report of a workshop on management techniques in archeology

Edited by Alice W. Portnoy

Formal contributions from:
Jerry Alexander
Albert Dekin
Dan Fox
Donald K. Grayson
William Mayer-Oakes
Alice Portnoy
Michael Roberts
Michael Schiffer
Fred Wagner

Informal contributions from:
Phil Bandy
Robert Campbell
Richard Keslin
John Montgomery
John Reichert
Alston Thoms
As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities to protect and conserve our land and water, energy and minerals, fish and wildlife, parks and recreation areas, and to ensure the wise use of all these resources. The Department also has major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Heritage Conservation and Recreation Service, a non-land managing agency within the Department, is responsible for assuring the identification, protection, and beneficial use of our important cultural, natural, and recreational resources. The Service offers grant assistance, technical information, and guidance to those in the public and private sectors involved in conservation or recreation projects.

U.S. Department of the Interior
Cecil D. Andrus, Secretary
Robert L. Herbst, Assistant Secretary

Heritage Conservation and Recreation Service
Chris T. Delaporte, Director
Dedication

This volume on archeological project management is part of the continuing effort of the Interagency Archeological Services Division to prepare and disseminate information useful for cultural resource management. In this series our objective is to stimulate constructive discussion and presentation of new data. So as to be of greatest utility to the historic preservation community, such information should be made widely and readily available as soon as reports are completed. For this reason, we decided in the beginning to distribute the author's manuscript as received with a minimum of editing. For our purposes the presentation of useful information, as quickly as possible, is more important than uniform type styles, format and editorial quality. In such a rapidly developing field where the effective lifetime of any given study may be rather short, we believe this is an essential compromise.

This report records the results of a workshop conducted by Texas Tech University, with financial support from Interagency Archeological Services. Participants explored the application of certain management techniques to the conduct of archeological research. In a program usually confronted with insufficient funds to conduct needed surveys and data recovery, it is imperative that means be considered to make such work more cost effective while still maintaining the integrity of the research process. In the latter connection, the Texas Tech workshop considered problems with Federal agency preparation of requests for proposals. This is a particularly sensitive portion of the contracting process to which our continuing attention is needed. Future workshops will include further discussion of this subject with our colleagues.

Finally, other topics on a wide range of archeological subjects are in preparation for this series. Comments on the series, on specific reports, or suggestions about topics that should be considered for presentation are welcome.

Rex L. Wilson
Departmental Consulting Archeologist and Chief, Interagency Archeological Services Division
Acknowledgements

The editor wishes to thank everyone who helped her prepare this report, especially Bill Mayer-Oakes for his guidance and patience, the CRI staff for their encouragement and moral support, the outside participants for their forbearance with her persistence, and most of all, the TTU Anthropology Department office staff, including Linda Austin, Joycelyn Graves, Cindy Latura, and Colette Anians.
Contents

Part One -- Problems

   Foreword -- (William J. Mayer-Oakes) ......................... 2
   Introduction -- (Alice Portnoy) ............................... 14
   Preface -- (Alice Portnoy) .................................... 17

Part Two -- Solutions

   Management by Objectives -- (Alice Portnoy) .................. 24
   Review of Network Techniques -- (Fred Wagner) .............. 28
   Project Applications -- (Alice Portnoy) ...................... 39
   Business-like Archeology -- (Danny Fox & Jerry Alexander) 44
   CLIC Experiments -- (Alice Portnoy) ........................ 68
   Research Design and MT -- (Alice Portnoy &
   William J. Mayer-Oakes) ..................................... 71

Part Three -- Reaction

   Introduction -- (Alice Portnoy) .............................. 101
   CRMBO -- (Albert Dekin) ..................................... 102
   Is there a future for PAST? -- (Michael Roberts) .......... 111
   RD considerations for the mega-survey: a first approximation -- (Michael Schiffer) .......................... 128
   Aspects of archeological research management -- (Donald K. Grayson) .................................. 140

Part Four -- Conclusion

   Summary and Analysis -- (Alice Portnoy) ..................... 156

Appendices

   A. Radium Springs RFP ......................................... 162
   B. Radium Springs proposal .................................... 171
   C. Canyon Lakes Proposal supplement ........................... 186
   D. Canyon Lakes Lab Project schedules ........................ 199
   E. Glossary ..................................................... 207
   F. Selected Management Planning Literature ................. 209
      (Jerry Alexander)
List of Figures

1. The Workshop Ingredients, Activities, and Results .................. 18
2. The MBO Process .................................................................. 25
3. Logical Relationships .......................................................... 30
4. Early Times ......................................................................... 32
5. Late Times ........................................................................... 33
6. PERT Flow Chart I ............................................................... 56
7. PERT Flow Chart II ............................................................... 59
8. Hierarchy of Objectives ......................................................... 78
9. CRI General Research Design Schematic .............................. 80
10. CRI Specific Research Design Schematic. ............................ 81
11. Work Schedule Example ...................................................... 82
12. Work Schedule and Budget Amounts Example ..................... 83
13. Multistage Work Schedule .................................................. 88
14. Work Schedule and Budget Amounts ..................................... 89
15. Milestone Chart ................................................................ 96
16. Management Component Description .................................. 97
17. Project Component Chart .................................................... 98
18. Weekly Supervisor's Report ................................................. 107
19. Bar Chart I ....................................................................... 115
20. Bar Chart II ...................................................................... 116
21. Bart Chart III .................................................................... 117
22. Flow Chart ........................................................................ 119
23. Budget ............................................................................... 121

vi
24. Variance Chart. ........................................ 123
25. Multi-stage Mega-survey Flow Chart. ................. 139
26. Radium Springs Map .................................... 169
27. Radium Springs Proposed Work Schedule ............. 182
28. Canyon Lakes Proposal Supplement Research Design Schematic .... 194
29. Canyon Lakes Simplified Milestone Chart ............. 205
PART ONE

PROBLEMS
FOREWORD

Archeology has developed into a complex and often sophisticated mixture of theory and method which supports the carrying out of a wide range of field and lab activities. From the broad problem front now available (defined as a "spectrum of possible objectives" by Mayer-Oakes, 1974) to the complex, multi-disciplinary framework for action described for the Koster site (Brown and Struever, 1973), it is clear that modern archeology is no longer a simple or pastime effort, in either concept or implementation. In short, we archeologists are today faced with complex and often complicated tasks in both conceiving and carrying out our chosen work. As much of the financial support for archeology has moved into the various federal agencies now doing archeology for public purposes by means of contract arrangements, the inadequacies in planning, budgeting and evaluating have become clearer. In particular, the need to make explicit plans for carrying out particular public-supported projects in archeology, has received some attention. The current scholarly interest in seeking agreement on "regional research designs" is a potential response to this need (Anderson, Seaman and Snow, 1976). A broader interest in planning is reflected in papers by King and Hickman (in press) and Aten (1975), and this also is a response to the felt need for more efficient and more accountable archeology.

Still a third area, that of the specific and detailed planning of particular projects, is considered very important. As outlined in requests for proposals distributed by NPS Interagency Archeological Services, there is need to make precise, step-by-step statements of the planned articulation of research resources (time, people, money)
with the cultural resources (archeological sites) for purposes of resolving archeological problems. (See, e.g., RFP 15950013, p. 5).

From a recent review which I conducted of a series of proposals accepted and awarded contracts by the Denver Interagency office, two conclusions can be made with regard to this need for project-level detailed planning. First, there is no standard or agreed-on approach yet evident among archeologists. Second, there is a wide range of such planning (from essentially no detailed planning to a clear and explicit management by objectives approach) which has currently been found acceptable, i.e., has been awarded public (contract) funds.

As public funds have become increasingly available (in the last 3 or 4 years) for application to problems concerned with "cultural resources", the concept of public or contract archeology as "cultural resource management" has become quickly established (cf. Lipe and Lindsay, 1974). Already, however, this concept of the archeologist as "manager" is in deep difficulty as federal agency archeologists bring one kind of perspective to projects, and often find this in conflict with the perspective of the academic or private archeologist hoping to carry out the contract work.

Because such "management" questions and conflicts have characterized other areas of public business (i.e., federal contracts), it seems reasonable to attempt to resolve them by techniques successfully employed by others. So far, this has not been done -- only limited and tentative attempts have been made to apply accepted, "business-like" management concepts and techniques to the scientific process of doing archeology. Multi-disciplinary management research, however, is an established activity in a number of scholarly fields (see PCI, 1976).
A conclusion from this effort is that "management needs more science and science needs more management". For us this conclusion could derive from the fact that archeological scientists working as contract archeologists have become much more keenly aware that they are "managers". As "manager" of a contract project he has research resources allocated to him (people, time, money). Objectives and procedures for the best use of these resources can probably best be established using "management" techniques. Although little has yet been done in archeology with such established management techniques, progress has recently been made in related fields. The business-accepted MBO (management by objectives) framework has been successfully utilized in public institutions of higher education (Harvey, 1976). A case study of the development of a specific managerial planning, control and evaluation technique in a University-based computer operation (Wetherbe, 1976) offers both a broad background statement of possibly-useful techniques and an example of application. The need for archeology to seriously consider making an application of such "management" techniques is strong, and it will become stronger as more archeologists with more diverse approaches enter the public-funded contract process.

MBO in Archeology

At the level of the actual process of "doing archeology", a few attempts to apply management-like concepts have been made. In the middle 1960's I began playing with the questions of the "operations" of archeology (Mayer-Oakes, 1966) and related them to coordinated "objectives". I first learned of the concepts of CPM (Critical Path Method) at that time but made no serious attempt to apply them. Rather,
in the laissez-faire or "academic" atmosphere of the time, simply went my own way, trying to develop an "operational" model for the carrying out of archaeology (Mayer-Oakes, 1968, 1970). As the interest in problem formulation became a focus of attention (Mayer-Oakes, 1973), the need to re-evaluate the concepts of operation and objective was felt. This re-evaluation has rapidly developed into a scholarly-based independent invention of the business concept of management by objectives. Best examples of this development are to be seen in several recent contract proposals (Mayer-Oakes 1972, 1976, a, b, c, d), but it has been crystallized most clearly in a paper given recently at New Orleans (Mayer-Oakes, 1976e) and in the schematic "research design" framework which has developed as a hallmark of this particular archaeological management by objectives approach (see Fig. 9).

A careful examination of this schematic should indicate the trend of our thinking. The scheme (or model) specifies, delineates and relates the areas of theory, method and technique in relationship to each other. It recognizes and locates the entities most responsible for the particulars of theory, method and technique, namely the research or problem orientation and a prime vehicle for expression, the "objectives-operations" conceptual framework which colors and influences all else.

This particular MBO approach, if we can call it that, utilizes the concept of a hierarchy of objectives, (see Fig. 8) bringing objectives down from the abstract heights of theory, through the less-abstract valleys of method to the sea-level concrete reality of technique. At this level, the co-ordinate concept of "operation" becomes most meaningful for contract purposes. Here is where we can specify just what action is going to happen, in enough detail to evaluate, often by quantification. At the same time that we make this
journey through the hierarchy of objectives, we find ourselves making transformations in our thinking about what we are doing (or really, proposing to do). We move from the rather vague and general level of problem formulation, to the more explicit restatement (at the lower method level) of problem as project and then finally, the ultimate restatement of project at the technique level as a series of tasks to be accomplished. Here is the operational level and here the critical coordination of objectives and operations must take place in a context of budget and work schedule. In our travel through this hierarchy of objectives we can distinguish both the conceptual and the activity aspects of the hierarchy. These are indicated in Figure 8.

Whether this approach is MBO or not is beside the point. The question is, does this or similar approaches offer something of value to the question of "How do we do better archeology?"

CPM and PERT in Archeology

In September and October of 1976 two graduate students and I began to seriously discuss the concepts of CPM (Critical Path Method) and PERT (Project Evaluation and Review Technique). We decided to apply PERT to a specific archeological project proposal, as a test case for an answer to the question, "is PERT a useful technique for archeology?" The paper by Fox and Alexander which resulted was presented at the workshop and is included below in this report.

On a recent visit to the National Air and Space Museum in Washington, D.C. I noted an exhibit illustrating PERT as an invention which helped accomplish a significant national goal. The following statement is the main label for that exhibit. It briefly summarizes the significant facts we wish to present on this managerial technique.
PERT is a managerial method for pulling together all of the tasks of a complicated project on a closely monitored schedule. PERT was developed in 1959 to manage the construction of the Polaris Missile Submarine, USS George Washington, the first ballistic missile submarine in the U.S. Navy. PERT has since become a familiar method in many industries including aviation, electronics, computers, construction and engineering.

The major function of PERT is to provide managers with a detailed schedule of individual tasks. The scheduled time intervals between these tasks are written on the arrows between blanks on the PERT network. These numbers are estimates of the shortest, most likely, and longest possible times (in weeks) needed to complete the task in the preceding blank. The network shown is one of the original PERT diagrams used in construction of the USS George Washington.

The PERT method requires updating the charts at periodic intervals to keep schedules in line with actual progress. When a task falls behind schedule, additional resources of the overall organization are committed to it, in order to bring that one task back on schedule with the other tasks. Thus PERT guarantees that no single problem will slow down the entire project or bring it to a stop without major efforts to avoid falling behind. Tasks which run behind schedule are said to be on the "Critical Path" -- the path which finally determines the time to complete the entire project. Thus PERT and other managerial techniques developed from it are sometimes called "The Critical Path Method".

Significant errors or misjudgments presented in the Radium Springs Proposal were identified by Fox and Alexander on the basis of their PERT analysis. The analysis itself seemed to offer an alternative approach to the preparation of proposals. Or, the application of such an analysis to a project by a contracting agency might provide a standard against which to judge a variety of proposals. At minimum, the clear and detailed conceptualization of activities required by PERT, and the concomitant statement of time and manpower required, should provide more realistic understanding of what we are doing and trying to do in contract archeology.
Because the results of this first PERT application seemed to us to be quite useful for the particular project involved, we initiated a further application. For the lab phase of our current Canyon Lakes project (an IAS-funded contract project) we prepared a PERT network. Our purpose was to help us achieve the objectives we stated in our proposal, within the framework of time, people, and money that was available for this project.

Thus in the late fall of 1976 and in the early months of 1977 I felt that the PERT technique and the CPM principles, procedures and attitudes involved offered significant possibilities for helping archeologists to do better archeology. From early September on, I had been inquiring among archeologists about recognition or use of this technique. I found that few archeologists were even aware of its existence. I found no record or evidence of any attempt to utilize PERT or CPM in archeology, other than our own.

To help evaluate PERT and other management techniques for possible use in archeology and to introduce a potentially useful technique to the archeological profession, I proposed a brief but intensive "workshop" on the topic.

At the time of the AAA meetings in Washington (late November, 1976) I approached Rex Wilson, the Departmental Consulting Archeologist responsible for the Washington office of the National Park Services-Inter-agency Archeological Services (NPS-IAS). He expressed general interest. Over the next few months he and his staff reviewed the first draft of the Fox-Alexander paper as well as the idea of the workshop which I had described to him. In late February, 1977 I submitted a formal proposal, requesting financial support for bringing six archeologists to Lubbock to join our local group of staff and students in a workshop.
This event was to be a group of about 15 people participating in a three-day intensive "immersion" in management techniques and their application to archeology.

I suggested we have three kinds of specialists brought to the workshop, to join with our staff and our own "PERT-experienced Archeological Specialists" (Alexander and Fox). These specialists were to be:

The Disinterested Archeological Specialists.
The Interested Archeological Specialists.
The PERT Managerial Specialist.

Our idea here was to bring together the archeological management specialists Alexander and Fox (and a non-archeological management specialist) with archeologists experienced in contract work as well as archeologists uninvolved or uninterested in contract work. This group, plus our own Cultural Resources Institute staff (all deeply involved in both basic and applied archeological research) was expected to make a useful "mix" of attitudes and experiences, an assemblage of minds which should be able to usefully assess and evaluate these new ideas for archeology.

At the end of the first week in April we learned that the NPS-IAS would provide funds on a contract basis for the workshop. Thus we moved rapidly to get the people together before summer field season commitments began. Although all the possible participants had been previously contacted, the shortness of time between contract award and workshop date made it necessary to revise some of our plans. Both Dick Adams and Tom Hester of the University of Texas at San Antonio had been invited but were unable to attend. We did not replace them, but
went on with plans, using only four "outside" archeologists. The workshop was held on May 4, 5 and 6, the report was worked on over the summer (when all participants were busy with other matters) and as I write this it is September 16, 1977, one day after our deadline to have this report complete ..... Fortunately the rest of the report is typed and ready to go, so we are not too far off schedule.

To conclude this Foreword I wish to list the workshop participants and to express to them our gratitude and pleasure for their help and their participation. I wish also to present our workshop "schedule" so that the interested reader may (in reading what follows) see what the differences are between our plans and our accomplishment.

Finally, I want to acknowledge and thank Alice Portnoy, our colleague and editor who has done so much to convert our mutual experience of the workshop to something tangible for the reader of this report.

William J. Mayer-Oakes
WORKSHOP

MANAGEMENT TECHNIQUES FOR ARCHEOLOGY

May 4, 5 and 6, 1977

Cultural Resources Institute
Department of Anthropology
Texas Tech University

Participants

Albert Dekin, Jr.  SUNY, Binghamton
Donald Grayson  U. of Washington, Seattle
Michael Schiffer  U. of Arizona, Tucson
Michael Roberts  Harvard U., Cambridge

John Reichert  Elect. Eng., TTU
Fred Wagner  Eng. Technol., TTU

Jerry Alexander  Anthropology, TTU
Dan Fox  Anthropology, TTU

Phil Bandy  CRI, TTU
John Montgomery  CRI, TTU
Alice Portnoy  CRI, TTU
Alston Thoms  CRI, TTU

Robert Campbell  CRI, TTU
Richard Keslin  CRI, TTU
William Mayer-Oakes  CRI, TTU
WORKSHOP AGENDA

Wednesday, May 4

9:00 Welcome by J. K. Jones, Vice President for Research
9:15 Introduction - William J. Mayer-Oakes
9:30 MBO for Archeology - William J. Mayer-Oakes

10:00 COFFEE BREAK

10:20 General Background - Fred Wagner
11:00 Project Application - J. D. Reichert
11:30 Discussion

12:00-2:00 LUNCH (at Union)

2:00 Radium Springs Analysis - Dan Fox and Jerry Alexander
2:45 Canyon Lakes Scheduling - Richard O. Keslin, Phil Bandy, John Montgomery

3:15 COFFEE BREAK

3:30 CRI Research Design - William J. Mayer-Oakes and Alston Thoms

4:00 Choke Canyon Planning - Alston Thoms, Alice Portnoy, William J. Mayer-Oakes
4:40 Discussion

5:00-7:30 FREE

7:45 Pick up for dinner at Continental Room
PRELIMINARY WORKSHOP AGENDA

Thursday, May 5

9 to 12
Discussion and Reaction to:
MBO
PERT
SCHEDULING applications
presented on Wednesday

12 to 2
LUNCH (at archeology lab)

2 to 3
Tour of Lubbock Lake Site and Museum

3 to 4
Brainstorming on topic of other management techniques for archeology

4 to 5
Initial discussion of participants' "Homework" projects

Evening
Unscheduled (slack time)

Friday, May 6

9 to 12
Presentation by each participant of "application"

LUNCH

2 to 5
Discussion of positive and negative aspects of the application of management techniques to archeology

Summarizing of workshop
INTRODUCTION

National, state, and local government agencies are increasingly involved in land use programs in which they are to various degrees responsible for plans and management of lands and all of their resources. These include cultural resources, broadly defined as archeological, historical, and architectural data and any environmental data necessary to understand them. When a specific land modification project is planned and proposed, the cultural resource management element is activated by legal requirements. The government agencies become the actual cultural resource managers, but are dependent on archeologists both to satisfy the legal requirements and to make recommendations for the cultural resource management program itself. They contract with archeologists for these services. It is true that the larger of these agencies are employing archeologists to administer their programs, but specific projects are usually carried out by non-agency archeologists.

A certain amount of literature, other than project reports, is being generated by professional archeologists engaged in contract work. This literature often grows out of meetings and conferences; the 1976 Proceedings of the American Society for Conservation Archaeology is one example. A comprehensive, broad treatment of basic questions concerning the archeological component of cultural resource management is given in the Airlie House Report (The Management of Archeological Resources, McGimsey and Davis 1977). Ideas about archeological preservation and planning from the point of view of an agency archeologist were presented at an annual meeting of State Historic Preservation Officers (Aten 1975). Some of the
problems archeologists may encounter when engaged in doing contract work and in making recommendations for management programs are discussed in papers such as King and Hickman's (in press).

Theory and method in scientific archeology in the contract setting are carefully treated by Schiffer and House (1977). The organization of research is less often discussed; one good example describes work at the Koster site (Brown and Struever 1973).

There has been very little attention given to the actual management of specific archeological projects—how they are planned, organized, budgeted, directed, controlled and evaluated and how these activities affect the resources themselves and their ultimate management. If we assume that the way in which a project is actually carried out affects the results, then we must accept the fact that how archeologists manage their projects affects the cultural resources, the way they in turn will be managed by government agencies, and the scientific knowledge the projects produce. It is probably fair to make the above assumption for any research project in any field, contract or non-contract, applied or "pure." Thus one way of doing "better archeology" of any variety may be to improve the management of the projects.

The need for improved management of archeological projects has been expressed informally by archeologists attending professional meetings. It is out of these expressed needs, the lack of formal treatment of them, and the experience of Dr. William J. Mayer-Oakes and the staff of the Cultural Resources Institute of Texas Tech University that the idea of having a workshop to study the application of management techniques to archeology grew. The abstract of the proposal to the National Park Service-Interagency Archeo-
logical Services for the workshop stated (Mayer-Oakes 1977):

We propose to organize and carry out a 3-day workshop on the application of specific proven management techniques (MBO, CPM and PERT) to the planning, organization and control of specific archeological projects. The primary goal of the workshop is to seriously examine these techniques in order to get a preliminary answer to the question, "Will such techniques help us to do better archeology?" Better archeology is here conceived of as more effective, efficient resolution of archeological problems and more accountable expenditure of public funds.
PREFACE

The "Workshop on Management Techniques Applied to Archeology", sponsored by the National Park Service-Interagency Archeological Services, was held on May 4, 5 and 6 at the Cultural Resources Institute, Department of Anthropology, Texas Tech University, Lubbock, Texas, under the direction of Dr. William J. Mayer-Oakes.

This report provides a description of the activities of the workshop, how the various presentations related to each other, and summaries of discussions during and after each presentation. Papers presented during the workshop appear in order of their presentation. The papers produced in preliminary form and presented during the workshop and then "polished" the following summer also appear in the order in which they were given. Presentations which did not have formal papers are summarized in this order. Working materials referred to in presentations and used in the workshop for study and discussion are found in the appendices. References cited are given at the end of each paper or section. A glossary of management terms and a selected bibliography of management technique materials are provided as additional appendices. A general representation of the "ingredients", activities and results of the workshop is given in Figure 1.

The workshop was opened and the participants welcomed by Dr. J. Knox Jones, TTU Vice President for Research and Graduate Studies. Then Mayer-Oakes described the background of the workshop.
Figure 1
The Workshop Ingredients, Activities and Results
and its objectives as stated in the proposal and in letters to participants. He noted that such a gathering also provided a valuable opportunity for a broad discussion of cultural resources and their management. The workshop participants agreed that this would be a worthwhile additional objective. Mayer-Oakes then introduced the concepts of Management by Objectives (MBO) which are summarized by the editor below.

Dr. Fred P. Wagner, Jr., Department of Engineering Technology, TTU, gave an introduction to networking techniques; his paper appears below. He also distributed copies of "PERT for the Engineer" (Kadet and Frank 1964). He participated in most of the workshop sessions, answering questions, evaluating management technique applications and commenting on project planning.
References Cited -- Part One

Anderson, D., T. Seaman, and C. Snow
1976 A proposal for a research design for the state of New Mexico. Unpublished manuscript in files of Laboratory of Archeology, Texas Tech University.

Aten, L.E.

Brown, J.A. and S. Struever

Fox D. and J. Alexander
1976 Business-like archeology -- the potential for application of management controls. Unpublished manuscript in files of Department of Anthropology, Texas Tech University, Lubbock.

Harvey, L. J.

Kadet, Jordan and Bruce H. Frank

King, T. F. and P. P. Hickman

Klinger, Timothy C., editor

Lipe, W. D. and A. J. Lindsay

Mayer-Oakes, W. J.
1966 Towards a theoretical framework for archeological operations. Unpublished manuscript in files of Laboratory of Anthropology, University of Manitoba.
1968 A theoretical framework for archeological operations.  
1968 Flagstaff Conference on "Interpretation".  
Unpublished 24 pp. typescript in files of Laboratory of Anthropology, University of Manitoba.

1970 Archeological investigations in the Grand Rapids, 
Manitoba, Reservoir, 1961-1962. Occasional Paper No. 3, 
Department of Anthropology, University of Manitoba.  
397 + XVI pp.

1972 Proposal for conservation archeology project in the 
Guadalupe Mountains National Park. Unpublished manuscript in file of Laboratory of Archeology, Texas Tech University.

1973 Problem formulation -- a neglected aspect of scientific 
(or any other) archeology. Paper presented at AAA meeting, New Orleans.


1976a Proposals for Canyon Lakes Archeological Mitigation 
project to Interagency Archeological Services, Denver.

1976b Proposal for Radium Springs Archeological Survey project 
to Bureau of Land Management, Denver.

1976c (jointly with Alston Thoms as senior author) 
Proposal for Lower Clear Boggy Creek Archeological Mitigation project to Interagency Archeological Services, Denver.


1976e Problem orientation, regional research design and multi- 
stage operations -- an example from the conservation archeology project at Guadalupe Mountains National Park.  

1977 Proposal for a workshop on management techniques 
applied to archeology. To National Park Service - 
Interagency Archeological Services, Washington.

McGimsey, Charles R. III and Hester A. Davis, editors 
1977 The management of archeological resources -- the 

PCI, (Practical Concepts, Incorporated) 

21
RFP 15950013
1976 Request for proposal for archeological mitigation in
Lower Clear Boggy Creek Watershed, Atoka County, Oklahoma
Denver -- Interagency Archeological Services.

Schiffer, Michael B. and John H. House
1977 Cultural resource management and archeological research:
the Cache project. *Current Anthropology* 18:43-68.

Wetherbe, J. C.
1976 A general purpose strategic planning methodology for the
computing effort in higher education: development,
implementation and evaluation. DBA dissertation
submitted to Texas Tech University.
MANAGEMENT BY OBJECTIVES (MBO)

We have spoken of MBO, CPM and PERT as "management techniques." The first of these, Management by Objectives, is much broader: it is a management system. Some of its concepts have been "independently invented" by Mayer-Oakes in his development of an objectives/operations framework for doing archeology. This framework will be described in a later section on research designs. In this section we will describe MBO itself, just as the general principles of CPM and PERT will be described in the next section.

Management is usually thought of as having five basic operations: planning, organizing, directing, controlling and evaluating (Harvey 1976:1). MBO is a system that puts these operations in terms of setting and meeting objectives on every level of the organization. The basic operations of MBO are (1) setting missions (broad statements of purpose), goals (general directions to take) and objectives (specific steps), (2) prioritizing objectives (ranking them in order to decide how to allocate resources to them), (3) quantifying objectives (determining standards of time, amount, etc. by which performance can be measured), (4) specifying activities for meeting the objectives, (5) measuring outcomes in terms of the standards, (6) evaluating the results and (7) revising and resetting further objectives (using the feedback from evaluation) (Harvey 1976). This process is shown in Figure 2.

A brief description of MBO as used in colleges and universities is given by Harvey (1976:1):

MBO is a simple logical concept which begins with the clear delineation of the mission, goals and objectives of an organization. The next steps in the process relate
The MBO Process

Figure 2
the activities of the organization to fulfilling the
goals and objectives and to evaluating the organization on the basis of measurable outputs. The strength of the concept is in the quantification of objectives for the organization, as well as for the individual administrators and faculty. This process of quantification, if properly done, allows for a clear determination of institutional as well as individual performance. Full accountability is achieved and authority and responsibility allocated to the proper places within the institution.

Success is measured by results rather than by compliance with directives or established procedures. One management specialist (Bliss 1976:55) states:

MBO threatens the three basic underpinnings of a bureaucracy -- tradition, centralized control, and red tape. It means thinking in terms of specific goals, rather than in terms of procedures and regulations. Setting specific goals and allocating time to those activities which contribute most toward their realization are the keys to effectiveness in any organization.

This suggests that some of the concepts of MBO may be useful to archeologists in at least four operations: managing the organization that does the archeology, developing research designs for archeological projects, writing proposals for project contracts and managing the projects themselves. We shall see examples of this in later sections.
References Cited (MBO)

Bliss, Edwin C.
1976  Getting things done: the ABCs of time management.
      New York: Charles Scribner's Sons.

Harvey, L. James
1976  Managing colleges and universities by objectives.
The management of any complex operation or project requires planning, control and decisions. In each of these functions networking techniques have proven to be useful tools. Note that these techniques are tools to aid the manager and not ends in themselves. The techniques to be reviewed in this presentation are CPM, PERT, and GERT. Since CPM tends to be the basic elementary system it will be presented first. After reviewing these techniques some applications to management will be mentioned.

CPM Technique

The CPM, Critical Path Method, technique involves division of the project into discrete units called activities, estimating the duration of each activity and then performing certain mathematical operations on these durations. The results indicate the sequence of activities that determine minimum project duration and slack time available on other activities.

Defining activities would seem to be an easy task. However it presents some problems and the list of activities will be different for each person. The level of detail is a function of use of the network. As a general rule activities should be of short duration and have identifiable beginning and ending points. It is easy to summarize from a detailed level of activities; the reverse is usually not possible. It is usually much easier to estimate duration for detailed activities.
The logical relationship between activities is usually easily defined and may have only one possible relation. In other cases the logical relations are subject to various arrangements and this feature may be the subject of considerable study during the planning of a project.

The duration of activities is always only an estimate of time needed. Hopefully, past performance can help in making these estimations but historical data on rates of production are not available in many cases.

CPM Example

To illustrate the application of this technique let us establish the following problem. A company wishes to make a marketing survey. The activities along with estimated durations are shown in Table I. The logical relationships between activities are obvious in most cases. Let us assume that hiring of personnel and design of the questionnaire can operate at the same time. Training of personnel requires completion of both hiring of personnel and design of questionnaire. The logical relationships may be indicated graphically as shown in Figure 3. In this system an arrow represents an activity. At a node point all activities emanating from a node cannot start until all activities into the node are completed. In some situations a dummy activity, such as 3 to 5, is needed to establish logical relationships but has a duration of zero time. A dummy is signified by a dashed arrow.
Logical Relationships

Figure 3
<table>
<thead>
<tr>
<th>Description</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan Survey</td>
<td>3</td>
</tr>
<tr>
<td>Hire Workers</td>
<td>5</td>
</tr>
<tr>
<td>Train Workers</td>
<td>7</td>
</tr>
<tr>
<td>Design Questionnaire</td>
<td>10</td>
</tr>
<tr>
<td>Select Households</td>
<td>4</td>
</tr>
<tr>
<td>Print Survey Forms</td>
<td>3</td>
</tr>
<tr>
<td>Ship Survey Forms</td>
<td>3</td>
</tr>
<tr>
<td>Conduct Survey</td>
<td>15</td>
</tr>
<tr>
<td>Analyze Survey Results</td>
<td>5</td>
</tr>
</tbody>
</table>

The time calculation can be broken down into three steps: forward pass to establish early start and finish times, backward pass to establish late start and finish times, and finally calculation of float.

The forward pass starts with the first activity of the network and assigns time zero to the beginning of the initial activity. Early start time plus duration gives the early finish time for any activity. At any node except the first, the early start time exiting the node would be the latest of the early finish times entering the node. On Figure 4 the early times have been recorded with the controlling values enclosed in a box. Note in particular node 6 with early finish times of 20, 17, 18; the controlling value would be the latest of these, 20. The early finish at the last node indicates the project duration.

The backward pass begins calculations at the end of the project assigning the project duration as the latest finish time of activities ending at the final node. The latest start time of any activity is the latest finish time minus duration. The latest finish time of any activity ending at a node must be the same as the earliest of the late finishes exiting from that node. On Figure 5 the late times have been recorded with controlling values at a node enclosed in a triangle.
Early Times

Figure 4
Late Times

Figure 5
Note that at node 3 the late time of activities departing the node are 13, 14, 16. Thus the latest time for completion of the activity entering would be 13.

The last step involves comparing the early and late start (or finish) times of each activity. The difference between late start and late finish times is the float for that activity. Those activities which have zero float are on the critical path since this sequence of activities determines the minimum project length. In our example the critical path is the sequence of activities between nodes 1, 2, 3, 5, 6, 7, 8.

It is often desirable to show all of these calculations in tabular form such as Table II. The critical path is easily identified from the total float column. Note also that in general float is a shared value. As an example notice the sequence from node 3 to 4 to 6. Each of these activities has one unit of float. If activity 3 to 4 uses one extra unit of time then there will be none available for activity 4 to 6 and another critical path will appear.

**TABLE II**

Tabular Form of CPM Data

<table>
<thead>
<tr>
<th>Node</th>
<th>Description</th>
<th>Duration</th>
<th>Early Start</th>
<th>Early Finish</th>
<th>Late Start</th>
<th>Late Finish</th>
<th>Float</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2</td>
<td>Plan Survey</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2 3</td>
<td>Design Questionnaire</td>
<td>10</td>
<td>3</td>
<td>13</td>
<td>3</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>2 5</td>
<td>Hire Workers</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>8</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>3 4</td>
<td>Print Forms</td>
<td>3</td>
<td>13</td>
<td>16</td>
<td>14</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>3 5</td>
<td>Dummy</td>
<td>0</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>3 6</td>
<td>Select Households</td>
<td>4</td>
<td>13</td>
<td>17</td>
<td>16</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>4 6</td>
<td>Ship Forms</td>
<td>3</td>
<td>16</td>
<td>19</td>
<td>17</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>5 6</td>
<td>Train Workers</td>
<td>7</td>
<td>13</td>
<td>20</td>
<td>13</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>6 7</td>
<td>Conduct Survey</td>
<td>15</td>
<td>20</td>
<td>35</td>
<td>20</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>7 8</td>
<td>Analyze Results</td>
<td>5</td>
<td>35</td>
<td>40</td>
<td>35</td>
<td>40</td>
<td>0</td>
</tr>
</tbody>
</table>
PERT

PERT, program evaluation and review technique, was developed at approximately the same time as CPM and introduces the feature of variability of duration. The logical relationships between activities are fixed but duration of activities are defined by the beta distribution. This distribution can be defined by three values, the minimum possible time, the usually expected time and the maximum time. These times are usually symbolized by \(a\), \(m\), and \(b\). The mean and variance of this distribution are given by:

\[
\text{mean time} = \frac{a + 4m + b}{6}
\]

\[
\text{var} = \frac{b - a^2}{6}
\]

The time calculations in PERT are performed just as in the CPM technique with the mean time used as duration. This technique allows us to make probabilistic statements about time to complete the project. The project duration is assumed to be normally distributed with the mean being the time calculated. The variance of duration will be the sum of the variance of activities on the critical path.

The use of probabilistic measures for activity and project duration has advantages in many areas but particularly in research. Often in research activities it is realistic to consider duration in terms of pessimistic, optimistic and usual times. All time estimations require judgement, experience and historical information if they are to reflect reality; this is no less so for PERT than for CPM. Some of the value of this technique is lost if the project must fit within a given time limit.

GERT

The last technique to be mentioned, GERT, graphical evaluation
and review technique, allows for probabilistic descriptions for both duration and sequence of activities. This technique is new and its application has been limited. The estimation of probabilities associated with path selection at a node introduces new problems because of a limited data base. The complex calculations and large amounts of data required almost demand computer solution for this technique. The use of GERT for complex research projects would have great appeal where initial study will determine the direction later steps will follow. The book by Whitehouse in the list of references describes GERT in detail.

Management Application

At the beginning of this presentation it was stated that these techniques were useful tools to aid in planning, control and decisions. Now that the tools have been described, the application of these tools will be mentioned.

Project planning is one of the most important aspects of management. The network techniques require considerable study of the project to define activities and estimate durations. A disciplined study such as this is useful for much of the planning function in addition to determining project duration. The expenditure of time and resources in planning prior to proposal submission will pay off in many ways. It may indicate the proper management decision is not to submit a proposal. If a fixed time is a part of a RFP, a study of various possible logical relationships will indicate how the project may be accomplished. In any case, such a study allows us to plan so that maximum results can be obtained.

During the performance phase, network techniques provide a valuable measure of compliance. Comparing actual duration with planned
durations allows the manager to be aware of time progress. In addition to measuring progress, the consequences of any time changes can be readily apparent on future activities. When problems are present, corrective actions can be taken early. Studies of time-cost tradeoffs can be made and economical solutions selected.

Management decisions should always be based on all information available with due consideration for the risks involved. The networking techniques provide a frame-work to picture this information. Decisions are never easy but a clear, accurate description of the situation reduces the uncertainty.
References Cited

Moder, Joseph J. and Cecil R. Phillips
1970 Project management with CPM and PERT, Second Edition,
Van Nostrand Reinhold Company, New York, N.Y.

Wiest, Jerome D. and Ferdinand K. Levy
1969 A management guide to PERT/CPM, Prentice-Hall, Inc.,
Englewood Cliffs, N.J.

Whitehouse, Gary E.
1973 Systems analysis and design using network techniques,
Prentice-Hall, Inc., Englewood Cliffs, N.J.
PROJECT APPLICATIONS

After presentations and discussions of management techniques themselves, we moved on to a consideration of project applications. We had a good look at how these techniques were applied to a large engineering project; this is summarized below. We then considered several examples of how these techniques have been used in archeological projects at TTU. These are described below. Discussion of these presentations closed the first day of the workshop.

Dr. John D. Reichert, Department of Electrical Engineering, Texas Tech University, followed Wagner with a presentation of how and why CPM and PERT were applied to the planning of a large engineering project. He described the proposal and contract negotiations for a $22 million solar power research project for Energy Research and Development Administration (ERDA). More than half the funds were to be paid to a subcontractor whose work had to be co-ordinated with the TTU work. There were 13 major project tasks, seven TTU teams of different kinds of specialists each with its own leader, and 118 actual tasks which had to be networked by computer. Wagner served as the network and computer consultant.

One of the major goals of the networking process was to show that the structure of the proposed project could not very well be "chopped" into sequential parts. That is, ERDA should buy the total package or nothing. Reichert and his associate, Dr. Stanley R. Liberty, TTU E. E. Dept., felt that if they just gave the agency a list of 13 project tasks, the agency might use it like a shopping list -- pick and choose certain tasks and try to save money.
But Reichert and Liberty felt strongly that the mission could not be fulfilled this way. So they designed a structure of interdependent, concurrent tasks which gave ERDA an idea of what they proposed to do and why it had to be done as a single project. They also designed a management structure that showed that there would be a mechanism for interaction between TTU and the subcontractor. It had interfaces on all 13 project tasks. It showed how TTU proposed to direct and control the subcontractor's work. It also showed that all people would be working at the same time and talking to each other. These charts were used as explanatory and selling tools to the agency. They were not CPM or PERT charts. They represented a "spider web" of relationships.

Reichert said that they told ERDA they were willing to use CPM and PERT in the project, but it would cost more money and the agency would not have access to the charts unless the agency itself paid the extra cost. PERT is expensive, especially for a large, complex project -- it requires the services of a specialist such as Wagner, computer services, and time from people working on the project. Bar charts showing tasks on a time scale were provided to ERDA -- tasks were still shown in parallel, so it was obvious that if the project were cut at any point, the agency would not get a deliverable. It would just get a bunch of pieces not very useful in themselves.

Reichert felt that agencies should not have access to the PERT charts because they may not realize or accept the fact that when inputs change, the charts have to be revised and plans shifted. They may just see something running late and start complaining and putting further constraints on the work which would jeopardize
the mission. The organization doing the research project should use the PERT charts for warnings. Reichert noted that research is hard to plan and options have to be kept open. "Back to the drawing board" is often a very necessary operation during the research process and is difficult to show on a PERT chart. A flow chart with do-loop capabilities is needed in research.

Reichert concluded that CPM and PERT are useful during proposal and contract negotiation stages because: they provide a common language to use with an agency; they demonstrate management capability; they show willingness to use proven management techniques to make work more effective and efficient. They are also useful for pre-planning, budgeting and other resource allocation decisions. He recommended that detailed time charts such as CPM and PERT be used only as "private tools" whenever possible.

The staff and associated graduate students of the Cultural Resources Institute of the Department of Anthropology of Texas Tech University have been experimenting with various management techniques in all their operations: running the Institute, developing research designs, writing proposals and managing projects. Two of the most intensive experiments were the application of CPM and PERT to two projects: first, an alternate work schedule for a proposal that had already been submitted and second, a schedule for actual implementation in the laboratory phase of a large ongoing project. The first was done by graduate students Daniel E. Fox and Jerry Alexander in conjunction with Alston Thoms, CRI staff archeologist who was proposed as project archeologist on the original proposal (BLM YA-512-RFP6-80, Radium Springs Archeological
Survey, New Mexico). The second was done by Alexander in conjunction with the project archeologists and lab staff involved with the lab work of the on-going project (NPS-IAS RFP 15950010, Canyon Lakes Park Excavation, Lubbock, Texas).

Fox and Alexander presented a paper, "Business-like Archeology", to the workshop for discussion. It explained CPM and PERT techniques, described how they had used them in the Radium Springs proposed work schedule, discussed their results and raised questions about the use of such techniques in archeology. Copies of this paper and abridged versions of the BLM RFP and the CRI proposal were distributed to the workshop participants for study and discussion. The paper is included in this section and the RFP and proposal appear as Appendices B and C.

Alexander then described the Canyon Lakes lab scheduling process. Copies of a proposal supplement of the schedule and its revisions and of various other charts were distributed to the workshop participants. The archeologists involved in the Canyon Lakes lab phase, Dr. Richard O. Keslin, project director, and Philip A. Bandy and John Montgomery, CRI staff archeologists and lab supervisors, supplemented Alexander's presentation and commented on the use of CPM/PERT in this application and the value of the resulting schedule. A summary of this presentation is included in this section and the proposal supplement and examples of the schedules and charts appear as Appendices D and E.

It must be noted here that during these experiments, terms were not always used entirely consistently, especially in definitions. This has not been corrected in the papers and charts, but is clarified here. This suggested usage should bring the terminology
in line with accepted MBO, CPM and PERT usage as well as with Mayer-Oakes' and CRI usage.

objective -- a specific, realistic goal to be accomplished in a project.

operation -- an identifiable part of a project, e.g. "artifact cataloging", which consists of the activities and events that will fulfill an objective of the project.

activity -- a time-consuming component of an operation, e.g. "type catalog cards", which uses manpower and/or other resources; an activity is placed on an arrow of a network or flow chart.

event -- a recognizable component of an operation which occurs at a specific point in time, but does not itself consume time; it is often the product of an activity or activities, e.g. "final report", or the beginning or end of an activity, e.g."start survey" or "cataloging completed"; an event is placed at a node of a network or flow chart.
BUSINESS-LIKE ARCHEOLOGY --
THE POTENTIAL FOR APPLICATION OF MANAGEMENT CONTROLS

Daniel E. Fox and Jerry Alexander

Introduction

In recent years, with a continuing increase in the volume of contract archeology stemming largely from Federal conservation mandates, a trend toward "conservation" archeology has developed and a responsibility to governmental and public concerns has been recognized. The corresponding legal and nationally integrated nature of contract archeology has encouraged the standardization of research and reporting, and of techniques and terminology. As might have been expected, conflict resulting from the competitive business orientation of a growing number of independent institutions doing archeology has attracted organizers and administrators who seek to standardize qualifications for practitioners, as well as controls for the management of archeological projects. In an attempt to avoid the conflict of basic attitudes about whether or not individual archeologists should be managed, the following paper studies the potential for application of a method of project analysis which might be employed by different contracting institutions as an aid in communication between them and with funding governmental agencies.

First, a discussion of the context of doing archeology will be presented.
Business-Like Archeology

As part of the continuing process of redefining the scope and role of archeology in its increasingly public context, another "new" archeology has come into practice. By whatever name--"conservation", "public", or "contract" (McGimsey 1972; Lipe 1974; Cunningham 1974a) -- current archeological research is becoming more and more involved in standardization, organization, and management, which probably are the inevitable result of the legal and nationally integrated nature of communication between archeologists and funding sources, particularly Federal agencies (Cunningham 1974a:8). Willey and Sabloff (1974:210) sum up the practical concern of the archeologist's general social responsibility:

In a growing and increasingly intercommunicative world the archaeologist can no longer proceed in the "laissezfaire" manner of the past. Archaeologists will have to be willing to cooperate fully with local governments in adherence to and enforcement of laws governing antiquities.

Recently, attempts have been made to develop workable standards for the quality of archeological research and reporting (Taylor 1973:283-284; Mayer-Oakes 1973; Brown and Struever 1973; and others), and for the qualification of archeological practitioners (Tunnell 1974; SOPA 1976). Techniques and terminology, which often vary considerably between research institutions, may eventually become standardized to facilitate communication between archeologists and with funding sources (Cunningham 1974a:8).
Organization vs. Independence

A prime deterrent to the organization of doing archeology appears to be a fear that archeologists' "independence" might be compromised (Taylor 1973:184). Indeed, this general feeling has been expressed by Willey and Sabloff (1974:210), as they warn, "it can only be hoped that the archaeologist of the future will manage to be a thinking and imaginative individual and not become a cog in a machine." Cunningham (1974a:8-9) questions what the successes of standardization might be:

Some practitioners may resist what they view as regimentation and so reduce their research. Given minimal requirements, some investigators may be tempted to "go by the book", merely meet those standards, and so discount their obligation to the discipline and to themselves.

This brings us to the overriding question: will conservation advance or merely expand and possibly stabilize U.S. archeology? Will conformity forces outweigh factors facilitating constructive innovation?

The answers to this question may be a long time coming. Attempting to get the most out of research funds, archeologists probably will become even more involved in administrative activities and business management procedures. In theory, the accompanying social change should be expected to entail a redistribution of power and privilege, which will be resisted by some and sought by others.

Regardless of whether or not American archeology remains individualistic, affiliated with academic institutions, or becomes corporately organized as a profession, there appears to be a need for the discipline to develop itself into a more sophisticated
(justifiable) social institution which has the capacity to deal constructively with conflicts caused by ongoing change and diversification. As Stephen Robbins (1974:15) points out, "Constructive conflict is both valuable and necessary. Without conflict, there would be no simulation to think through ideas, organizations would be only apathetic and stagnant." Hopefully, conflict among archeologists will be manipulated so as to provide for the maintenance of personal integrity and thereby promote constructive innovation.

The remainder of this paper is devoted to a study of the potential for the application of a method of management analysis, a communication device which might be employed by different administrators--archeologists or businessmen--doing archeological projects.

Scheduling Analysis: PERT

Management is a term which is associated most often with organized or business-like endeavors. Involved in management are the functions planning, scheduling, and controlling, which can be used to increase the efficiency of any project. PERT is one management efficiency device which incorporates the above functions and which has been used effectively in different sorts of organized research and development projects.

PERT as a Managerial Tool

PERT, an acronym for Program Evaluation and Review Technique, was developed by the Navy Special Projects Office in cooperation with a management consulting firm (Levin and Kirkpatrick 1966). PERT is a management tool which can be used to minimize job
delays, interruptions, and conflicts; to coordinate and synchronize parts of the overall job; and to expedite the completion of projects (Levin and Kirkpatrick 1966).

As mentioned previously, PERT involves planning, scheduling, and controlling functions which are essential to the definition of management in general. The first aspect, planning, is a listing of the jobs to be implemented before any activity actually is begun. Involved in this planning phase are considerations of gross requirements for supplies and manpower, along with estimates of costs and time allotments for the various jobs which comprise the entire project (Wiest and Levy 1969). The second phase, scheduling, is the laying out of the actual jobs in the order (time/space) in which they are to be performed.

The difference between scheduling and actual job performance is determined during the control phase. The analysis and correction of this difference forms the basis for control (Wiest and Levy 1969).

**PERT as a Flow Chart**

Planning, scheduling, and controlling are brought together by PERT as a network system and are shown graphically as a flow chart. This communicative device is the basic tool used in a PERT analysis (ENTELEK 1964).

The network system is simply the charted sequence of jobs required for the completion of a project. Jobs are classified as events and activities. Events are defined as specific accomplishments or objectives occurring at determinable points in time (Levin and Kirkpatrick 1966).
Events, therefore, cannot consume time and are depicted as circles on the PERT flow chart.

An activity, defined as the work which is required to accomplish an event, is shown as an arrow on the PERT flow chart. Some activities must be completed before others can begin, although occasionally two or more activities which are more or less independent of each other can go on concurrently. Such activities are shown as broken line arrows on the flow chart (Levin and Kirkpatrick 1966).

Leading to events, activities require time - the basic element which ties the network together and which is the essence of PERT. Because the exact time required for some project activities cannot be predicted during planning and scheduling phases, PERT analysis considers unpredictable time in three ways. Estimates of optimistic, pessimistic, and most likely times are used to calculate an expected time for an activity.

The most optimistic time is that estimate which has a small probability of being reached. In other words, it is the shortest conceivable time in which an activity can be completed. In contrast, the pessimistic time is the maximum possible amount of time it would take to complete an activity. Pessimistic time takes into consideration adverse weather, breakdowns, bad luck, and other delaying factors.

The best intuitive estimate of time in which an activity can be accomplished is considered the most likely time. Most likely time usually is based on experience with the amounts of time known to have been taken for similar activities during previous projects. Most
likely times can be predicted most accurately for standardized activities performed under identical conditions.

Optimistic, pessimistic, and most likely time estimates can be combined in a formula that gives the expected time for a proposed activity. Such a formula usually assumes that optimistic and pessimistic times are about equally likely to occur, and that the most likely time is four times more likely to occur (Wiest and Levy 1969). Once these calculations are made, the time estimates are entered into the flow chart, above the activity arrows. Those arrows with the longest time allotments are considered to be the basic constituents of the critical path of a project.

In determining the critical path of the entire project, consideration must be given to every activity. Because some activities can go on concurrently, the critical path is the longest path in the project network. The longest path can be defined as those activities which are critical in determining the project's duration.

Once the critical path has been determined, management can work to control the project by shortening these activities or by watching them closely to insure that each critical activity does not run over-time. With the completion of the critical path and all related or concurrent activities, the project is finished.

**PERT as a Process**

Because most kinds of projects involve at least some activities for which it is difficult to estimate precise times of duration,
PERT is an active and on-going process. The PERT flow chart is not simply a drawing board tool, but should be updated and revised throughout the project.

In certain cases manpower and capital can be added to insure that commitments to a completion date will be met. A more involved PERT analysis would compute these exceptions to the schedule as slack time and latest allowable time. Such calculations and interpretations may require an experienced or trained management consultant; therefore, the explanation of these and other more complicated aspects of PERT are beyond the scope of this paper. Following is an example of the application of PERT to the analysis of a proposed archeological project.

An Example

A project proposal, Archeological Survey of Radium Springs Geothermal Leasing Area, New Mexico (Mayer-Oakes 1976), designed by the Cultural Resources Institute (CRI) of Texas Tech University, was chosen as an example for the application of a PERT analysis. The Radium Springs proposal was submitted by CRI in response to a Bureau of Land Management solicitation (YA-512-RFP6-80).

The Project Analysis

Table 1 presents a descriptive outline of twelve individual steps or "operations" that would be required in order to complete the proposed intensive archeological survey (Mayer-Oakes 1976). Although many of these operations might be broken down into sub-operations, the minimal definition of the twelve steps listed here
<table>
<thead>
<tr>
<th>OPERATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Literature search</td>
<td>As required by the RFP statement, a literature review, proposed as the location, scanning and recording of citations of pertinent archeological background information from libraries at TTU's Southwest Collection, the Laboratory of Anthropology at Santa Fe, the University of New Mexico at Albuquerque, and the New Mexico State University at Las Cruces.</td>
</tr>
<tr>
<td>B. Recruiting</td>
<td>In addition to personnel named in the proposal* (PI, PA, SC, RAC, and RERSC), the recruitment of APA, 5 CC(LA), 12 FH, C, CH, SB, PP, and DP.</td>
</tr>
<tr>
<td>C. Sampling Design (Pre-Field)</td>
<td>As proposed to fulfill requirements of the RFP statement, the design of a two-stage approach to a 15% random stratified sample, and the definition of the first stage sample.</td>
</tr>
<tr>
<td>D. Establishment of Field Headquarters</td>
<td>Procurement of equipment and supplies, loading and transportation to field location, and organization of field camp, field lab, and field headquarters.</td>
</tr>
<tr>
<td>E. Field Survey (Stage 1)</td>
<td>Designed to satisfy RFP statement requirements, an intensive archeological survey coverage of approximately a 3% sample from each of six strata, with operations including: observation (in a zig-zag pattern along 25 meter interval transects), collection (of minimal samples of cultural material), recording (of sites, archeological features, and other data with notes, record forms and photographs), and marking of site (with a central rebar numbered marker).</td>
</tr>
<tr>
<td>F. Sampling Design (Field)</td>
<td>The determination of variation of site densities among the six strata, and the recalculation of field effort proportions, based on Stage 1 Field Survey data.</td>
</tr>
<tr>
<td>G. Field Survey (Stage 2)</td>
<td>Same general operations as stated for &quot;G. Field Survey (Stage 1),&quot; except that subsequent to site evaluation at the close of the survey, certain sites will be selected for additional artifact collection.</td>
</tr>
<tr>
<td>PERSONNEL*</td>
<td>EQUIPMENT, SUPPLIES &amp; SERVICES</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>PI, PA, APA, SB</td>
<td>Expendible office supplies; copy services</td>
</tr>
<tr>
<td>PI, PA, SB, (APA?)</td>
<td>Inter-community communications services, institutional personnel services</td>
</tr>
<tr>
<td>RERSC, PI, PA, SC</td>
<td>Consultants' equipment and supplies</td>
</tr>
<tr>
<td>PI, PA, APA, SB, 5 CC(LA)</td>
<td>Institutional purchasing services; transportation; materials for construction and furnishing of field camp, kitchen, lab, and headquartered; equipment and supplies for field survey, lab, etc.</td>
</tr>
<tr>
<td>PA, APA, CC (LA), 2 FH, C, CH</td>
<td>Office supplies, record forms, cameras, maps, hand-tools, vehicles, sample containers, kitchen supplies, etc.</td>
</tr>
<tr>
<td>same as &quot;C&quot;</td>
<td>Same as &quot;C&quot;</td>
</tr>
<tr>
<td>Same as &quot;E&quot;</td>
<td>Same as &quot;E&quot;</td>
</tr>
</tbody>
</table>
H. Preparation of Interim Report

Corresponding with the completion of lab work, and the reorganization and delivery of all field record forms, the preparation and delivery of an Interim Report.

I. Sampling Design
(Post-Field)

The estimation of site density for each type of site in each of the sampling strata, based on data gathered during the entire survey.

J. Lab Work

Washing and cataloging of artifact samples; analyses and encoding of survey data; organization and storage of samples, forms, equipment and supplies.

K. Return to Texas Tech

The disassembly of the field headquarters; the loading of equipment, supplies and samples; the disengagement of remaining field personnel; and the transportation to Tech headquarters.

L. Final Report Preparation

Writing and coordination, graphics design, National Register considerations, editing, typing and proofing, and delivery of the Final Report.

* PERSONNEL:

PI Principal Investigator (Dr. William J. Mayer-Oakes, TTU)
PA Project Archeologist (Mr. Alston V. Thorns, TTU)
SC Statistical Consultant (Dr. Stuart L. Pimm, TTU)
RAC Regional Archeology Consultant (Dr. Stanley Bussey, NMSU)
RERSC Regional Ecology and Remote Sensing Consultant (Dr. E.B. Fish, TTU)
APA Assistant Project Archeologist
CC(LA) Crew Chiefs (and Laboratory Assistants)
FH Field Hands
C Cook
CH Cook's Helper
SB Secretary-Bookkeeper
PB Photo Processor (not mentioned in Proposal)
DP Drafts Person, or Graphics Designer (not mentioned in Proposal)

Table 1b
<table>
<thead>
<tr>
<th>PERSONNEL*</th>
<th>EQUIPMENT, SUPPLIES &amp; SERVICES</th>
<th>TIMES (Hours)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PI, PA, APA, SB, 5 CC(LA)</td>
<td>Office equipment and supplies, record forms, etc.</td>
<td>24 40 120 50.7</td>
<td></td>
</tr>
<tr>
<td>Same as &quot;C&quot;</td>
<td>Same as &quot;C&quot;</td>
<td>30 40 60 41.7</td>
<td></td>
</tr>
<tr>
<td>PA, APA, 5 CC(LA), C</td>
<td>Washing and cataloging facilities and supplies, sample storage containers, record and analysis forms</td>
<td>170 290 420 291.7</td>
<td></td>
</tr>
<tr>
<td>PA, APA, 5 CC(LA)</td>
<td>Transportation</td>
<td>16 24 40 25.3</td>
<td></td>
</tr>
<tr>
<td>PI, PA, APA, 2 CC(LA), SB, SC, RAC, RERSC, DP, PP</td>
<td>Office supplies and equipment, inter-community communications services, photo-lab facilities and supplies, drafting equipment and supplies, National Register forms, etc.</td>
<td>198 286 472 302.3</td>
<td></td>
</tr>
</tbody>
</table>

** Expected Time (te) = \( \frac{\text{OPT.} + 4 \times \text{M.L.} + \text{PES.}}{6} \)
is thought to be sufficient for a general analysis of the proposed project.

Each operation is assigned a letter for use in notation in a "network" or "arrow diagram" which can be used as a communication device. Gleaned from various parts of the CRMO Proposal and the RFP statement, a brief description of activities and a listing of personnel, equipment, supplies, and services is associated with each operation. Estimates of optimistic, pessimistic, most-likely times, and calculated "expected times" are presented in Table 1, based upon the analysts' practical experience in archeological fieldwork, and from consultation with the proposed Project Archeologist. An attempt has been made to avoid the influence of contract or scheduled time limits presented in the Proposal and in the RFP statement.

An Analysis of One Major Operation

This is a breakdown of the Final Report Preparation, depicted on the total project flow chart as one event. This operation, like other major project activities, can be recognized as a group of separate but related activities for which times can be estimated (Table 2).

Figure 6 shows events two, three, and five as being concurrent. Events one, four, six, and seven are on the critical path because they are expected to require the longest time to complete.
## TABLE 2

**FINAL REPORT PREPARATION**

<table>
<thead>
<tr>
<th>OPERATIONS</th>
<th>OPT.</th>
<th>M.L.</th>
<th>PES.</th>
<th>Te</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Writing - Coordination</td>
<td>120</td>
<td>160</td>
<td>240</td>
<td>166.7</td>
</tr>
<tr>
<td>2. Graphics Design</td>
<td>80</td>
<td>120</td>
<td>200</td>
<td>126.7</td>
</tr>
<tr>
<td>3. Photo-Processing</td>
<td>50</td>
<td>80</td>
<td>160</td>
<td>88.3</td>
</tr>
<tr>
<td>4. National Register consideration</td>
<td>30</td>
<td>50</td>
<td>80</td>
<td>51.7</td>
</tr>
<tr>
<td>5. Editing</td>
<td>16</td>
<td>40</td>
<td>80</td>
<td>42.7</td>
</tr>
<tr>
<td>6. Typing - Proofing</td>
<td>40</td>
<td>60</td>
<td>120</td>
<td>66.7</td>
</tr>
<tr>
<td>7. Delivery of Final Report</td>
<td>8</td>
<td>16</td>
<td>32</td>
<td>17.3</td>
</tr>
</tbody>
</table>

**Critical Path time -- 302.4**
Total Project Time = 302.4 Hours
(In this case, the time expected in order to accomplish the "Final Report Preparation" operation)
Conclusions

Table 3 presents a summary and comparison of the "expected times" calculated as part of the PERT analysis and the times for corresponding operations outlined in the CRMO Radium Springs Proposal. Because time is the focus of the Program Evaluation and Review Technique, the conclusions to this analysis are limited to a discussion of the differences between these times.

Many of the times compared in Table 3 correspond rather closely, especially those for such operations as Pre-field Literature Search and Recruiting activities, and both Field Survey stages. In these cases, the somewhat greater "expected times" calculated as part of the PERT analysis may reflect a more pessimistic view on the part of the analysts.

For the three Sampling Design operations (Pre-field, Field and Post-field), and the operation labeled "Return to Texas Tech", no times were given in the CRMO Proposal. Although it appears that the Sampling Design operations are "non-critical", or can be delayed to some extent without affecting the total project time (see Figure 7), it is possible that the Proposal is optimistic that these consultation activities can be accomplished efficiently. Similarly, the analysts suggest that the return of personnel, equipment, supplies, samples, etc., to Texas Tech is a critical operation which may take at least two days to accomplish.

More noticeable differences between the Proposal times and the PERT "expected times" include the operations labeled "Establishment of Field Headquarters", "Preparation of Interim Report", "Lab Work", 

-57-
<table>
<thead>
<tr>
<th>OPERATION</th>
<th>EXPECTED TIME (HRS)</th>
<th>OPERATION</th>
<th>PROPOSED TIME (HRS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Literature Search</td>
<td>58.5</td>
<td>Pre-field (Literature Search)</td>
<td>40.0</td>
</tr>
<tr>
<td>B. Recruiting</td>
<td>56.0</td>
<td>Pre-field (Recruiting)</td>
<td>40.0</td>
</tr>
<tr>
<td>C. Sampling Design (Pre-field)</td>
<td>20.8</td>
<td>Pre-field (Sampling Design)</td>
<td>not given</td>
</tr>
<tr>
<td>D. Establishment of Field Headquarters</td>
<td>119.7</td>
<td>Field (preparing equipment and supplies, and setting up base camp)</td>
<td>40.0</td>
</tr>
<tr>
<td>E. Field Survey (Stage 1)</td>
<td>98.3</td>
<td>Field Survey (stage 1, or a &quot;3% random stratified sample&quot;)</td>
<td>84.0 (30% of time proposed for 10% sample)</td>
</tr>
<tr>
<td>F. Sampling Design (Field)</td>
<td>20.8</td>
<td>Field (Sampling Design)</td>
<td>not given</td>
</tr>
<tr>
<td>G. Field Survey (Stage 2)</td>
<td>206.7</td>
<td>Field Survey (stage 2, or the remainder of the 10% sample)</td>
<td>196.0 (70% of time proposed for 10% sample)</td>
</tr>
<tr>
<td>H. Preparation of Interim Report</td>
<td>50.7</td>
<td>Preparation of Interim Report (proposed to occur at the end of the 13th week, or during the Report Preparation sub-stage)</td>
<td>(not actually specified in the proposal)</td>
</tr>
<tr>
<td>I. Sampling Design (Post-field)</td>
<td>41.7</td>
<td>Post-field (Sampling Design)</td>
<td>not given</td>
</tr>
<tr>
<td>J. Lab Work</td>
<td>291.7</td>
<td>Proposed as Field Lab Completion sub-stage; but implied to be operational throughout Field stage and during the Report Preparation sub-stage</td>
<td>80.0 (time actually allotted in proposal)</td>
</tr>
<tr>
<td>K. Return to TTU</td>
<td>25.3</td>
<td>Proposed to occur at close of Field Lab Completion sub-stage</td>
<td>not given</td>
</tr>
<tr>
<td>L. Final Report</td>
<td>302.4</td>
<td>Post-field (Report Preparation and Report Writing sub-stages)</td>
<td>160.0</td>
</tr>
<tr>
<td><strong>Total Project Time</strong></td>
<td><strong>861.5</strong></td>
<td><strong>Total Project Time (within RFP statement time limits)</strong></td>
<td><strong>640.0</strong></td>
</tr>
</tbody>
</table>

**TABLE 3**
Total Project Time = 861.5 Hours

Figure 7
and "Final Report Preparation". It is possible that the analysts' perception is overly pessimistic in estimation of the time required for the procurement of essential equipment and supplies, the loading and transportation of equipment, supplies, and personnel to the field location, and the construction and organization of the field camp, field lab, and field headquarters. However, even the optimistic time offered as a part of the PERT analysis (62 hours) is greater than the Proposal time (40 hours) for this critical operation.

The preparation of an Interim Report is mentioned in the CRMO Proposal simply to occur at the end of the 13th week and following the completion of lab work. It is conceivable that this operation could occur as an end result of activities which might be carried on throughout the Pre-field and Field stages of the Project. However, the actual preparation of the Interim Report is listed in the Proposal as occurring simultaneously with the preparation of the Final Report, during the Report Preparation sub-stage. For this reason, it has been considered a critical operation in the PERT analysis.

The most noticeable differences between the Proposal times and the PERT "expected times" involve two of the most critical operations of the Project -- Lab Work and Final Report Preparation. One practical solution to these time differences is implied in the Proposal: that the Project Archeologist, the Assistant Project Archeologist, Crew Chiefs (Lab Assistants), and possibly other human resources would work during extensive overtime periods for the accomplishment of Lab Work activities and for the preparation of the Final Report.
In conclusion, a realistic, probabilistic PERT analysis requires that the times for each critical operation be estimated without consideration of specified or contract time limits. Considering its own institutional resources and the financial restrictions of the RFP statement, CRMO sought to devise a plan of operations which would satisfy the basic objectives stipulated by the RFP statement in such a way as to meet the time limits specified by the RFP statement. As a result of this effort, the CRMO Radium Springs Proposal appears to be somewhat idealistic and deterministic.

The total project time estimated by the PERT analysis is 221.5 hours (about 5 1/2 weeks) greater than that proposed to be met by CRMO. Without compromising archeological objectives or obtaining additional funds or an extended total project time, it seems likely that the proposed project could only be accomplished successfully (on time) at the expense of financially uncompensated overtime provided by CRMO field personnel.

Discussion

A principal factor which must be considered in the evaluation of the potential for application of PERT is that all time calculations are based on estimated optimistic, pessimistic and most-likely times for project operations. For this reason, it seems appropriate that the following two questions be asked:

1. Who can be depended upon to do this estimation?

   An analyst representing a bidding institution might tend to be overly optimistic in his estimations. In contrast, someone unfamiliar
with the resources and organizational structure of a bidding institution might be more pessimistic. Authors of introductory textbooks about PERT admit to this criticism of the application of scheduling analyses (e.g., Horowitz 1967:161).

2. By what standards can time be estimated?

Regardless of generally accepted standard times for various "routine" field and laboratory operations, many aspects of any major archeological investigation cannot be accurately estimated before the project is underway. For this reason, pessimistic (as well as optimistic and most-likely) time estimates should be considered in the calculation of any "standard" times established for different types of archeological projects designed to deal with different objectives having to do with different (or unknown) kinds of cultural resources.

The correct application of Program Evaluation and Review Techniques seems to have potential as a device for:

1. communicating the management of scheduling of operations proposed (or actually undertaken) as part of an archeological project; thereby presenting a justification of expenditures of time and funds for review by funding sources, particularly Federal agencies.

2. exposing the operations of independent contracting institutions to review by competing institutions (considering "peer review" as "good business" for "forcing the hand" of "laissez-faire" archeology.)

3. encouraging problem formulation, organizational efficiency, and possibly the advancement of archeological technology.
4. developing more realistic standards of time and resources required for currently accepted archeological operations. However:

1. A standardized (or required) application of PERT may expose the discipline of participating independent archeological organizations and practitioners to enforced standardization and eventual management by the funding sources, or by nationally-oriented archeological administrators. This tendency toward outside control might alienate many experienced professional and amateur archeologists, while at the same time attracting business-oriented people to a growing new aspect of the American free enterprise system. Sponsoring educational institutions may resist restrictions on "academic freedom". Although the analysts could find no documentation of institutional research policies in the Texas Tech University libraries or Research and Graduate Studies office, a number of recent sources on the nature of universities (Committee on Institutional Research Policy 1954, Chambers 1962, Brabacher 1965, Cross 1968, Danhof 1968, and probably others) warn against the loss of institutional integrity to governmental controls of institutional research.

2. Even though PERT seems to be a simple method of project evaluation and review, its influence on the actual scheduling of archeological projects might be to encourage efficiency beyond sophistication to the point of regimentation of archeological operations. This might restrict spontaneous intellectual inquiry (there would be "no time" for scholarly activity) and alienate archeological personnel who might be interested in contributing to the
development of method and theory in the discipline of archeology.

3. It takes time to do a PERT analysis. Relatively unfamiliar with the method, the analysts spent approximately 120 man-hours analyzing the CRMO Proposal. One solution would be the employment of management specialists (Mark E. Randall, personal communication September 26, 1976; Cunningham 1974b). Would this lead to the design of archeological projects by businessmen, instead of archeologists?

4. The application of management controls (PERT and probably other methods) might necessarily entail the standardization of the "human resources", as well as the operations and objectives involved in doing archeology; not that this has not already occurred to some extent (formally and informally) in contemporary contract archeology. Archeologists are becoming stereotyped as "Professionals": administrators, (PI's), field or survey archeologists (PA's), assistant archeologists, staff or squad members (APA's, CC's, LA's, etc.), and "diggers" (FH's). Where are the "scholars"? Why, of course, somewhere in graduate school, possibly being trained to be PA's, APA's, CC's, LA's, and if they are worthy of public responsibility, PI's.
References Cited

Bayard, Donn T.

Brown, James A., and Stuart Struever

Brubacher, John S.

Chambers, M. M.

Chang, K. C.

Committee on Institutional Research Policy

Cross, George L.

Cunningham, Robert D.


Danhof, Clarence H.

ENTELEK
1964 Planning and Scheduling with PERT and CPM. Programmed text by ENTELEK, Inc., Massachusetts.

Evarts, Harry F.
1964 Introduction to PERT. Allyn and Bacon, Boston.

Haury, Emil W., and others
Horowitz, Joseph

King, Thomas F.

Levin, Richard I., and Charles A. Kirkpatrick

Lipe, William D.

Mayer-Oakes, William J.


McGimsey, Charles R., III

Redman, Charles L., ed.

Robbins, Stephen P.

SOPA
1976  Recent establishment of a Society of Professional Archeologists.

Taylor, Walter W.

Tunnell, Curtis
1974  Memorandum to Members of the Texas Antiquities Committee. Texas Antiquities Committee, Austin (August 21, 1974).

Wiest, Jerome D., and Ferdinand K. Levy
Willey, Gordon R., and Philip Phillips

Willey, Gordon R., and Jeremy A. Sabloff
THE CANYON LAKES LAB SCHEDULE EXPERIMENT

Having gained experience in applying CPM and PERT in a proposed work schedule for the Radium Springs project, CRI staff members and associates felt it would be worthwhile to try the techniques on an actual project, preferably one with a fairly long time span and large number of objectives. The lab and report preparation phase of the Canyon Lakes project met these criteria. It would last eight months and, having many objectives (see Appendix D, Proposal Supplement), would be quite complex. Alexander, who was not working on the Canyon Lakes project, would do the PERT analysis as part of his thesis research. All lab personnel, especially those in supervisory positions, would work with him in developing the schedule. They would break down the operations into their component activities and events, arrange them in logical order, determine manpower needs and estimate times for them. Alexander would then make the PERT calculations, design the PERT network and suggest changes that might expedite the project (such as switching resources onto the critical path from slack time areas). He would also help develop different types of charts as needed for different purposes, e.g. quick progress checks, communication with lab assistants, and detailed work plans. Examples of these charts are found in Appendix E. He would also periodically help check progress and revise the charts, a necessary part of any PERT application.

Several benefits from his application of PERT were generally agreed upon by Alexander and the project personnel. (1) The
analysis showed that one of the supplemental (not specified in the contract) objectives could not be fulfilled within the given time frame and allocated resources. It was relegated to "only if time permits" status. (2) The charts posted in the lab gave lab assistants a broader picture of their work and how it fit into the overall project; this probably made their work more interesting and effective (the charts provided a graphic display of an MBO process). (3) The detailed work schedules reduced the amount of time supervisory personnel had to spend answering questions and explaining steps to lab assistants. (4) When certain activities took more time than estimated, the charts provided "early warnings" as to which operations were falling behind. If they were on the critical path, it was clear that they would affect the completion date of the entire project and available resources could be allocated to them (such as temporary work-study student assistants).

Some disadvantages were also noted. The PERT analysis itself was extremely time-consuming; if Alexander hadn't been available "free", it probably couldn't have been done. All lab personnel, especially the supervisors, spent many "overtime" hours breaking down activities and making time estimates. This time and personnel use must be considered as part of a project that is going to use PERT or other management techniques. The time saved and other benefits gained by using PERT in the project must be balanced against the time spent doing the analysis and keeping the charts up to date. Alexander also commented that he felt that the lab personnel did
not make full use of the PERT charts; they did not make frequent enough progress checks and were apathetic about revising the charts regularly. Also, the first network proved to be too hard to understand to be a useful communication tool and other types of charts had to be devised.

Alexander and the lab supervisory personnel concluded that a CPM analysis in which the "most likely times" were used directly instead of estimated times based on the PERT formula, would have been just as useful and much less time-consuming. They also concluded that simple "milestone" charts were more effective as communication and "warning" devices than network-type charts. All felt that the detailed planning imposed by the PERT analysis was beneficial.
RESEARCH DESIGNS AND MANAGEMENT TECHNIQUES

The morning of the second day was devoted to a consideration of research designs for archeological projects. Mayer-Oakes described the development of a general research design set in a conceptual framework of objectives and operations; his paper appears below. A description of how this research design has been used in conjunction with management techniques was then presented by CRI staff members Alston Thoms and Alice Portnoy. This is summarized below.

Since the evening of the second day was going to be used by the participants to produce their preliminary papers for presentation the next day, they were given the "afternoon off". They enjoyed an extensive tour of the Lubbock Lake Site given by its project director, Dr. Eileen Johnson, TTU Museum.
RESEARCH DESIGN -- THEORETICAL UNIFORMITY, CLARIFICATION OR STAGNATION?

William J. Mayer-Oakes

Introduction

Personal Background

It has encompassed what we might think of as a normal "laissez-faire", grant-to-grant development of an individualized concept and style, using a modification of MBO, the "objectives-operations" approach, within a version of the multi-stage framework first formalized by Walter Taylor. Our framework for either sponge-like culture-historical problem orientation or special topic - narrow focus problem orientation comprises the four operations of:

- problem formulation,
- observation,
- analysis,
- interpretation.

This model of operations is seen as cyclically repetitive, with wide adaptability, to various kinds of problems and styles of approach. For example, it covers empirical, descriptive, inductive research as easily as it does theoretical, experimental or other kinds of deductive research. It is particularly well suited to the most sophisticated hypothetico-deductive or theoretical-empirical characteristics.

This background of slowly evolving ideas and practices for the "management" of a research project was recently subjected to a hot house forcing, beginning in June 1976 with a response to a major RFP for a complex mitigation project under NPS-IAS auspices.
A heavy summer of writing and refining a complex proposal followed this.

1976-7 Contact with Feds

This "hot house" or intensification of concern with Research Design has gone on since the September 1 establishment of CRI (and CRMO). Various other federal agencies have provided RFP's to which we have responded with proposals stemming out of this basic background. They include the SCS, BLM, Bureau of Reclamation and BIA in addition to NPS-IAS.

Preliminary Conclusion

On the basis of this 11 months of "intensive immersion" in contract proposal writing for a variety of agencies I have concluded that there is not general agreement upon:

1) what a Research Design is;
2) exactly who does it for contract work; or
3) precisely when it is done in the contract process.

These conclusions characterize both the agencies putting up the contract funds and the units proposing to do the work. Another conclusion is that at least one agency apparently ignores the concept of explicit research design, by awarding contracts solely on the basis of lowest bid.

My general summarizing thought here is that the explicit research design in archeological research is a necessary tool for the management of the process of doing research. This view is probably widely acceptable at an elementary level, but it has been rarely emphasized or developed in the literature. The Fox and Alexander paper suggests this may be changing.
Trends

I think it is possible to discern trends toward Research Design uniformity, either due to factors of proximity (geographic or intellectual) or to factors of RFP requirement.

**Proximity**

This is normal enough in non-contract research contexts, i.e., "geographic" research neighbors often implicitly agree on basic goals and objectives though differing in method and technique of implementation. "Intellectual" research neighbors also often agree quite explicitly on both objectives and methods, whether they be highly integrated (like SARGE) or less so (like "new arky" or "processualists"). On the basis of this background of "normalcy" for archeological research, the transfer of archeological people into positions of influence in the awarding of contracts can be expected to produce reflections of the basic academic or pure research scheme of things. And it apparently does, e.g.,

a) the Denver IAS staff committee which reviews proposals and awards contracts appears to have a "set" of customary responses towards certain styles of research and kinds of terminology;

b) the New Mexico BLM seems to have a "set" towards "predigestion" and the development of professional specifications for contractors to respond to with but technical performance;

c) the Texas SCS has apparently a simple interest in cost; it does not request or realistically consider submitted Research Designs.

**Agreement (uniformity)**

Agreement or consensus among researchers (a kind of uniformity) that
is based on felt geographic or regional needs (and there are attempts, e.g. in New Mexico to explicitly derive such a consensus in terms of an explicit regional research design) is probably a healthy thing, enabling concentration of effort and possibly leading to wider sharing of concepts of "significance". A major point of the R. H. Thompson regional overview letter to the Advisory Council was to utilize the regional overview in deriving nationally variable criteria of significance. Less clear to me is the value of agreement based on shared methodological or problem interests since these seem inherently more variable than geographic factors.

To the extent that uniformity is based in doing whatever the agency wants in order to "get the contract", it is probably unhealthy.

Most Favorable Climate, Currently

IAS (Denver) has promulgated RFP's and Scope of Work that explicitly state the need for "problem-oriented" work and stress the requirement for research "contributions to knowledge" as an integral part of the CRM process.

A caution is expressed here about the possible difficulty of the presence of too much regional experience at IAS, and internal agreement on preferred approaches (there seems to be a clear bias in favor of a limited range of methodology, specifically an emphasis on hypothesis formulation not always directly growing from the specific data base). In a sense, the flavor of proposals funded by IAS Denver is that of a "school" of archeology -- surely not desirable in the necessarily broad context of national financial support.
What Is Research Design?

The concept of research design as it has been applied and developed in archeology stems largely, I think, from the background of interest in sociological research design. Perhaps we can point to Binford's classic (1964) article which leaned heavily on this style of research -- a style which is essentially foreign to anthropology's traditional, individualistic "seat of the pants" manner of working.

Nowadays research design is a shibboleth. That is, the concept of and the need for a research design is something very much like motherhood or apple pie: we can't be against it but there are probably as many varieties as there are different kinds of mothers and different kinds of apple pie. This can be really confusing because of the variety and because in many cases the concept is essentially given lip-service and has not been thoroughly developed by many individual scholars.

The Airlie House Report (1977) clarifies the situation with regard to research design in what is probably by now a relatively out of date presentation. The report was initiated in 1974 and was modified and brought up to date in the fall of 1976. Thus, it is likely to be quite out of date in terms of the use of research design concepts in contract research. Research design use has, in my experience, expanded tremendously during the academic year 1976-7 as the field of cultural resources management has moved ahead extremely rapidly, particularly as now agencies are seriously and extensively getting into the act of contract proposal requesting and selection. A couple of statements from the Airlie House Report may make this clear. On page
72 of the report under the section entitled "Research Design", after a brief introductory statement, there is a paragraph listing four major "elements of a research design". I refer the interested reader to this page for details of this information, but another page in the report (p. 112), in a glossary section of the entire report, gives a specific and relatively brief definition for research design. I quote this in its entirety because it neatly sums up the concept as it has been developed in this report.

RESEARCH DESIGN A plan for conducting an archeological investigation preparatory to undertaking a particular study. It includes a statement of the problem, basic assumptions, activities and techniques, including strategies and methods required for problem solution and hypothesis testing, and a specification of the relevant data and how they will be utilized for a full understanding of the resource. A research design is usually in sufficient detail to permit the evaluation of its methodological sophistication and feasibility.

Responding to National Park Service Interagency Archeological Services (IAS) proposals has clarified for the Cultural Resources Institute of Texas Tech University what we mean by research design. Perhaps the best quick way to indicate what this has meant to us is to view our concept of research design as it has developed since September of 1976 through the style of the schematic which we have utilized to accompany the rather lengthy narrative statements about research design. These schematics have characterized several of the proposals which we have prepared that have in fact requested a research design. Figure 8 is a brief indication of the hierarchical and, if you will,
Fig. 8 Hierarchy of objectives.
relative nature of usage of the terms objective and operation. This is a framework in which we see three major levels of usage of the terms. At the uppermost or most abstract level theoretical and methodological considerations are of primary importance and so the emphasis is mostly on objectives and only incidentally on operations. This is also true at the intermediate level in which problems stated at the theoretical-methodological level become rather differently stated when they are transformed into specific projects. Here of course objectives are again paramount although operations become, perhaps, more explicit and clarified. It is finally at the lowest level, the most tangible or concrete, that activities come to the fore and operations take precedence over objectives, although, as in all the levels, the two are conjoined. And here is the level at which specific tasks or works are to be conceived and carried out. This figure essentially describes the conceptual framework that we are using in this scheme utilizing the twin coordinate concepts of objective and operation.

Figure 9 is our generalized schematic for a research design with the several elements of action and concept incorporated with the basic three level hierarchical framework indicated in Figure 8. Figure 10 is an adaptation of the schematic outlined in Figure 9 applied now to a very specific project and included as a guiding schematic to the actual proposal of a project to be carried out including the specification of a particular set of tasks to be attempted. Figures 11 and 12 are the supplementary schematics which, in fact, are tables that define the work schedule in terms of the
Figure 9 CRI RESEARCH DESIGN SCHEMATIC

RESEARCH ORIENTATION
RFP - MINIMAL
RFP - SUPPLEMENTAL
CRI - SUPPLEMENTAL

CONCEPTUAL FRAMEWORK
objectives - operations

PROBLEM FORMULATION
(METHODOLOGY)
Problem Goal
Problem Objectives
Project Objectives

TECHNIQUES TO BE USED
work objectives - operations

WORK SCHEDULE
time-people-activity

BUDGET
$

(Theory Level)
(Method Level)
(Technique Level)
(Problem Level)
(Project Level)
(Work Level)

Conceptual Hierarchy
Activity Hierarchy

80
Figure 10 RESEARCH DESIGN SCHEMATIC

(THEORETICAL)

RESEARCH ORIENTATION - Problems
RFP - Minimal  CRI Supplemental
Culture History  Model Building
Seasonality  Catchment
Site Function  Site Survey
Compare-Contrast

CONCEPTUAL FRAMEWORK
Objective - Operation Terminology

(METHODOLOGICAL)

PROBLEM FORMULATION
Primary Goal -- reconstruct behavior
1) model building  4) culture history
2) site function  5) compare-contrast study
3) seasonality  6) site preservation

(TECHNOLOGICAL)

TECHNIQUES - Work objectives - operations

WORK SCHEDULE

BUDGET

IMPLEMENTATION = PRIMARY GOAL
<table>
<thead>
<tr>
<th>TIME</th>
<th>STAGE</th>
<th>ACTIVITY</th>
<th>PERSONNEL**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeks 1 - 2</td>
<td>Pre-Field (TTU campus and various off campus localities)</td>
<td>Recruit personnel, conduct background research, make field preparations</td>
<td>PI, PA, APA</td>
</tr>
<tr>
<td>Week 3</td>
<td>Field-Stage (AT-90 and vicinity Atoka County, Oklahoma)</td>
<td>Prepare site for excavation; conduct catchment and site surveys</td>
<td>PA, APA, 4CM</td>
</tr>
<tr>
<td>Week 4</td>
<td></td>
<td>Conduct exploratory excavation; catchment and site surveys</td>
<td>PI, PA, APA, 4CM</td>
</tr>
<tr>
<td>Weeks 5 - 7</td>
<td></td>
<td>Conduct extended excavation, catchment and site surveys</td>
<td>PI, PA, APA, 4CM</td>
</tr>
<tr>
<td>Week 8</td>
<td></td>
<td>Prepare a site for preservation; conduct catchment and site surveys</td>
<td>PA, APA, 4CM</td>
</tr>
<tr>
<td>Weeks 9 - 10</td>
<td>Post-Field (TTU campus, primarily CRI Lab)</td>
<td>Washing, cataloging and preliminary analysis</td>
<td>PA, APA, 4CM</td>
</tr>
<tr>
<td>Weeks 11 - 14</td>
<td></td>
<td>Detailed evaluation and interpretation of data</td>
<td>PI, PA, APA</td>
</tr>
<tr>
<td>Weeks 15 - 18</td>
<td></td>
<td>Prepare final draft report</td>
<td>PI, PA, APA</td>
</tr>
</tbody>
</table>

Figure 11: Work Schedule Example

*Not including consultants and special personnel (e.g., typist, draftsman, secretary), they will work for short period through the project.

** PI = Principal Investigator
PA = Project Archeologist
APA = Assistant Project Archeologist
CM = Crew Member
<table>
<thead>
<tr>
<th>STAGE</th>
<th>TIME</th>
<th>AMOUNTS</th>
<th>PERSONNEL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-FIELD</td>
<td>0.5 months</td>
<td>Salaries 875.00</td>
<td>PA,APA,SB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fringe Benefits 70.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Per Diem 100.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mileage 320.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equipment (camera &amp; transit rental) 250.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supplies 300.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Services (xeroxing, telephone) 50.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indirect Cost 188.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Total 2,153.13</td>
<td></td>
</tr>
<tr>
<td>FIELD</td>
<td>1.5 months</td>
<td>Salaries 4,575.00</td>
<td>PA,APA,4CM,3C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fringe Benefits 366.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Per Diem 1,650.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mileage 960.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equip. (living quarters rental) 300.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supplies 000.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Services (consultants, telephone) 500.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indirect Cost 983.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Total 9,334.63</td>
<td></td>
</tr>
<tr>
<td>POST-FIELD</td>
<td>2.5 months</td>
<td>Salaries 4,875.00</td>
<td>PA,APA,4CM,3C,SB,SS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fringe Benefits 390.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Per Diem 000.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mileage 320.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equipment 000.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supplies 000.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Services (drafting, photo, C-14, Report Production) 1,850.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indirect Cost 1,048.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Total 8,483.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.5 months</td>
<td>Total $ 19,970.88</td>
<td></td>
</tr>
</tbody>
</table>

Figure 12 Schedule and Budget Example

*PA = Project Archeologist  CC = Crew Chief  LA = Lab Assistant
*FH = Field Hand  SB = Secretary Bookkeeper  C = Consultants
*SS = Special Service (machinery operator, draftsman, typists, etc.)
multi-stage framework of action specifying the amount of time and the
number of people involved. Figure 12 shows the way these are coordinated
and interrelated with the proposed project budget and the proposal as
a whole.

In response to another specific request for a plan to carry out
salvage work -- a mitigation objective -- we have prepared a com-
prehensive and explicit "research design". This latter phrase or
label has come to be almost meaningless, because while it is used
widely is has quite variable meaning. The research design for one
project may be very different in scope and content from that for
another project. The research design for a given project may be
highly variable, depending upon the background and inclinations of
the archeologist drawing up the research design. Our attempt here
(in the response to the IAS-NPS RFP for the Hog Creek project) has
been to focus on the three major levels of intellectual activity --
theory, method and technique -- in a way that should make our proposal
most meaningful to the manager of the archeological resource.

Figure 10 is the schematic framework we have created in an
attempt to clarify as well as make comprehensive a capsule statement
of a particular research design. It is at the same time a general
framework within which both other projects and other individual
archeologists could be accommodated. We think this formulation of
research design (or something quite similar to it) could function
as an agreed-on framework of general understanding about what we do
and how we do it, in archeology.

In this research design for a particular mitigation project
to be funded by federal funds, the critical elements of
theory at the top, followed (in a sequence of intellectual trans­formations) by method and finally by technique are presented from top to bottom. The initial theory elements are called "Research Orientation" and "Conceptual Framework". Here we have a research orientation specified in an RFP from Interagency Archeological Services -- Denver. The RFP states that for such and such a project respondents must have a minimal set of responses. Judging by both the RFP statements and the contracts that have been awarded, the basic response that is required is a proposal for what I would call sophisticated culture history. If an archeologist applies with a proposal that deals only with that, however, chances are he will not be awarded the contract. You need to get brownie points by doing something more. You need to do something beyond this minimum that is required quite specifically for management purposes. The National Park Service wants to do, as they say, problem oriented archeology, so you are asked to come up with your own problems and add them to those required by the Park Service. If your suggestions are good enough you will receive a higher rating in the evaluation of the proposal.

What we have done in this case of a proposal prepared by our Cultural Resources Institute, is to put in problems reflecting the specific interest and expertise which our staff has adding them to the total research orientation. Thus, as can be seen in the upper lefthand portion of the schematic, there are both minimal and supplemental theoretical concerns which are derived from the RFP, plus a supplemental item of theory and problems derived from our own Cultural Resources Institute. Now, how about the question of applied
versus basic research? The Park Service is the one that says where to go and what to do, in general. And we as archeologists are responding to this kind of specific request for a proposal. There is nothing basic or pure in the normal sense of these words. This is clearly directed research, not fundamental or basic research. We consider basic or pure research to be essentially self-directed or self-initiated by the archeologist.

While the major portion of the research orientation is derived from the requirements of the project sponsor, the other component of theory, the conceptual framework, is entirely derived from the archeologist. We list our concepts of objectives and operations in the upper right of the schematic and then utilize them to transform the theoretical concerns (problems) into a problem formulation, the first major step of action in our four-part model of doing archeology.

Because this schematic is in fact a planning document, we see that the main effort needed is the statement of what we plan to do, on three levels. The first and most abstract level is the "problem" level. Here we distinguish between a goal and its component objectives. The next step is to transform problems (stated in terms of objectives) into projects. When these project objectives are stated we have completed our methodological formulations and are ready to transform these project objectives into the action level, or into work objectives with associated operations. This section of the schematic is quite different in significance from the upper portion. In the upper portion, our stress is on conceptualization of our research problem -- attention is focused on the ends we desire
to achieve by our research, stated in terms of the broad or general methods to be applied in order to achieve the ends or objectives. In the lower portion of the schematic research design we focus on the actual way we plan to implement the methods and problems stated above. We have expressed this in terms of techniques to be utilized in applying the stated methods to the stated problems. Our central concept of implementation is the final transformation of objectives, viz., the stating of work objectives, now paired with one or more detailed activities which we call operations. While these operations are stated as techniques and associated with the appropriate work objectives, they are also restated in terms of a work schedule that specifies details of time, people and activity. (Figs. 13, 14). Finally, in order to complete the technique planning at the level of implementation we propose a specific financial budget.

Here then is a document and last step -- the implementation part of the schematic -- which in particular ought to speak most directly and effectively to the most managers. Our transformation of objectives from the most abstract level of problem through the intermediate level of project right down to the specific techniques-to-be-applied level of work is just what the Interagency program is asking for right now. The RFP's request the archeologist to spell out, step by step, how he is going to articulate time, people, place, money and activity. The work schedule and budget combined do just this.

What I have done in this section of the paper is to ask the basic question, what is research design, and to provide you with three particular answers. The answer is that research design is this
<table>
<thead>
<tr>
<th>TIME (when)</th>
<th>(amount)</th>
<th>LOCATION</th>
<th>STAGES</th>
<th>PERSONNEL* (which)</th>
<th>(number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>After award of contract</td>
<td>first two weeks</td>
<td>TTU Campus</td>
<td>PRE-PROJECT</td>
<td>Preliminary background research; recruiting personnel; and field preparation.</td>
<td>PI, PA</td>
</tr>
<tr>
<td>Week 1</td>
<td>(1)</td>
<td>TTU Campus</td>
<td>PRE-FIELD</td>
<td>Background research; model building; recruiting; and field preparation.</td>
<td>PI, PA, 2APA, SB, PM</td>
</tr>
<tr>
<td>Week 2</td>
<td>(1)</td>
<td>TTU Campus, various off campus localities</td>
<td></td>
<td>Model building; preliminary background statements; and site and institution visits.</td>
<td>PI, PA, 2APA, SB, PM</td>
</tr>
<tr>
<td>Weeks 3-16</td>
<td>(14)</td>
<td>Hog Creek Project Area and vicinity</td>
<td>FIELD</td>
<td>Exploratory and intensive excavation; site and catchment surveys; and site preservation.</td>
<td>PI, PA, 2APA, 10FCM, SB, 3C, 1SS, PM</td>
</tr>
<tr>
<td>Weeks 17-28</td>
<td>(12)</td>
<td>TTU Campus</td>
<td>POST-FIELD</td>
<td>Clean, catalog, describe materials; lithic study; comparative-contrastive study; analysis; and interpretation.</td>
<td>PI, PA, 2APA, 4LA, SB, 3C, PM</td>
</tr>
<tr>
<td>Weeks 29-40</td>
<td>(12)</td>
<td>TTU Campus</td>
<td></td>
<td>Report Preparation</td>
<td>PI, PA, 2APA, 3C, SB, xSS, PM</td>
</tr>
<tr>
<td>TOTAL</td>
<td>40 wks.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*PI = Principal Investigator  PA = Project Archeologist  SB = Secretary Bookkeeper  APA = Assistant Project Archeologist  FCM = Field Crew Member  LA = Laboratory Asst.  C = Consultants  SS = Special service personnel (backhoe operator, draftsman, printer, etc.)  PM = Project Manager
<table>
<thead>
<tr>
<th>STAGE</th>
<th>TIME</th>
<th>AMOUNTS</th>
<th>PERSONNEL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-FIELD</td>
<td>0.5 months</td>
<td>Salaries 1,250.00, Per Diem 220.00, Mileage (and CRI vehicle) 324.00, Equipment 2,625.00, Supplies 750.00, Fringe Benefits 100.00, Indirect Cost 269.00</td>
<td>1PA, 2APA, 1SB, 1PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Total 5,538.00</td>
<td></td>
</tr>
<tr>
<td>FIELD</td>
<td>3.5 months</td>
<td>Salaries 26,250.00, Per Diem 10,837.00, Mileage (and CRI vehicles) 4,276.00, Supplies 1,750.00, Services 4,200.00, Fringe Benefits 2,100.00, Indirect Cost 5,644.00</td>
<td>1PA, 2APA, 10FCM, 1SB, 3C, SS, 1PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Total 55,057.00</td>
<td></td>
</tr>
<tr>
<td>POST-FIELD</td>
<td>6.0 months</td>
<td>Salaries 21,600.00, Mileage (and CRI vehicle) 100.00, Services 4,250.00, Fringe Benefits 1,728.00, Indirect Cost 4,644.00</td>
<td>1PA, 2APA, 4LA, 1SB, 3C, SS, 1PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub Total 32,322.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TOTAL $ 92,917.00</td>
<td></td>
</tr>
</tbody>
</table>

*PA = Project Archeologist APA = Assistant Project Archeologist FCM = Field Crew Member LCM = Lab Crew Member LA = Laboratory Assistant SB = Secretary Bookkeeper C = Consultants SS = Special Services (machinery operator, draftsman, typist, etc.) PM = Project Manager
generalized, vague thing which Binford more than any other single scholar has pointed up as a necessity in doing archeology. A second answer is that it is the generic concept that we all adhere to these days usually in a very uncritical and ill-defined way although this has been specified rather carefully in the Airlie House statements. And finally, the third answer to the question is our specific development of the concept of research design. The development presented here is not in words and explanation, but rather in the simpler and more direct and condensed format of the schematic that we have utilized in project proposals.

Who Does Research Design?

There is a clear and unequivocal answer to this -- the professional archeologist who is responsible for the project does the research design for the project. But there are some potential problems here when there is a federal or other agency archeologist involved who has some specific archeological responsibility. In a situation like this there are likely to be a number of questions and problems and it is in just this area that at least in the New Mexico versions of it, the BLM proposals or requests for proposals in recent months have created some specific problems for archeologists responding to BLM RFP's. Some archeologists have responded by taking a kind of a "shying away" from it stance, saying, "I'm not a technician, I need to be the professional making the important decisions about research design, not simply carrying out what the BLM archeologists want to have done". Some archeologists have gone to the other extreme by saying that they're happy to do whatever the agency wants them to do.
There is of course a middle of the road position in which various archeologists quibble about being "technicians" and they don't respond to certain proposals but they do respond to the ones that they like and they can get a contract for. I think there probably is general agreement that a non-professional, whether an archeologist or a bureaucrat, should not prepare a research design which is the basis for carrying out a project.

When Is A Research Design Done?

It is clear that a research design should be done before doing any kind of an archeological action which requires a research design. How completely designed, how often modified, and in what manner modified, are all serious questions to be asked about such a research design.

A very important question which has been raised on several occasions in recent months is whether or not a research design should be incorporated in a proposal for a project. The alternative to this is that the research design itself cannot be done until after the project commences. This is a real tough question and it is one for which we do not get a clear cut or unequivocal answer from the Airlie House seminars as can be seen in the following quotation which is a footnote from page 50 of the report.

IAS requires, and recommends to other federal agencies, that the research design be an integral part of the proposal package, since it is a rather crucial indicator as to what the offerer expects to do. Elaboration and modification at later stages in the work are to be expected, of course. The IAS feels that restricting negotiation to a single research design focuses attention only on those approaches, factors, or techniques of which the agency and
the single contractor are aware and that this could have a "settling" tendency; that is, a tendency to normalize research performance at a minimal level. This approach would then be a little more than a formalization of that used in salvage archeology contracting during the 1950s and 1960s. [While not disputing that the approach recommended by IAS will provide the agency with maximum data for selecting the best contractee nor that this is desirable, the editors nonetheless are of the opinion that except for very small projects it is totally unrealistic unless the IAS is willing to underwrite the costs of preparing such detailed research designs. The fiscal aspects of archeological research must be conducted according to sound business practices in addition to sound scientific approaches. It is our belief that in most instances a good choice of contractee by an experienced agency can be made on the basis of a statement of qualifications and a research proposal (see page 218 for discussion). Development of a full research design before final awarding of a contract might well be desirable. Two opinions could then be available to the agency with the choice depending upon temporal and fiscal factors, plus perhaps the agency's experience in selecting archeological contractors. The first would be to select on the basis of statements of qualification and research proposals several potential contractees and to contract with them for the development of full research designs. The full contract would then be awarded by selecting one of these. (Or if none were acceptable the process could be repeated.) This approach is more costly but temporarily more efficient. A second alternative would be to select a contractee (on the basis of qualifications and a research proposal) and enter into a two-stage contract. The research design developed in the first stage would have to be accepted before the second stage became operative. If the research design was unacceptable and negotiations failed to make it so, the contract would be terminated and a similar one entered into with what had initially appeared to be the second best firm and the process repeated. This approach has the potential of being less costly but also the potential of being more time consuming.]

It seems generally agreed that research designs can and should develop, change and grow. Perhaps this dynamic aspect of research design will occur within a project or perhaps from project to project. It may be characteristic of an individual or the approach
of a particular organization. Here we have the concept so often stated in archeological projects and even publications, namely the site or action that is "revisited" time and time again, always learning something new and developing useful and new ideas each time. Surely, as an investigation grows and is better able to delineate and approach problems, we would expect that the research design underlying that investigation would also change.

Conclusion

Research design as applied to contract work needs much more careful attention, especially in the nitty gritty area of project management. It is clear to me that we are heavily involved when we do contract archeology in "applied" research whether "pure" or not. Perhaps it is best to think of this in terms of the source of primary impetus for a project, that is, the project is either "inner" or "outer" directed. When the interests of the outer sort coincide with those of the project doer, good work and good contracts result. When a response is simply to a request from some source that can be considered "outer" and the work is done as but a service, then we can anticipate all sorts of problems which will probably support and make more significant the chasm or schism between "academic" and "contract" archeology. This we certainly would not like to see happen.
CRI RESEARCH DESIGN AND MANAGEMENT TECHNIQUES

Dr. Mayer-Oakes has just described the development of our CRI general research design (Fig. 9), which is based on an objectives/operations conceptual framework. We shall now tell you something about how we actually use it in various types of projects in conjunction with specific management techniques. We use it in specific research design development, proposal writing, and project planning and implementation. Mayer-Oakes also described one of our research designs for a specific project (Fig. 10), and some of our multi-stage work schedules (Figs. 11 and 13) and budgets (Figs. 12 and 14) from this and another project.

The objectives of any particular project are found in our research design. We decide what operations will be necessary to accomplish each objective and then break these operations down into their component events and activities. We first take any deadlines (work-start dates, reports and other deliverables, etc.) specified in the RFP as the fixed nodes (events) in our network or flow chart. Then we estimate the amount of time (in person/days) required for each activity. We set these times between the fixed nodes and arrange activities in logical sequence, looking for concurrent activities. We see what resources will be available to carry out the activities. We look for "float" or "slack" time. We rearrange activities in the most efficient way, place them on arrows, and put the time duration (in days) needed for each activity.
We draw dummy (broken line) arrows between related but independent events. We identify critical path activities. Out of this network, adding extra time where we think we can for unforeseen occurrences, we develop a work schedule and then a budget.

We often work together on a big blackboard developing these flow charts. This group process produces good time estimates because it draws on the wider data base of different experiences. It is a good informal substitute for the PERT estimated time calculations which are so very time consuming and which don't have a very good data base in archeology anyway. This process is definitely helpful in project planning and proposal preparation.

When we are planning a very large, complex project such as the one we're subcontracting for the University of Texas at San Antonio which has three major sub-projects, we also develop milestone charts (Fig. 15) showing project management as a separate component which will co-ordinate the operations of the sub-projects. Figure 16 is a page from the proposal for this project which describes this component and the milestone chart. We also develop charts (Fig. 17) which show relationships and responsibilities of various components. We know that all these charts could be improved and we try to do so continuously.

It should be noted that the agencies which fund archeological projects do not seem to be very interested in management capability, at least not to the point of being willing to pay very much for it. They tend to cut or even eliminate the management component in proposed projects if it is very extensive or explicit. This is what happened to the management component of the project described above.
TTU NUECES RIVER PROJECT - PLANNING AND SCHEDULE

**Scholarly Nodes**
- PrF: Pre-field stage completion
- F: Field
- PoF: Post-field
- L: Lab
- D*: First Draft
- D: Second Draft
- FR: Final report
- HS: Historic Site report
- LS: Literature search
- RP: Report preparation
- MG: Management Project
- HI: History Project
- EH: Ethnohistory Project
- HA: Historic Archeology Project
- PA: Prehistoric Archeology Project

**Management Nodes**
- 1: Field schedule detail for HI, EH, HA, PA
- 2: Post-field schedule detail for EH
- 3: " " HI, HA
- 4: " " PA
- 5: " " 2 HI, HA
- 6: " " 2 EH
- 7: PoF schedule detail for HI
- 8: " " PA
- 9: " " 3 EH
- 10: " " 4 EH
- 11: " " 3 HI
- 12: Final schedule check - comprehensive

**Legend**
- ▲: Increasing management activity
- ▼: Decreasing management activity
- △: Preliminary report
- □: Report draft
- ◼: Completed operation
- ◣: Final report
Figure 16

Nueces Project Plan

In Figure 15 we present our preliminary plan and chart showing in "milestone" fashion the various project stages, objectives, and deadlines. This scheme is an adaptation of CPM, with the fixed time schedule a primary determinant. Our idea in using an explicit management planning and control technique is to help accomplish the total project. We also wish to explore the possibilities for application to archeology. Thus we would also utilize both PERT and a more precise CPM approach after the project commences.

Managing Actions

On the top line of Figure 15 is the schedule of "management nodes." These are activities aimed at providing an up to date detailed final schedule of the succeeding stage of the particular project. For example, at MG node 2 a week and a half effort would be made by the Project Director and the Project Manager to review, expand in detail and (in consultation with Dr. Wagner and the Ethnohistorian) agree on the schedule of activities to be carried out in Post-Field stage one of the ethnohistory project.

The "scholarly nodes" indicated on the chart are drawn for the specific work schedules proposed by the four projects. Each node is the event which signifies completion of the preceding activity or stage. Thus these nodes function as milestones in a total framework or "master plan" for the TTU project.

People

1. Project Director will be Dr. Mayer-Oakes.
2. Project Manager will be Alice Portnoy.
3. CPM-Archeologist Consultant will be Jerry Alexander.
4. Computer-PERT consultant will be Dr. F. Wagner.
TTU PROJECT
Dr. W. J. Mayer-Oakes
PROJECT DIRECTOR

HISTORIC PROJECT
D. Fox, Director

Historic Archeology
D. Fox, Sup.

Field & Lab People

Ethnography
J. Bowermon

Archival History
S. Connor, Sup.

Project Historian
D. Everett

S. Head, APH
S. Connor, Consult.

Archival History
S. Connor, Sup.

Project Manager
A. Portnoy

Consultants
J. Alexander
F. Wagner

Prehistoric Survey
A. Thoms, Sup.

Field & Lab People

Prehistoric Testing
J. Montgomery, Sup.

Field & Lab People

TTU Nueces River Project
Figure 17
We feel that this is both unfair and shortsighted, since management is a necessary part of every project, whether identified as such or not. It certainly uses resources and so should be viewed as a legitimate cost and be funded as such. Better management costs more but can pay off in increased effectiveness and efficiency in doing archeology, whether in or out of a contract setting.
PART THREE

REACTIONS
INTRODUCTION

The morning of the third and final day was devoted to the presentation and discussion of the "homework" that the four visiting archeologists had produced the previous evening. These contributions grew out of their highly varied attitudes, interests and experience, and the presentations and discussions of the two previous days. They applied what they had learned or had found particularly interesting during the workshop to some of their own activities and presented the results to the workshop.

Dr. Albert A. Dekin, Jr., SUNY-Binghamton, presented a discussion about the use of MBO in archeological projects. Michael Roberts, Peabody Museum, Harvard University, explained the use of bar charts in managing projects and how a calculation of variance, such as suggested by GERT, could be incorporated to improve their usefulness. He "polished" this up during the summer after the workshop and his paper is included in this section, as are the others. Michael B. Schiffer, University of Arizona, produced a flow chart (included here with the paper that he wrote during the summer) depicting the development of research designs for and the operations of a multi-stage mega-survey. Dr. Donald K. Grayson, University of Washington, gathered the threads of the workshop discussions about relationships and problems with funding agencies, consulted with the other archeologists and produced a preliminary "group report" which triggered the writing of his paper during the summer.
In the approximately twenty years since its introduction in management science, management by objectives (MBO) techniques have become widely accepted and have themselves been adapted as integral parts of more sophisticated management techniques (c.f., Newman et al. 1967). MBO is essentially a means for measuring change and for evaluating the effectiveness of management in accomplishing such change. It is useful to all of the various functions of management: planning, decision making, organizing, directing and controlling (Scanlan 1974: Ch. 1; etc.). MBO involves the establishment of meaningful and attainable objectives by those with the greatest knowledge regarding their appropriateness. These objectives must also be verifiable, in the sense that management must be able to measure when the objective is accomplished (c.f., Koontz and O'Donnell 1972).

It is generally accepted that the application of such techniques leads to better overall management, improved organization, more effective measurement of progress, more accurate planning and a more efficient and dynamic utilization of resources. However, several problems and weaknesses should be stated, as MBO must not be seen as a cure for all management ills. These include its failure to deal
with responsibility and ethics or to provide operational guidelines for goal setters. Dangers include the false perception of precision in establishing objectives, the inflexibility of objectives once they are set, and a tendency to see objectives as minimal or maximal standards (e.g., Scanlan 1974: Ch. 9; Kepner and Tregoe 1965; and Terry 1972). Objectives themselves are difficult to determine, state, quantify and measure.

In spite of these problems, MBO techniques are widely and successfully used in business, engineering and government. It has not been widely applied in an educational or scientific research context. Yet it deserves our consideration, as any technique which would increase the efficiency and effectiveness of our scientific and applied research projects could be useful to our projects, to sponsors and administrators, and to science.

Each of the various organization structures in which cultural resource studies (and cultural resource management studies in particular) are conducted would necessarily apply MBO techniques differently. But many, if not most, exist in an academic framework or are spinoffs from such institutions. They are faced with a scientific/academic tradition which values individual achievement and initiative and in which personnel management and outer-direction are not an explicit part of the conduct of research (see Harvey 1976). Seemingly most people want to be the manager and few want to be the managee.

We should not allow these problems to cause us to ignore the benefits which could result from a more explicit application of MBO techniques, especially since we may find that we were using similar
techniques, albeit implicitly and with a lack of rigor. As an example, in preparing for this workshop, I suddenly discovered that some of my managing efforts were informa' incomplete and implicit steps toward management by objectives. To a large degree, many archaeologists may discover that they were doing it all along, and that it has worked for them. One goal of this brief report is to suggest that MBO is valuable because it explicitly formalizes what the successful manager may have already been doing, and thus allows us all to manage better.

1976-77 at SUNY Binghamton

One morning last fall, I sat down and scrawled 5 items on a sheet of steno paper torn from a notebook. These were as follows. Fall Goals -
1. Provide contract support $ for students
2. Establish Procedures & Policies for PAF Ops + Programs
3. Do PR Brochures etc.
4. Do research
5. Prepare Curriculum and Courses, do course flyer + outline

In retrospect, this list is a mix of mission-type goals and tasks-objectives, yet it was an attempt to organize and to order our energies for the Fall. It could represent an initial step in organizing and planning through objectives and would certainly have benefitted from more explicit treatment. Had I gone on to set verifiable objectives under each item on the list, we would have been well on the way to MBO. As it turned out, we did not accomplish all of these "objectives" until the Spring of 1977, although we might have done it earlier with better (i.e., more explicit) management.
Let us look a bit more closely at item 1 on the Fall 1976 list: Provide Contract + Support $ for Students. The past success of our facility has been tied quite closely to the extent of our Highway Salvage Program, and we thrived in direct proportion to its funding. The summer of 1976 saw an unanticipated reduction of almost 80% in monies available (based on the previous year), in spite of plans for extensive field work. It was apparent to me that it was ill-advised to place all of our eggs in this one basket and that diversification of applied research opportunities was necessary. Lacking clearly defined objectives, goals or quotas, I decided to expand our contacts in order to attract more diverse work opportunities and to actively seek contracts from all opportunities which crossed my desk.

During the nine months following September 1976 (at which time the above list was made), I responded to every solicitation for a proposal or estimate of costs which was sent to us. I filed federal forms (245) for architects and engineers, I wrote to prospective contracting officers and I contacted firms and agencies in order to increase the number of requests for proposals (RFP's) which were sent to us.

By June of 1977, we had contracted for more than $430,000 (7/76-6/77) worth of applied research, with our 1977 Highway Salvage Program and Salvage Excavations accounting for a little more than 50% of this total. We had field parties in 5 states during this month of June, our payroll included more than 80 staff, our graduate students had full employment opportunities for meaningful research and we hired staff from all over the northeast.
I would argue that much of what we did in this last year could be cast in MBO terminology and that we could have done it better if we had done it explicitly and mindfully.

This successfully attained objective brought with it problems of a different nature. It was increasingly difficult to articulate the resource needs of several large concurrent projects, some of which had stringent completion requirements. As these problems grew, so did my interest in teaching and applying management techniques. In particular, we were having problems in planning resource needs, in controlling staff functions, and in insuring information flow in support of operational decisions. I attempted to improve both the structure and the process of our programs by instituting a weekly supervisor's report and making our organization more formal and explicit.

As an example, our contract excavations on Interstate 88 were originally organized on a typical hierarchical organization chart. However, to insure adequate information flow along the links in that structure and to insure our administrative ability to evaluate progress towards completion of the project, I devised a Weekly Supervisor's Report (Fig. 18), and made it mandatory for all our supervisory staff. It worked remarkably well to insure that all staff gave some thought to what they were doing, to how well they were doing it, to how successful their predictions were and to what additional resources they would be needing. The flow of information upward from the field supervisors to the project director made obvious where resource or organizational needs were and made it easy to assign responsibility for satisfying those
Project: ___________________________ WEEKLY SUPERVISOR'S REPORT

Supervisor: ___________________________ Week ending____________

Position: ___________________________

I. SUMMARY of week's activities and evaluation of results and completion of objectives.

Monday-

Tuesday-

Wednesday-

Thursday-

Friday-

Comments and explication:

II. OBJECTIVES for next week's activities (for week ending_________)

Monday-

Tuesday-

Wednesday-

Thursday-

Friday-

Comments and explication:

Recommendations, Comments and Requests for Additional Resources (Be Specific):

Signature: ____________ Date: ______

Initials of immediate supervisor____

Figure 18
needs (see Scanlan 1974:259). While this was not explicitly MBO, it was an application of MBO principles and it did serve to improve our management, information flow, resource allocation and controlling of staff function. These two management techniques (organizational chart and supervisor's report) improved both the structure and the process of our field operations. This raises the important question: How much explicit use of management techniques do archaeologists need?

Advice on this point is free and straightforward. First, assess your operations and see if you have any potential or actual problems in resource use (again, staff, money, supplies, equipment, time, etc.), or whether any benefits would accrue from the more efficient or effective use of such resources. If you find problems, then analyze your situation and try some minimal applications of management techniques. It may be that you only need to better organize your time to make your operations more effective. However, the bigger the scope of your resource use, the more likely you would be to benefit from some more formal MBO applications, at least at the project level (e.g., Silverman 1976). This is simply because the larger your resource use, the greater absolute impact a low proportional change would have.

Explicit statements of a project's purpose or a facility's mission assist in both program and project development. Functional organization charts assist in proposal planning and information flow and control. Milepost or Gantt charts, tasks and performance schedules, and objectives statements are all appropriate at all project phases. These are all clearly derived and applied heuristic devices which have been found effective when applied at a scale and
resolution appropriate for the project's scope and state.

Recommendations From Our Experience

1. Familiarize yourself with what management techniques exist which have been found useful in applications similar to yours.
2. Read a few articles, books or short courses on management applications.
3. Assess your present and past management approaches.
4. Try some new explicit techniques.
5. If they help, keep expanding your applications until you find a balance between the sophistication of the techniques, their costs and their benefits.
6. Make no commitment to higher-order techniques (like PERT) until you have exhausted the potential of simpler (and more cost-effective) ones.

Recapitulation

We have initiated the explicit use of mission statements, organization charts, milepost charts, objectives setting and weekly reports. In the near future, we will improve our tasks and milepost schedules and attempt to get greater staff involvement in organization and objectives determination. These goals conform to our overall educational and costs-effectiveness missions and to staff development. I believe that the continued improvement of our operations will result.
References Cited

Harvey, L. James

Kepner, Charles H. and Benjamin B. Tregoe

Koontz, Harold and Cyril O'Donnell

Newman, William H. and Charles E. Summer and E. Kirby Warren

Scanlan, Burt K.

Silverman, Melvin

Terry, George R.

NOTE: There are a very large number of management texts to suit your needs, tastes, pocketbook and proclivities. Investigate major series, ask managers and peruse several before settling down to study.
IS THERE A FUTURE FOR P.A.S.T.*?

Michael Roberts

In any review of management literature it becomes apparent that there is a multitude of management graphics of varying complexity and usefulness. We have seen an example of one such technique applied to the problems of the archaeological manager (Fox and Alexander 1976). For the archaeologist there are several drawbacks to many of these techniques. First and foremost is the expenditure of resources (time, people, money) to feed and care for the technique (updating, revision, etc.) which in many cases is not appropriate to the processes of archaeological research. This is also true in so-called contract archaeology in which research is constrained by time and funding limitations and thus is specifically amenable to tight control and reporting requirements, since the funding limitations of such work can, in general, not bear the expense of many management techniques. Other disadvantages stem from the fact that the users of these techniques have been production-oriented in attempting more efficiently to produce a product with known design and assembly procedures. Some techniques that have been used in research and development programs have been found useful, however. We will discuss a modification for archaeology of one such technique later.

*P.A.S.T. (Probabalistic Archaeological Scheduling Technique, Acronym, courtesy of Dan Fox, Texas Tech.)
One distinct advantage, to my mind, in the use of management tools in any project is that it forces the planner to think about the details of the process of getting from point A to point B. This can be applied in a research situation as well as in a production framework. Management techniques are designed not only to plan a process but to communicate both upward to customers or supervisors and downward to the people who will be doing the work. It is these two aspects of management techniques—planning and reporting—that I see as the most valuable and practical for the archeologist. The selection of the proper method for planning and reporting can allow the archeological manager to plan cost effectively and report a project and its progress.

Since all archeological projects both contract and non-contract, large and small, can and should be approached as research, they are heavily endowed with uncertainties. I feel that the greatest power of the management tools presently available is in the forecasting and assessing of these uncertainties and subsequent modification of the planned operations. When assessing the details of a project, however, it is necessary to get as much information as possible on the individual activities involved. This means getting the direct input from all personnel who actually perform a task. This can take the form of verbal explanations of what it takes to dig a test pit by the crew person, to the details of an experimental program for assessing a specific remote sensing technique. What follows is a discussion of a particular technique that I have successfully used in the engineering profession in scheduling complex operations and still
allowing for major changes in the course of the project, coupled with a reporting method that is useful and informative to the customer/supervisor as well as the worker. I will then describe a variation of this method developed at the workshop which may be of some value to archaeological project planners.

Bar Charts

For years bar charts, sometimes called waterfall charts, have been used in the aerospace industry to schedule the processing of research and development projects. These charts take into account the availability of special equipment, facilities, and personnel along with the logical sequencing of events leading to the completion of the project. Fig. 19 shows such a chart depicting the events and their respective time frames for a small archaeological survey. This chart depicts only the major tasks of the project and is generally sufficient to let the project supervisor schedule people and resources into and out of the project as efficiently as possible. There are, however, uncertainties even in a project as small as this. Suppose that in the background phase of the operation we know that an amateur who has important data necessary for the location of several collecting localities within a project tends to be away on business trips and it is unknown whether he will be available for a day or a few hours. This possibility must be recognized in the commitment of time to the background phase of the project. It may be only the project director who is familiar with this situation and thus he/she must allow for this uncertainty when forecasting the amount of time needed for proper completion of the
background phase. At the same time it is possible that the amateur will be out of town during the projected period of the background phase and thus sufficient funds must be allocated for telephone or other communication.

This may be a simplistic example but it is one that the manager must face when deciding how much of the available resources must be allocated to a project or a specific phase of a project. In the above case the upper-level manager must decide on the basis of several levels of other data whether to seek out this amateur or get the data in some other way. In the case of the uncertainties of the field situation the unknown is always lurking in the background to bite the planners and performers of a project. What do you do on the last day of a project, for instance, if the last excavation unit exposes a corner of the great lost city of the Iroquois, and this is in an area that will be completely destroyed very soon? In the planning of the project the possibility that such a thing will happen must always be in the minds of the planners. This means that enough "fat" must be built into a project schedule (based on a realistic evaluation of the level of uncertainties to be encountered) to deal with such a possibility. I am convinced, however, that in the planning of a project such possibilities must be considered and the sequencing of various tactics must be applied so as to maximize the probability of meeting all the project objectives within the time and funding constraints. Figure 20 illustrates the same general data as in Figure 19 but with the details of each phase as seen by the planner. With Figure 21 a portion of the same data is presented.
<table>
<thead>
<tr>
<th></th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>BACKGROUND RESEARCH</td>
<td>/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIELD SURVEY</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>REPORT PREPARATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td></td>
<td></td>
<td></td>
<td>/</td>
<td></td>
<td>/</td>
</tr>
<tr>
<td>Delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>/</td>
</tr>
</tbody>
</table>
### SMALL CREEK WASTEWATER TREATMENT PLANT

#### RECONNAISSANCE SURVEY

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BACKGROUND RESEARCH</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assess Data in State Files</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assess Data in Univ. Anthro. Dept. Files</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview Local Experts &amp; Collector</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop &quot;Sensitivity&quot; Strategy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FIELD SURVEY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop Sampling Strategy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Walkover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsurface Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>REPORT PREPARATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write Draft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare Graphics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submit Draft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervision Review</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copy Edit.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 20*
<table>
<thead>
<tr>
<th>Task</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BACKGROUND RESEARCH</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assess Data in State Files</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assess Data in Univ. Files</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview Local Experts, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop Sensitivity Strategy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FIELD SURVEY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop Sampling Strategy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Walkover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsurface Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crew #1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crew #2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
with personnel assignments. In general, it is important to identify
the areas of uncertainty and deal with them first if possible, thus
helping to reduce the uncertainties of succeeding tasks. It
cannot be repeated too often that this form of project planning,
if done right, helps to force the planner to examine the details of
a project before starting and minimize the surprises. It should
also be remembered that this process can be applied equally as well
to a large, complex project as to a small one such as is
illustrated here.

Flow Charts

While bar charts are useful to assist the planner in the
conceptualizing of a project's details, flow charts are useful
for the communication of a project's plan both upward to the
customer and downward to the worker. For small projects that have
few if any parallel operations the information may be passed on
in the form of a simplified bar chart, but for larger projects a
flow chart has proven the best communicator. Figure 22 is a
flow chart of a relatively large project with several parallel
operations. Various symbols can be employed to illustrate the
operations involved and the tasks that have been completed. The
key accompanying Figure 22 represents typical types of such symbols.

P.A.S.T.

Now that we have introduced bar charts and flow charts,
it is time we put them together in a form that will assist the
archaeologist in planning projects and allowing for uncertainties
that may appear. The form I plan to use here is a step-by-step
Figure 22
discussion from receipt of request for proposal (RFP) to final project plan. This will incorporate a probabilistic approach to planning, developed as a "homework" project at the workshop.

**Step 1**

With the receipt of the request for proposal, the manager must evaluate the size of the project in terms of the number of specific tasks and determine if this particular project warrants more than one subdirector. For small projects it is possible that the individual project director will control all aspects of a project, such as the one described in Figure 19. On the other hand, for large projects with many tasks it may be necessary to assign several task managers to handle different aspects of the project. For our example, we will use a relatively large project that requires several task managers. With the RFP thus evaluated, several task managers are assigned, each having experience or special expertise in the specific operation under his/her direction. For instance, in the present example, Task Manager A would be responsible for the evaluation of remote sensing data, while Task Manager B would be responsible for environmental reconstruction, and Task Manager C would be responsible for evaluating known data on site location. These task managers may each have one or more people working under them.

**Step 2**

Each task manager will work up a "task description work sheet". Figure 23 is such a sheet for one part of a task in this project. Incorporated in this sheet are a narrative description of the task; necessary personnel; least, nominal and worst case time requirements
## TASK NAME DOCUMENT RESEARCH

### PERIOD OF PERFORMANCE

\[ T_L 11.5 \quad T_M 25 \quad T_M 33 \]

### DIRECT LABOR

<table>
<thead>
<tr>
<th>Position</th>
<th>Rate</th>
<th>MH</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Archeologist</td>
<td>$12.00/hr</td>
<td>145.6</td>
<td>$1,747.20</td>
</tr>
<tr>
<td>Assistant archeologist</td>
<td>$8.00/hr</td>
<td>103.2</td>
<td>$903.00</td>
</tr>
<tr>
<td>Photographer</td>
<td>$4.50/hr</td>
<td>9.6</td>
<td>$43.20</td>
</tr>
</tbody>
</table>

### CONSULTANCY

TRAVEL

<table>
<thead>
<tr>
<th>Distance</th>
<th>Rate/hr</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 mi.</td>
<td>.14</td>
<td>$140.00</td>
</tr>
</tbody>
</table>

### MATERIAL

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xerox</td>
<td>$20.00</td>
</tr>
<tr>
<td>Expendable Material</td>
<td>$30.00</td>
</tr>
</tbody>
</table>

**TASK TOTAL** $2,883.40

### NARRATIVE DESCRIPTION

Review histories, deeds, etc. to assess sequence of ownership of house and mill.
(more about this later); and expenses expected. These work sheets can more accurately reflect the actual expected resource expenditure if the task manager develops these work sheets with the people who will actually be doing the work, as far down the line as possible. It should be remembered that for small projects or those that have well known procedures this step can be performed without such sheets. When the sheets are collected by the project manager, it is a simple matter of integrating them into an overall picture of the project and its resource expenditure.

**Step 3**

With the work sheets in hand the project manager can now develop a bar chart that can be used to describe the details of the entire project and thus manipulate the sequence of events so as to minimize the influence of uncertainties on resource expenditure. This step is the heart of P.A.S.T. and uses "so-called" probabilistic methods to identify uncertainties. Figure 24 shows a detailed bar chart with numbers representing various quantities to be used in the calculation of project time and uncertainty. An explanation of the numbers follows.

TE -- Time Estimated. This number is derived in the same manner as in all pert operations (see Fox and Alexander 1976) and is

\[ TE = \frac{T_l + T_m + 4T_n}{6} \]

- **T_l** - the least possible time required to complete a task
- **T_m** - the longest realistic (worst case) time required to complete a task
- **T_n** - the time the task is expected to take under normal circumstances
## DATA RECOVERY AT THE SHAW SITE

### TASK 1: DOCUMENTARY RESEARCH

<table>
<thead>
<tr>
<th>DAYS</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>9</th>
<th>11</th>
<th>13</th>
<th>15</th>
<th>17</th>
<th>19</th>
<th>21</th>
<th>23</th>
<th>25</th>
<th>27</th>
<th>29</th>
<th>31</th>
<th>33</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Regional Histories</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL = 1</td>
<td>TN = 5</td>
<td>TM = 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Census, Deeds, Etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL = 2</td>
<td>TN = 5</td>
<td>TM = 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Arch/Hist. Society Data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL = 2</td>
<td>TN = 4</td>
<td>TM = 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Interviews</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL = 2</td>
<td>TN = 5</td>
<td>TM = 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Document Photo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photographer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL = 0.5</td>
<td>TN = 1</td>
<td>TM = 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Draft Report</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Archaeologist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL = 3</td>
<td>TN = 5</td>
<td>TM = 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: TL = Total Labor, TN = Total Number, TM = Total Minutes
V -- Variance. This number is an index of the amount of uncertainty for a given task and is derived by subtracting Tl from Tm, dividing by a constant, and squaring the result. We now have a number that represents the probable extension of the nominal time (Tn) based on the level of uncertainty for that specific task. The expected time (Te) then will be added to this variance to produce a number that will provide enough time to accomplish the task while considering the uncertainties involved. This time is called Tprop.

\[ V = \frac{T_{mx} - Tl}{3.2} \]

\[ T_{prop} = TE + V \]

Tprop -- is the time used in the proposal where cost-reimbursible or not-to-exceed contracts are used, and a safe margin is needed that is not too unrealistic.

Once the variance number is derived, an examination of the cause of that uncertainty is called for. In the present example, the uncertainty of 2.4 for the examination of regional histories derives from the fact that we don't know enough about the availability or accuracy of the existing material. Once this is recognized, it may be possible to modify the sequence of events, in order to assess the availability or accuracy earlier than planned and reduce the influence of the uncertainty on the overall project. This seems like a straightforward and obvious method that would be used in the normal process of any project plan but it is
surprising how many projects are planned that don't recognize the unforeseen. When pressed by a potential customer to reduce resource expenditure it is these "fat"-containing areas (i.e., nominal + variance) that can be negotiated. Thus another advantage of identifying uncertainties is in the identification of those areas that can be negotiated. There must be a constant understanding on the part of the manager of what is being traded and how it will affect the results of the project. The skill of the manager in thinking on his/her feet in order to modify a project as new data become available during its course, is most valuable since it must be made perfectly clear that a planned schedule must not "lock up" the process of getting from A to B. The detailed planning of a process must only aim to provide general guidance for the project and to insure that it is open to modification as new data become known. At the same time allowance must be made for experimentation with different processes during the performance of a project in order to deal more cost effectively with situations as they arise.

Once the details of a project plan are worked out it is time for the manager to build communication devices. At this point it should be made clear that detailed planning schedules are for the eyes of the "in-house" staff only. It is wise not to offer too many targets for the reluctant customer or too many details of a project to the questioning reviewer. This does not mean that this information is confidential but that it is the background data that will be used by the manager in negotiations.

A general overall bar chart that illustrates the sequence
of events and the major "milestones" as in Figure 19 should be sufficient to make the potential customer understand that you have a grasp of the project requirements and can effectively follow through to completion.

A flow chart can be used to communicate the status of the project at regular intervals to the customer, supervisor or workers. This will include information on percent completion and any slips caused by unforeseen circumstances. Figure 22 shows such a flow chart of a project in progress.

Is There A Future For P.A.S.T.?

The question posed in the title of this paper asks whether such a system of management is valuable to the archaeologist on a day-to-day basis for projects in a full range of sizes. After some experience with this and other techniques, both in and out of archaeology, it is clear to me that such methods may be useful in certain circumstances. The first requirement is the availability of enough time in the initial stages of a project to apply the formal planning process. In many projects such time is lacking. Another requirement is the availability of enough time to keep the reporting mechanisms up to date. This implies a close communication between the workers and the manager, a circumstance not always feasible when field crews are widely dispersed, but nonetheless necessary. If the method is not used throughout the project, I strongly believe that it has a future in project planning, at least, in that it forces the planner to visualize all the steps in a project and organize them in the most efficient manner.
For this reason, if for no other, I believe that there is a future for P.A.S.T.
The application of management aids, such as PERT and GERT, to archaeological research depends upon the availability of specific kinds of information that will enable accurate predictions to be made about the occurrence and duration of various activities throughout project execution. Admittedly, this information may take the form of probability distributions; but, in comparison to the customary amount of information known about archaeological research activities, the requirements of these management tools are indeed formidable. While one can despair over this situation and advise continued dependence upon intuitive approaches to archaeological project design and management, there is some cause for optimism -- at least over the long haul. If we begin to systematize the knowledge about the design and execution of field projects as it accumulates, then perhaps in the not-too-distant future a basis will be laid for rigorous employment of formal management techniques. At the very least, we shall be in the position, finally, of asking penetrating questions about the relationship between specific research goals and the activities we carry out to reach them. At the present time there is ample reason to believe that we know precious little about these relationships.

In this contribution I would like to begin the process of dissecting research designs -- i.e. project plans -- into their component activities, goals, and the relationships among them. As an example I have chosen to deal with a particular kind of survey
project that is frequently encountered in a cultural resource management context: the large scale (i.e. greater than 100-square-mile study area) sampling survey conducted (usually) by federal agencies to begin the process of complying with the provisions of the Executive Order 11593. I have focused my attention on this type of study because of the rather substantial shortcomings that are becoming painfully evident in their design. Increasingly, similar ventures, or mega-surveys, are being carried out in other countries for both management and purely research purposes. Thus the present exercise has somewhat more than academic implications. In the thumbnail sketch that follows, references have been kept to a minimum. A more developed version of the mega-survey (Schiffer n.d.) will acknowledge more explicitly my debts to other researchers, particularly those in conservation archaeology.

The mega-survey strives to achieve several widely agreed-upon goals deriving from legal requirements and the framework of archaeology (adapted from Vivian et al. 1977): (1) provision of information on the kinds of resources present (both rare and abundant types) and their relative frequencies, densities, and distributions, (2) determination of recent and ongoing destructive processes affecting the resource base, (3) assessment of resource significance, with special reference to National Register criteria, (4) formulation of management recommendations, and (5) formulation of research recommendations. Although it has often been assumed that a 10% stratified random sample of the study area will supply information adequate for reaching these goals, nothing could be further from the truth. The process of research design is a bit more complex. In far too many instances single-stage projects using only probabilistic techniques have been
unsuccessful in meeting their goals because the designers have failed to consider the relationship between research activities and project goals. In fact, it is not unfair to point out that the process of research design has been avoided entirely in these cases by ritualistic applications of cookbook approaches. It is no surprise that many of these studies have come up with little more than quicky culturehistories and a catalog of useless site descriptions. Research design is a rather difficult activity in science, perhaps the most difficult, and it cannot be taken so lightly in cultural resource management studies. Despite much propaganda proclaiming the utility of probabilistic sampling techniques as discovery procedures, the evidence shows clearly that for discovery, nonprobabilistic techniques are far more productive and efficient. For parameter estimation, however, particularly of frequently occurring population elements, probabilistic techniques are indispensible. Because the mega-survey must be concerned with both discovery and estimation of rare and abundant elements, a creative interplay of probabilistic and nonprobabilistic techniques in a multistage design is the only recourse for doing an adequate job.

Let us now turn to a more detailed consideration of how these goals may be met in a flexible multistage design. Throughout the presentation I will be concerned particularly to show how research activities produce information that governs the selection of subsequent research activities. These bits of crucial information are termed intermediate goals. The mega-survey design is divided up into 3 principal stages: background studies, reconnaissance, and intensive survey. The latter stage, in turn, consists of 3 substages.
Stage 1 -- project initiation and background studies

Although in archaeology we are frequently wont to use the phrase "unknown area," in no situation can this be true literally. Regardless of how remote the study area is or how uncommon have been visits by archaeologists, some information of value for designing research can be gleaned from available sources. The goals one is striving to achieve in this stage are a general grasp of the conditions under which archaeological survey will have to be carried out and a provisional statement of research problems. These kinds of information, obtained from searches of areal and topical archaeological literature, ethnographies, site records, historical records, government documents and maps, and consultation with archaeologists and other experts on the study area, will permit at the end of stage 1 the formulation of a detailed work plan for stage 2 and the initial design for the remainder of the project. The latter plan is revised throughout the project's duration as information comes in. It is also responsive to the need for integrating research and management interests.

Stage 2 -- reconnaissance

Although reconnaissance is usually carried out on a fairly casual basis during many surveys it can, if designed carefully, make the difference between modest success and conspicuous failure in the mega-survey. Several important intermediate goals lie at the heart of stage 2 which permit the effective design of more intensive survey efforts. These include: statement of ethno-archaeological research potential, statement of historic sites research potential, provisional enumeration of rare types of sites and
other resources, statement of preservation and destructive processes, delineation of environmental and topographic zones, specification of eroded, colluviated and alluviated surfaces, designation of visibility and accessibility factors relative to pedestrian survey tactics (including land-holding patterns), tentative listing of the range of resources, site types, and artifact varieties, identification of the nature and extent of nonsite resources, and provisional estimates of site density and distribution factors. These lines of information are obtained by the judicious application of the following research procedures: conversations with and observations of residents and users of the study area, interviews with collectors and specialist researchers (geologists, historians, even speleologists), documentary research, recording of extant artifact collections, acquisition and analysis of remote sensing, geomorphological and environmental data, and conduct of a random walk or other low coverage survey. In turn these intermediate research results form the basis for 4 additional general research activities that lead to a detailed work plan for stage 3 and a revised general research design: delineation of strata on the basis of resource zones, topography, geological deposition and erosion, and zones of visibility and accessibility; specification and pilot testing of survey techniques appropriate for each stratum; and construction and pilot testing of site and collection recording procedures; and reformulation of research questions and relevant data specifications.

At this point some archaeologists might feel that the implementation of intensive survey techniques has been delayed unnecessarily by the preliminary stages outlined above. I contend, however, that
these stages provide the only sound basis for systematically designing a mega-survey. Without this degree of preparation and familiarization with the resource base, the investigator is liable to encounter too many surprises in the field long after it is possible to modify the basic survey strategy. For example, the present approach allows one to determine an adequate sample size using preliminary estimates of the actual parameters of the resource base. One needs to find out before, not after, completing a survey that 50 square miles must be intensively covered rather than the 10 that were allotted. As another example, one needs to know beforehand that 80% of the study area is in impenetrable hardwood forest or buried under recent alluvium in order to make intelligent decisions about investing effort in covering those areas and experimenting with newer and more appropriate techniques for finding sites under these adverse conditions. In addition it is sometimes possible to find local collectors who have amassed a vast amount of useful information that can be drawn upon at an early stage. In my opinion, we should resist the urge to commit ourselves to a particular intensive survey strategy until a great deal has been learned about the parameters of the resource base, the environment, and survey conditions; such information is obtainable only by efficiently designed and executed early stages.

Stage 3 -- Intensive survey

At this point the archeologist is at last ready to begin acquiring data from intensive survey activities. A finely honed research design with detailed data specifications and tested recording forms is in hand; high-resolution information on the conditions of surveying and logistics is available: strata have been laid out with
respect to relevant environmental and technical criteria; and
cogent research questions have been isolated and refined. The
choice of appropriate survey techniques is sensitive to a wide
range of factors relating to the resources, survey conditions, and
research questions. Space does not permit detailed treatment of these
relationships (see Plog, Wait and Plog n.d.). Beyond these
considerations, recent work has shown that it is unwise to treat
the resource base as an undifferentiated whole to which one particular
technique is applied uniformly. Instead, specific techniques are
adapted to estimating particular segments of the resource base,
survey conditions permitting. For example, it is not cost-effective
to survey large tracts of land at one-meter intervals to insure
discovery of the entire range of site types, including isolated
artifacts. The latter portion of the resource base can be
estimated using a relatively small sample, and less intensive techniques
can be used for the rest. On the other hand, large, infrequent site
types will be poorly represented in the usual probabilistic sampling
survey which is far more appropriate for estimating the most
frequently occurring site types. In view of these considerations,
it is best to employ a mixed or multiple-technique survey strategy
(Doelle 1977). It is also necessary to apply and/or develop
specialized techniques for discovering sites in situations of poor
visibility and accessibility. And finally, testing should be
used to identify areas of research potential and to help refine
the inferences that have been made about site contents from surface
materials during surveys.

Stage 3 can begin, then, with the use of specialized techniques
for site discovery in low visibility areas and the use of pedestrian tactics within a probabilistic framework in high visibility areas. The choice of the particular probabilistic technique, unit size, shape and number, and other specifics will depend closely upon information obtained in stage 2 about site variability, density and distribution characteristics, as well as logistic factors. This intensive survey data will be most useful in estimating the parameters of the most frequently occurring site types. Also in early stage 3 work, ethnoarchaeological studies of land use and ongoing destructive processes may take place, as will historic research, the recording of extant collections, and the interviewing of informants and collectors. The second part of stage 3 involves the beginning of testing activities and the initiation of varied survey techniques for finding rare types of sites, especially quarries, workshops, shrines, rockshelters, etc., whose locations can sometimes be predicted on the basis of environmental, ethnoarchaeological, ethnographic, or remote sensing data. The third and final substage involves additional testing and nonprobabilistic survey of high density areas to find additional rare types of sites and to increase the sample size of specific kinds of sites as needed for analysis relative to research questions. Nonsite survey (closely spaced pedestrian tactic) is also carried out, perhaps within the same strata as the probabilistic work, but at a much reduced coverage. And finally, it may be desirable to apply a very low intensity, large coverage treatment to increase the sample size of the larger sites. This would usually be required to permit accurate estimates to be made of the population parameters of those rare elements.
(particularly necessary for National Register determinations), rather than mere discovery (which is more efficiently conducted with purpose, nonprobabilistic techniques).

Analyses of the data obtained by this battery of diverse techniques will permit the overall research goals to be achieved to an appreciable extent. Resource estimates, although often based on impressively small sample fractions (1%), may be surprisingly accurate because of the extensive amount of stratification employed and the constant interplay of probabilistic and nonprobabilistic techniques. Assessments of significance will be drawn from broad familiarity with the resource base gained from probing the research potential from many points of view. Factors affecting the condition of the resources will be identified to a large extent. Research and management recommendations will rest on an unusually diverse, comprehensive, and firm data base. And finally, it will be no accident that the mega-survey results in an impressive increase in our knowledge of study area.

Obviously the present discussion is not intended to substitute for a project-specific research design. In fact, the plan for a mega-survey is completely devoid of resource-specific considerations -- as it must be to remain truly general. Because it deals only with the acquisition of minimal-level management information it must also be modified to meet the needs of the local research context, especially as the latter changes during the course of the project.

The plan for a mega-survey as presented above may come as a rude awakening to the many archaeo-bureaucrats who have just discovered probabilistic sampling and give Binford's (1964) seminal article on survey design a cursory reading. Since that paper was written,
alerting archaeologists to just some of the factors involved in designing regional studies, over a decade of experimentation has led to the appreciation of an even greater number of difficulties attending the design of mega-surveys, particularly the need for creative application in a multistage framework of probabilistic and nonprobabilistic techniques. It seems that a flexible, integrated approach to research design is required to produce the high quality of information needed for compliance with cultural resource management legislation.

Quite clearly, if we are ever to apply formal management techniques to our projects we must first be able to refine our research designs to a much greater degree than is now customary -- or perhaps even possible with present knowledge. It seems fruitful, however, to conceptualize the process of research as involving a series of activities related to one another by intermediate goals, the achievement of which lead to better-informed decisions on the choice of subsequent activities. Viewed in this way, the basic unpredictability of scientific studies is acknowledged but, at the same time, one is consciously striving to minimize the occurrence in the field of unpleasant surprises that can be avoided by proper planning. Hopefully this all-too-brief discussion will call attention to weaknesses in present unidimensional approaches to mega-survey design and will pave the way for eventual employment of formal management techniques in archaeological research.

Note: a tentative flow chart depicting a multi-stage mega-survey was produced during the workshop and appears as Figure 25.
References Cited

Binford, Lewis R.


Doelle, William H.


Plog, Stephen, Walter Wait, and Fred Plog


Schiffer, Michael B.


Vivian, R. Gwinn, Keith Anderson, Hester Davis, Rob Edwards, Michael B. Schiffer, Stanley South

STAGE 1 PROJECT INITIATION AND BACKGROUND STUDIES

SEARCH METHODOLOGY LITERATURE

SEARCH AREA LITERATURE

COMPILE SITE RECORDS

CONSULT ARCHAEOLOGISTS WITH LOCAL EXPERTISE

SEARCH HISTORICAL RECORDS

NEGOTIATE CONTRACT

SEARCH PREVIOUS RESEARCH QUESTIONS

STATEMENT OF PREVIOUS INFORMATION NEEDS

INTEGRATE MANAGEMENT AND RESEARCH

STATEMENT OF INFORMATION NEEDS

STAGE 2 RECONNAISSANCE

STATEMENT OF RESEARCH POTENTIAL

TALK TO RESIDENTS OF STUDY AREA AND OTHER INFORMANTS

TALK TO COLLECTORS AND RECORD COLLECTION DATA

STATEMENT OF POTENTIAL STUDIES

SEARCH AND ANALYZE MAP AND REMOTE SENSORING DATA

STATEMENT OF CHANGES AND ACCESSIBILITY

SEARCH PREVIOUS RESEARCH QUESTIONS AND RELATED INFORMATION

SEARCH FOR RARE TYPES OF SITES

STATEMENT OF RANGE OF SITE TYPES

STATEMENT OF POTENTIAL SITE DENSITY

STATEMENT OF SITE DISTRIBUTION

DELINEATE STRATA, RESOURCES, TOPOGRAPHY, VISIBILITY

DEVISE SITE AND COLLECTION RECORD PROCEDURES

IDENTIFY APPROPRIATE SURVEY TECHNIQUES

REFORMULATE RESEARCH QUESTIONS AND RELEVANT INFORMATION

STATEMENT OF ETHNO-ARCHAEOLOGICAL RESEARCH POTENTIAL

SPECIFY TECHNIQUES FOR SURVEY IN LOW VISIBILITY AREAS

BEGIN TESTING

DO NON-PROBABILISTIC SURVEY OF HIGH DENSITY AREAS

FINISH HISTORIC RESEARCH

BEGIN TESTING

DO NON-SITE SURVEY

DO LOW INTENSITY SURVEY FOR LARGER SITES

CONTINUE TESTING

FINISH HISTORIC RESEARCH

FINISH RECORDINGS OF EXTRACT COLLECTIONS

END SURVEY FOR RARE SITES

DO NON-PROBABILISTIC SURVEY OF HIGH DENSITY AREAS

ANALYZE AND INTERPRET RESULTS

STAGE 3 INTENSIVE SURVEY

CONSULT WORKSHOP WITH LOCAL EXPERTISE

STATEMENT OF ETHNO-ARCHAEOLOGICAL RESEARCH POTENTIAL

SPECIFY TECHNIQUES FOR SURVEY IN LOW VISIBILITY AREAS

BEGIN TESTING

DO NON-PROBABILISTIC SURVEY OF HIGH DENSITY AREAS

FINISH HISTORIC RESEARCH

BEGIN TESTING

DO NON-SITE SURVEY

DO LOW INTENSITY SURVEY FOR LARGER SITES

CONTINUE TESTING

FINISH HISTORIC RESEARCH

FINISH RECORDINGS OF EXTRACT COLLECTIONS

END SURVEY FOR RARE SITES

ANALYZE AND INTERPRET RESULTS

GENERAL STRUCTURE FOR A CULTURAL RESOURCE MANAGEMENT MULTI-STAGE MEGA-SURVEY

DEVELOPED DURING THE WORKSHOP BY MICHAEL B. SCHIFFER
ASPECTS OF ARCHAEOLOGICAL RESOURCE MANAGEMENT:
A SUMMARY STATEMENT

Donald K. Grayson

The management of archaeological resources involves non-archaeological supervisory personnel in various government agencies, agency archaeologists, and non-agency archaeological consultants of various sorts. In this discussion, I am going to focus on three aspects of the cultural resource management tasks which these individuals perform. First, I am going to outline some relationships among agency archaeologists, their non-archaeological supervisors, and outside archaeologists which may interfere with the ability of agency archaeologists to elicit acceptable archaeological research. Second, I am going to briefly examine difficulties with federal requests for proposals. Third, I am going to explore various management techniques which have the potential of playing a role in the construction of archaeological research programs.

Working Relationships

Agency archaeologists are uniformly bound into a web of relationships which tie them to their non-archaeological supervisors on the one hand, and numerous non-agency archaeologists on the other. These relationships exert differential pressures on the agency archaeologist because all three sets of individuals hold different conceptions as to precisely what kinds of data are required to meet management objectives.

140
Supervisory personnel usually conceptualize the required data as a simple list of sites within the project area coupled with associated levels of significance of those sites. In addition, these personnel are, of course, interested in the most efficient—cheapest and quickest—means of compiling such a list. From the point of view of the professional archaeologist, such a conceptualization is extremely unrealistic, since the resultant temporal and monetary restraints often render regional approaches to archaeological data recovery and analysis impossible.

The agency archaeologist, on the other hand, needs to satisfy several sets of demands. From the archaeological point of view, this individual needs to educate his supervisors and co-workers to archaeological processes and the requirements of cultural resource management mandates. He is also required to translate managerial needs into specific research objectives, and is expected by the agency to deliver archaeological work which not only meets managerial needs, but which is also found acceptable by the archaeological community. In addition, the agency archaeologist is usually under tremendous peer, and often self, pressure to encourage archaeological projects whose goals and results are those of modern scientific archaeology. While the job of the agency archaeologist is not to deliver good archaeology, but to cause good archaeology to be delivered, the supervisory setting often defines "good archaeology" as site lists, and does not provide resources sufficient for the execution of scientific archaeological programs.

These needs and conflicts are manifest in various ways, often including requests for proposals (RFP's). In these requests, the
agency archaeologist frequently attempts to satisfy peer and personal pressure by writing a technical scope of work that at times could provide a framework for acceptable scientific archaeological research. Typically, however, the time and money provided for the requested work are appropriate only to the requirements of the non-archaeological supervisor. Since the RFP represents a crucial point of articulation between agency archaeological programs and non-agency archaeological contracts, it is appropriate to examine some characteristic problems associated with these requests.

Requests for Proposals

The RFP procedure is an important one, since it is the receipt of an RFP which leads to the application to conduct federal archaeological contract work. Unfortunately, there is widespread dissatisfaction in the archaeological community with RFP's issued by federal agencies. I am not going to review the entire RFP procedure here. However, I am going to examine one RFP in some detail in order to point out some problems which I feel characterize RFP's in general.

I have chosen to briefly examine the Radium Springs Archaeological Survey RFP (Appendix B), issued by the Denver Federal Center of the Bureau of Land Management (BLM), since this request embodies difficulties contain in many such documents. I underline the fact that I do not feel that this RFP is particularly bad, but am examining it instead because in many ways it seems characteristic of RFP's as a whole.

The Radium Springs RFP (YA-512-RFP6-80) was issued in 1976 to solicit proposals for an archaeological survey of approximately
320 square miles south-south-east of Truth or Consequences, New Mexico prior to leasing for geothermal development. The general goals for this work as stated in the RFP clearly reflect the varied demands on agencies and archaeologists outlined above. According to the RFP, the requested work must provide archaeological data which will be used:

1. for the Radium Springs Geothermal Environmental Analysis Record (EAR);
2. in the development of Unit Resource Analyses (URA's), Management Framework Plan (MFP's), and other management documents;
3. to bring the BLM into compliance with Executive Order 11593, Section 2;
4. in conjunction with previously existing models which will allow the prediction of site location; and,
5. to increase understanding of prehistoric lifeways in this part of the American Southwest.

Goals 1 through 3 are clearly primarily agency goals: EAR's, URA's and MFP's are internal documents produced and used by the BLM during the normal course of activities, while BLM compliance with Executive Order 11593 is, of course, a federal requirement. Goals 4 and 5 are hybrids. The BLM would certainly benefit from an accurate predictive site location model, and meeting this objective can thus be seen as an accomplishment which might be of value in making management decisions. On the other hand, the possession of such a model would not circumvent the need for the archaeological surveys required by 36 CFR Part 800. As a result, the successful construction of such a predictive model would be of greater interest to research
archaeologists than it would be to the BLM insofar as federal antiquities requirements are concerned. Goal 5, involving cultural reconstruction, is even further outside normal BLM archaeological data needs, given that this goal goes beyond the predictive locational model specified by objective 4. While increased understanding of prehistoric lifeways might be of general interest to some BLM managers, such data are certainly not required by them to meet cultural resource management commitments. Goals 4 and especially 5, then, seem primarily generated by the agency archaeologist, not by federal mandates which the BLM must follow.

The Radium Springs RFP is very explicit in how these goals are to be met. The survey is to "provide a statistically valid estimate of archaeological site densities in various geographical zones within the subject area, and as much useful data as possible on any sites located. This shall be accomplished by sampling and intensively surveying portions of the subject area. In addition, it is expected that the contractor will collect a relatively large and accurate amount of archaeological data in the field from specific sites."

How these objectives are to be met is not a matter of choice on the part of the archaeologist doing the survey. That person is to draw a 10% sample (32 square miles) of the study area using a stratified random sampling design. This design is to be applied only to federal lands within the area, not to privately owned lands. And, it is required that the "stratification scheme" shall be designed to have regional applicability throughout southern New Mexico."

There can be no doubt that such an RFP would elicit many proposals, and that the field routine required by the RFP would be completed.
However, I strongly doubt that the finished product would meet all of the goals stated by the request. Two of the more obvious difficulties may be briefly examined:

1. Sample size. The RFP requires a 10% sample size, but nowhere provides the rationale for such a sample. While the prime objective of the study is stated as being "to provide a statistically valid estimate of archaeological site densities", the RFP allows no consideration of whether or not a 10% sample is adequate to meet this objective. Depending upon site distribution and regional environmental complexity, such a sample size may be greater than is required, or may be grossly inadequate. The archaeologists submitting proposals under this RFP are allowed no leeway in choice of a sample size. Because there is little reason to believe that a 10% sample will be appropriate, it would seem that the project is doomed from the outset.

2. Regional applicability. The RFP requires that the "stratification scheme" employed have regional applicability throughout southern New Mexico. Yet, there is no consideration of the fact that the environments represented in the study area may differ greatly from those of the rest of southern New Mexico and that the stratification scheme employed may, therefore, have no applicability to areas far removed from the study area. To take a single example, the study area itself consists of both federal and private lands. It is reasonable to suggest that the privately owned lands differ in some important environmental ways from public ones, probably because of economic considerations. If that is so, it is likely that the
federal lands to be surveyed within the study area will not be representative of the area as a whole, and that the stratification scheme derived in the RFP will not even be applicable to the private lands immediately adjacent to the surveyed properties. How, then, could the sampling design possibly be applicable to all of southern New Mexico?

These two problems are only some of those which characterize the Radium Springs RFP. Others could be mentioned. For instance, the RFP requires a stratified random sample, yet the reason for requiring this approach is not given, and the required sampling scheme is nowhere articulated with the request's objectives. Also, no provision is made for the fact that random sampling approaches may not be appropriate for the location of extremely rare cultural manifestations. Finally, the time frame provided by this RFP is typical of many such requests. Received by potential applicants in mid-August of 1976, the final report on the project was to be due on December 31 of that year. Four months were to be allowed to write the proposal, receive the contract, conduct the field work and analyses, and write the final report.

The Radium Springs RFP is not bad as RFP's go: many much more poorly conceived RFP's could be cited (for instance, a classic example is provided by RFP DACW57-77-R-0188, "Archaeological salvage excavations at 45SA11, North Bonneville, Skamania County Washington", issued by the Portland District, U.S. Army Corps of Engineers). That is part of the problem. It is my suspicion that at least some of the flaws present in such poorly written requests are due to the conflicting demands placed upon agency archaeologist by his supervisor and by the expectations of outside archaeologists. Fortunately, there would seem to be some simple steps which could be taken to improve this particular document
which would reconcile these differing expectations. Given that RFP's are meant to bring in a number of proposals to meet a certain set of stated goals, from which the best proposal is to be chosen, it would seem that the Radium Springs RFP could have been improved by:

1. Providing a more reasonable set of objectives. For instance, while it is reasonable to expect a "statistically valid estimate" of archaeological site densities within a given project area, it is not reasonable to expect a sampling scheme applicable to one area (the project area) to be automatically applicable to another (southern New Mexico). Before the Radium Springs RFP could be counted as a good one, the stated objectives would have to be rewritten so as to make them obtainable ones.

2. Allowing the submitting archaeologists latitude in research design. If one goal of the RFP is to obtain the best possible product, it would follow that the archaeologists who are submitting proposals should be allowed free rein in building research designs meant to meet RFP requirements. In the Radium Springs instance, this could be accomplished simply by stating the primary objective ("to provide a statistically valid estimate of archaeological site densities"), and allowing those submitting proposals to determine how best to meet this objective. This approach would elicit a varied set of research designs from which the best could be chosen. To proceed in any other fashion would seem to negate a major advantage of the RFP process.

Requests for proposals which are much weaker than the Radium Springs RFP could readily be cited. All of those who have done archaeological
contract work are familiar with many poorly conceived and poorly written proposal requests. The problem seems to be a general one. I have outlined some ways in which one specific RFP might be improved; I believe these suggestions to be generally applicable to many RFP's. I also believe that archaeologists have been remiss in their responses to poorly written proposal requests. Most of us either ignore them or attempt to work within their bounds. Both approaches are poor since neither will lead to a change in RFP quality. This is true especially since in most parts of the country some archaeologist can always be found who will attempt to meet the goals of even the most absurd RFP.

Rather than ignoring poorly written RFP's, or attempting to operate within their bounds, it would be more profitable to write critiques of the RFP itself and provide them to the issuing agency. The archaeologist involved might sacrifice the opportunity to work on a poorly conceived project, but in the long run improved RFP's, and therefore improved archaeology, will result. A second step may also be taken with inadequate RFP's. When an RFP is received with stipulations which are not appropriate for the project's objectives, or with inappropriate objectives themselves, multi-level proposals may be submitted, each level keyed to different levels of funding and delivery schedules, including explicit statements on precisely how each different level will allow a closer approximation to the goals specified for the project. Not only does this approach help to develop better RFP's, but the product produced by the researchers themselves cannot be questioned as long as the report produced is commensurate with the specific level of research chosen from a series of research designs by the funding agency. Finally, in instances in which the RFP would not appear to allow compliance with the National Historic Preservation Act of 1966
(Public Law 89-665) and associated procedures, appeal may always be made to the SHPO. If the SHPO agrees that the work requested under the RFP will not allow compliance with federal cultural resource management procedures, he will initiate formal contact with the issuing agency to insure that such compliance is forthcoming.

Management Systems

Assuming adequate requests for proposals, it is possible to turn to the discussion of management systems. It is, of course, clear that meeting the management objectives requires archaeological research, and it is reasonable to suggest that the conduct of this research could be improved by the application of various management tools. Systematic management techniques can provide many benefits. Such techniques can:

1. assist in visualizing variables and their relationships in any given archaeological research program;
2. provide a means of integrating method, theory, and technique—that is, of operationalizing research design;
3. provide a structure whereby an adequate estimate of the time and money required to complete a research project can be made;
4. avoid surprises in budgeting of time and money as well as those which might otherwise occur during the actual execution of the project;
5. allow ready manipulation of otherwise intractable scheduling problems;
6. provide an excellent means of insuring continuity of the project regardless of changes of personnel at even the highest level;
7. permit increased communication between all levels and all participants in archaeological research; and,
8. permit the wise, cost-effective use of public funds in historic preservation.

We can be certain that management techniques are appropriate to archaeological problems for the simple reason that we all use them at least implicitly. The challenge, therefore, becomes making effective and explicit use of appropriate management systems.

There are many management systems which can be used in an archaeological context. These differ in numerous ways. They differ, for instance, in terms of efficiency of communication, cost of execution, information required for successful application, precision, explicitness of display of the structure of component variables, and ability to incorporate probabilistic decisions. Representative techniques include flow charts, bar charts, and networking (for instance, Project Evaluation and Review Technique or PERT, and Graphic Evaluation and Review Technique, or GERT).

We have evaluated one of these techniques--PERT--in detail as to its potential for contributing to the management of archaeological research programs. PERT proceeds by breaking down a given archaeological project into the activities and units of which it is composed. These activities and other units are then charted according to their structural relationships, and time values assigned to each component. From the time assignments and their relationships, the duration of the project is estimated. PERT has two notable benefits. The first of these results from the fact that PERT has as a prime goal the discovery of the critical path of a project--the path connecting activities which are critical in determining the total duration of
the project. Because the critical path determines project duration, critical path definition provides a clear view of ways in which projects may be reorganized so as to reduce their length. For complex projects in which the interrelationships of all activities and events are not readily visible, PERT provides an excellent means of attaining an efficient project structure.

Second, assuming adequate data on the timing of activities, PERT also allows the calculation of the variance of the time required for the execution of each activity within the project, and of the project duration as a whole. Knowledge of such variances would be extremely helpful in managing archaeological projects, for they would provide a means of dealing with the vagaries involved with the timing of events in archaeological research projects.

Clearly, PERT has the potential of adding a significant dimension to the management of archaeological research programs. However, our analysis of PERT suggests this technique to be cumbersome and time-consuming in the archaeological setting. We do not know the conditions under which the use of PERT would be cost-effective in archaeology. Also, the implementation of this technique requires a great body of accurate, quantitative data on the timing of archaeological procedures. The technique rapidly loses its unique values as the accuracy and availability of such data decreases. Unfortunately, such data are rarely available. For example, PERT might require that we be able to reasonably estimate the time required to survey a given unit of space, to excavate a given volume of soil, to conduct a use wear analysis, to analyze a body of faunal remains, to construct a subsistence-
settlement system model, or to write up such analyses.

Even though it does not seem possible to meaningfully apply systems such as PERT or GERT to archaeological research projects at the current time, a major benefit of an attempt to apply PERT analysis is the documentation of our lack of knowledge of the duration of specific archaeological activities. Whether or not we use PERT or a similar technique, archaeologists are often called upon to make at least implicit estimates of the probable length of future archaeological activities, and particularly of the overall duration of any given archaeological project. Careful monitoring of our projects will begin to provide such data; as this occurs, we will be able to make use of the predictive powers of PERT and similar techniques. Not until such time will it be possible to realistically evaluate the cost-effectiveness of such approaches in the archaeological setting.

We also evaluated the use of techniques simpler than those represented by PERT and GERT. Such simpler techniques include Management by Objectives (MBO) and the use of bar and flow charts. All of these approaches have the advantage that they display in discrete fashion the separate activities which together compose a research project. In the long run, all make similar demands on our knowledge concerning the duration of archaeological activities, knowledge which is simply not ordinarily available. These simpler techniques, especially the use of bar and flow charts, give a less effective indication of where the project is going, but they do provide a less complex means of communication than is provided by such techniques as PERT and GERT. Like PERT and GERT, however, these
approaches demand data which archaeologists simply do not have if they are to be used to full advantage.

Summary and Conclusions

It is clear that systematic management techniques have application in the archaeological setting, both in routine cultural resource management programs and in the manipulation of large and complex research programs. It is also clear that the most useful of these approaches, as exemplified by PERT and GERT, make demands on our knowledge concerning the duration of archaeological activities which we cannot yet meet. While simpler approaches make correspondingly simpler demands on our knowledge, they nonetheless demand the same kinds of unavailable data. The time is not yet ripe for the full application of systematic management techniques to archaeological programs. However, the attempt to apply such techniques makes it very clear that it is essential that we begin to gather data on the duration of archaeological activities if we are to become fully efficient in managing our activities.

It is also evident that major problems exist in the writing of requests for proposals by federal agencies. These problems seem, in part, to result from conflicting relationships between federal agency archaeologists, their non-archaeological supervisors, and their archaeological peers outside the federal government. I have discussed two major difficulties associated with RFP's, although others certainly exist. First, the project objectives specified by RFP's are often unattainable within the time and funding constraints of the request. Second, RFP's frequently do not allow contractors sufficient latitude
in constructing research designs. All too often, RFP's contain weak research designs which must be implemented by contractors. Not only does such an approach discourage more innovative and more exacting archaeologists from applying for such projects, but this approach must also result in poor project results. Steps toward remedying these problems must be initiated both within the issuing agencies and by contracting archaeologists. They include the incorporation of attainable project objectives with the RFP, allowing latitude in the construction of research designs by contractors, and constructive criticism of RFP's by potential applicants.

Acknowledgments

This paper represents a summary of ideas resulting from discussions which took place during the workshop. In particular, Albert A. Dekin, Jr., Michael Roberts, and Michael B. Schiffer assisted in preparing a draft of this paper. I am most grateful to William J. Mayer-Oakes for organizing the workshop, and for inviting my participation.
PART FOUR

CONCLUSIONS
SUMMARY

The afternoon of the third day was devoted to summary statements and assessments of the workshop by the participants. They agreed that management techniques were especially helpful in the planning stages and the understanding of the "big picture" of a project. They also concluded that care must be taken to use these techniques appropriately. Wagner made additional comments and suggestions. Portnoy presented a quickly prepared summary of the workshop itself and its content. This presentation appears below.

The reader of this Report is referred at this point to Figure 1 in the Preface -- The Workshop Ingredients, Activities and Results.
ANALYSIS

This is an attempt by a cultural anthropologist who is a workshop participant to provide a short summary and objective assessment of this Management Techniques Applied to Archeology Workshop. A cultural anthropologist might summarize the workshop by analyzing it as she would any similar event such as a storytelling gathering, a legal trial, or a political assembly. There are two main components of such events: 1) a body of oral narrative from the event, only fragments of which are usually recorded and 2) the event itself, including the people involved and their relationships, the transactions that took place and the context, for example, location, season, time and other associated events.

The cultural anthropologist usually has at least two major objectives in her study of both the body of narrative and the event itself: finding their meaning and finding their significance. Most simply, meaning here refers to the information content, significance to whatever importance that information has. In this case, the anthropologist has also been asked to assess or find value for the body of narrative and the event or at least to suggest ways in which the participants themselves can make evaluations.

The cultural anthropologist can choose any of a number of approaches to analyze her subjects. One traditional approach to the search for meaning is the identification of recurrent themes. Another approach, most often used in structural analyses as
developed by Claude Levi-Strauss, is the identification of binary oppositions. The occurrences of resolutions or mediations of these oppositions give clues to significance. A traditional approach in seeking significance is to describe the relationships of the narrative and the event to their context. These approaches represent the operations which will be used in this attempt in achieving the objectives of finding meaning and significance.

The cultural anthropologist will try to evaluate and assess the workshop by asking "how well did we do whatever we wanted to do?" and "what will be the probable results of the workshop?"

To identify recurrent themes in our search for meaning, we look for redundancies in the narrative. Topics which came up over and over again in presentations and discussions included 1) everyone's implicit use of management techniques, 2) RFP's and the problems they present and how we deal with these problems, 3) "deliverables", 4) the need for some kind of peer review in many areas, stages, and levels, 5) professional ethics, 6) archeological research designs: who should do them, when, how good they are, 7) overall objectives in terms of value to the public for their costs, 8) the necessity for appropriate and flexible use of management techniques.

Another way to discover meaning is to find and list terms that were used as binary oppositions during the workshop. They included: implicit/explicit, planning/control, agency archeologist/non-agency archeologist, managers/professionals, efficient and effective management/good archeology, small and simple projects/large and complex projects, research/management, uncertainties of research/adequate data for management, academic archeology/contract
or CRM archeology, pure science/applied science, professional/technical, realistic/idealistic, scholarship/business, formal/informal, scientific archeology/traditional archeology, structured/unstructured.

One way of finding significance is to see if any particular ideas or terms can be used to resolve the oppositions. Management techniques, referred to below as "MT", were found to be capable of this in many cases. They are described below.

MT can help make explicit what we have been doing implicitly. Understanding of MT by those doing the work (the whole archeological team including the principal investigator) helps them plan and control their own work. To accomplish this MT should be used 1) as early as possible, preferably before any commitment, 2) in greater detail after commitment, 3) to control sequence of operations after startup, 4) as an early warning system. MT can provide for communication between agency and nonagency archeologists. MT can do the same for managers and professionals. MT can make archeological projects more efficient and effective and therefore better archeology.

MT will vary according to size and complexity of project. They are tools which must be flexible and offer alternatives and adaptations. MT can help accomplish research: as tasks become more visible they become more likely candidates for innovation and experimentation, e.g. in survey techniques. MT show how resources can best be deployed to accomplish research goals; do-loops can be added as resources and constraints permit. MT can expose inadequacies of data and areas of uncertainty and suggest how to cope with them. Projects to which MT have been applied may enlarge the data base for other projects.
Significance is also found by describing relationships of narrative and event to context. It was suggested that workshop participants ask the following questions: how can we best use what we've done here? what kind of report will be most useful? what will the NPS and IAS and Rex Wilson get out of it? what will the public get out of it (ultimately)? what will cultural resource managers including professional archeologists get out of it? what will other (including "traditional") archeologists get out of it?

After attempting to ascribe meaning and significance to the workshop by the above analysis, the cultural anthropologist suggested that workshop participants try to evaluate and assess the workshop by looking at the following: 1) stated objectives as in the workshop proposal, 2) other objectives developed during the workshop, e.g. to broaden it to overall discussion of CRM; to record this discussion, 3) how well our operations satisfied our objectives, 4) what we are going to do with all we've learned and discussed here (indicated in presentations by the four visitors), 5) the underlying structure of the workshop itself in terms of management and control (basic framework, then self-regulating), 6) effective use of expert consultants in MT.

This summary has been kept close to its original form as a quickly prepared oral presentation at the end of the workshop. The author feels that by doing so she is preserving the flavor of the workshop, which she experienced as a very stimulating and satisfying combination of structure and spontaneity.
Appendix A. Radium Springs RFP
The Contracting Officer will enter into discussions (but see Section C-29) with those offerors whose responses to this solicitation fall within a competitive range. The competitive range shall be established by the Contracting Officer after the technical and price evaluation of all proposals received pursuant to the procedures described in 41 CRF 1-3.805.

I. EVALUATION FACTORS

The following factors shall be used in the evaluation of the proposals. Factors A, B, C, D, E and F are listed in descending order of importance. Factor A is slightly more important than factors B and C, which are equal in value. Factors B and C are more important than factors D, E, and F which are equal to each other in value. The subfactors under factor F are listed in descending order of importance:

FACTOR A - Proposed research design

FACTOR B - Proposed sampling design. Regional application of the proposed design must be demonstrated.

FACTOR C - Credentials and past performance of those persons who would be in charge of the project. This includes the principal investigator and the project archeologist.

FACTOR D - Availability and adequacy of interdisciplinary consulting resources.

FACTOR E - Availability and adequacy of proper storage for archeological materials collected.

FACTOR F - Cost.

   1. Cost Realism - Proposed costs should accurately reflect the technical approach proposed by the contractor. Unrealistically high or low cost proposals may be determined to be nonresponsive.

   2. Validity of Proposed Costs - Most likely cost outcome or final cost to the government.
3. Cost Consciousness - Proposed costs should include all reasonable measures to insure quality technical effort with the maximum utilization of resources at the optimum expenditure levels.

SECTION F
DESCRIPTION/SPECIFICATIONS

1.0 BACKGROUND

The objectives of this effort for the Bureau of Land Management are both short-term and long-term. The short-term objective is to provide information for the "Human Values" section of the Radium Springs Geothermal Leasing Environmental Analysis Record. Long-term objectives include: providing information to be used in writing or updating Unit Resource Analyses, Management Framework Plans, and other documents; providing information to be used in compiling those Cultural Resources Inventories required by Executive Order 11593, Section 2; providing information to be used in conjunction with scientific models already in existence to improve our ability to predict the locations of archeological sites; and to provide information to increase our understanding of prehistoric ways of life in this part of the American Southwest.

2.0 OBJECTIVE

The primary objective of this project is to provide a statistically valid estimate of archeological site densities in various geographical zones within the subject area, and as much useful data as possible on any sites located. This shall be accomplished by sampling and intensively surveying portions of the subject area. In addition, it is expected that the contractor will collect a relatively large and accurate amount of archeological data in the field from specific sites.

3.0 GENERAL REQUIREMENTS

3.1 The contractor shall provide all expertise, personnel, research facilities and equipment necessary to accomplish the following:

3.1.1 Intensively survey a minimum of 32 square miles of BLM land for archeological remains.

3.1.2 Draw the sample to be surveyed from a population of BLM administered lands bounded as shown on the study area map (See Section M, Attachment I). The diagonal texturing represents non-federal lands (state and private). None-federal lands are not to be included in the survey. All other lands within the heavy black outline are Federal and should be considered in drawing the sample.
3.1.3 The method of sampling shall be a random stratified sample. The stratification scheme shall be designed to have regional applicability throughout southern New Mexico and shall be designed at a 10% level.

3.1.4 The contractor shall conduct a literature review to the extent necessary to fulfill the work requirements of this contract.

4.0 SPECIFIC REQUIREMENTS

4.1 Personnel Requirements

4.1.1 The contractor shall provide the necessary personnel to fulfill the following minimum requirements:

4.1.1.1 One project archeologist with a Ph.D. in anthropology or a Master's in anthropology plus two years field experience. This person will be responsible for directing all field operations and maintaining high quality field work; for conducting the necessary research and analysis; for interpreting the data; and for preparing the final report.

4.1.1.2 One field crew leader with at least a B.A. plus one season of archeological field experience for each field crew.

4.1.1.3 Field crew members with at least 20 semester hours of undergraduate credit in anthropology.

4.1.1.4 An adequate number of field crews to complete the required work in the allotted time. Each field crew shall consist of not less than three persons (including crew leader).

4.1.1.5 A statistical consultant to ensure proper and appropriate statistical procedure in planning and drawing the sample to be intensively surveyed. The statistical consultant shall also be responsible for the accuracy and validity of those calculations necessary to the final report.

4.2 Field Survey Requirements

4.2.1 The contractor shall accomplish the following tasks during the course of the field survey period:

4.2.1.1 Each Field crew shall walk parallel transects with personnel walking at intervals of no more than 50 meters. This requirement may be waived only in areas where the terrain is prohibitive. Waiver of this requirement shall be documented in the progress report and the final report.

4.2.1.2 All archeological sites must be recorded in the field on appropriate forms. Forms shall contain, at a minimum, the information contained on BLM Form 6230-2 attached hereto (See Section M, Attachment II).
4.2.1.3 Archeological artifacts shall be collected only for purposes of identification. They shall be stored in appropriate storage facilities or returned to the site.

4.2.1.4 Any hearth with prehistoric affiliations or any collection of three or more artifacts within a 10 meter radius shall be recorded on the forms specified in 4.2.1.2 herein.

4.2.1.5 For each archeological site located, the following information shall be collected:

4.2.1.5.1 Location: Every site shall be accurately plotted on U.S. Geological Survey (USGS) maps (either 7 1/2 or 15 minute scale).

4.2.1.5.2 Cultural affiliation and/or dates of use.

4.2.1.5.3 Description of on-site and surrounding environment. This shall include: altitude; land form on which site is located; type of land form occurring within one mile of site; major vegetation types on-site and immediately surrounding site; type of wildlife occurring in the area; and identification of major types of surface lithic material naturally occurring in the area.

4.2.1.5.4 Type of site.

4.2.1.5.5 Occupation area (in square meters or hectares).

4.2.1.5.6 Ceramic information: ceramic types present; description of diagnostic sherds present (if any); estimated average ceramic density on a site-wide basis.

4.2.1.5.7 Chipped stone information: estimated average density on a site-wide basis. Presence or absence on site should be noted for the following: large, medium and small angular debitage; large, medium and small simple flakes; retouch or sharpening flakes, blades; cores; choppers; scrapers; projectile points (provide accurate drawings); or other tools (specify and describe). Raw materials shall be identified. If possible, it should be noted whether these materials are locally available.

4.2.1.5.8 Ground stone information: The type of objects found must be identified, as well as the raw materials used.

4.2.1.5.9 Non-utilitarian objects: Presence or absence on-site of such objects as shell or stone beads, turquoise, obsidian, cruciforms, etc., and descriptions of these.

4.2.1.5.10 Estimated number of hearths on a site-wide basis, and presence/absence of sotol or mescal roasting pits.

4.2.1.5.11 Condition of site.

4.2.1.5.12 Evaluation of excavation potential.

4.2.1.5.13 Evaluation of significance according to National Historic Register criteria (See Section M, Attachment III).
4.3 Deliverable Requirements

4.3.1 One brief interim progress report indicating how much area has been covered and how many sites were found.

4.3.2 One BLM Form 6230-2 (or COAR approved substitute) with designated sections completed for each site located as specified above.

4.3.3 Final Report containing the following:

4.3.3.1 A discussion of the research design used.

4.3.3.2 A description of the methodology and field techniques used.

4.3.3.3 A discussion of the procedures used for identification and evaluation.

4.3.3.4 Analysis and interpretation of data collected.

4.3.3.5 Estimated site density for each type of site in each geographical zone, and the level of confidence for the estimates. The calculations and procedures through which these figures are obtained shall be included.

4.3.3.6 All data collected on the archeological sites located. Data will be provided in the format of 4.2.1.5.1 through 4.2.1.5.13 with any additional information following.

4.3.3.7 One set of USGS maps showing what areas were surveyed and showing accurately the locations of all sites found. Maps shall be presented in map tubes and not folded up.

SECTION H

DELIVERIES OR PERFORMANCES

This Archeological Survey shall commence within five (5) calendar days of award and run through December 31, 1976. All work required in Section F herein shall be accomplished in accordance with the following schedule:

Item 0001 — The literature search shall commence within five (5) calendar days of award. The field survey work shall commence promptly after adequate data has been gathered and shall continue during the last quarter of calendar year 1976 until the entire study area has been surveyed.

Item 0002AA — The interim progress report shall be delivered within seven (7) calendar days after completion of the field survey requirements.
Item 0002AB - The Antiquity Site Inventory Forms shall be delivered within seven (7) calendar days after completion of the field survey requirements.

Item 0002AC - The final report shall be delivered not later than December 31, 1976.

All deliverables required hereunder shall be delivered to the COAR in the quantities specified in Section E herein at the following address:

Bureau of Land Management,
Las Cruces District Office,
P.O. Box 1420,
Las Cruces,
New Mexico 88001.

SECTION I

INSPECTION AND ACCEPTANCE

1. Final inspection of all work, reports, data and documentation performed and delivered hereunder shall be made by the Contracting Officer's Authorized Representative (COAR) designated in writing by the Contracting Officer. All such data, reports and documents shall be delivered to the COAR at the locations and times designated in Section H herein. Final acceptance of all work required herein shall be made by the Contracting Officer.

2. The COAR review of all work required herein shall be completed within twenty-one (21) calendar days of receipt from the Contractor. The Contractor shall make any changes or revisions necessary to comply with the requirements of Section F as a result of the COAR reviews. Quality of work is subject to verification by BLM with payment to be withheld pending completion of any necessary corrective work by the Contractor.

SECTION M

TECHNICAL PROPOSAL PREPARATION INSTRUCTIONS

The Technical Proposal shall address, at a minimum, the following items. The format and organization of the proposal is at the proposer's discretion.

1. The proposed research design, including method of sampling, must be presented in sufficient detail to be evaluated in accordance with Section D herein. A bare outline is not adequate.

2. The proposal will include location of laboratory facilities, and a description of equipment and capabilities.
3. The specific arrangement for the storage of cultural materials must be detailed.

4. The proposal must include resumes of key personnel.

5. The number of field crew, size of field crews and composition and qualification standards for field crews must be detailed.

6. Allocation of man/hours for each of the key personnel, and for field crews in general must be detailed with associated tasks.

7. The proposer must include a list of all contracts or research grants received over the last three years for related work with references, addresses and phone numbers. The proposer shall indicate the degree of involvement of proposed key personnel on these past projects.

8. The proposer must provide copies of examples of major research endeavors performed by key personnel. These will be returned if the proposer requests.
STUDY AREA MAP
ATTACHMENT NO. 1

Figure 26

Boundary of subject area

Federal land

Non-Federal land

Truth or
Consequences

SIERRA DE LAS UVAS
Appendix B. Radium Springs proposal
I. Theory and Method

A. Introduction

The TTU department of anthropology's Cultural Resource Management Office (CRMO) proposes to accomplish an archeological survey on BLM-administered land in the Radium Springs proposed Geothermal Leasing Area of southern New Mexico. The following proposal is in response to a Bureau of Land Management solicitation (YA-512-RFP6-80) for a negotiated contract.

Beginning in 1972, the TTU department of anthropology has stressed the concept of "conservation archeology" as a needed response to the general conditions of archeology in the 1970's. This point of view was first written down in a proposal to the National Park Service dated May 30, 1972 (1). This proposal was an idealistic statement proposing a comprehensive, long-range regional research program. Perhaps the most important aspect of the NPS proposal (beyond that of geographic proximity to the Radium Springs area) that bears on the present more limited intensive survey, is the ideology of problem formulation it presents. Basically, the proposal sets up an archeological activity framework in terms of the twin concepts of "objectives" and "operations" (2). Objectives are seen as primary (goals) or secondary (objectives) in nature. In this framework, secondary objectives appropriate to achieving the primary one become the major focus of attention. These secondary objectives (now, simply objectives) are spelled out, in turn, as comprised of substantive "problems" and the appropriately related methodological "problems". With such an ideological framework established, a particular research design for multi-stage action and achievement can be proposed.

In addition to this stress on the intellectual and "problem oriented" framework for doing conservation archeology, the department of anthropology has proposed and accomplished long-range studies aimed at informing and involving regional and local levels of government in the work (3). Beginning in 1973, at the request of the regional association of governments (SPAG) the department has made modest progress in carrying out fundamental survey and inventory actions (4). This work with a wide range of local level lay people has been viewed as fundamentally essential to long range accomplishments in conservation and management of cultural resources (5).

The contract and grant projects in conservation archeology have culminated in the establishment of CRMO as a part of the department of anthropology at Texas Tech University. A "vita" or statement of general qualifications of CRMO is attached as Appendix B. Here the vitas of the three full-time staff archeologists are presented, plus
the vita of the faculty archeologist proposed for Principal Investigator.

B. Objectives and Operations

As presented in the RFP this project has both long-range and short range goals. Goals are major overall broad kinds or clusters of objectives, largely unanalyzed. The long range goal is spelled out in Section F, 1.0 of the RFP in terms of four general objectives: information to be used in preparing various documents; information to be used for E.O 11593 inventories; information to be useful in archeological site location prediction; information to be useful for regional culture history. The short range goal stated in the RFP (Section F 1.0) is "to provide information for the 'Human Values' section of the Radium Springs Geothermal Leasing Environmental Analysis Record."

The primary objective of the project (stated in 2.0 of RFP Section F) "is to provide a statistically valid estimate of archeological site densities in various geographical zones within the subject area, and as much useful data as possible on any sites located." We use the term "objective" to delimit a specific "end" or desired achievement in the sense of "means-ends" as the ever present pair of elemental factors in scientific research. The short range goal is viewed as comprised of definable and distinct objectives which together, once achieved, comprise the achievement of the stated short range goal. The term "operation" is our term for "means". An operation is the activity taken to achieve the objective. This activity is distinct and definable, like an objective, but it is usually more complex. Below, in our Problem Formulation we state the simply phrased objectives and the simply phrased coordinate operations. Section II, below, restates the objectives and operations for each major problem being addressed. Emphasis in Section II is on the techniques or actions which we propose to utilize.

Our restatement of the primary objective presented in the RFP is as follows:

GOAL - Information for Human Values section of EAR
Primary Objective - estimate of site densities
Secondary Objective - maximum site data

C. Problem Formulation

The topic of problem formulation has received only slight attention in the literature of archeological method and theory. Mayer-Oakes has discussed this recently (2) but has also viewed the concept in a much more elemental way as the potentially quite complex starting point for the cyclical inductive - deductive process of scholarly research (6). For the Radium Springs project, the problem has been clearly formulated in terms of discrete general and specific requirements (Section F of RFP, 3.0 and 4.0). For purposes of this proposal, thus, we define the complex, multi-stage "problem" of the Radium Springs Archeological Survey in terms of five major sub-objectives
each to be achieved by carrying out particular operations. When five sub-objectives (literature search, sampling design, survey design, evaluation and interpretation) have been accomplished, the Goal and Objectives stated above at the close of section B will have been accomplished.

Literature Search

The RFP statement (3.1.4 of Section F) requires the conduct of "a literature review to the extent necessary to fulfill the work requirements of this contract." Technique objectives and operations appropriate to this sub-objective are stated below in II. Techniques.

Sampling Design

The RFP statement (3.1.1,2,3, of Section F) requires that the contractor "intensively survey a minimum of 32 square miles of BLM land for archeological remains." It further requires that the survey be done as a 10% "random stratified sample" drawn "from a population of BLM administered lands. . . .shown on the study area map" which is included as part of the RFP. Previous experience of the PI and PA (7) suggests (and the two-day site area visit confirms) that a necessary refinement to the general sample method could best enable us to accomplish the primary objective of site density estimates. The refinement is to carry out the actual field collection of the sample on the basis of a proportional stratified sample, in a two-stage approach. The first stage would derive an approximate 3% sample using the ecological strata in their areal frequency proportions. On the basis of this sample a field analysis of variance in site density among each of the strata will be made. If significant variance is evidenced, new proportions will be calculated and used for the remainder of the sample collection. This procedure should minimize skewing of the collection record due to extant variation in occupation of the various ecological zones used as strata.

Statistical Procedures

The statistical objectives of the study are to minimize the variances of the estimates of the densities of sites consistent with reasonable expenditure. The sampling design which will accomplish this is a two-stage stratified proportional random sampling. Within the region are three geomorphological surfaces which are likely to affect both the distribution of sites and the ease by which these sites may be found. These surfaces are mountains, bajadas (dissected slopes) and mesas (flat areas). Bajadas may be further subdivided into the flat divide areas of creosote bush and dry stream beds (arroyos). Two major vegetational types dominate the mesas: grassland with interspersed yuccas, and sand dune areas with mesquite. These subdivisions give a total of five strata in which to sample. A sixth which should be added is playa, or dry lake bed.

The proportions of the six areas that are selected affect the objective of minimizing variances. For each of the areas three sets of parameters are required to enable the statistician to calculate
optimal distribution of effort. These are as follows:

1. Percentage cover of the six strata;
2. Cost of undertaking transects in the six strata;
3. Variance of densities of sites in the six strata.

The first two sets are known already from previous field work or can be readily obtained from aerial photographs. The third set of parameters must be estimated from field collection activity.

Initially, proportions of the field effort to be expended in each of the six regions will be calculated on the assumption that the variances in each of the six strata are the same. Field work will then be undertaken. After about two weeks of sampling, preliminary estimates of the variances will be calculated and new proportions re-calculated. Field effort will then be reapportioned.

This procedure will require rapid turnaround of field observations. Data from the field forms will be encoded onto standard computer forms, keypunched and preliminary analyses undertaken as the data become available. The limiting factor is likely to be the transcription of data from the field forms to computer forms. Field workers will consult with the statistician prior to field work on methods of standardising their comments in ways compatible with requirements of both field forms and computer forms. Problems encountered subsequent to this will be discussed by the field workers and the statistician after the first two weeks of field work.

The procedures outlined above will guarantee maximum accuracy in estimating densities of sites and will permit rapid analyses of the data to be prepared.

A paper by Judge and others (8) describes a very pertinent project at Chaco Canyon which comes to the same methodological conclusion as the independently derived one of our statistical consultant. Another and more recent source confirms from Oaxaca (9) the conclusion that transect sampling (such as proposed for this project) is likely to be most useful for archeology.

Survey Design

The RFP statement 3.1.1;4.2.1-5 of Section F) requires that a minimum of three person field crews "walk parallel transects . . . at intervals of . . . 50 meters . . . (collecting) artifacts . . . only for purposes of identification." While the intensive survey required does not specify it we presume that a 100% observation or coverage is what is required in each of the square miles to be sampled. Experience of both the PI and the PA with a 100% sample, E.O. 11593 "exemplary" project (7) suggests that a closer transect interval (25 meters) is required for 100% coverage. This same experience also suggests that wavy-line or "zig-zag" transects be used rather than straight-line ones.
The RFP also requires that site records be made in the field. Time and personnel logistics to accomplish this are developed below under II. Techniques and IV. Work Schedule.

Another requirement of the RFP is to record prehistoric hearths and artifacts concentrations. This will be accomplished by use of a modified version of the "Bandy Hearth Mapper" (10).

Evaluation Design

The RFP (Section F. 4.21.5.12,13) requires that evaluations for "excavation potential" and "significance according to National Register criteria" be made in the field. Time and personnel arrangements to accomplish this are developed below under II. Techniques and IV. Work Schedule.

Analysis and Interpretation Design

The RFP (Section F, 4.3.3.4) simply states that the Final Report will include "Analysis and interpretation of data collected." While the informational data collected will be compiled on specific BLM forms, it will also be codified for computer manipulation. The analysis will include computer activities. Interpretation will thus include the results of both manual and machine analysis.

D. Pioneering Nature of Project

Because of the primary objective -- to get a reliable estimate of site densities in a stratification scheme that is applicable to southern New Mexico -- this is a pioneering project. To our knowledge no such study has yet been accomplished, although several that are comparable in methodology have been reported by Mueller (11). To the extent that the Radium Springs area geographic variation matches that of southern New Mexico the project results should be applicable.

II. Techniques

In the section above we have discussed objectives and operations in a theoretical and methodological context. Here we emphasize the techniques proposed to "operationalize" or carry out the activities needed to accomplish the objectives.

A. Literature Search

Objective

1. Objective of literature searching is to extend maximally the bibliography already gathered for preparation of this proposal. The resultant bibliography derived from the one-week search will be used to help guide fieldwork as well as to provide a literature context within which analysis and interpretation can take place in the last stage of the project.
Operations

1. Activities will be composed of location, scanning and recording citations of pertinent literature from at least four sources:
   a. TTU library including the separately-housed "Southwest Collection";
   b. Laboratory of Anthropology, Santa Fe;
   c. University of New Mexico libraries, Albuquerque;
   d. New Mexico State University libraries, Las Cruces.

B. Sampling

Objectives

1. Define sample to be used for first stage survey recovery.
2. Determine variation of site densities among the six strata, based on first stage survey recovery.
3. Recalculate field effort proportions, based on first stage results.
4. Estimate site density for each type of site in each of the sampling strata, at conclusion of survey.

Operations

1. The sample will be defined by the statistical consultant from the data on land ownership boundaries to be provided by the BLM, utilizing the pre-determined conditions (10%, proportional stratified random sample of six geographical zones). Both the remote sensing consultant and the PI and PA will work with the statistician to determine the exact ground areas to be sampled. From field and map observations it is clear that "back-up" sample units will be needed for the logistically impossible sample units that may be drawn. (Some section corners are not present; some land is not in fact surveyed.) This work will be accomplished during the first two weeks of the project.

2. The statistician will make the necessary calculations, based on data gathered during the first stage.

3. The statistician will make the necessary calculations, based on data gathered during the second stage.

4. The statistician will make the necessary calculations, based on data gathered during the entire survey.
C. **Intensive Survey**

**Objectives**

1. Stage 1 coverage of approximately a 3% sample from each of the six strata.

2. Stage 2 coverage of the remaining 7% sample from each of the six strata.

**Operations**

1.a. **Observation** -- Zig-Zag, 25 m interval transects will be walked by each of the 5 three-person survey crews on the basis of locational data provided by the 1 three-person reconnaissance crew. This pattern will be altered in the bajada zone to include 25 m contour interval transects for the slopes, as well as arroyo floor transects.

1.b. **Collection** -- Minimum samples of cultural material will be taken at this time.

1.c. **Recording** -- Hearths, artifact or ecofact concentrations and the other required site characteristics will be recorded by the survey crew chief in the field at the time of location. Sites will be marked with central rebar numbered markers which will also be used as local datum for map and photographic recording of hearths or concentrations.

2.a. **Observation** -- same as 1.a., above.

2.b. **Collection** -- same as 1.b., above, except that subsequent to site evaluation at close of field survey stage, certain sites will be selected for additional artifact collection.

2.c. **Recording** -- same as 1.c., above.

D. **Site Evaluation**

**Objectives**

1. Excavation potential evaluation.

2. Significance for National Register evaluation.

**Operations**

1. Excavation potential in terms of both natural vertical exposures and horizontal dimensions of the site will be recorded at time of site location.

2. Determination of significance will be made after field survey is completed, during Field Lab stage work. This time context of maximum site data accumulation will provide the most reasonable background for the subjective procedure required. Any modifications in these determinations suggested by subsequent analysis and interpretation will be included in the Final Report.
E. Analysis and Interpretation

Objectives

1. To draw conclusions from collected data about the amount and significance of site frequency and density variation in the area of work.

2. To place these analyzed and interpreted data on site occurrence in a framework of regional culture history.

3. To place these analyzed and interpreted data on site occurrence in a framework of regional environmental history.

4. To synthesize the information resulting from accomplishment of above three objectives, and present it as concluding section of the Final Report.

Operations

1. The statistical consultant and the computer will provide the basic data to be used by the PA for this objective.

2. The regional archeological consultant will be utilized intensively for this objective.

3. The regional ecology and remote sensing consultant will be utilized intensively for this objective.

4. The PI will work intensively with the PA in the accomplishment of this objective.

III. Personnel

A. Archeological

1. Principal Investigator proposed is Dr. William J. Mayer-Oakes. His time on the project would be at the 10% level. Specific, anticipated periods of activity are shown in the following work schedule. In addition, he would routinely be in the field on a bi-weekly basis during the field stage of the project. Vita and bibliography are attached below as part of Appendix B.

2. Project Archeologist proposed is Alston V. Thoms. His time on the project is 100% as is the time of all other archeological personnel (though some are for periods less than the four months proposed for the project). Vita and bibliography are attached below as part of Appendix B.

3. Assistant Project Archeologist will be recruited, will be BA level with supervisory field experience. He will also function as chief of reconnaissance crew of two field hands. Job of the reconnaissance crew will be to locate sample units in field and provide both location and access route information to the five other three-man survey crews.
4. Five Crew Chiefs will be recruited, will be at BA level with field experience. As leader of three-person crew, chiefs will be responsible for all field recording. They will transform functionally to Lab Assistants for final stage of field work.

5. Twelve Field Hands will be recruited at BA level with course work in anthropology.

6. One Cook and one Cook's Helper will be recruited for the field stage. Cook will be required to have had appropriate experience.

7. One Secretary-Bookkeeper will be recruited for the duration of the project.

B. Consulting

1. A Statistical Consultant is required for the project. We propose to employ Dr. Stuart L. Pimm of Texas Tech University. His vita is attached below as part of Appendix A. We are particularly fortunate to have Dr. Pimm available for this project because of his previous work in the immediate area. He received his Ph.D. from nearby New Mexico State University and has conducted field research on playa sites—less than twenty miles south of the BLM area. This direct field experience in the same basin (Jornada del Muerto) will prove invaluable.

2. As Regional Archeology Consultant we propose to employ Dr. Stanley Bussey of New Mexico State University. Dr. Bussey has recently completed a series of archeological projects in the area. These are indicated in his vita which is attached as a part of Appendix A. He has provided the PI with a summary statement of the area culture history (12). From this statement and three recent personal communications it appears certain that the potential for significant new information about both Archaic and Formative cultures is high in the Radium Springs area. Not only is there likely to be evidence for a unique regional Cochise unit, but from Bussey's work in 1973 at a Mimbres phase site near Hatch, New Mexico there appears to be a prospect for a relatively unknown eastern extension of classic Mogollon culture.

There is an NPS mitigation project currently underway in the Placitas Arroyo area (13). It will be possible to consult with the field group from North Texas State University carrying out this project on the Southwestern edge of the Radium Springs area. In addition, Dr. Bussey has provided us with a copy of the Tularosa Basin report (14) which details recent work in the area immediately to the east of the Jornada del Muerto. This will be a useful supplement to other bibliographic material. While this particular area of southern New Mexico is not well known archeologically, there are two sites reported from the immediate area, namely Rincon (15) and Hatch.

3. The Regional Ecology and Remote Sensing Consultant we propose to employ is Dr. Ernest B. Fish of Texas Tech University. In addition to his training and experience in these two disciplinary area, Dr. Fish
is a native of New Mexico with substantial New Mexico desert grassland research experience. We plan to use his expertise in both disciplines to great advantage, particularly in the sample selection process and in the final analysis and interpretation during post-field stage.

IV. Proposed Work Schedule

A. Description of Events

This narrative presentation of a proposed event sequence can be most effective if used in conjunction with the following table of events labelled "IV. Work Schedule (16 weeks)."

The time period proposed is 16 weeks with the entire period being broken down into three stages of activity, based upon location. Pre-field work occupies the first week and will be carried out mostly in Lubbock. Field work will be done in New Mexico at the Radium Springs area location for a period of eleven weeks. Post-field work will be carried out for four weeks at the CRMO Lab on the Texas Tech campus. This series of stages based on location is further broken down into six activity sub-stages. Literature search and recruiting take place during the pre-field stage. Field Preparation sub-stage is accomplished during the first week of the field stage. Field Survey sub-stage takes up the next seven weeks of the field stage. The Field Lab Completion sub-stage takes place during the final three weeks of the field stage. Report Preparation sub-stage makes up the first two weeks of the post-field stage, while Report Writing is carried out during the final two weeks of the project.

During week 1 the PI and PA will concentrate on recruiting and assisting the APA who will do the literature search. PI and PA will work with statistician.

During week 2 the 5 CC will assist in preparing equipment and supplies needed for the field and will set up field base camp.

During weeks 3-9 the two-stage sampling survey with full crew of 19 will take place, working out of base camp. APA will lead reconnaissance crew as needed for section corner locations and access routes. Lab processing will also be accomplished.

During weeks 10-12 the 5 CC will shift to LA duties and work with PA and APA to carry out the evaluation objectives. Field Camp will be discontinued at close of this period.

During weeks 13-14 the lab work necessary for Final Report writing will be carried out by crew of 5. At end of week 13 the Interim Report and all field forms will be delivered.

During weeks 15-16 the same crew of 5 will assist in preparing Final Report.
At the close of the field season the records, artifacts, and other data collected will be returned to temporary storage in CRMO Lab. At conclusion of project the records and collections will be deposited in the Texas Tech Museum which is the official repository.

B. Field, Logistic and Other Special Conditions

Both the PI and the PA have visited the Radium Springs area. On Sept. 11 we made north-south and east-west highway transects across the mesa or basin part of the area. On Sept. 12 the PA also visited the bajada and Caballo mountain area, contacted local informants and scouted field camp possibilities.

Based on this preliminary direct observation information we can plan to have back up or alternate sample units when those drawn as random are not surveyed or do not have corner markers. We expect the mountain area rate of survey to be significantly slower than other areas. We also are prepared to use horses for one survey party if required. If wet weather occurs so as to interfere with field work beyond 2 days we will require a time extension.

Two of the specific requirements of the RFP appear to be unrealistic given the current time schedule. It may not be possible to obtain a field crew with education requirements stated. The five day interval between award and initiation of project may also be unrealistic. We will attempt to recruit as much of the field crew (including APA and Cooks) in New Mexico as possible.

The basis for time frame of work schedule and crew size proposed is the Chimayo project experience. On this project 18 acres per man-day was achieved on a 100% survey in bajada type terrain. We have estimated that one-third of the Radium Springs project will require this pace. The other two-thirds have been calculated on the basis of a 35 acre per man-day achievement.
### IV. WORK SCHEDULE (16 weeks)

<table>
<thead>
<tr>
<th>TIME</th>
<th>STAGES</th>
<th>PERSONNEL *</th>
</tr>
</thead>
<tbody>
<tr>
<td>(when)</td>
<td>(location)</td>
<td>(which)</td>
</tr>
<tr>
<td>(amount)</td>
<td>(activity)</td>
<td>(number)</td>
</tr>
<tr>
<td>week 1</td>
<td>I-pre-field</td>
<td>PI, PA, APA</td>
</tr>
<tr>
<td></td>
<td>Literature search; recruiting</td>
<td>3</td>
</tr>
<tr>
<td>week 2</td>
<td>II-field</td>
<td>PA, APA, 5CC</td>
</tr>
<tr>
<td>weeks 3-9</td>
<td></td>
<td>PA, APA, 5CC, 12FH, C, CH</td>
</tr>
<tr>
<td>weeks 10-12</td>
<td></td>
<td>PA, APA, 5LA, C</td>
</tr>
<tr>
<td>weeks 13-14</td>
<td>III- post-field</td>
<td>PI, PA, APA, 2LA</td>
</tr>
<tr>
<td>weeks 15-16</td>
<td></td>
<td>PI, PA, APA, 2LA</td>
</tr>
</tbody>
</table>

* PI = Principal Investigator  
PA = Project Archeologist  
APA = Assistant Project Archeologist  
CC = Crew Chief = LA = Lab Assistant  
FH = Field Hand  
C = Cook  
CH = Cook's Helper
NOTES AND REFERENCES CITED


5. The second grant from SPAG has recently been made. Dr. Campbell is sole Principal Investigator and already is well launched on a comprehensive laboratory project to assemble a broad base of records for the 15-county SPAG area.


Both of these items are included with this proposal, the Thomas report (abridged) is Appendix C; the Mayer-Oakes one is Appendix D.

9. Flannery, Kent V. (editor)
Chapter 5, "Sampling on the regional level", pp. 131-161 is most relevant to our present concern. The article on "Relative efficiencies of sampling techniques for archeological surveys" by Stephen Plog supports the Judge, et al (8) conclusion from Chaco area that small quadrat sample units are most effective. Possibly this conclusion could be incorporated into the second stage sampling at Radium Springs.

10. Bandy, Philip A.
1975. Surface Mapper. Unpublished ms. on file in the Department of Anthropology, Texas Tech University, Lubbock.

11. Mueller, James W. (editor)


13. National Park Service RFP 1595 0009 details the contract requirements for the mitigation study.


15. Hammack, Laurens C.
1963. The Las Cruces dam site: lithic sites near Las Cruces, New Mexico. Ms. on file at Museum of New Mexico, Santa Fe.
Appendix C. Canyon Lakes Proposal supplement
SUPPLEMENTAL INFORMATION

I. Previous Work at Canyon Lakes site

A. Survey Phase

During 1975 Charles Johnson acting for the Texas Tech Museum carried out a reconnaissance and trench testing survey of the Canyon Lakes area. Although no report on this Lubbock city-sponsored contract project has yet been completed, various preliminary statements in the form of proposals for further work were prepared. The substance of the results of this work was presented in the RFP.

B. Mitigation Phase

During July and August, 1975 the Texas Tech University department of anthropology field school in archeology carried out excavations at areas 3 and 4 of 41Lu35 in an attempt to correct the total lack of mitigation effort to that date. A report on this work was written and presented in fall 1975, by Katz and Bandy.

C. Analysis Phase

Beginning in September 1975 and continuing to the present, the preparation of a final report on that 1975 excavation at 41Lu35 (the Nash site) has been underway. Myra Hyde is preparing an MA thesis which will report the excavation and stress the historical and processual faunal analysis of the major finds. The major results were Neo-Indian in age, no evidence for earlier components coming to light in these limited, horizontal-stressing excavations.

D. General Background

In the above statements and what follows below, we stress the directly pertinent research, data and literature. Rather than select and repeat bibliographic data already available, we simply include the extensive bibliography pertinent to the Nash site which has already been prepared by Hyde and is attached below in appendix 5. Campbell has presented a partial bibliography for the SPAG region of 15 counties surrounding Lubbock. He is currently at work on a project anticipated to be complete before Jan. 1, 1977. This project for SPAG is strictly the library and lab job of collecting, collating and recording in published form all published and unpublished data bearing on the cultural resources of the SPAG area. The Canyon Lakes project will thus have at its disposal a most complete and up to date bibliography of pertinent information.
II. Proposed Goals and Objectives, In Detail

This section will present in barest outline form the objectives of the proposed project at Canyon Lakes. The term objective we use to delimit a specific "end" or desired achievement in the sense of "means-ends" as the ever present pair of factors in scientific research. Each of the three goals is viewed as comprised of definable and distinct objectives which together, in achievement, comprise the achievement of the stated goal. The term operation is our term for "means". An operation is the activity taken to achieve the objective. This, too, is distinct and definable, like an objective, but it is often more complex. Part II thus outlines the simply stated objectives, Part III uses the same outline format to present the more complete and detailed statement about proposed operations, stressing the methodological aspects of the operations.

A. Cultural History Goal

1. Natural environment reconstruction objective.
   a. Natural stratigraphy sub-objective
      i. Soil stratigraphy data.
      ii. Associated flora data.
      iii. Associated fauna data.
   b. Ecological framework sub-objective.
      i. Periodization data.
      ii. Comparison data -- past periods and present.

2. Human utilization of natural resources objective.
   a. Lithics sub-objective.
   b. Flora sub-objective.
   c. Fauna sub-objective.
   d. Landscape sub-objective.

3. Intra-component activities objective.
   a. Bison utilization process sub-objective
      i. Killing.
      ii. Butchering.
      iii. Processing (activity complex).
      iv. Seasonality.
   b. Small game (and other) utilization process sub-objective.
   c. Tool manufacture process sub-objective (by component).
      i. Bone industry.
      ii. Lithic industry.

4. Cultural stratigraphy objective.
   a. Tool inventory classification sub-objective.
   b. Tool function sub-objective.
   c. Correlation with natural stratigraphy sub-objective.
5. Regional significance objective.
   a. Local inter-site comparisons sub-objective. (By component).
      1. Lubbock Lake.
      2. Plainview.
      4. Other Llano Estacado sites.
   b. Plains site comparisons sub-objective. (By component).
   c. New World sites comparisons sub-objective. (By component).

B. Site Preservation Goal.
   1. Selection objective.
   2. Implementation objective.
   3. Utilization objective.

C. Method Testing Goal.
   1. Excavation sampling objective.
   2. Small power equipment objective.
   3. Rapid surface recording objective.
   4. Tool technology reconstruction objective.

III. Methodology and Operations, in Detail

A. Culture History will be derived on the basis of the study of both excavation and surface observation data gathered as a result of the proposed project. To the extent possible, standard archeological field procedures such as described by Hester, et al. will be followed. Some of the specialized control and recording techniques utilized by the Lubbock Lake project (Johnson) will be used to the extent that they are consonant with the time, money and personnel limitations of the Canyon Lakes project. Otherwise, the standard forms, format and control procedures (all metric) used by the anthropology department will be followed. Our attempt will be to utilize the best of and the maximum of any pertinent previous work at Canyon Lakes or Lubbock Lake site. This will include re-cleaning and drawing of the profiles of all extant trenches cut by Charles Johnson at 41Lu26 and 35. (No notes or field records are available at the Museum, but are in Johnson's possession according to both Dr. King and Dr. Eileen Johnson).

1. Natural environment of the potentially several prehistoric occupations will be approached through a series of sub-objectives to be achieved via several kinds of controlled excavation and field observation.
   a. The natural stratigraphy will be determined from observations and recording (graphically and photographically) all the soil layers exposed in two main kinds of excavation. The first kind is trenching, by use of a back hoe. The second kind will be by hand tool (shovels and
trowels) extension of areas known from the previous work of Katz and Bandy or observed on the surface or in the back hoe trenches cut by the proposed field crew. The natural stratigraphy will be further developed on the basis of study of both flora and fauna collected from the excavations. Results of paleo-biological analysis will be interpreted utilizing the ecological framework of extant biotic communities. Our attempt will be to supplement the work done at Lubbock Lake site, where emphasis has been placed on large mammals, and no pollen collection or analysis has yet been done. To these ends we have selected several technical consultants who will be available to provide specialized services in four main areas. (See appendix 3 below for discussion and listing of consultants including vitas).

Dr. Vaughn Bryant of Texas A & M University will provide the paleo-botanical expertise needed; we shall ask him to collect and analyze pollen from the sites. Dr. Jack Hughes of West Texas State will be consulted for large vertebrate data, particularly bison. Dr. Robert L. Packard of Texas Tech Museum will be consulted for small vertebrates. Dr. C. C. Reeves of Texas Tech will provide general Pleistocene geology, soils and geomorphological consulting expertise.

The ecological framework(s) from the past will be correlated on the basis of both superposition principles (for relative dating) and absolute dates. We hope to secure a number of appropriately placed charcoal samples for absolute dating purposes. If suitable grab samples are not located we will plan to reduce soil matrix samples for reduction charcoal dates prior to submitting bone or any other organic material.

2. Natural resource utilization by prehistoric peoples will be approached by the lab study of collected cultural and natural materials. Although some study of lithics from Lubbock Lake has provided information on this, the recent work of Bandy and Katz and Katz provide a broad base upon which to approach the source analysis of lithic finds at Canyon Lakes. Floral and faunal utilization will be approached primarily through the observation and testing of bone breaking (see below). All of these sub-objectives will be correlated with the landscape reconstruction which itself will be the overall most comprehensive result of the natural environment reconstruction objective.

3. Intra-component activities will be documented largely in terms of the bison utilization process already established by Katz and Bandy and being analyzed in detail by Hyde. Special efforts to record the much larger samples of surface material exposed at the sites will be made. Two experimental approaches will be applied in an attempt to record as much of these surface data as possible in the very limited time available. First, the hearth mapper invented and field tested by Bandy will be adapted to the task of rapid plotting of surface finds at 41Lu35 and 41Lu 26. Secondly, an attempt will be made to rapidly record living surfaces photographically using a string grid frame for reference. This latter action is best thought of as a crude experiment and will be tested against more traditional recording techniques. Small game utilization process is included here primarily because it has not received much attention at Lubbock Lake or elsewhere on the Llano Estacado.
The tool manufacturing process study will consist of detailed and experimental lab study of fracture and use indications in both osteological and lithic materials collected at the sites. With bone a special attempt will be made to duplicate and test the observations and conclusions of Johnson\(^5\) (see discussion in Notes). With stone, the pattern of technology model construction, sample replication and experimental testing carried out by Bandy\(^6\) at Alibates will be followed.

4. Cultural stratigraphy will be developed on the basis of various specialized kinds of study of the cultural material recovered from excavation or surface work. Definition of the cultural succession will be accomplished as a result of lab studies aimed first of all at establishing a tool inventory. A tool inventory will be defined on the basis of attribute studies to support a classification into morphological types of tools. This morphological analysis will be done in both qualitative and quantitative terms, as presented by Bandy.\(^6\) For achievement of a statement about tool function, the morphological typology will be utilized as a basis for testing the implications of the tool manufacturing sequence derived in achieving the intra-component lithic activities objective, above. The general pattern or procedures developed and used in Bandy's thesis should provide "technological function" types for both stone and bone artifacts.

As a summation of cultural stratigraphy, the details of natural and cultural level correlation will be investigated. Katz and Bandy present conclusions about inter-site stratigraphic correlation that conflict with the interpretation presented by Johnson\(^9\) for the Lubbock Lake site. A special attempt will be made to resolve this, by careful delineation of 4A and 5A zones at 41Lu35 excavations. It may well be that inter-site positive cultural correlations do not exist for these two. If so, that is a problem for work in the future, beyond the Canyon Lakes project here proposed.

5. Regional significance will be investigated by means of a comparative literature study, primarily. Local Llano Estacado sites such as Lubbock Lake, Plainview, and Blackwater Draw will be accessible in terms of collections, unpublished data as well as publication, however. Our attempt will be to set the cultural record from Canyon Lakes in the increasingly wide perspective of the Llano Estacado, the North American Great Plains and the New World as a whole.

B. Site Preservation is a possible goal of this project, motivated by the prospect first of all of preserving important prehistoric cultural data for future usage. This is a normal goal of the conservation ethic (see Lipe\(^10\)). At Canyon Lakes, if feasible mechanically, site preservation by soil or water cover may well relieve time pressure of the Park construction schedule.

1. The selection objective could be met by correlation of construction activities with areas where soil or water cover would not destroy cultural resources.
2. The implementation objective could be met by fill deposit activity monitored by the project director. Water cover will depend upon planned water levels.

3. The utilization objective could be met by establishing a "living" or "action" exhibit-research unit, as has been planned for Lubbock Lake and as has been carried out at Dinosaur National Monument. This latter objective is clearly beyond the scope of the present proposal, yet provided basic motivation for selection and implementation objectives.

C. Methods Testing Goals are in general the "extras" proposed for this project -- that is, they are beyond the primary cultural history objectives, beyond the secondary cultural process objectives, and constitute areas of methodological contribution to the field of archeology. They grow out, none-the-less, of the specific fundamental needs and objectives of the project in its simplest terms. (see Mayer-Oakes' paper on this topic).

1. The primary problem of the Canyon Lakes project has already been stated as an "excavation sampling" problem. This is conceived of as two-dimensional, the deep excavation context (vertical dimension) assumed to be present at the two numbered sites (41Lu35, 26) and the shallow, component excavation context (horizontal dimension). With regard to the former we have the major source of difficulty. Basically, deep site excavation sampling strategy has been ignored. Brown has recently presented the only specific and detailed consideration of this topic known to the writer. His complex and detailed conclusions provide the theoretical basis for an experimental excavation project in which financial and time considerations are minimal. The stress he places on seeking comparable activity units per layer is a lead that can be followed via the several steps of the bison processing activity complex. Should these activity areas be present in more than one component, valid comparisons could be drawn. To the extent that is is feasible, the earlier stated objective of unaligned transect sampling by means of back hoe trenches will be responsive to data indicating comparable activity areas in vertically distinct loci. This, in fact, will be a prime basis for decision about quadrat lateral (horizontal) extensions and further excavation sampling. An important methodological contribution from the Canyon Lakes project can be in this area of explicit and theoretically oriented deep site excavation.

2. A second method objective is much more limited. We expect to find use for power tools beyond the city-provided standard machinery. Our proposal item is to use the small, archeologist-operated back hoe and loader, having this available on a rental basis for the three months the heavy equipment is not available. Such an "intermediate" level of power tool digging and earthmoving equipment has not been much used in field archeology, but promises to be most helpful, particularly on a project of this sort, with severe time, money and labor limitations.
3. Rapid surface recording is a clear desideratum of this project. The two methods proposed as supplements to standard procedure are both "experimental". The rapid photo thru grid has been used for both excavation and surface contexts (see Hester, et al., pp. 138-40) but rarely as a sole recording device, rather it has been used as an aid to laborious and time-consuming plotting by hand. Our hope here is to develop a way of scaling so that photo-grammetric methods can be used to enhance the value of a quickly done "grid-over photo" for basic record purposes.

A more well-developed technique which simply needs to be applied, for similar quick recording of horizontally expressed data is the Bandy's "hearth mapper". Here we plan simply to use the device and make material substitutions to improve the longevity and reliability (sensitivity) of the mechanism.

4. Finally, the tool technology reconstruction objective is important to restate for its general significance. Although we have stated details above (under A, 3, C.) where the substantive results are a prime objective, the anticipated broadly useful nature of this approach and its uniqueness are likely methodological contributions. No published lithic technology reconstructions or experiments have yet proceeded as far as Bandy has. Nothing comparable has even been attempted, to our knowledge, with bone material. The results of this area of the project may in fact have the most significant methodological value.

IV. Summary and Overview

In summary, we have proposed to do an urgent (i.e., salvage) archaeology project, within an intellectual framework that offers much to the problem-oriented field worker. Our primary stated goal is what we think of as "sophisticated" culture history. We additionally expect to approach limited kinds of culture process objectives, building, as a project team, upon both the pertinent local past work (at Lubbock and Canyon Lakes sites) and our own special interests and backgrounds. Finally, some of the methods we expect to apply in attempting to achieve our objectives, are in themselves worth while general objectives.

There are severe time limitations -- we are limited to four months of field work. There are significant data limitations -- we do not have access to a careful and complete final report on previous work. The Hyde study is still in progress; the several proposal-reports by Johnson are incomplete, incautious and undetailed; thus we must depend upon the Katz and Bandy field data for detailed site record information.

With all this in mind, it seems clear that the results of the proposed project will depend mostly upon how much money is available to enable the project team to maximize the value of their effort in the prescribed time.

Although we propose to do this very difficult project with an awareness of the potential difficulties and limitations, we see it
as an opportunity to demonstrate again the value of "real world" archeology. That is, we expect to stress fundamental and proven objectives and operations, seeking innovation and change, but cautiously. This attitude is exemplified by much of the content of MacNeishes' recent little book, the title of which is a poignant reminder of our current condition in archeology, "The Science of Archaeology?"
Canyon Lakes Park
a project in archeological
excavation study

GOAL I
a series of archeological
excavation projects to
accompany park development

GOAL II
a series of archeological
sites or areas to be
established as preserves
or "living museums", as
integral part of park system

BY MEANS OF

Problem Objectives

Substance
1. Natural environment
2. Resource exploitation
3. Intra-camp activity
4. Cultural stratigraphy
5. Archaic tool inventory
6. Bison Butchering

Method
1. Excavation sampling
2. Use of power tools
3. Flotation sampling
4. Screening sampling
5. Lab feedback

Figure 28

HUMAN SETTLEMENT & ENVIRONMENT HISTORY

(BASIC OBJECTIVE)
NOTES

1. Katz, Paul R. and Philip A. Bandy

   Summary of bison utilization process interpretation is presented on p. 6 of this report which is attached as appendix 4.

2. Hyde, Myra B.

   Problem statement is presented on p. 1, with following details and Nash site-oriented bibliography. Attached as appendix 5.

3. Campbell, Robert G.

4. Hester, Thomas R., Robert F. Heizer and John A. Graham

5. Johnson, Eileen McAllister

   Discussion of a "logical" butchering process is presented on pp. 140-147. A bone tool called a "muscle separator" is posited as a key element in the process, but no experimental or other supporting evidence is presented. This provides a convenient and quite significant problem to be treated by the Canyon Lakes analysis, if the appropriate tool is recovered. Field methods and techniques are described in detail on pp. 18-26.

6. Bandy, Philip A.
A discussion of the regional role of Alibates flint as a dominant material is presented as part of this thesis.


   Detailed discussion of the local and regional chert materials is presented on pp. 68-73. This is particularly significant, because it represents a formalization of the regional variety known to exist, but not previously analytically established.

8. Bandy, Philip A.
   1975. Surface Mapper. Unpublished ms. file is in the Department of Anthropology, Texas Tech University. Lubbock.

9. Johnson, Charles

   On pp. 97 and 98 the interpretation of zone 4A as Archaic is presented. This zone has been identified by Katz and Bandy at the Nash site 1975 excavations where it is associated with ceramics. Further work focussed on this apparent conflict may help to derive a more accurate interpretation.

10. Lipe, William D.

11. Mayer-Oakes, William J.
   1976. Problem orientation, regional research design and multi-stage operations -- an example from the conservation archeology project at the Guadalupe Mountains National Park. Abstract presented to chairperson for First Conference on Scientific Research in National Parks.

   A basic point made in the paper is that the requirements of the Inter-Agency Service contract research program in public conservation archeology may well provide a critical meeting ground for the oft-times diverse interests of "pure" and "applied" research in archeology.

12. Brown, James A.
13. Two reports attached to letters are referenced in note 8 of original portion of proposal. A version of the report which went to Handly on July 12, 1975 has now turned up with xerox copies of illustrations. The xerox copies are impossible to use, but if the original can be found it will be very useful. Current whereabouts of Charles Johnson is unknown.

14. MacNeish, Richard S.
Appendix D. Canyon Lakes Lab Project schedules
CANYON LAKES PROJECT -- LABORATORY SCHEDULE

<table>
<thead>
<tr>
<th>OPERATION</th>
<th>ACTIVITY</th>
<th>PERSONNEL</th>
<th>WORKING DAYS</th>
<th>EVENT DEADLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Processing Artifacts</td>
<td>1. Clean and catalogue samples of bone, lithic, anddebitage. Also counting samples, recording the number on a card, then transcribing to a permanent record.</td>
<td>J. Montgomery(30%)</td>
<td>45</td>
<td>March 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P. Bandy</td>
<td>(since Jan. 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>J. Mowers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>K. Hooper</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. Burton</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P. Stewart</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Separating above mentioned material (for analysis).</td>
<td>Same as 1</td>
<td>5</td>
<td>March 11</td>
</tr>
<tr>
<td></td>
<td>3. Cross-indexing the material.</td>
<td>Same as 1</td>
<td>5</td>
<td>March 18</td>
</tr>
<tr>
<td>B. Analysis Bone</td>
<td>1. Comprehensive research of literature.</td>
<td>Bandy</td>
<td>10</td>
<td>March 11</td>
</tr>
<tr>
<td></td>
<td>2. Accumulation of comparative materials (present day bone, defleshing, replica of breaking and bone flaking).</td>
<td>Bandy</td>
<td>10</td>
<td>March 11</td>
</tr>
<tr>
<td></td>
<td>3. Consultants view of material</td>
<td>Bandy</td>
<td>10</td>
<td>March 11</td>
</tr>
<tr>
<td>OPERATION</td>
<td>ACTIVITY</td>
<td>PERSONNEL</td>
<td>WORKING DAYS</td>
<td>EVENT DEADLINE</td>
</tr>
<tr>
<td>-----------</td>
<td>----------</td>
<td>-----------</td>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td>5.</td>
<td>Testing the above mentioned scheme with any revisions needed.</td>
<td>Keslin, Bandy Montgomery</td>
<td>2</td>
<td>March 18</td>
</tr>
<tr>
<td>6.</td>
<td>Make recording form for bone analysis.</td>
<td>Bandy</td>
<td>6</td>
<td>March 28</td>
</tr>
<tr>
<td>7.</td>
<td>Train staff in use of classification scheme.</td>
<td>Bandy Lab Personnel</td>
<td>6</td>
<td>March 28</td>
</tr>
<tr>
<td>8.</td>
<td>Utilization of bone classification scheme.</td>
<td>Lab Personnel</td>
<td>44</td>
<td>May 27</td>
</tr>
<tr>
<td>9.</td>
<td>Key punching for classification scheme.</td>
<td>Typist</td>
<td>5</td>
<td>June 3</td>
</tr>
<tr>
<td>10.</td>
<td>Data manipulation of classification scheme (computer).</td>
<td>Keslin Bandy</td>
<td>7</td>
<td>June 14</td>
</tr>
<tr>
<td>11.</td>
<td>Written preliminary summary of bone analysis.</td>
<td>Bandy</td>
<td>13</td>
<td>July 1</td>
</tr>
</tbody>
</table>

**B'. Analysis Chip-Stone**

<table>
<thead>
<tr>
<th>EVENT</th>
<th>DEADLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Background literature research (on going activity).</td>
<td>Proceeding</td>
</tr>
<tr>
<td>2. Separate lithic (chip-stone) material for study.</td>
<td>Done (event A)</td>
</tr>
<tr>
<td>3. Devise a classification and codification scheme for chip-stone analysis.</td>
<td>April 8</td>
</tr>
<tr>
<td>OPERATION</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>AA.</td>
<td></td>
</tr>
<tr>
<td>Analysis</td>
<td></td>
</tr>
<tr>
<td>Burn Rock</td>
<td></td>
</tr>
<tr>
<td>(This event has a low priority or non critical time)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>PERSONNEL</th>
<th>WORKING DAYS</th>
<th>EVENT DEADLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Background literature research (on going activity).</td>
<td>Bandy</td>
<td>Prior to May 6</td>
</tr>
<tr>
<td>6.</td>
<td>Sort and identify samples from burn rock.</td>
<td>Bandy, Lab Personnel</td>
<td>July 15</td>
</tr>
<tr>
<td>7.</td>
<td>Preliminary written summary of burn-rock analysis.</td>
<td>Bandy</td>
<td>July 22</td>
</tr>
</tbody>
</table>

If time allows these activities will be incorp. with dates later.

<table>
<thead>
<tr>
<th>PERSONNEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montgomery</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB.</td>
</tr>
<tr>
<td>Analysis</td>
</tr>
<tr>
<td>Burn Rock</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>PERSONNEL</th>
<th>WORKING DAYS</th>
<th>EVENT DEADLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Sorting material and utilization of chip-stone scheme.</td>
<td>Bandy, Work Studies Person</td>
<td>10</td>
</tr>
<tr>
<td>5.</td>
<td>Preliminary written summary of chip-stone analysis.</td>
<td>Bandy</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PERSONNEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandy, Keslin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC.</td>
</tr>
<tr>
<td>Matrix</td>
</tr>
<tr>
<td>Separation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>PERSONNEL</th>
<th>WORKING DAYS</th>
<th>EVENT DEADLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.</td>
<td>Sample several matrices</td>
<td>Bandy, Keslin Montgomery</td>
<td>10</td>
</tr>
<tr>
<td>1-4.</td>
<td>Process matrices, sort from 1-4. this operation sample and identify, quantify and consult with specialist. Analysis comes from material.</td>
<td>Keslin, Bandy Lab Personnel</td>
<td>6</td>
</tr>
<tr>
<td>OPERATION</td>
<td>ACTIVITY</td>
<td>PERSONNEL</td>
<td>WORKING DAYS</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>------------------------------------</td>
<td>---------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>D. Supplementary Field Work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Carbon Dating</td>
<td>1. Select samples to be tested.</td>
<td>Mayer-Oakes, Keslin, Bandy</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>2. Package the samples.</td>
<td>Lab Personnel</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3. Select analyst for dating materials.</td>
<td>Mayer-Oakes, Keslin</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>4. Ship material</td>
<td>Lab Personnel</td>
<td>2</td>
</tr>
<tr>
<td>F. Pollen Analysis</td>
<td>0. Select samples of pollen to be tested.</td>
<td>Mayer-Oakes, Keslin Bandy, Montgomery</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1. Segregate the pollen to be tested.</td>
<td>Lab Personnel</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2. Soil profile drafting.</td>
<td>Brook Bowman</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3. Ship material</td>
<td>Lab Personnel</td>
<td>4</td>
</tr>
<tr>
<td>G. Natural Stratigraphy</td>
<td>1. Select and analyse soil samples.</td>
<td>Montgomery</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>2. Draft soil profiles.</td>
<td>Brook Bowman</td>
<td>7</td>
</tr>
<tr>
<td>OPERATION</td>
<td>ACTIVITY</td>
<td>PERSONNEL</td>
<td>WORKING DAYS</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**H. Supervisor Synthesis**

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>PERSONNEL</th>
<th>WORKING DAYS</th>
<th>EVENT DEADLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Coordination of all material.</td>
<td>Keslin, Bandy Montgomery</td>
<td>34</td>
<td>April 1</td>
</tr>
<tr>
<td>2. General background research.</td>
<td>Keslin</td>
<td>14</td>
<td>March 18</td>
</tr>
<tr>
<td>3. Evaluation of experimental bone research.</td>
<td>Keslin</td>
<td>85</td>
<td>July 1</td>
</tr>
<tr>
<td>4. Preliminary accumulation of chapters.</td>
<td>Keslin Bandy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**I. Overall Project Evaluation**

Subsequent to drafting and writing activities.

<table>
<thead>
<tr>
<th>PERSONNEL</th>
<th>WORKING DAYS</th>
<th>EVENT DEADLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayer-Oakes, Keslin, Bandy</td>
<td>9</td>
<td>July 13</td>
</tr>
<tr>
<td>OPERATION</td>
<td>ACTIVITY</td>
<td>PERSONNEL</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>J. Final Draft</td>
<td>Edit and rewrite draft.</td>
<td>Keslin Bandy</td>
</tr>
<tr>
<td>K. Final Typing and Proofing</td>
<td>This is after rewriting and editing the final draft.</td>
<td>Bandy Keslin</td>
</tr>
</tbody>
</table>
SN - Supervisor Synthesis
SO - Soil & Pollen Analysis
ST - Natural Stratigraphy
PR - Processing Materials
BO - Bone Analysis
FL - Flint Analysis
DA - Dating
PE - Project Evaluation
FD - Final Draft
FT - Final Typing

Simplified Milestone Chart
Canyon Lakes Project Lab Schedule

Figure 29
Appendix E. Glossary
GLOSSARY

activity - a time-consuming component of an operation, e.g. "type catalog cards", which uses manpower and/or other resources; an activity is placed on an arrow of a network or flow chart.

critical path - the longest path, or sequence of connected activities, through a network; its length determines the duration of the project.

do-loop - a sequence of activities that is repeated until a problem is solved or a pre-set standard reached.

event - a recognizable component of an operation which occurs at a specific point in time, but does not itself consume time; it is often the product of an activity or activities, e.g. "final report", or the beginning or end of an activity, e.g. "start survey" or "cataloging completed"; an event is placed at a node of a network or flow chart.

flow chart - a graphical representation of a logical sequence of connected activities.

network - a graphical representation of a project's activities and events and their relationships; a project graph.

objective - a specific, realistic goal to be accomplished in a project.

operation - an identifiable part of a project, e.g. "artifact cataloging", which consists of the activities and events that will fulfill an objective of the project.

variance - measure of uncertainty.
Appendix F. Selected Management Planning Literature

(Jerry Alexander)
SELECTED MANAGEMENT PLANNING LITERATURE

Jerry Alexander

Buffa, Elwood S.

Carroll, Stephen T. Jr., and Henry L. Tosi
1971 The relationships of characteristics of the review process to the success of the management by objectives approach. Journal of Business, XLIV, 3 (pp. 299-305).

Cook, Desmond L.

Drucker, Peter F.

Evarts, Harry F.
1974 Introduction to PERT. Allyn and Bacon, Boston.

Frank, E. R.

Frazer, Willard

Graves, C. W.

Harvey, L. James

Humble, John W.

Johnson, Richard A.; Dast, R. E. and James Rosenzweig
Kelley, William R.  

Kobayashi, Shigeru  

Koontz, Harold and Cyril O'Donnell  

Lasagna, J. R.  

Levin, Richard I.  

Levinson, Harry  

Mahler, Walter R.  

Miller, R. W.  

Moder, Joseph and Cecil Phillips  

O'Brien, J. J.  

Raia, Anthony  

Riley, M. W.  

Ripley, Kathryn Jane  
1966 Steps to establish a technical college and the evaluation of "PERT" as a planning tool for educators. Eric.

Stillian, Gabriel N.  
Stries, D. M. and Maurice Murphy
1963 PERT/CPM. Materials Management Institute, Boston.

Thierauf, Robert J. and Richard Grosse

Whitehouse, Gary E.

Wiest, Jerome and Ferdinand Levy

Yudl, Gary
1971 Decision making in a changing world. Edited by staff of innovation. Auerbach, Princeton.
1964 Planning and scheduling with PERT and CPM, programmed text. ENTELEK, Inc. Massachusetts