AN ANALYSIS AND COMPARISON OF SELECTED PROJECT MANAGEMENT TECHNIQUES AND THEIR IMPLICATIONS FOR THE INSTRUCTIONAL DEVELOPMENT PROCESS

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ABSTRACT

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Training products must be introduced quickly to be economically advantageous to the corporation. This has emphasized a problem in the instructional development process, broadly based in the allocation of resources. What tools are available to an instructional developer to aid in the timely design, development, and production of a training product? If ineffectual project management results in the delay of product delivery, the product may be less than effective. The results of missed deadlines in the corporate environment equate to a loss in profits.

The purpose of this study was to collect baseline data concerning problem variables affecting the management of instructional development projects. This foundation will exist for future research in the area of allocating resources in instructional development projects. The problem variables, which affect time and cost resources allocated to the development of instructional products, are important for further research in the application of project management techniques to instructional development projects.

Specific research questions were developed to focus on the seven selected project management techniques and the

similarities and differences among their functions, specific purposes, and components. Components from across these selected project management techniques were chosen for creating a synthesized project management technique to better track and control instructional development resources.

The case study methodology was used to point out problem variables. In order to ensure the collection of similar data from each of the four case studies, an interview guide containing 80 questions was developed. In-person, audio-taped guided interviews were conducted with project managers and instructional developers from each of the four participating companies.

The findings of the study show that companies do not use just one project management technique to track and control their resources. A merging toward a synthesized project management technique in the practice of instructional development has already begun. A synthesized, tailored project management technique has been developed in order to provide a basis for further research.

DEDICATION

This dissertation is dedicated to my daughter,
Alexis Christine Dingman.

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I would like to express my appreciation to the many people who have assisted me in this project.

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PROBLEM

The purpose of this study is to research the effective and efficient application of project management techniques to instructional development projects. Concepts, processes, and relationships from selected project management techniques are derived, and then used to design a synthesized project management technique tailored to track and control resources for instructional development projects.

Statement of the Problem

Although many view the transition from an industrial society to an information society as a recent turn of events, the movement in this direction actually began over three decades ago. By 1956, white-collar workers outnumbered blue-collar workers and for the first time more Americans worked with information than in the production of goods. In the following year, the Russians launched the satellite Sputnik and the space age began; more significantly the era of satellite communications transformed the world into what Marshall McLuhan later referred to as the "global village." The transmission and receipt of information could no longer be delayed.

Harvard sociologist, Daniel Bell (1976) referred to these pivotal years of 1956-57 as the "post-industrial society." The post-industrial society has rapidly evolved into its own era, no longer associated with its predecessor, the industrial society. It is more accurately referred to as an information society within its own right.

In this society the creation, processing, and distribution of information is critical. As Peter Drucker (1980) notes, "The productivity of knowledge has already become the key to productivity, competitive strength, and economic achievement. Knowledge has already become the primary industry, the industry that supplies the economy the essential and central resources of production" (p. 16). Society's strategic resource is information, not simply a single resource, but society's most important one (Bell, 1976).

John Naisbitt (1982) describes in detail the following ten trends that are driving today's American society:

1. Our economy is shifting from an industrial base, to a foundation in the creation and distribution of information.

2. Simultaneous movement in the dual directions of high tech and high touch balances the use of each new technology with a human element. For example, a continuing education program might balance the high tech use of instructional video tapes with the high touch element of small group discussions.

3. As part of a global economy, America must move on. The notion that the United States needs to remain the world's industrial leader must be relinquished.

4. Long-term time frames must prevail over short-term. American managers cannot continue to sacrifice the future of their companies in order to make "this" year appear profitable.

5. In a movement from centralized control to a more decentralized power structure, we have rediscovered the ability to be innovative from the bottom up; achieving results.

6. In all aspects of our lives, we are shifting to self-reliance rather than relying on institutional help.

7. The framework of representative democracy has become obsolete in an era of instantaneously shared information. Since we are as well informed as our representatives and receive information in a timely manner, the trend is toward a participatory democracy.

8. We are moving away from hierarchical structures in favor of informal networks.

9. There is a movement away from the traditional industrial cities of the North towards cities in the South and West.

10. We are moving from an either/or society with limited options to a free-wheeling multiple-option society (p. 1).

Many of these trends reflect the movement towards an information society. Information, knowledge, and creativity form the critical resources in an information society. All of these items are found in a single key resource; humans. Of Naisbitt's ten trends, those impacting most significantly the movement toward an information society are: (a) an economy based on information, (b) the movement away from an industrial society to a more global economy, and (c) movement away from traditional industrial cities of the North.

Acceleration in the rate of change occurs in moving from an industrial to an information society. As Naisbitt (1982) points out:

> While the shift from an agricultural to an industrial society took 100 years, the present restructuring from an industrial to an information society took only two decades. Change is occurring so rapidly that there is not time to react; instead we must anticipate the future. With the new information society, then, there is a change in time orientation as well.
>
> In our agricultural period, the time orientation was the past. Farmers learned from the past how to plant, how to harvest, and how to store. The time orientation in an industrial society is *now*. Get it out, get it done, *ad hoc*, the bottom line and all that. (p. 18)

Naisbitt further states that time orientation in an information society is the future. For the present, we must learn how to anticipate the future. The areas of instructional development and project management are vital to an information society whose charter is to act proactively.

Instructional development is critical to the charter because anticipating the future will include forecasting training needs and beginning to develop appropriate instruction. Project management will ensure that training products are available when the future becomes today.

One reason for the acceleration and the need to look toward the future is what Naisbitt terms the "collapsing of information float." Communication is the lifeblood of an information society. A simple communication model is composed of a sender, a communication channel, and a receiver. As technology advances, the flow of information through the communication channel accelerates. The amount of time information spends in the communication channel (information float) -- for example, pony express versus Federal Express or electronic mail -- lessens (collapses) as technology advances. The sender and receiver may be on opposite sides of the continent, but the contract can still be signed, sealed, and delivered in a matter of minutes via facsimile machines; thus, business practices hasten. The sender and receiver of information are brought closer together, lessening turnaround time and collapsing information float.

Technological advances are a major contributing factor to the pace of our new society. There is now the capability and need to disseminate information at a rate like never before. Alvin Toffler (1980) writes:

> In engineering, in manufacture [sic], in research, in sales, in *training* [italics added], in personnel, in every department and branch of the corporation the same quickening of decision-making can be detected....The results of this generalized speedup of the corporate metabolism are multiple: *shorter product life-cycles* [italics added], more leasing and renting, more frequent buying and selling, more ephemeral consumption patterns, more fads, *more training time for workers (who must continually adjust to new procedures)* [italics added] more frequent changes in contracts, more negotiations and legal work, more pricing changes, more job turnover, more dependence on data, more ad

> hoc organization -- all of it exacerbated by inflation. (p. 230)

By the time students in high technology majors (i.e., engineering) graduate from professional programs their knowledge is already obsolete.

Training is a major product of an information society and as Toffler indicates, the hastening of the pace in the corporate environment is leading to a shorter product life cycle. Workers must be continually trained to keep up with the latest systems brought about by technological advances.

Corporate America is spending billions of dollars to train and educate its workforce. There are three major reasons for this spending: (a) illiteracy, (b) fewer workers entering the workforce, and (c) continually changing job requirements.

Educating 23 million functionally illiterate adults, who can not read at the fourth-grade level, is a primary reason for this spending. Another 30 million cannot read at the ninth-grade level.

According to a 1980 joint study between the U.S. Department of Education and the National Science Foundation, most Americans are moving toward "virtual scientific and technological illiteracy." Over half of the jobs created over the next decade will require education beyond high school, yet thirty percent of students who enter high school do not graduate (Galagan, 1988).

Schools in the United States lag behind the USSR, Japan, and Germany, because of a shortage of qualified high school science and math teachers and college-level computer science and engineering instructors. There has been a downward trend in SAT scores over the last two decades. According to Naisbitt (1982), "The generation graduating from high school today is the first generation in American history to graduate less skilled than its parents" (page 31).

Schools turn out increasingly inferior products and corporations reluctantly enter the education business (Naisbitt, 1982; Galagan, 1988). Over 300 of the nations largest companies now operate remedial courses in basic math and English for entry-level workers. Although the demand for skilled workers is high, corporations are getting workers who cannot qualify for jobs that are already technologically obsolete. Galagan (1988) cites an example of changing skill requirements from the insurance industry:

> Five jobs -- messenger, file clerk, customer assistance clerk, claims adjuster, and policy writer -- have become one, thanks to technology. The "claims adjuster" now answers the phone, assesses the customers' needs, consults the computer for information on the nature and rates of insurance coverage the company offers, and writes a customized insurance contract using computerized policy writing rules. The skills for such a job are greater than any one of the original five jobs: communication skills, diagnosing customer's needs, and understanding and relating groups of information. (p. 27)

Secondly, the labor force growth rate is slowing because fewer graduates are available. Seventy-five percent of the workforce available for the year 2000 is already out of school. Baby-boomers are older, and as the population ages the supply of new labor will decrease. Workers will have to continually upgrade their skills over the course of their career. Rosabeth Moss Kanter (1989) writes:

> Even where companies *want* to keep the same employees long term and promise them a job for life, they can only afford this is [sic] they keep people growing and learning through elaborate retraining, as IBM did to avoid layoffs in 1985--in short, keeping them *employable* within the same corporation. Continuing upgrading of skills and pursuit of new opportunities is a lifelong proposition even inside a single corporation. Of course, it is essential in the wake of restructuring. (p. 322)

Finally, technology eliminates some jobs and creates others. Job requirements typically change every 12 to 18 months, creating a constant need for training. This can be verified throughout the literature. Kanter (1989) writes:

> Education and training, continuing education and retraining, have to be at the top of the agenda. If an educated workforce has been America's number-one asset in the past, it is even more critical in the rapidly changing world of the global corporate Olympics, in which innovation renders old skills obsolete and requires new ones, including the professional knowledge to produce those innovations. Training needs must be addressed both inside and outside of industry. (p. 365)

Tom Peters (1987) agrees:

> ...That is, as the pace of change picks up, the rate at which skills become obsolete--for scientist, machine operator, and actuary alike--is quickening. The customer prescriptions featured value added through quality, service, and responsiveness; factory/operations center hands and sales and service people are the necessary heroes. The innovation prescriptions were clear--*everyone* must innovate. Everyone *must* be prepared (1) to contribute ideas and (2) work together with less supervision. And only constant training will provide the basis for constant adaptation. (p. 388)

This "constant adaptation" Peters refers to will be critical to surviving in the continually changing information age.

According to predictions made by the United States Department of Labor, over the next 12 years as many as 50 million workers will be trained or retrained. In an interview (March, 1988), Ann D. McLaughlin, head of the Department of Labor under President Reagan, was quoted:

> We are facing dislocation of workers, particularly men who have been in the heavy industries and now need retraining to move into other industries. ... We see the increase in immigrants and minorities and women into the work force, which means, again, retraining and training. People today, ... are probably going to have a career change -- not just a job change -- four times in their lifetimes. (p. 9A)

The career changes McLaughlin refers to are a result of our constantly changing society. As John Naisbitt and Patricia Aburdene (1985) write: "In the new information society where the only constant is change, we can no longer expect to get an education and be done with it. There is no one education, no one skill, that lasts a lifetime now" (p. 141). In an industrial society, the ending or changing of a job or career is devastating; in an information society, these changes will become the norm. New and revised education and training products will be in constant demand, so their developmental turnaround time will be an issue.

Training products must be introduced quickly to be economically advantageous to the corporation. This emphasizes a problem in the instructional development process. Resource allocation is the base of this difficulty.

What tools are available to the instructional developer to aid the timely delivery of a particular training product? If the mark is missed completely due to ineffectual project management design, development, or production, the delivered product may be outdated. Missed deadlines in the corporate environment mean lost dollars. An example of wasted resources on an instructional development project, using interactive videodisc, is found in Clara Steier's dissertation (1987):

> This researcher knows of an instance where a government agency undertook the production of a videodisc without prior experience. After identification of the tasks, they proceeded to shooting of each task in a sequence. Seven weeks were spent in shooting and fifteen months in editing before the project was aborted and started over. The lack of planning and record keeping made editing of the disc impossible. (p. 26)

Another example of time and money lost resulting from the lack of accurate advanced project planning is found in Steier's discussion of the Parsloe, *et al.* Level 3 interactive videodisc research. She writes:

> First, no guidance is given on how to cost design variables or to judge time. The guidance is merely that of content categories. Secondly, the authors presume costing will be accomplished in phases providing insight to management on cost variables and a more accurate assessment of time as the project progresses. However, most projects for industry and government often require the submission of a firm-fixed price for the total project before any work is begun. Such costing is prone to severe errors in judgement because it is often undertaken without benefit of a content analysis or a design specification which could provide some insight. (p. 34)

It is important to solve the problem of inadequate resource allocation now, because as the speed of developing technology and tools accelerates, new courses will need to be developed even faster. If Steier's research is correct, and developmental resource planning continues to be inaccurate, more money will be added to the cost of training products. This will result in higher implementation costs for the new technology. In turn, the high cost will limit the number of people who will be able to benefit from that technology; therefore, timely development of training materials is imperative.

Purpose of the Study

The purpose of this study is to collect a base level of knowledge concerning problem variables that affect the management of instructional development projects. As a result, a foundation will exist for further research in the area of allocating resources in instructional development projects. Variables which affect time and cost resources allocated to the development of instructional products are important to furthering research in the application of project management techniques to instructional development projects.

This study consists of three parts: (a) to determine how selected instructional development models account for project management tasks; (b) to determine how various project management techniques vary in their functions, specific purposes, and components, and; (c) to employ this information to aid in the development of a synthesized project management technique, tailored to better track and control resources in instructional development projects. In turn, this synthesized technique can be used to raise empirical questions and provide necessary hypotheses that can be tested to deliver the instructional product in an efficient and effective manner.

In order to meet the training needs of a constantly changing information society, instruction will need to be developed efficiently and effectively. The project management techniques being studied are purported to serve that purpose, both for education and training.

Relevance to Educational Technology

Efficiency and effectiveness are underlying themes in instructional development literature. They are the driving force for instructional developers and the yardstick by which results are measured. Efficiency is emphasized perhaps partly due to the funding problems often faced by educators and training groups. As Ivor Davies (1984) writes: "The important thing is that efficiency implies a sense of direction and good organization. Instructional development must be concerned with efficiency, ... However, efficiency does not imply effectiveness..." (p. 9). He defines effectiveness as being:

> ... concerned with doing the right things with the right things that need to be done.... If developers fail to manage development properly, so that learners fail to achieve required levels of mastery, then instructional development has been

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> ineffective -- no matter how efficient it might be. (p. 10)

Davies continues:

> In order to be effective, developers must make effective decisions. Learning needs must be identified, resources arranged, methods chosen, motivation harnessed, progress monitored, and plans for improvement implemented. These are time-consuming tasks for developers to undertake. Yet they are essential ones, if effectiveness is to be obtained. (p. 10)

He explains that if developers are going to be effective, they must be:

1. Sensitive to the needs of the task, as well as to the learners who must accomplish that particular task.

2. Diagnosticians in order to determine requirements, so that mastery can be achieved.

3. Decision-makers that will choose optimal learning designs without passing up unplanned opportunities.

4. Flexible in order to implement what the learning situation requires and vary development plans accordingly.

Davies writes: "All of this, of course, requires dedication and skill. Above all it involves a clear understanding of where time goes" (p. 10).

Davies' discussion of efficiency and effectiveness in instructional development is heavily dependent upon project management concepts. He mentions good organization, the proper management of development, arranging resources, taking advantage of unplanned opportunities, and being cognizant of the passage of time, as important factors in efficient and effective instructional development; however, the question remains, "Where are instructional developers provided with project management guidelines?"

Instructional development models often contain steps to "organize management" or "manage resources," but do not contain detailed instructions for executing the management phase, as they do, for example, in the design phase for writing objectives.

Conversely, the project management literature doesn't account for specific instructional development concerns. As Elliot King (1987) writes:

> Project management itself has been widely seen as an engineering and construction discipline with a confusing jargon all its own.... project management has suffered from a more fundamental problem as well, "It is not stressed as a management discipline," observes Daniel Fishman, executive vice president of NDC systems ... "Managers do not understand the concepts. They want to see plans but don't understand there is a scientific approach to developing them. And they don't understand why this approach should be used. (p. 136)

Thus, it is useful to bring together the disciplines of instructional development and project management, in order to research the effective and efficient application of project management techniques to instructional development projects.

Theoretical Base

Efficiency and effectiveness are critical to both instructional development and project management. The theoretical foundation for research based on these concepts can be found in organizational theory. In applying project management techniques to instructional development projects, an understanding of this theory is necessary to provide a basis for the application. According to Richard Johnson (1967), "The business organization is a social, or man-made system. It is only through the process of *organization* that the vast complex of men, materials, machines, and other resources are combined into an efficient, effective, and viable business enterprise" (p. 44).

Organizations, according to Talcott Parsons (1960) are "social units (or human groupings) deliberately constructed and reconstructed to seek specific goals" (p. 17). Educational institutions and corporations may both be categorized as organizations. The specific goals of the organization serve as the standard for the measurement of success. A specific organization measures its effectiveness by the degree to which its goals are realized. Efficiency is measured by the amount of any resource used to produce a unit of output. This output is closely related to the organizational goals (Etzioni, 1964, p. 8).

An instructional development team (the organization) has the specific goals of designing, developing, and producing a training product. The team's effectiveness is measured by that training product. Project management, in turn, deals with the amount of resources consumed (efficiency) during the design, development, and production of the training product. Project management techniques are central to efficiency and effectiveness in instructional development.

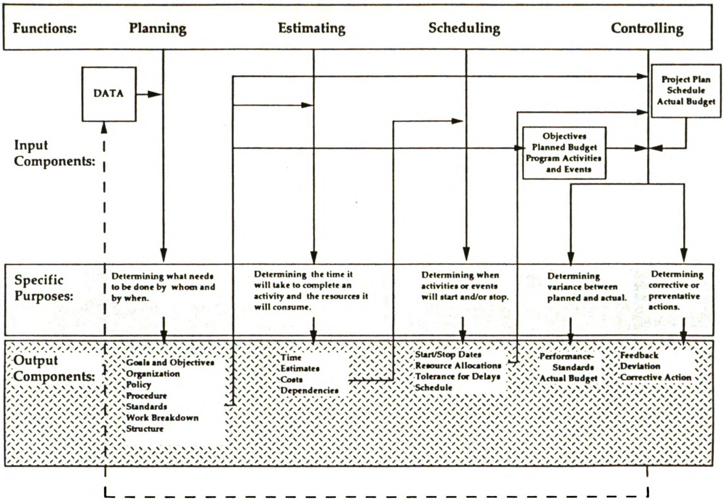
Research Questions

The discussion of organizational theory leads to the two broad questions to be answered, with three more specific questions resulting from the broad questions.

A. How do the selected project management techniques differ in their functions, specific purposes, and components?

Each of the selected project management techniques (i.e., Critical Path Method (CPM), Decision Critical Path Method (DCPM), Gantt charts, Graphical Evaluation and Review Technique (GERT), milestone charts, Precedence Diagram Method (PDM), and Program Evaluation and Review Technique (PERT)) have the same general purpose; to control resources. All of these techniques control resources through a set of functions, generically defined as: (a) planning, (b) estimating, (c) scheduling, and (d) controlling. This set of functions is common to all of the selected project management techniques (see Figure 1).

Each function is composed of a specific set of purposes as presented in the middle row of Figure 1. For example, verification and decision-making are two specific purposes found in the controlling function. The specific purposes each employ two types of components; input and output. Each of these specific purposes and input-output components are emphasized to varying degrees, depending on the selected project management technique.



General Purpose: Control Resources

Figure 1

Project Management Technique

From the first broad question, two specific questions are derived:

1. **How are selected project management techniques different or similar in their support of project management functions?**

Each project management technique studied emphasizes the various general functions to different degrees. For example, PERT emphasizes the controlling function. Considering alternatives and making action plans (decisions) based on alternatives is a focal point in this technique. In contrast, Gantt charts highlight the planning function. They are not used for considering alternative actions, but rather to plot specific activities or events against time or money. As a result, not only do the functions vary in their emphasis of specific purposes, but also in their focus on various input-output components.

2. **In terms of advantages and disadvantages, how do project management techniques differ in emphasis with respect to their specific purposes?**

PERT and Gantt charts are two selected project management techniques. The emphasis is placed on the controlling function, with respect to its specific purpose of decision-making. For example, while a PERT diagram results in a network diagram that illustrates interdependencies, Gantt charts are not networks and do not show interdependencies which are critical to the controlling function. PERT diagrams can be very valuable in predicting the impact of delaying the start of any given task, while the Gantt charts provide little predictive value.

The second broad question to be answered follows:

B. Which combination of these components, from across selected project management techniques, can be applied most efficiently and effectively to instructional development projects?

Evaluation is critical to the instructional development process. Many instructional development models provide for feedback at each stage of the process. The output component, feedback, from the decision-making purpose may be particularly important in the application of project management techniques to instructional development projects.

The specific question generated from this broad question is:

3. Which components, from across selected project management techniques, could most logically be incorporated into a synthesized project management technique; designed to better track and control instructional development resources?

To illustrate, one component of the planning stage is to write objectives. Some project management techniques may emphasize this component more than others. Because this component is important to the instructional development process, it may be incorporated into a more effective and efficient synthesized project management technique, tailored to track and control instructional development resources.

Assumptions

There are several assumptions that have been made in this research:

1. The application of case study methodology meets the research objective.

2. Those interviewed accurately described their activities and actions in the instructional development process.

3. The researcher's bias has been controlled through the use of the guided interview and the examination of pertinent case documentation.

4. The selected training groups are representative of "typical" groups meeting the selection criteria.

5. The study will generate variables acting upon efficient and effective delivery of instructional development products.

Limitations

There are several limitations to this study. First, in reviewing the literature, only selected research studies that meet the following criteria were considered: (a) The study must include at least one of the project management techniques being used in this study. (b) The selected research must meet the criteria for reliability and validity as outlined in Walter Borg and Meredith Gall (1983) and Donald Campbell and Julian Stanley (1963) (See Appendix A). There is a vast amount of literature in this field; therefore, the writer was necessarily selective in choosing existing representative research.

Secondly, there are a number of project management techniques that were not included in this study. The results of that body of literature are not considered within the scope of this research. This study only considers Critical Path Method (CPM), Decision Critical Path Method (DCPM), Gantt charts, Graphical Evaluation and Review Technique (GERT), milestone charts, Precedence Diagram Method (PDM), and Program Evaluation and Review Technique (PERT) due to time and other resource constraints.

Third, there are only a small number of cases included in this study; therefore, every project management technique is not sampled in the case study process. However, each case study presented employs a different project management technique. Only the selected project management techniques listed above have been sampled. This may result in overlooking problem variables which affect the total project resources.

Fourth, the proposed tailored, synthesized project management technique has been designed specifically for instructional development projects and the outcome will not necessarily be valid for other types of projects.

Finally, the research is not generalizable without further research that has been completed with proper sampling techniques and specific hypotheses.

Definition of Terms

Activity

A part of a project that consumes resources and has a definite beginning and end is an activity. This term is synonymous with the terms *task* and *job*.

Arrows and Nodes

In diagramming a project management schedule (e.g., PERT and CPM Networks), arrows are often used to represent activities, while nodes (usually circles) are used to represent events.

Case Record

A case record organizes the volumes of data into a comprehensive, primary resource package. It includes all of the major data which will be used in doing the case analysis and case study. The information has been edited, redundancies omitted and the pieces assembled together in order (Patton, 1980).

Case Study

A case study is a recognized method of inquiry defined as an "in-depth investigation of a given social unit resulting in a complete, well organized picture of that unit" (Issac & Williams, 1979, p. 20).

Crisis Training

Crisis training is defined by Beverly Geber (1988) as having "to react to a sudden training need. You have much less time than you need to prepare a training program from scratch, and a lot more people to train than you'd like to train" (p. 41).

Critical Path Method (CPM)

The Critical Path Method (CPM), designed for construction projects, is a network technique focusing on the trade-offs between project costs and project completion dates. The technique allows for planned variation in the duration of a project. The variation is planned through the assignment of resources. The goal of the technique is to discover the least cost schedule (Weist and Levy, 1977). CPM proponents argue that most jobs consume less time if additional resources (e.g., personnel, money, or machines) are applied to the project.

Decision Critical Path Method (DCPM)

The Decision Critical Path Method (DCPM) emphasizes choosing between alternative paths leading to a single project goal. The project network contains sets of tasks to be completed, their duration and precedent relationships, and information leading to alternative groups of tasks. Each group is a mutually exclusive approach to the project, one of which must finally be chosen (Weist and Levy, 1977).

In this technique, jobs are shown as circles. Choices or alternatives are shown as decision nodes represented by triangles.

Documentation

Documentation is any written material or project records given to the researcher for examination, for example, a PERT diagram of the project being studied.

Dummy Activity

An arrow only representing the dependency of one activity on another without the consumption of resources is a dummy activity. A synonymous term is a *dependency arrow*. Dummy activities are usually represented by dotted lines.

Events

Events are the beginning and ending points of activities. *Nodes* and *connectors* are synonymous terms.

Gantt Charts

The Gantt chart is a process oriented two dimensional bar chart displaying activities and events in relation to time or money. The activities and events are listed along a vertical axis to the left of the chart. They are plotted against a horizontal scale usually consisting of time elements (most often days or months). An alternative form of Gantt charts plot the activities and events in relation to the money they consume.

The Gantt chart, often referred to as a bar chart, displays one bar representing the planned duration and time frame of a particular task. Another bar, shown in a different color or hatching pattern, shows the actual progress made toward any given task.

General Interview Guide

A general interview guide contains a set of issues or topics to be explored with each respondent. It is outlined before the interviewing begins. During the actual interview, the interviewer adapts both wording and question sequence to specific respondents (Patton, 1980).

Graphical Evaluation and Review Technique (GERT)

Graphical Evaluation and Review Technique (GERT) is a probabilistic network with a variety of node types. These nodes have both an input and output side that are characterized by certain logical relations connecting jobs or tasks. There are two different output sides that determine the type of branching that will result from the node. One type of branching, deterministic, is used when all activities emerging from the node are used. The second type, probabilistic, is used when only one of several emerging activities will be performed (Weist and Levy, 1977).

Instructional Development Process

According to the Association for Educational Communications and Technology (AECT) (1979), the instructional development process is "... a systematic approach to design, production, evaluation, and utilization of complete systems of instruction, including all appropriate components and a management pattern for using them."

Networks

Networks or arrow diagrams are graphic representations of project plans. Networks show the interrelationships between various activities. A project schedule is a network that includes time estimates.

Milestone Charts

Milestone charts are product oriented displays. Milestones are specific accomplishments which result from resource consumption. The milestone chart lists activities and events along a vertical axis. Discrete points or milestones are plotted in relation to time. Various symbols are used to distinguish between scheduled and achieved milestones.

Milestone charts do not show interdependencies between events and activities.

Precedence Diagramming Method (PDM)

The Precedence Diagramming Method (PDM) is an extension of the Critical Path Method (CPM). In typical PERT or CPM project management techniques, there is only one type of precedence relationship; a finish to start (FS) relationship. In this relationship, the task leading into a node must be completed before any task emerging from the node can begin. In PDM three other relationships are possible, start to finish (SF), start to start (SS), and finish to finish (FF). PDM incorporates alternate relationships and allows a lead-lag quantity to be associated with any of the relationships.

(Lead-lag is the minimum time involved in the relationship between two tasks (Weist and Levy, 1977).)

Program Evaluation and Review Technique (PERT)

Program Evaluation and Review Technique (PERT) is a networked-based management tool providing planning, estimating, scheduling, and controlling of resources required to meet program objectives. Its applications are primarily research and development projects.

Each activity in the network incorporates three estimates to arrive at an expected value. These three estimates; most probable, pessimistic, and optimistic time estimates, are combined in a weighted formula to arrive at a time estimate used in the PERT diagram.

Project

A project is a set of activities directed toward a specific goal or objective, which will be completed within a finite time period. Resources will be consumed in this process (Kerzner, 1984, p. 21).

Project Management

According to Kerzner (1984):

> Project management is the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives. Furthermore, project management utilizes the systems approach to management by having functional personnel (the vertical hierarchy) assigned to a specific project (the horizontal hierarchy). (p. 4)

Moder, Phillips and Davies (1983) make the distinction that a project is "a one-shot deal." Although projects may have similarities, they are not being repeated in an identical manner. This results in continually replanning and changing the schedule due to unexpected delays.

Project Management Functions

There are four identified project management functions: (a) planning, (b) estimating, (c) scheduling, and (d) controlling.

Planning is a continual process, and includes determining which tasks must be done to meet project objectives; communicating these tasks to others so appropriate action may be taken within an appropriate time frame, and the effective use of resources over an entire project life cycle.

The planning of resources includes time, money, personnel, and materials; a schedule of activities results. In planning money, budgets are created. Human resource matrices and manpower loading charts are the results of manpower planning. Materials become tied to a budget, if new materials are bought or the allocation is made of physical resources to different activities over the project life cycle (Roman, 1986).

Estimating is an activity resulting in an educated guess of the time and money needed for task completion, including determining the resources an activity will consume.

Scheduling determines when activities and accomplishments will begin and end.

Controlling is the action taken to resolve conflict. It may be a preventative or corrective action, but the action is based on analysis and evaluation. Controlling is rooted in the plan of the project. Time, money, human, and material resources are monitored so projects are carried out according to plan (Roman, 1986).

Purposeful Sample

Purposeful sampling is a strategy used to learn and understand components of select cases without generalizing to all cases. Certain information must be known about the case before it is studied (Patton, 1980).

Resource Loading

Rescheduling tasks not on the critical path to another time period so that resources can be used to their maximum efficiency is referred to as resource loading.

Resources

Project resources include machines, money, personnel, materials, and time.

System

Robert Heinich (1979) defines a system as "a process which synthesizes and interrelates the components of a process within a conceptual framework, insuring continuous, orderly, and effective progress toward a stated goal."

Technology

Y.R. Simon (1983) defines technology as "a rational discipline designed to assure the mastery of man over physical nature, through the application of scientifically determined laws" (p. 173).

Training

Training can be defined as learning experiences or activities designed to facilitate, strengthen or improve performance on the job.

Significance of the Study

The degree to which the completion of an instructional development project is adequately planned, estimated, scheduled, and controlled will affect those who have access to new technologies, due in part to the cost of the training. This study will be significant to educational institutions, corporations, and governmental training agencies developing instructional projects because it provides a synthesized, tailored project management technique for instructional development projects. In turn, it will reduce missed deadlines and provide more accurate required resource estimates. This helps ensure effective and efficient delivery of instructional development projects.

Organization of the Study

Chapter II contains a review of selected literature and research. Reference is made to information concerning: (a) systems theory, (b) the philosophy of technology, (c) model design and analysis, (d) project management, and (e) instructional development. Chapter III describes study methodology, including the research design, sample, instrumentation, data collection, and analysis. The results of the investigation and a discussion of the results are contained in Chapter IV. Chapter V summarizes the study's findings and presents conclusions, recommendations, and reflections.

Summary

Training products must be quickly introduced to be economically advantageous to the corporation. This has emphasized a problem in the instructional development process, broadly based in the allocation of resources. What tools are available to an instructional developer to aid in the timely design, development, and production of a particular training product? If ineffectual project management causes product delay, the delivered product may be ineffective. The results of missed deadlines in the corporate environment mean lost profit.

The purpose of this study is to collect a baseline level of knowledge concerning problem variables affecting the management of instructional development projects. This foundation will exist for further research in the area of allocating resources to instructional development projects. The problem variables, which affect time and cost resources allocated to the development of instructional products, are important for further research in the application of project management techniques to instructional development projects.

CHAPTER II

REVIEW OF LITERATURE

This chapter, which is divided into five sections, presents a review of the literature related to: (a) systems theory, (b) the philosophy of technology, (c) model design and analysis, (d) instructional development models, and (e) project management techniques.

Project Management and Instructional Development as Systems

General System Theory is an important element in the foundations of project management and instructional development. In order to discuss the relationships between these fields, it is appropriate to begin with an overview and historical background of General System Theory and its basis in these disciplines. From that point, key concepts will be defined and brought to light in the areas of project management and instructional development.

In 1951, Ludwig von Bertalanffy, a biologist, founded General System Theory by illustrating the concept with respect to biological organisms. General System Theory is defined by von Bertalanffy (1968) as:

> A logico-mathematical field whose task is the formulation and derivation of those general principles that are applicable to systems in general. (p. 253)

This discipline establishes some general principles applied across systems to provide a foundation for integration into larger systems. This discussion evolves from the key term "system." A system, as defined in broad terms by Jere Clark in a 1977 article, is "a set of interrelated elements functionally integrated into a working whole so as to achieve some purpose" (p. 37).

The term's definition is tailored to a project management and instructional development discussion. A more specific definition of a system is Robert Heinich's, which defines a system as "a process which synthesizes and interrelates the components of a process within a conceptual framework, insuring continuous, orderly and effective progress toward a stated goal" (Association of Educational Communications and Technology [AECT], 1979). This definition of a system can be incorporated into the definitions of project management and instructional development to illustrate their common system functions, while maintaining their individual functional characteristics. Each discipline can then be reconciled as a system.

This can be done with the field of project management through Harold Kerzner's (1984) definition:

> Project management is the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives. Furthermore, project management utilizes the systems approach to management by having functional personnel (the vertical hierarchy) assigned to a specific project (the horizontal hierarchy). (p. 4)

Therefore, project management is a "system" making orderly and effective progress toward its stated goal of planning, organizing, directing, and controlling company resources, toward completing specific, relatively short-term goals and objectives.

Instructional development, according to AECT (1979), is "... a systematic approach to design, production, evaluation and utilization of complete systems of instruction, including all appropriate components and a management pattern for using them." This definition of instructional development can be merged with the term "system," as a systematic process that makes orderly and effective progress toward the goal of designing, producing, evaluating, and utilizing complete instructional systems.

In each case, the system is interweaving processes and components, whether project management or instructional development processes, and the components are moving in a stated direction.

The two systems being discussed, project management and instructional development, clearly work within a larger framework. General System Theory provides a mechanism to bring the distinct areas of project management and instructional development together. For example, project management techniques can be used to develop courseware. They may be viewed as being composed of subsystems working within an environment or completed system integrated into a suprasystem. The subsystem, the system, and the suprasystem are viewed as a complete picture.

Clark defines a subsystem as "the clearly defined parts or components making up a system" (p. 37). Von Bertalanffy originally defined subsystem in anatomical terms. His illustrative analogy is a human being viewed as a system. The system (the human), is composed of subsystems, such as the circulatory system, skeletal system, and nervous system. Each subsystem specializes in one function, yet it is still integrated into the whole human being. This analogy allows better understanding of subsystem interrelationships and an overall knowledge of system operations. For subsystems to achieve overall system integration, they must be able to communicate efficiently and effectively; however, communication may be a problem.

In 1956, Kenneth Boulding described communication problems during the integration of systems. Subsystem specialists, each having their own jargon, were able to communicate among their own specialty groups efficiently and effectively to achieve the desired results, but communication between specialty groups was ineffective. Boulding advocated that subsystem specialists needed a common language to execute successful joint ventures. For example, mathematics is a common language to physicists, economists, and chemists. Boulding proposed all scientific areas can be grouped according to their level of development. He suggested nine levels:

1. The first level is that of static structure. It might be called the level of frameworks; for example, the anatomy of the universe.

2. The next level is that of the simple dynamic system with predetermined, necessary motions. This might be called the level of clockworks.

3. The third level is the control mechanism, or cybernetic system, which might be nicknamed the level of the thermostat. The system is self-regulating in maintaining [its] equilibrium.

4. The fourth level is that of the "open system" or self-maintaining structure. This is the level at which life begins to differentiate from not-life; it might be called the cell.

5. The next level might be called the genetic-societal level; it is typified by the plant, and it dominates the empirical world of the botanist.

6. The animal system level is characterized by mobility, teleological behavior, and self-awareness.

7. The next level is the "human" level, that is, of the individual human being considered as a system with self-awareness and the ability to utilize language and symbolism.

8. The social system or systems of human organization constitute the next level with the consideration of the content and meaning of messages, the nature and dimensions of value systems, the transcription of images into historical record, the symbolizations of art, music, and poetry, and the complex gamut of human emotion.

9. Transcendental systems complete the classification of levels. These are the ultimates and absolutes and the inescapables and unknowables, and they also exhibit systematic structure and relationship. (Kerzner, 1984, p. 59)

These nine levels can be grouped into three broader categories. The first three levels: frameworks, clockworks, and thermostat provide input to the physical sciences; such as physics and chemistry. The next three: the cell, the genetic-societal, and the animal system level are descriptive of the biological sciences; such as, biology, zoology, and botany. The final three levels: the human level, the social system; and the transcendental system provide input into the arts and social sciences, such as, humanities and religion.

Boulding (1956) explores the problem of communication among all scientists. He writes; "communication between the disciplines becomes increasingly difficult" due to the division into subgroups. The growth of total knowledge is deterred by the loss of meaningful communication. A solution to this problem is the development of a generalized framework on which to "hang" our specific bits of knowledge:

> It is one of the main objectives of General Systems Theory to develop these generalized ears, and by developing a framework of general theory to enable one specialist to catch relevant communications from others. Thus the economist who realizes the strong formal similarity between utility theory in economics and field theory in physics is probably in a better position to learn from the physicists than one who does not. Similarly a specialist who works with the growth concept -- whether the crystallographer, the virologist, the cytologist, the physiologist, the psychologist, the sociologist or the economist -- will be more sensitive to the contributions of other fields if he is aware of the many similarities of the growth process in widely different empirical fields. (p. 4)

Thirty years later, references to this type of concern are still prevalent. Paul A. Strassmann (1985), in his book

Information Payoff: The Transformation of Work in the Electronic Age, is still predicting a need for change to more "generalized ears."

> Professional and technical people will change their current roles as specialists, controlled in every respect by their coordinators-managers, to become generalists who include many traditional managerial functions in their everyday work. (p. 198)

As technology continues to develop, so does our need for a General System Theory.

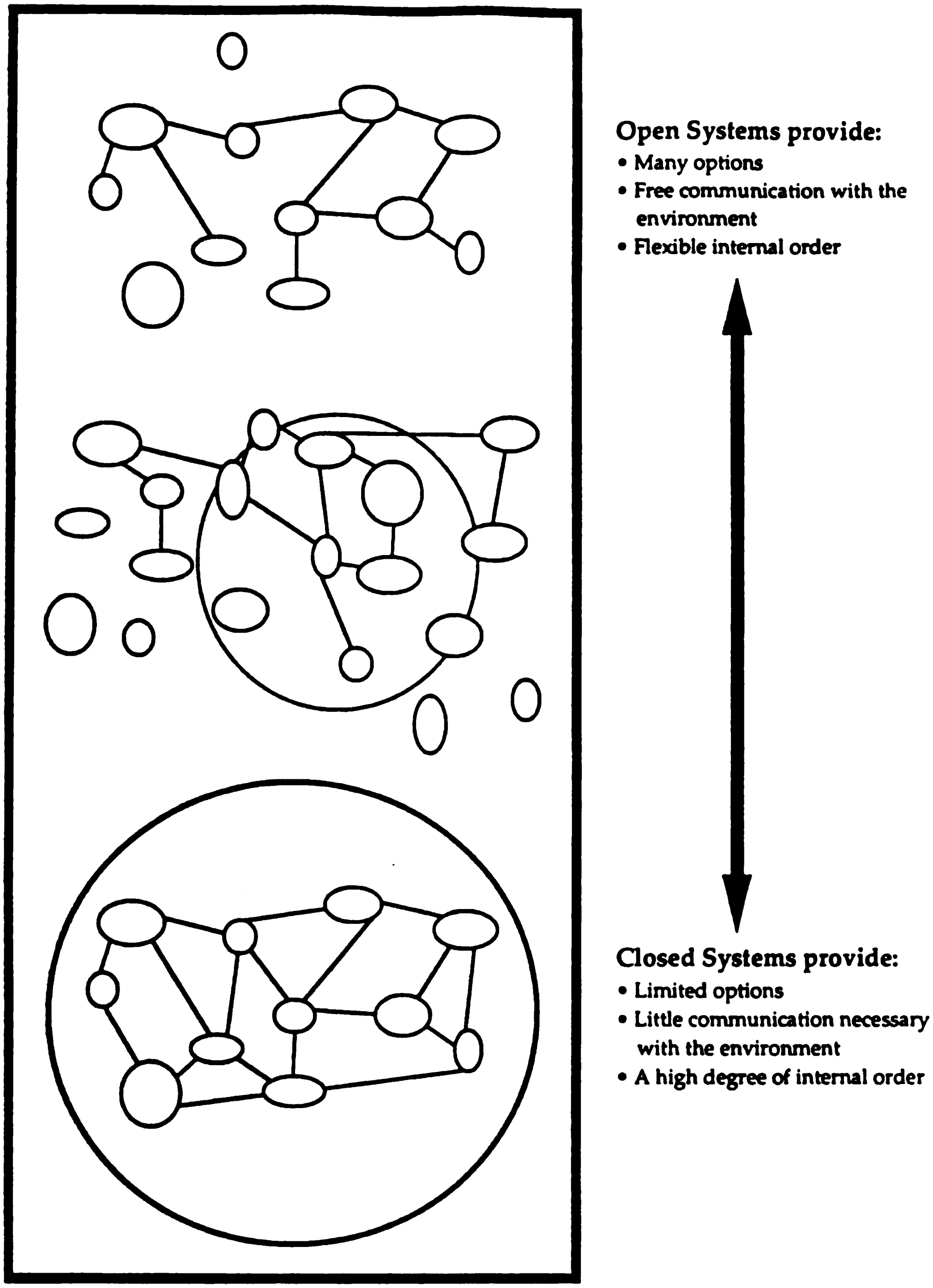
The suprasystem or environment of a system can be defined as "those factors relevant to a specific system, but outside of the direct influence of the system" (Delp, 1977, p. 69). An illustrative example is a human being, defined as the key system, with clearly definable boundaries. (The key system can be defined as the focal system under consideration.) The sound of thunder would be relevant to the system (his concentration), but outside his direct influence. Hence, weather conditions are illustrative of a suprasystem or environment within which a human being operates.

A key system can be open or closed. Although a completely open or closed system is non-existent, they may be defined in the following relative terms. An open system allows a relatively free flow of information across its boundaries, as illustrated in the top portion of Figure 2. It is adaptive because it is able to modify its structure to better suit its environment. At the opposite end of the continuum, closed systems severely restrict the flow of information, limiting interaction between itself and other systems in the environment. Systems may be viewed on a continuum between open and closed as shown in Figure 2.

System Stability

To describe system stability, the terms "steady state" and "equilibrium" are necessary. Every system has some mechanism to aid in maintaining its stability. Providing for system stability is similar to a thermostat maintaining constant room temperature. Furnaces and air conditioners are mechanisms used to maintain a comfortable room temperature. This is known as a "steady state." There is a continuous flow to support the constant temperature. The term "steady state" refers to a condition in open systems, where the system's composition remains constant, through a continuous flow and exchange of component material (Buckley, 1968, p. 18).

Equilibrium is characteristic of closed systems. Since a closed system does not allow a flow across its boundaries, it is in a constant state of equilibrium. A system is able to maintain stability through several means: (a) the changing of the environment, (b) the changing of the system, or (c) a combination of both the system and the environment changing. For example, as the weather changes to more frigid temperatures, the human being may wait for environmental factors to change (e.g., the sun to come out), the human system may take charge of the situation and put on a coat, or



Modified from William E. Hug and James E. King (1984)

Figure 2

Open and Closed Systems

a combination of events may occur and the system and the environment may change together.

An Adaptive System

An adaptive system, due to entropy, needs mechanisms for maintaining system stability. Entropy refers to a system's tendency toward increasing disorder (Weiner, 1967, pg. 20). The concept of negative entropy is defined by Wiener (p. 20-21) as "systems tend toward an increasing state of organization and differentiation."

"The processes and mechanisms by which systems resist entropy" is referred to as homeostasis (Weiner, p. 42). An adaptive system must be an open system capable of adapting to its environment to perpetuate itself. For a system to be adaptive it must receive feedback, "the property of being able to adjust future conduct by past performance" (Weiner, p. 47), from its surroundings and make appropriate adjustments.

Systematic Checks and Balances

The relationship among subsystems can be competitive or cooperative. "Allometry" describes "the measure of the competition among subsystems of a specific system for the same resources" (Bertalanffy, 1968, p. 66).

Milsum (1972) discusses the results of several subsystems using common resources. If individual subsystems do not follow the priorities of the overall system, but act to achieve the objectives of their subunit at the cost of the objectives of the total organization, suboptimization occurs.

The consequences of suboptimization are outlined by Milsum: "If particular subsystems of a larger system operate so as to optimize their own individual 'good' (performance indices), the net result will almost never be overall system optimization."

If suboptimization is allowed to continue until all of the system's common resources are consumed, the results can be the complete destruction of the system.

Key system results are greater than the observed results of each of the individual subsystems. This concept in General System Theory is known as synergy. Fuller (1970) defines synergy as the "behavior of whole systems unpredicted by the separate observed behaviors of any of the system's separate parts or subassembly of the system's parts" (p. 64). Synchronized energy is important to developing systems with tightly integrated components. The more integrated the components, the more synergistic the effect.

Alternative Solutions

Although there isn't a "best" system or "perfect" system, any system goal or objective may be achieved through several alternate means. The concept of equifinality is defined as "the same final state may be reached from different initial conditions and in different ways" (Bertalanffy, p. 40). In colloquial terms, equifinality has been expressed as "there's more than one way to skin a cat." Equifinality increases with alternatives. As equifinality increases, the probability of goal achievement also increases.

An Application of General System Theory

Project management and instructional development may be viewed as systems. Efficient and effective applications of project management and instructional development are based on an open system architecture. Reciprocal relationships among subsystems, systems, and suprasystems are necessary for each system to achieve its goal.

> The systems approach analyzes alternative ways of reaching that important end result or state (or goal) to determine the most effective and efficient way of reaching it. By analyzing the effect of each step or activity upon the entire system and by using problem-solving techniques, the most appropriate method and solution may be determined. (Trimby and Gentry, 1984, p.81)

The following discussion will apply general system concepts to the specific systems of project management and instructional development.

A Project Management System

In an example of a project management technique as the key system it is composed of several subsystems. If the project is the construction of a new home, one subsystem is the customer for whom the house is being built. Another subsystem is that of the resources available, for example, equipment, materials, money, manpower, and the time schedule. The vendors supplying building materials to the project exemplify external elements composing the suprasystem or environment.

Franklin Moore's (1964) flow of resources is the basic force that identifies the dynamic nature of a system. The implication is that a management technique spans many organization disciplines while still carrying out management functions. The technique is called systems management, project management, or matrix management.

> An organism is an open system which maintains a constant state while matter and energy which enter it keep changing (so-called dynamic equilibrium). The organism is influenced by, and influences, its environment. Such a description of a system adequately fits the typical business organization. The business organization is a man-made system which has a dynamic interplay with its environment -- customers, competitors, labor organizations, suppliers, government and many other agencies. Furthermore, the business organization is a system of interrelated parts working in conjunction with each other in order to accomplish a number of goals, both those of the organization and those of individual participants. (Johnson, *et al.*, 1967)

An efficient and effective project management system must be an open system, that maintains a steady state.

An adaptive project management system needs mechanisms to sustain system stability. Project management systems can resist entropy through efficient and effective communication feedback. This feedback mechanism is one of the system's forms of homeostasis. For example, a note from the project manager to a subcontractor that the project is running ahead of schedule provides the subcontractor with feedback on early target dates. The subcontractor may also have feedback, from past performance, that this project manager is often ahead of schedule at this point in the project and will probably fall behind in the next phase.

According to Kerzner (1985):

> Knowing how to communicate does not guarantee that a clear message will be generated. There are techniques that can be used to improve communications. These techniques include:
>
> - Obtaining feedback, possible in more than one form
> - Establishing multiple communications channels
> - Using face-to-face communications if possible
> - Determining how sensitive the receiver is to your communications
> - Being aware of symbolic meanings such as expressions on people's faces
> - Communicating at the proper time
> - Reinforcing words with actions
> - Using a simple language
> - Using redundancy (i.e., saying it two different ways) whenever possible (p. 266)

One reason for the delay at a particular point may be competition among subsystems for resources or allometry. Allometry can be caused by functional divisions (different departments) competing for the same resources. Project planning helps prevent the negative impact of allometry.

Synergy is the system's principle which states that the whole is greater than the sum of its parts. The whole project of building a house is synergized through the installation of the electrical system, plumbing, interior decorating, and landscaping.

Equifinality increases as the number of alternatives increase. This concept can be illustrated in project management with respect to CPM or PERT project planning. The paths shown through CPM or PERT in multiple critical path planning is an example of equifinality or multiple means to the same ends.

An Instructional Development System

An instructional development project used to develop a training program may also be viewed as a system. When the system is a corporation's office automation training program, subsystems are instructors, facilities, equipment, students, and the curriculum. External elements that affect the system and make up the environment or suprasystem are management's corporate goals and objectives.

Gentry's (1989) restatement of the entropic effect indicates that "if the energy level designed for a specific instructional system is reduced, the system tends to deteriorate in terms of efficiency, effectiveness, and relevancy." In a corporate office automation training environment the latest products are given the highest energy level. As instructional systems are put in place, they are often considered complete. The original instructors may move on to new ventures and the course's efficiency, effectiveness, and relevancy may no longer be scrutinized; thus, the instructional system begins to deteriorate as entropy takes its toll.

Regularly scheduled evaluations are homeostatic processes by which instructional systems can resist entropy. The feedback loop as part of the instructional development process is an example of a homeostatic method in the instructional development system.

Allometry, the measure of competition among subsystems, is seen in the instructional development process. Using the resource of time as an example, there is often a competition between the subsystem which will be duplicating the instructional material and the development system that is completing the development of the product. Both systems need the resource of time at the end of the project to complete the product.

Synergy is the inability to predict the results of an entire system based on an observation of its separate subsystems. Effectiveness and relevancy of an instructional development product cannot be evaluated by looking at the objectives and instructional materials in isolation. The rest of the instructional development system, for example, the target population and the post-test must be evaluated in conjunction with the objectives and instructional materials. The entire instructional development system works together to form the total effectiveness and relevancy picture of the system.

Equifinality, an alternative means to the same end, can be exemplified in instructional development by considering several alternative media that could be used to accomplish the same instructional objectives. For example, video tape may be one media alternative, while another might be stand-up instruction. Each may be equally effective for a particular set of objectives.

Summary

Systems exist along a continuum between open and closed architectures. To maintain stability, open systems allow a continuous flow between themselves and the environment. This is known as maintaining a steady state. Closed systems maintain system stability through equilibrium. Systems naturally tend toward increasing disorder, referred to as "entropy." Systems may tend toward increased organization or negative entropy by processes of homeostasis, such as feedback. Several subsystems in a single system may compete for the same resources; this is termed allometry. The more integrated the subsystems, the more synergistic the effect. The synergy may be accomplished through many different methods. Increased alternatives to the same goal are referred to as equifinality.

Philosophy of Technology

Change (any significant alteration in the status quo) (Havelock, 1973), in today's society, has increased like never before. The cause and effect of this rate of change is the process of technological innovation. Although the process remains unchanged, the stages through which innovations move has compressed into a shorter temporal cycle. Technological innovation is essentially three steps: (a) the creation of a feasible idea, (b) the practical application of the idea, and (c) its diffusion throughout society.

The diffusion of change in society may also be viewed as a three part process. The path of least resistance starts the diffusion. To reduce chances of rejection, it is applied in non-threatening conditions. For example, microprocessors were first used in toys and robots. Robots performed jobs that were unsafe or dirty.

Secondly, diffusion is used to improve products that society has already accepted. For example, microprocessors are being used to improve cars. The word processor can be seen as an improvement over the typewriter.

The third stage is to use the technology to create products and provide applications that are currently unimagined. (Naisbitt, 1982, p. 22) This cycle is occurring at an ever quickening rate. Alvin Toffler (1980) writes:

> Society is changing at an ever accelerating pace. Technology is both cause and effect of this rapid social change. And, unless we understand the dynamic interplay between technology and society, we cannot make our own future; instead we will simply react to the surge of events rather than direct them.

Toffler suggests we must be proactive, rather than reactive to function effectively and efficiently in today's society. Project management is an important tool in directing events rather than reacting to them. Project management assists by taking a proactive approach to operating in the future, instead of maintaining a reactive existence.

Technology is at the center of change. According to Saettler (1968):

> The word technology (the Latin form is 'texere,' to weave or construct) does not necessarily imply the use of machines, as many seem to think, but refers to 'any practical art using scientific knowledge.' This practical art is termed by the French sociologist Jacques Ellul, as 'technique.' He believes that 'it is the machine which is now entirely dependent upon technique, and the machine represents only a small part of technique. Not only is the machine the result of a certain technique, but also its instructional applications are made possible by technique. Consequently, the relation of behavioral science to instructional technology, parallels that of the physical sciences to engineering technology, or the biological sciences to medical technology'. (p. 5)

To many, the phrase "scientific knowledge" lends twentieth century flavor, resulting in the vague sense that technology is a new phenomenon. However, the term "scientific knowledge" taken in the broader sense of formulating and testing hypotheses, will lead us to an expanded view of the history of technology.

> In our day-to-day activities we are often faced with problems for which we must gather information and seek answers. In order to focus our information gathering we try to identify possible solutions or explanations to our problem and then gather the information needed to see if a given explanation is correct. These "educated guesses" about possible differences, relationships, or causes are called hypotheses. (Borg and Gall, 1985, p. 87)

With respect to this interpretation of scientific knowledge, man has been operating on the basis of technology since his beginnings.

Man is separated from his pre-human predecessors because of language, use of fire, and his ability to make tools. Many use man's ability to make and use tools, and his resulting dependence upon them, as the sole distinguishing factor. Our ability to gather information, look for alternative solutions or explanations to the current problem, and finally test the hypotheses to improve technology are also critical to this distinction.

Pre-historic men were hunters and gatherers, controlled largely by nature. When they discovered food could be grown in addition to collecting it, a transition from a hunting and gathering society to an agricultural society occurred. The first great civilizations tied to agriculture developed near the river valleys. Man became farmers.

Shift to food production resulted in lifestyle changes. Once man was no longer dependent upon finding food, the standard of living was raised, and population increased. Any given area can support more farmers than hunters and gatherers. Irrigation systems like those built in China made it possible to renew crops on a yearly basis. Man was settled and built permanent shelter. A need for social and political institutions to manage the new society became evident.

Over 200 years ago, another great surge of technology played an important historical role. As world trade expanded, there was an increased need for products. This led to a series of inventions during the 18th and 19th centuries that increased productivity. Inventions like the steam engine, internal combustion engines, electrical power, and rubber, along with progressing manufacturing, transportation and distribution systems resulted in the Industrial Revolution.

The latest surge in technology has resulted in yet another major societal change, the Information Society. The information society is the culmination of technological changes, transitions from an agrarian society to an industrial society, to our current information society.

As society experiences these changes through technology, a philosophy of technology develops. A dictionary definition of philosophy as "a basic theory or viewpoint" will serve in this discussion of a philosophy of technology.

There are three basic viewpoints; those pessimistic about technology, those who believe technology is a positive force, and those who are neutral and believe technology is a synthesis of both "good and bad."

A pessimistic viewpoint argues that technology robs people of their jobs. A view commonly held by those displaced from industrial jobs, they feel they have been "replaced" by robots. It's also maintained by those who feel technology has robbed people of privacy and dignity. This is often reflected in the "big-brother is watching" scenario.

This pessimistic attitude may be seen in the writings of such "back-to-nature" advocates as Jean-Jacques Rousseau and Henry David Thoreau. Rousseau felt science, although brilliant, was a result of pride and vanity and not a real expression of fundamental human needs. Thoreau also reflected this view in writing that man should be seen "as an inhabitant, or a part and parcel of Nature, rather than a member of society." More recently this pessimistic view of technology is found in the works of Jacques Ellul and Lewis Mumford.

Jacques Ellul (1980) believes technology dominates modern society. His book, The Technological Society, begins with a definition of "technique." Ellul defines technique as "the *totality of methods rationally arrived at and having absolute efficiency* (for a given stage of development) in *every* field of human activity." Ellul places emphasis on efficiency, which has different meanings in the pursuit of different activities. For example, efficiency in project management can be defined as completing the project on time and within budget. Efficiency in a field like surveying would be obtaining an accurate measurement.

According to Ellul, the technological society is one in which technique is the central component. He believes the old milieu of nature has been replaced by technological milieu. The major thrust of his book gets specific about how technology dominates society.

Ellul believes while technique solves some societal problems, in the process of solving the problem, others develop. As Mitcham and Mackey (1983) write:

> The desired effects of a new technique are inseparably linked with the creation of new and necessarily more technical problems. In advanced industrial society, for example, technology solves the traditional problem of food production only to create a new problem of pesticide poisoning. What makes this situation worse is that the undesirable

> effects of new techniques are "essentially unpredictable" so that "every solution to some technical inconvenience is able only to reinforce the system of techniques *in their ensemble*." (p. 5)

Ellul believes, technology is becoming man's master, rather than his tool.

Similarly, the philosophy of Lewis Mumford's work, Technics and the Nature of Man focuses on the relationship between technology and man's nature. Mumford fears technology is too powerful. In earlier times, he writes, man was in sync with human values and nature. Now he believes technology will prevent man from realizing human goals.

Optimistic philosophy is in opposition to Ellul and Mumford's pessimistic views. This philosophy is seen as far back as the 16th century philosophers such as Francis Bacon who believed "knowledge is power." They maintain technology is the root of progress. This viewpoint, most frequently held by scientists and engineers, sees technology as a solution to the social problems of modern society. It is a commonly held belief that man is in control of the tools brought about by technology and is ultimately in control of his destiny. "Scientific management," program planning and budgeting, as well as systems analysis are all outgrowths of this optimistic philosophy of technology.

The third viewpoint concerning technology is neutral. Technology is considered a synthesis of good and bad; a neutral tool, which can be used positively or negatively. For example, automobiles may be used for buying groceries at the local supermarket or robbing a bank. Many hold technology is not a new phenomenon, and is not worthy of any special attention. Some say computers are not as traumatic to today's society as the Industrial Revolution was to 18th century England. Lyn White, a philosopher maintaining this viewpoint writes, "Technology opens doors, but it does not compel man to enter."

There are at least three approaches to the philosophy of technology; pessimistic, optimistic, and neutral. However, the question remains; Is technology accelerating, and if so, what are the effects on society?

In answer to the first question: Is technology accelerating, the overwhelming evidence points to an affirmative response. In casual conversation, there is a constant lament by professionals, such as doctors and lawyers, that it is nearly impossible to keep abreast of new advancements in their fields. However, there is more "scientific" evidence of this quickening in technological advancement. Some of this evidence can be seen in the writings of Charles R. Walker (1968):

> The historian of science Derek Price has put together some hard-core data, helpful toward realizing this major cause of acceleration. He tells us, for example, that the multiplication of scientists has followed an exponential law, doubling in the United States every fifteen years so that we now have a population of about a million persons with scientific and technical degrees. A large proportion of everything scientific that has ever occurred has happened within the memory of men now living. Using any reasonable definition of a scientist, we can say that 80 to 90 percent of all the scientists that have ever lived are

> alive....Any young scientist, starting now and looking back at the end of his career upon a normal life span, will find that 80 to 90 percent of all scientific work achieved by the end of the period will have taken place before his very eyes, and that only 10 to 20 percent will antedate his experience. (p. 1)

Naisbitt (1982) confirms the findings of Price:

- Between 6,000 and 7,000 scientific articles are written each day.
- Scientific and technical information now increases 13 percent per year, which means it doubles every 5 years.
- But the rate will soon jump to perhaps 40 percent per year because of new, more powerful information systems and an increasing population of scientists. That means that data will double every twenty months.
- By 1985 the volume of information will be somewhere between four and seven times what it was only a few years earlier. (p. 24)

Thirdly, there is evidence of shortening the product life cycle; from conceptualization to implementation, from the idea to the practical application of scientific research, the time between idea and application has been drastically reduced. Frank Lynn (1967) has studied 20 major inventions, e.g. frozen foods, antibiotics, integrated circuits, and synthetic leather, since the beginning of the century. The average time needed for a major scientific discovery to be translated into a useful technological application has been cut by more than 60 percent.

So, overall, the answer to the question, Is technology accelerating?, appears to be an overwhelming "Yes!" (Walker, (1968); Naisbitt, (1982); Moss Kanter, (1989); Toffler, (1970)). However, the question remains, how does the acceleration of technology ultimately effect society?

The effects of the acceleration of technology upon society depend upon the values of the society. Robin Williams defines values as: "those conceptions of desirable states of affairs that are utilized in selective conduct as criteria for preference or choice or as justifications for proposed or actual behavior." Williams distinguishes fifteen major value-belief clusters that are salient in American culture, as follows: (a) activity and work, (b) achievement and success, (c) moral orientation, (d) humanitarianism, (e) efficiency and practicality, (f) science and secular rationality, (g) material comfort, (h) progress, (i) equality, (j) freedom, (k) democracy, (l) external conformity, (m) nationalism and patriotism, (n) individual personality, (o) racism and related group superiority. One of these value clusters is the emphasis that American culture places on efficiency and practicality.

Mesthene (1970) discusses how American corporations have found efficiency in technological advancement critical to their survival.

> Thus, corporations have proved to be highly efficient in exploring technological possibilities for new consumer products and services that can be marketed and sold for a profit. There are a number of reasons for this efficiency. The system of feedback and reward is speedy and highly visible; the corporation whose product does not sell quickly shifts its product line or goes bankrupt. It is this tension between possibility of great success and quick failure, in fact, that creates the presumption that few technological possibilities

> for the private sector will go unexplored and that few of the wrong guesses will remain hidden for very long. Because of this kind of built-in efficiency, the corporate system has served us well--better than most, one is inclined to agree--when our greatest need as a society was feeding, clothing, and sheltering our population and raising our standard of living, that is, when our greatest need was for translating our technological progress into an abundance of private goods and services. (p. 72)

Efficiency is also critical to instructional development. If an instructional product is not prepared in a timely manner it may cause cost over-runs, and/or inconvenience clients. In order to efficiently handle instructional development projects, a synthesized, tailored project management technique is useful. The literature of model design and analysis will aid in the development of this technique.

Summary

As a result of the accelerating rate of technological change in today's society, it is necessary to become proactive in order to function efficiently and effectively. Project management is an important tool in directing events rather than reacting to them.

Technological change has resulted in the movement of society through two major eras: (a) an agricultural society and (b) an industrial society. Society is now moving into a new era called the information society. A philosophy of technology has developed. Three basic views of the philosophy of technology are held. Those holding the pessimistic view argue that industrial workers have been displaced from their jobs through technological advances that leave them unskilled in a technologically advanced job market. The optimistic viewpoint, most often held by scientists and engineers, sees technology as a solution to societal problems. The third viewpoint considers technology as a neutral tool that can be positive or negative depending on how it is used.

The acceleration of technology will affect society based on societal values. American culture values efficiency and it has become critical to the survival of American corporations and institutions. Efficiency is also critical to instructional development. If an instructional product is not delivered on time, it may become outdated and as a result may teach non-current skills.

Model Design and Analysis

The rationale for including model design and analysis literature in the review is two-fold; first, both instructional development and project management models are analyzed. Secondly, the result of this research is a synthesized, tailored project management technique used to track and control resources for instructional development projects. Therefore, a central factor in this study is based on model design and analysis literature.

According to Snelbecker (1974), "a model is a concretization of a theory which is meant to be analogous to or representative of the processes and variables involved in the theory" (p. 32). This definition is dependent upon a definition of theory. A theory may be generally defined as "a set of propositions that are syntactically integrated and which serve as a means of predicting and explaining observable phenomena" (p.31).

Instructional development models are prevalent throughout the literature. These models attempt to graphically depict the development of an instructional product. Rubenstein (1975) writes:

> A model is constructed to facilitate understanding of relationships between elements, forms, processes, and functions, and to enhance the capacity to predict outcomes in the natural and man-made world. Understanding a phenomenon or an idea implies an ability to place it in a larger context or framework. Understanding may improve prediction and provide means for control of outcomes when cause-effect relations are identified. (p. 238)

Rubenstein states a model improves outcome prediction and may control those outcomes. If a model lacks a certain element, according to Rubenstein, this reflects a lack of the particular problem in the "real-world." It appears these models are missing an important element in the development process, the element of resource allocation. While it is true some models do include resource allocation to a degree, the methods and procedures are not adequately outlined.

The research result becomes a synthesized, tailored project management technique, used to better track and control instructional development resources. There are three approaches to model development: (a) adaptation or modification of an existing model, (b) synthesis of existing models, and (c) creation of a new model. This research will include a synthesis of existing models.

The model design and analysis literature proved useful in providing a process for developing a synthesized, tailored project management technique for instructional development projects.

Rubenstein (1975) outlined the following steps for the early stages of the modeling process. First, establish the purpose of the model. The purpose of the synthesized tailored project management technique is to track and control resources in instructional development projects, so that the instructional product can be developed efficiently and effectively.

Secondly, Rubenstein suggests listing the possible elements, for example, observations, measurements, and ideas, that may relate to the purpose. At this stage, Rubenstein does not eliminate remote ideas, as they may prove useful in a closer examination of the elements.

The third step is to select the elements from the second step that are relevant to the purpose outlined in step one.

During step four, the elements are aggregated and grouped together as Rubenstein writes, "by the virtue of the strong connections between them." Basically, this step is a classification process.

The fourth step is repeated until a technique consisting of seven chunks (plus or minus two) surfaces. This is the process that will be used in answering the third specific research question.

According to Lowther and Saltinski (1975) models (or in this case techniques) should be designed to include the following:

- Input provisions
- Direction and/or sequence of information flow
- Interaction-synthesis sectors
- Constraints
- Output provisions
- Self-regulatory mechanism

The synthesized, tailored project management technique will be developed to include a mechanism for handling these items.

Summary

There are three processes used to develop systems models: (a) an entirely new model may be built from scratch, (b) an existing model may be adapted or modified to fit a specific set of concerns, and (c) is to develop a new model from a synthesis of existing models. This research uses a synthesis of existing models to create a tailored project management technique used to track and control instructional development resources.

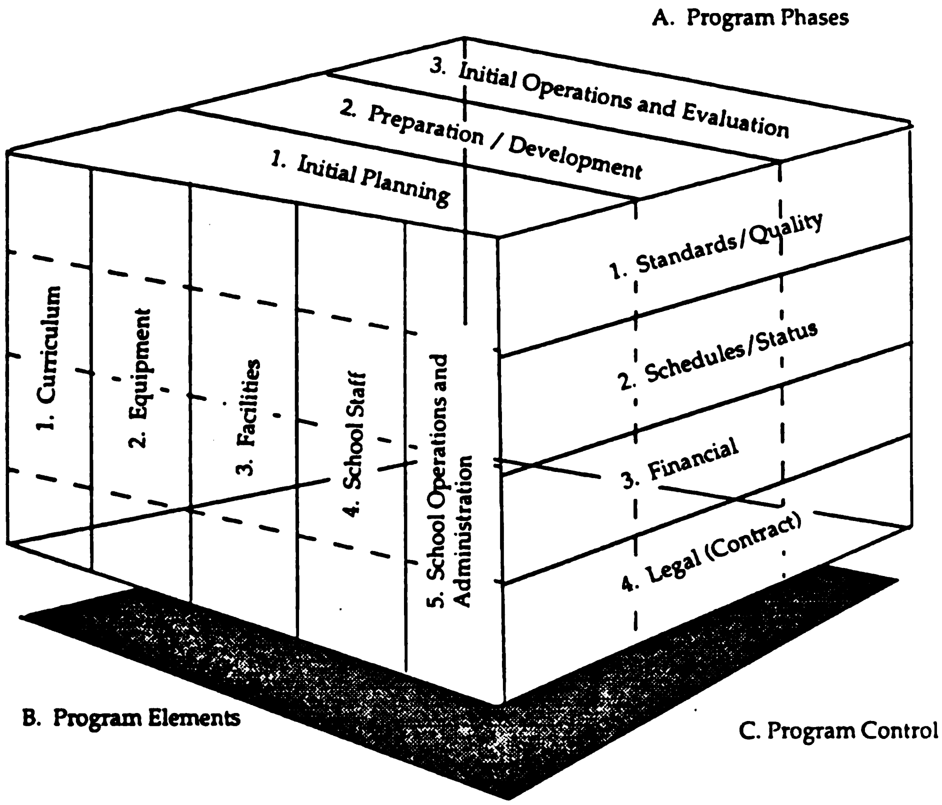
Instructional Development

The models selected for discussion in this area of the literature review provide perspective to the area of project management within the field of instructional development.

Some instructional development models address management problems briefly at best; for example, Kemp (1977) mentions support services. This deals primarily with the product after development. This researcher's concern is not with the management of the instructional product during delivery, but rather the management of resources contributing to the development of the instructional product. This literature review will discuss three instructional development models that do address the resource management issues to some extent. These models are (a) Control Data's Education Project Model, (b) Tuckman's and Edwards' Systems Model for Instructional Design and Management, and (c) the Instructional Development Institute Model.

The Control Data's Education Project Model (see Figure 3) is a three-dimensional model capturing sufficient detail while easily communicating to new project managers. The model provides a method for (a) analyzing project needs, (b) staffing project personnel, and (c) tracking project tasks to attain coordinated effort. The third factor is the most significant to this study. The model includes three different perspectives used to analyze project needs and track project implementation.

The first dimension is the program phases: Time and linear activities progression. This dimension is composed of the following: (a) initial planning which could be further broken into definition, design and maintenance, (b)



Modified from Tom D. Conkright (1979)

Figure 3

Conceptual Model for a Systems Approach to Managing Complex Educational Projects

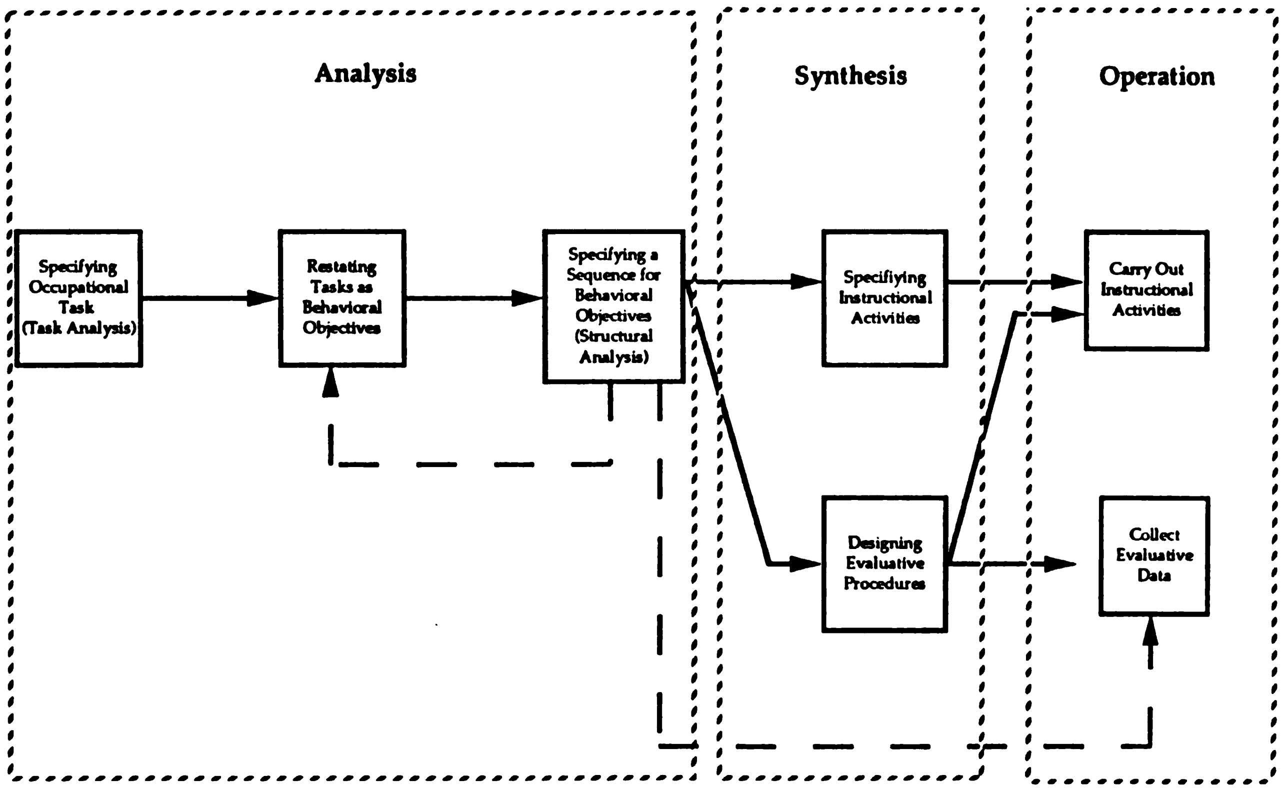
preparation and development, and (c) initial operations and evaluations.

The second dimension, program elements, includes (a) curriculum, (b) equipment, (c) facilities, (d) school staff, and (e) school operations and administration.

The third dimension, program controls includes, (a) standards/quality, (b) schedules/status, (c) financial controls, and (d) legal (contract) controls. This model identifies the tasks that must be performed to plan, staff, and implement an instructional project (Conkright, 1979).

A second model entitled "A Systems Model for Instructional Management" developed by Tuckman and Edwards (1971) is illustrated in Figure 4. The model is divided into three phases, (a) analysis, (b) synthesis, and (c) operation. During the analysis phase, post-instructional tasks are analyzed, the objectives are restated, and the objectives are sequenced. The second phase involves two activities taking place simultaneously. The first is the specification of instructional activities and the second is the design of evaluation procedures. The operation phase implements the instruction and collects evaluation data. Feedback and iteration allows for the system to account for the data collected during implementation.

According to AECT (1977), instructional designers and developers have not come to an agreement upon using one specific model; however, the Instructional Development Institute (IDI) model from the University Consortium for



Modified from
(Tuckman and Edwards, 1971)

Figure 4

A Systems Model for Instructional Management

Instruction has a generic set of steps that overlap with many other models (as shown in Figure 5). Educators in several hundred school systems have been trained in the use of this model. The Instructional Development Institute model originated from the University Consortium for Instructional Development and Technology.

The first stage, "Define" includes "organize management" which is concerned with the activities of (a) assigning team responsibilities, (b) establishing links of communication, and (c) specifying project planning and control procedures. There is no direct mention of resource allocation.

Several instructional development models are outlined in this section. Each model includes some degree of project management instruction. While some of these models only allude to specific management functions in the instructional development process, others make no provision for these types of activities.

To further accentuate the lack of project management activities in the instructional development process, Wallace Hannum (1983) writes of discrepancies between instructional development models and their application. In his article, he outlines three model-independent potential problem areas: (a) inadequate knowledge or skills, (b) failure to follow the procedures of the model, and (c) failure to adequately manage the effort.

The third discrepancy, failure to adequately manage the effort, is particularly interesting here. Hannum explains

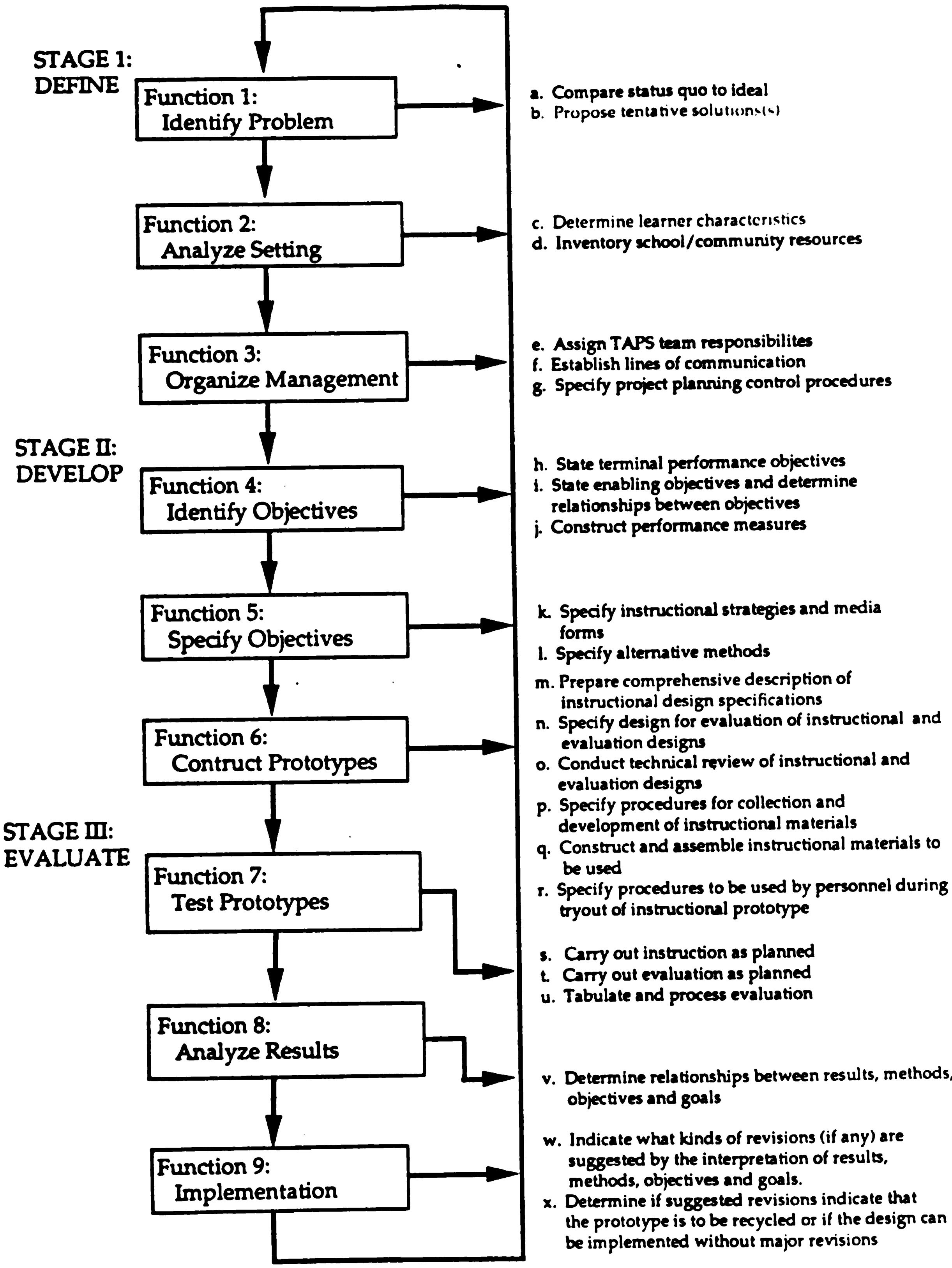


Figure 5

Instructional Development Institute Model

that unrealistic deadlines may cause steps or procedures in the instructional development model to be rushed or eliminated in order to meet production schedules.

Other causes could be skeptical supervisors who permit the omission of certain steps in the model. The solution must reside in management, writes Hannum, which may be an adjustment in management's productivity expectations in terms of the expected volume of output. He states,

> If the managers are looking only for quantity of output (minutes of videotape, number of frames of programmed instruction or computer assisted instructions), then they must have a realistic estimate of production rates. The managers should also have criteria for judging the adequacy of the output so they don't simply count minutes or frames without regard to quality. The manager must also have an understanding of the various procedures specified in the instructional development model and the contribution of each procedure to the total effort. The solution to this discrepancy will most likely involve additional management training focused on the specific cause of their "mismanagement." (p. 17)

Hannum continues:

> One option is to ignore this availability and implement the instructional development model faithfully (and sequentially). This may result in some replication, which seems to be a waste of time, money, and instructional development talent. It also seems a bit unrealistic for the developers not to "peek" at existing objectives and materials or even to do a bit of "cutting and pasting" and thus get the instructional development effort done sooner. (p. 18)

The solution to this dilemma lays outside the boundaries of instructional design. The solution to the problem of productivity lies in the realm of project management.

Summary

There are three instructional development models reviewed in this chapter: (a) Control Data's Education Project Model, (b) Tuckman's and Edwards' Systems Model for Instructional Design and Management, and (c) the Instructional Development Institute Model. Each of these models deals in part with the management of instructional development projects; however, a more detailed project management model is necessary to more completely handle the project management concerns of the instructional developer.

Project Management

The following selected project management techniques are included in this study: (a) Critical Path Method (CPM), (b) Decision Critical Path Method (DCPM), (c) Gantt charts, (d) Graphical Evaluation and Review Technique (GERT), (e) milestone charts, (f) Precedence Diagram Method (PDM) and (g) Program Evaluation and Review Technique (PERT). The first broad question to be answered in this research (How do the selected project management techniques differ in their functions, specific purposes, and components?) is answered primarily with respect to the existing literature in the field of project management. Since the results of the literature review are the basis for answering the first broad research question, the detailed information is presented in Chapter IV. The review of the project management literature (in this chapter) includes a general sketch of each of the selected project management techniques. In order to answer this question there is a need to evaluate the research with respect to these selected project management techniques. The literature was evaluated and only those meeting specific criteria were chosen. (Refer to Appendices A and B for the criteria and a sample evaluation.)

The second broad question, (Which combination of these components from across selected project management techniques, can be applied most efficiently and effectively to instructional development projects?) is answered primarily through data gathered during the case study interviews. The review of the project management literature provides a foundation for the interview guide used in the case study research. The purpose of the interviews is to aid in determining problem variables affecting constraints in the allocation of resources for instructional development projects. Since the project management literature does not include problems specific to the instructional development process, the results of the interviews presented in Chapter IV, in conjunction with the literature used to answer the first broad question will highlight which components can be efficiently and effectively applied to instructional development projects. The combined results of the literature review and the case studies is used to gather information for the synthesized, tailored project management technique presented in Chapter V.

Gantt Charts

Gantt charts are one of the oldest and still useful techniques for managing projects. Henry L. Gantt developed Gantt charts in 1917 to chart processes to establish a structured form for planning and controlling production operations. The Gantt chart is a two dimensional bar chart displaying simple activities and events in relation to time or money (see Figure 6). The amount of work required to go from one point in time to another is an activity. Activities are shown as horizontal bars, where each bar reflects the duration of an individual activity. Events are defined by starting or ending points for one or more activities. Gantt charts are bar charts graphically portraying the duration of tasks from the Work Breakdown Structure. Gantt equals a graphical Work Breakdown Structure. It is a useful tool in production management, but inadequate for complex interrelationships

Milestone Charts

A milestone chart has a product oriented display. By definition, a milestone is a specific accomplishment resulting from the organization's consumption of resources. It is similar to a Gantt chart, in that it does not display the interdependencies that exist between events and activities, illustrated in CPM and PERT charts. Typical milestones are dates for status reviews, and the beginning and the end of major phases. For example, begin needs

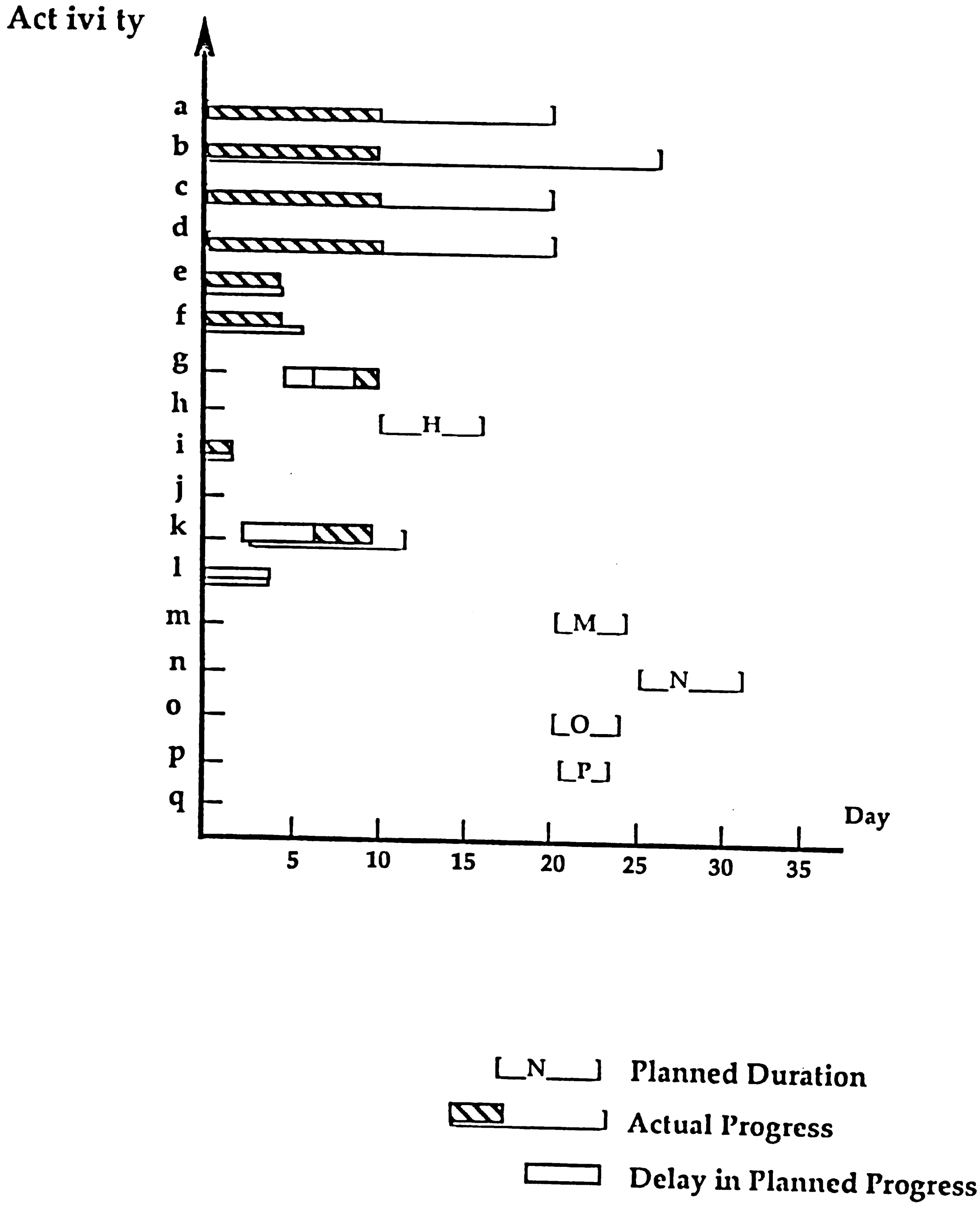


Figure 6 Gantt Chart

Modified from Jack Meredith and Samuel Mantel, Jr. (1985)

analysis, complete instructional modules, and deliver training. The milestones terminate with a tangible output (see Figure 7).

Milestone charts may be constructed at many different levels. For senior management, a few milestones indicating critical dates are sufficient even on large projects.

Project managers may use milestones as major decision making points. It may indicate a time a key technical achievement must be obtained or additional resources will be added.

Milestones relevant to the project team may be more frequent and the major milestone chart can have one item broken down into other smaller tasks forming another milestone chart, with finer detail and more frequent milestones (Meredith and Mantel, Jr.; 1985).

Critical Path Method (CPM)

The Critical Path Method (CPM) was developed in the late 1950's (December, 1956 through February, 1959) by DuPont Company and Remington Rand Univac. CPM is a technique used in large projects and is concerned with the trade-off between the cost of a project and the completion date. Originally, the Critical Path Method (CPM) was developed to solve scheduling problems in an industrial setting. The objective of the research team was to determine how to best reduce the time required to perform routine plant overhaul, maintenance, and construction work. They were primarily interested in the optimum trade-off of time (project duration) and the total

Figure 7 Milestone Chart

Modified from Jack Meredith and Samual Mantel, Jr. (1985)

project cost. Ultimately they wanted to determine the duration of the project which minimizes the sum of direct and indirect costs from direct means. Labor and materials while indirect costs include the usual items, i.e. supervision, as well as "cost" of production time lost due to plant downtime. It was applied primarily to construction projects, for example, bridges, houses, and skyscrapers. CPM is a deterministic technique rather than a probabilistic technique. It allows for variation in the duration of a job not due to random factors such as good luck or bad luck, but due to the planned assignment of resources. CPM proponents argue most jobs can attain a reduced duration if additional resources (e.g., manpower, money or machines) are applied. The main feature is to arrive at a project schedule which minimizes total project cost. Figure 8 is an example of an activity-in-node diagram.

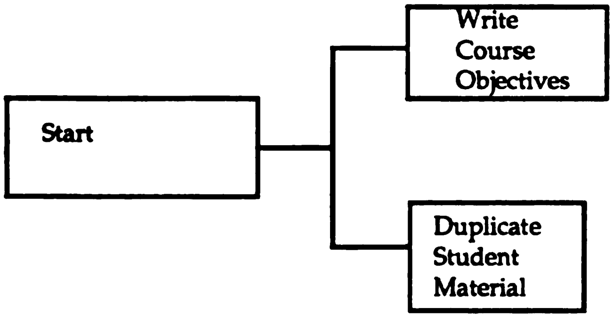


Figure 8

An arrow diagram or activity-on-arrow network doesn't put tasks in boxes. The activity-on-arrow approach places the tasks on the arrows that connect events. Events are shown at beginning or end of the task, indicated in Figure 9 by the circled numbers.

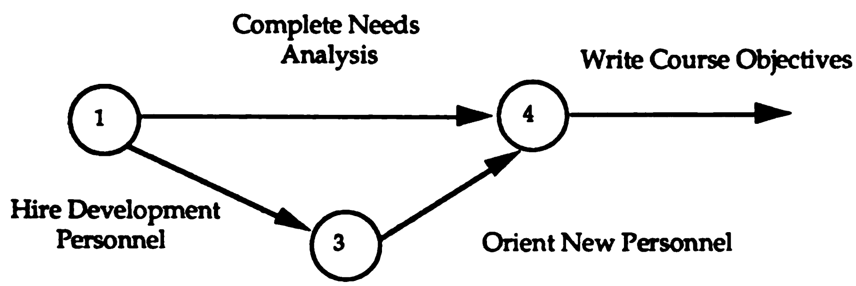


Figure 9

Lines are activities which use time, personnel, and other resources for completion. Each activity begins and ends into a node which is called an event. Time flows from the tail to the head of each arrow. Events are a point in time, which signifies the completion of all activities terminating at the specified event.

Dashed lines are called dummies. These lines only illustrate precedence relationships, but they do not consume resources. These are called activity-on-arrow or arc arrow diagrams. The reverse of this is the arrow-on-node diagram. In contrast to Gantt charts, planning is a completely separate activity from scheduling.

Slack paths are paths with float time. If there is no slack or float the activity is on the critical path. The critical path is the longest path through the network. There is no significance to the length of the arrow in a network.

All activities preceding a specific activity must be completed before a given activity can begin. Activities without predecessors may begin anytime after the project starts and when all activities without successors are complete; then, the project is complete.

Decision Critical Path Method (DCPM)

The emphasis of Decision Critical Path Method (DCPM) is on alternatives chosen to reach the terminal objectives. The project chart contains tasks that must be completed, their duration and precedent relationships, and information for alternative series of jobs. Each group of tasks contains mutually exclusive job approaches, one of which must be chosen. An example of the DCPM diagram is shown in Figure 10. The arrows out of each circle mean that each activity will happen concurrently. For example, activities J1, J2, and J3 will all begin at the same time. The triangle indicates a decision or choice can be made among alternate activities. For example, node J1 becomes a choice between J1,1; J1,2; or J1,3 (Weist and Levy, 1977).

Graphical Evaluation and Review Technique (GERT)

Graphical Evaluation and Review Technique (GERT) is a probabilistic network with a variety of node types. These nodes have both an input and an output side that are characterized by certain logical relations connecting jobs or tasks. There are two different output sides determining the

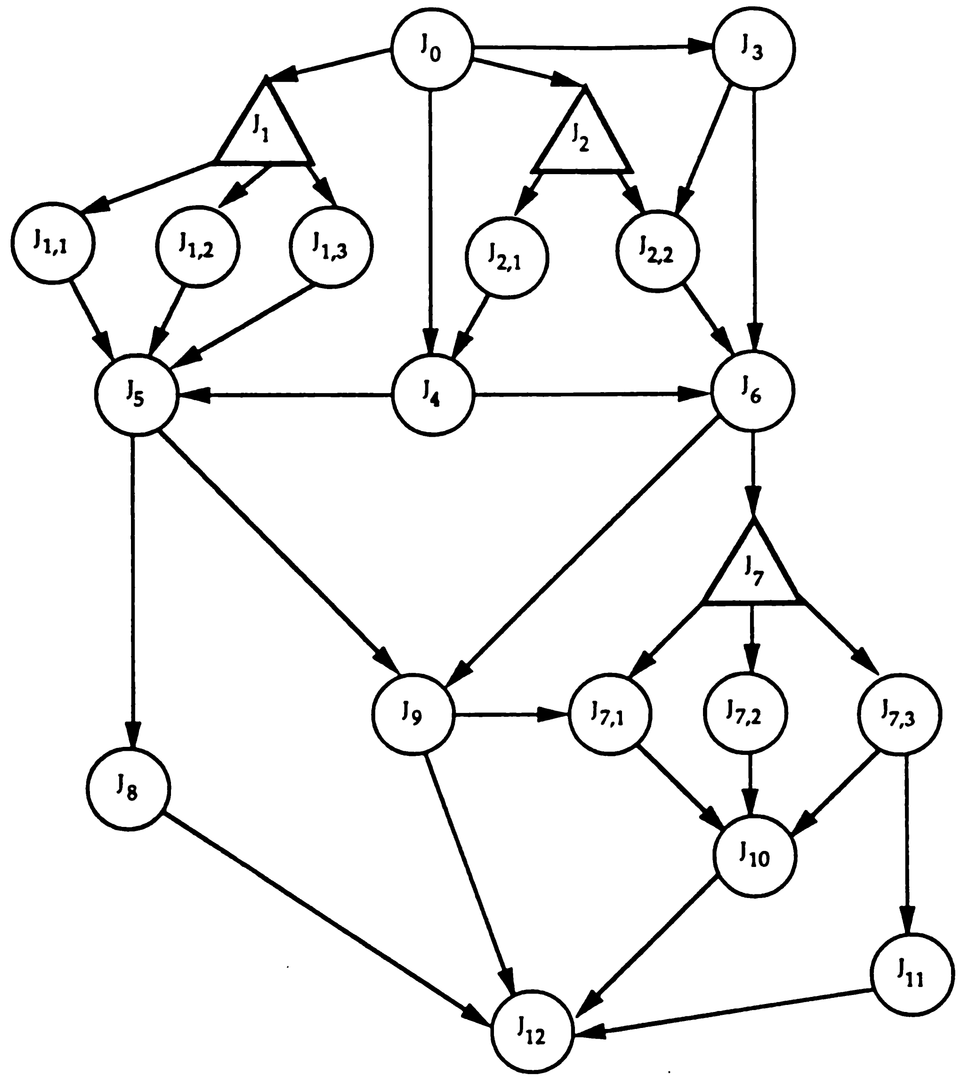


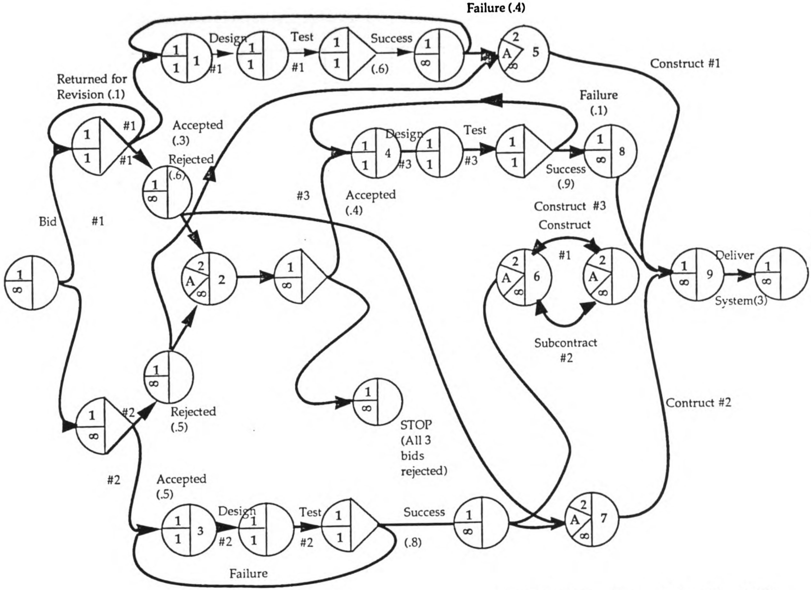
Figure 10

Decision Critical Path Method (DCPM)

type of branching that will result from the node. One type of branching, deterministic, is used when all activities emerging from the node are used. The second type, probabilistic branching, is used when only one of several emerging activities will be performed. An example of a GERT diagram is shown in Figure 11.

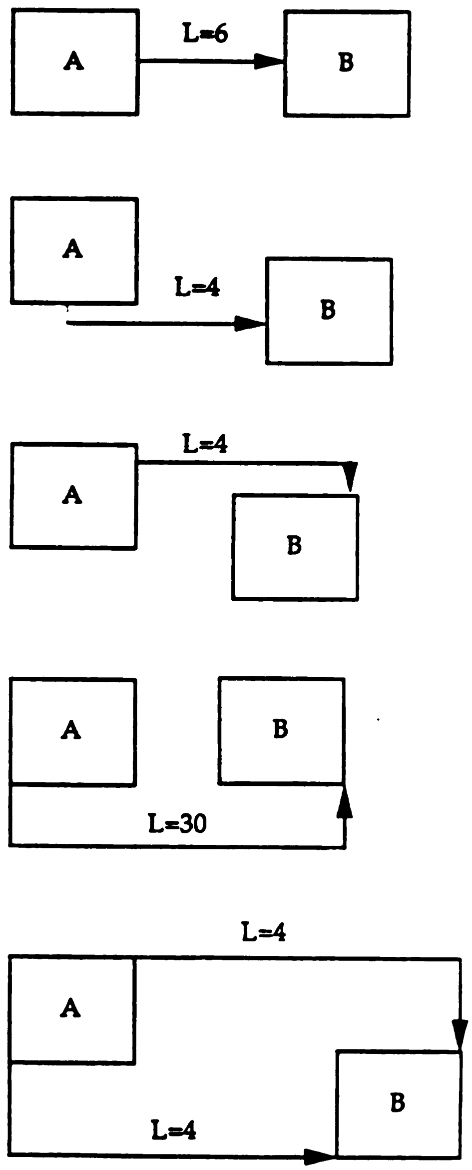
Precedence Diagramming Method (PDM)

The Precedence Diagramming Method (PDM) is an extension of the Critical Path Method (CPM). In typical PERT or CPM project management techniques, there is only one type of precedence relationship, a finish to start (FS) relationship. In this relationship, the task leading into a node must be completed before any task emerging from the node can begin. In PDM three other relationships are also possible; start to finish (SF), start to start (SS), and finish to finish (FF) (See Figure 12). Not only does PDM incorporate alternate relationships, but it also allows a lead-lag quantity to be associated with any of the relationships. (Lead-lag is the minimum time involved in the relationship between two tasks.)



Modified from Jerome Weist and Ferdinand Levy (1977)

Figure 11 Graphic Evaluation and Review Technique (GERT)



Finish-to-start relationship

Start of B must lag 6 days after A is finished

Start-to-start relationship

Start of B must lag 4 days after A is started

Finish-to-finish relationship

Finish of B must lag 4 days after A is finished

Start-to-finish relationship

Finish of B must lag 30 days after A is started

Composite start-to-start and finish to finish relationships

Start of B must lag 4 days after A is started and the finish of B must lag 4 days after A is finished

Modified from Weit and Levy, 1977

Figure 12

PDM Network Relationships

Several studies at the time showed major military development contracts indicated that actual costs, on average, were two to three times the earliest estimated costs and the length of the projects were 40 to 50 percent greater than the earliest estimates. Studies of commercial projects indicated 70 percent cost overruns and 40 percent time overruns. Although the companies were optimistic in their estimates, in order to get the contract, the lack of adequate project management planning and controlling for large projects are cited as the reasons (Moder, Phillips and Davis, 1983).

Program Evaluation and Review Technique (PERT)

Program Evaluation and Review Technique (PERT) was developed to plan and accelerate the development of the Polaris ballistic missile in 1958. Developed by a research team, with a representative from Lockheed Aircraft Corporation, (the major contractor of Polaris), Navy Special Projects Office, and the Consulting firm of Booz, Allen, and Hamilton. PERT evolved from Gantt charts, Line-of-Balance and milestone reporting systems. The Special Projects Office of the U.S. Navy, concerned with performance trends in the execution of large military development programs, introduced PERT on its Ploaris Weapon Systems in 1958, and it spread rapidly through United States defense and space industries. At the same time the Navy was developing PERT, the Dupont Company was concerned with the increasing time and money required to bring new products from research to production.

Their initiative resulted in a similar technique called CPM (Critical Path Method). Due to time elements, the team concentrated on the planning and controlling functions. An example of a PERT diagram is shown in Figure 13.

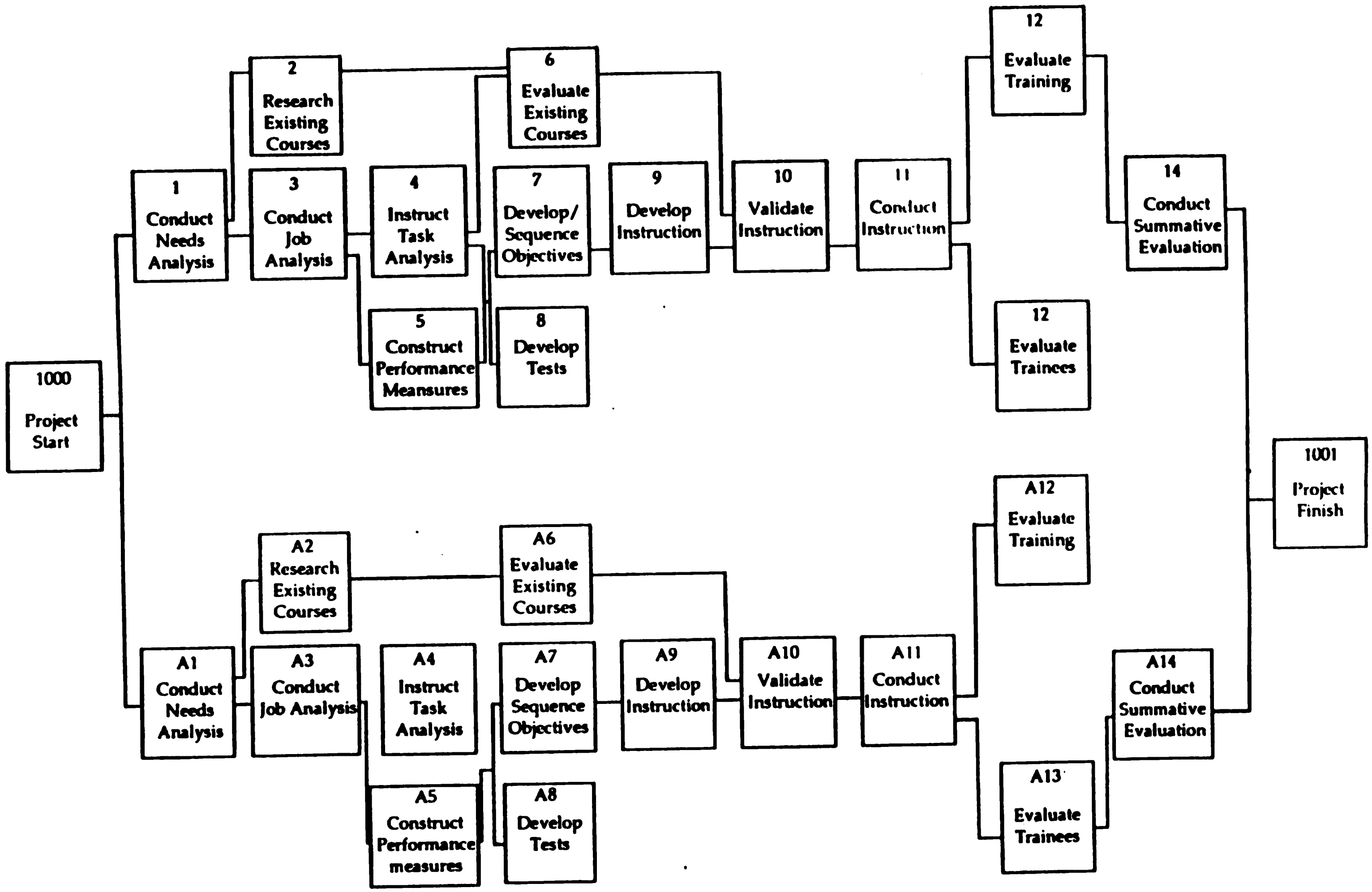
It is a management tool that provides a means for planning, scheduling and controlling resources required to meet program objectives. Applications have been primarily research and development projects, and is a probabilistic technique accounting for uncertainties. An emphasis on precedence relationships is shown through the networks. PERT uses statistical probability to determine if the project will be completed on time; therefore, it is more likely to be applied to one-time projects, like Research and Development projects, where the duration of the activities are uncertain.

A basic requirement is the sequential presentation of tasks, events, and activities on a network which includes time estimates. Individual tasks are written in the form of the Work Breakdown Structure. These events and activities will be formed into a network.

Events and activities are sequenced according to the logic that allows critical and subcritical paths. Activities are given three-way time estimates. Finally, the critical path and slack times are computed (Meredith and Mantel, 1985).

Summary

A search of the systems literature shows that systems exist along a continuum between open and closed



Adapted from Company A

Figure 13

PERT Diagram

architectures. In order to maintain their stability, an open system allows a continuous flow between itself and the environment. This stability is referred to as maintaining a steady state. Closed systems maintain system stability through equilibrium. Systems naturally tend toward increasing disorder, referred to as *entropy*. Systems may tend toward increased organization or negative entropy by mechanisms such as feedback, a process of homeostasis. Several subsystems in a single system may compete for the same resources, and this is termed *allometry*. The more integrated the subsystems, the more synergistic the effect. The synergy may be accomplished through many different methods. Increased alternatives to the same goal are referred to as *equifinality*.

A search of the philosophy of technology literature shows that because the accelerating rate of technological change in today's society, it is necessary to become proactive in order to function efficiently and effectively. Project management is an important tool in directing events rather than reacting to them.

Technological change has resulted in the movement of society through two major eras: (a) an agricultural society, (b) an industrial society. The current era is the information era. A philosophy of technology has developed. Three basic views of the philosophy of technology are held. The pessimistic view argues that industrial workers have been ousted from their jobs through technological advances that leave them unskilled in a technologically advanced job market. An optimistic viewpoint, most often held by scientists and engineers, sees technology as providing solutions to societal problems. The third viewpoint considers technology as a neutral tool that can be positive or negative depending on how it is used.

The acceleration of technology will effect society based on the societal values. American culture values efficiency and it has become critical to the survival of American corporations and institutions. Efficiency is critical to instructional development. If an instructional product is not delivered on time it may be outdated teaching non-current skills.

A search of the model design and analysis literature shows that there are three processes used to develop systems models: (a) an entirely new model may be built from scratch, (b) an existing model may be adapted or modified to fit a specific set of concerns, and (c) a new model may be developed from a synthesis of existing models. This research uses a synthesis of existing models to create a tailored project management technique which will be used to track and control instructional development resources.

A search of the instructional development literature shows that there are three instructional development models dealing to some extent with resource allocation: (a) Control Data's Education Project Model, (b) Tuckman's and Edwards' Systems Model for Instructional Design and Management, and

(c) the Instructional Development Institute Model. Each of these models deal to some extent with the management of the instructional development project; however, a more detailed project management technique is necessary to more completely handle the project management concerns of the instructional developer.

A search of the project management literature finds two basic types of project management techniques. The first type, like Gantt charts and milestone charts provide a macro view of the project. The second basic type of project management technique is the network-based diagram. The selected project management techniques that are networked based include: (a) CPM, (b) PERT, (c) DCPM, (d) PDM, and (e) GERT. Five network type project management techniques were investigated. Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) represent the classic dichotomy between network type diagrams. Precedence Diagramming Method (PDM) brings another factor into focus with the concept of lead-lag time. Decision Critical Path Method (DCPM) is a more developed version of CPM, actually diagramming the various options that are available. The last project management technique, Graphic Evaluation and Review Technique (GERT) is a variation on PERT and provides a looping mechanism for tasks that are cyclic in nature.

CHAPTER III

METHODOLOGY

This study is designed to collect baseline data on variables associated with effective and efficient application of selected project management techniques to instructional development projects. This baseline data is used to generate hypotheses to be tested by future researchers. In this chapter, a description is provided of the study design, sampling plan, data collection instrument, data collection procedures, the preparation of the data, and the data analysis.

Study Design

This study employs the case study method. Its purpose is to glean fundamental factors affecting the delivery of an instructional development project on time and within budget. In other words, its purpose is to discover salient variables in managing the instructional development process as a project. Isaac & Williams (1979) define case study as an

> ... in-depth investigation of a given social unit resulting in a complete, well-organized purpose, the scope of the study may encompass an entire life cycle or only a selected segment; it may concentrate on specific factors or take in the totality of elements and events. (p. 20)

The case study method is a legitimate method of inquiry to uncover new variables which will provide a foundation for further research. Isaac & Williams further explain that "because they [case studies] are intensive, they bring to light the important variables, processes, and interactions that deserve more extensive attention."

In this study, the social unit is defined as the instructional development team. The selected segment this project focuses on is the unit project management concerns. Glaser and Straus (1970) and Patton (1980) indicate case studies are a valid means of research to derive concepts and interrelationships forming a basis for a set of hypotheses in a given area. In this research, the functions, specific purposes, and components are the concepts and interrelationships derived, then synthesized into a tailored project management technique. This synthesized, tailored project management technique is the focus for generating hypotheses for further research in the application of project management techniques to instructional development projects. Since a careful search of databases and professional journals show the research literature to date on the application of project management techniques to instructional development projects is lacking, the case study method provides a viable means of developing a foundation for data meeting the objectives of this study and answers established research questions.

Four sets of instructional development project case study data from business and industry have been collected and analyzed. Each selected case meets the criteria outlined in the sampling plan.

The data have been collected by the researcher through in-person interviews, using a general interview guide (Appendix D), and through the examination of project documentation. Complete cases have been built by interviewing project personnel (i.e., project manager, instructional designer, editor, production crew, etc.). A single individual may be responsible for the tasks of one or more team positions. Confidentiality was provided to each companies' participants. Each case was alphabetically coded and all other identifying information was screened and coded appropriately.

Research Questions

The two broad questions to be answered, with three more specific questions resulting from the broad questions are as follows:

A. How do the selected project management techniques differ in their functions, specific purposes, and components?

Each of the selected project management techniques (i.e., Critical Path Method (CPM), Decision Critical Path Method (DCPM), Gantt charts, Graphical Evaluation and Review Technique (GERT), milestone charts, Precedence Diagram Method (PDM), Program Evaluation and Review Technique (PERT))have the same general purpose; to control resources. All of these techniques control resources through a set of functions, generically defined as: (a) planning, (b) estimating, (c) scheduling, and (d) controlling. This set of functions is common to all of the selected project management techniques (see Figure 14).

Each function is composed of a specific set of purposes. For example, verification and decision-making are two specific purposes found in the controlling function. The specific purposes each contain two types of components: (a) input components and (b) output components. Each of these specific purposes and input-output components are emphasized to varying degrees, depending on the selected project management technique.

From the first broad question, two specific questions are derived:

1. **How are selected project management techniques different or similar in their support of project management functions?**

Each of the project management techniques studied emphasize various general functions to varying degrees. For example, PERT emphasizes the controlling function. Considering alternatives and making action plans (decisions), based on alternatives are a focal point in this technique. In contrast, Gantt charts highlight the planning function. They are not used for considering alternative actions, but rather to plot specific activities or events against time or money. As a result, the functions vary in their emphasis of specific purposes and in their focus on various input-output components.

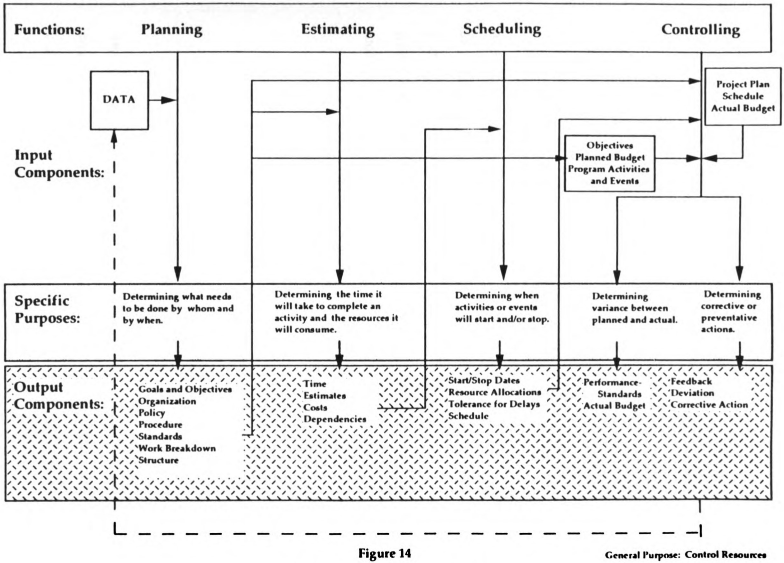


Figure 14

Project Management Technique

2. **In terms of advantages and disadvantages, how do project management techniques differ in emphasis with respect to their specific purposes?**

PERT and Gantt charts are two project management techniques; the emphasis placed on the controlling function varies with respect to its specific purpose of decision-making. For example, while a PERT diagram results in a network diagram illustrating interdependencies, Gantt charts are not networks and do not show interdependencies. These interdependencies are critical to the controlling function. Gantt charts provide little predictive value, while the PERT diagrams can be valuable in predicting, for example, the impact of delaying the start of any given task.

The second broad question to be answered follows:

B. **Which combination of these components, from across selected project management techniques, can be applied most efficiently and effectively to instructional development projects?**

Evaluation is a critical component in the instructional development process. Many instructional development models provide for feedback at each stage of the process. The output component, feedback, from the decision-making purpose may be particularly important to the application of project management techniques to instructional development projects.

The specific question generated from the second broad question is:

3. **Which components, from across selected project management techniques, could most logically be incorporated into a synthesized project management technique, to better track and control instructional development resources?**

To illustrate, one component of the planning stage is to write objectives. Some project management techniques emphasize this component more than others. Since this component meshes well with the instructional development process, it may be incorporated into an ideal synthesized project management technique, tailored to better track and control instructional development resources.

Sampling

Sample Selection

To ensure the objectives of the study are met, a purposeful sample was used. All cases were selected by the researcher through her professional contacts. For purposeful sampling for the case study method of research, Patton (1980) tells us one case, by itself is purported to constitute a legitimate study. Three cases were established as a minimum to cover variability due to content, staffing, and project size. The minimum of three cases is also useful to provide a means for comparisons from which more definitive variables are derived. Given access and the personal resources of the researcher, only four case studies were made, one of these serving to pilot the case study procedures. The final research is based on these studies.

Data Collection Instrument

Data was input from two sources. First, data is collected from print and instructional computer programs. These references included professional journals, periodicals (such as, Personal Computing, Info World, etc.), books, and Computer-Based Instruction (CBI) dealing specifically with project management techniques. These references were initially located through computer-based searches of Abstracted Business Information (ABI)/Inform, Dissertation Abstracts, and Educational Resources Information Center (ERIC). From these bibliographies, additional references are sought.

Secondly, data is collected through case studies of four instructional development teams involved in courseware development. These teams are responsible for the development of courses to meet corporate needs. The following criteria were used to describe the target population, from which the cases are selected:

1. Each case study is required to use one or more of the selected project management techniques.

2. Each case study must use a different project management technique from the list of selected project management techniques.

3. The case must have enough of the development work completed, so data could be collected for each of the project management functions: (a) planning, (b) estimating, (c) scheduling, and (d) controlling.

4. Each case provides more than one team member for interviewing, unless a single individual performed all of the activities required to plan, develop, and produce the training product.

5. The participant must be a U.S. based corporation selected from the area of business and industry, as opposed to hospitals, schools, and government agencies.

Neither the type of training product provided, nor the training method were factors in the selection of a particular organization.

As mentioned, this research's purpose is to gather baseline data to apply to project management techniques for instructional development projects. The case study method was selected for this purpose. Patton (1980) also indicates case studies are valid in developing interrelationships to form a set of hypotheses. Since data dealing with project management techniques and instructional development projects is limited, this is a viable means of building a foundation for future research in this area. The data is collected through taped, in-person, general guided interviews, follow-up telephone interviews, and documents made available by the participants of this study.

The purpose of the open-ended interview is not to project "the interviewer's preconceived categories for organizing the world, but rather to access the perspective of the person being interviewed" (Patton, 1980). The general interview guide approach "involves outlining a set of issues that are to be explored with each respondent before interviewing begins." It is a basic checklist containing all relevant topics, so that common information is obtained from each person interviewed.

> Interview guides can be developed in more or less detail, depending on the extent to which the researcher is able to specify important issues in advance and the extent to which it is felt that a particular sequence of questions is important to ask in the same way or the same order to all respondents. (Patton, 1980)

The strengths of the guided interview technique include an outline to increase the comprehensiveness of data and somewhat systematic data collection for each respondent. Any logical gaps in data are anticipated and closed, while the interviews remain fairly conversational and situational.

The weaknesses include the fact that important and salient topics may be inadvertently omitted. In order to compensate for this weakness, follow-up telephone interviews were used to fill-in gaps. Another weakness is the flexibility the interviewer has in question sequencing and wording which can result in substantially different responses; thus, reducing their comparability.

Interviewing Principles

These guidelines for interviewing as suggested by Patton (1980), were followed:

Open-ended Questions

Using open-ended questions minimizes the imposition of the researcher's predetermined responses when gathering data. This style of questioning permits the interviewee to take any direction while using whatever words they want to represent what they say. It provides a complete repertoire of possible responses, rather than those imposed by the researcher.

Singular Questions

Ask one question at a time. The interviewee will not become confused as to which question they are answering or have to choose between answering several questions. It ensures a complete and clear response to each question. Analysis is also easier, since it is clear which question the respondent is answering.

Clear Questions

The interviewer must use terms within the respondent's frame of reference. Questions using the respondent's language are more likely to be clear to the respondent. Transitions help the interviewee focus on the subject of immediate interest to the researcher.

Neutral Questions

The use of neutral questions allow rapport to develop by conveying empathy and understanding without being judgmental. Patton (1980) notes: "... that the person being interviewed can tell me anything without engendering either my favor or disfavor with regard to the content of their response."

Maintain Control of the Interview

In order to keep the interview on schedule to ensure adequate time, the researcher must maintain control of the interview. Knowing the interview guide, asking questions to get needed data, and giving appropriate verbal and non-verbal feedback allows the researcher to maintain control. The interviewer must listen carefully to ensure that the respondent is answering the question being asked.

Recording Interviews

Explain to each respondent (interviewee) the justification for taping the interview. The use of a tape recorder does not preclude note taking. Notes taken during the interview can assist the researcher in forming new questions as the interview continues and review previous responses. The notes help during the analysis phase to locate quotes from the tape. Note taking aided in pacing the interview. When important points are written, the interviewee is provided with clues as to what interests the researcher.

Notes were expanded after the interview by recording impressions and adding information observed during the interview. The tape was checked immediately after the interview to ensure the tape recorder functioned properly. Interviews were scheduled for sufficient time in data clarification, elaboration, and evaluation. As much time is spent going over the interview, expanding and elaborating notes, and making observations, as was spent in the interview. The data analysis begins during this review while information pertaining to the situation is fresh.

Data Collection Procedures

Below are a set of procedures that were adhered to during data collection. These procedures have been used in previous research and have been adapted from Steier (1987):

1. Review the literature and finalize an interview and demographic data guide.

2. Obtain a list of potential cases for the study through contacts of the researcher.

3. Contact the identified participants by telephone and enlist their support. Determine whether the case meets the established sample criteria and make an appointment for a personal on-site interview.

4. Follow-up with a letter explaining the research study, confirming the appointment, outlining the time requirements, and requesting consent for their participation (See Appendix C).

5. Conduct taped on-site interviews.

6. Go through the interview notes and content immediately following the interview, to expand notes into more complete detail.

7. Send a thank-you letter for the participants cooperation.

8. Develop a case record for each case by: (a) transcribing the interview tapes, (b) organizing the field notes, and (c) eliminating redundancies and ordering the content.

9. Conduct follow-up interviews for clarification of content and additional data which may have been overlooked.

10. Provide findings as requested.

The general interview guide according to Patton (1980) is the "outlining of a set of issues that are to be explored with each respondent before interviewing begins." Patton (1980) and Whyte (1982) agree that issues are not covered in any particular order and with any standard wording. The actual questions are generated during the interview. The guide serves only as a checklist to ensure similar information is collected from all of the people interviewed. Whyte (1982) explains the reason for the interview guide:

> In research we want the informant [respondent] to talk about things of vital interest to him, but we also need his co-operation in covering matters of importance to the researcher, though possibly of little interest to the informant [respondent].

The general interview guide approach is used to ensure systematic collection of similar data across people and cases, establish an initial organization of the content for analysis, provide topical areas to explore, probe, and ask questions to elucidate and illuminate a particular subject, and to keep the interviews focused. Additionally, demographic information such as experience and training of team members is collected. Patton recommends this be done toward the end of the interview, rather than starting the interview with many potentially boring questions. Differences in the breadth and depth can be controlled to some extent through the general interview guides and follow-up interviews before the analysis begins.

Pilot Interview

Using the interview guide, a pilot interview was conducted with one of the cases. As a result some clarifying questions were added to encourage the researcher to probe for more specific answers. The changes were not substantial.

Interviews

Interviews were conducted at the respondents place of business. They were audio-taped using the interview guide as a basis. Approximately eight hours were needed to conduct interviews for each case, depending on the number of personnel on the team and the complexity of the project. Each interview lasted from two to three hours. Notes taken during the interview were reviewed immediately and details expanded. Each interview was then transcribed so that case studies could be developed. Interviewees were sent thank-you notes after the interview was completed.

Case Record

The data was compiled into a case record for each group interviewed. The process included: (a) transcribing interview tapes, (b) organizing notes, (c) eliminating redundancies, and (d) organizing the content. Follow-up telephone interviews were conducted to clarify and collect additional data.

Data Analysis

The data was collected from two sources as previously stated. Data from each of these sources was analyzed in the form of abstracts or matrices. In treating the first set of resources (print media and CBI) the steps below were followed:

1. Locate research applicable to each type of project management technique being included in the design, through the means previously discussed.

2. Evaluate the research for validity, reliability and acceptability (See Appendix A).

3. Abstract research that meets the criteria discussed in step two. (See sample abstract form in Appendix B).

4. Group the data according to commonalities.

After data have been located, evaluated and accepted as reliable and valid, the information was abstracted and grouped. Final data analysis is reported in the form of matrices, and conclusions drawn on the basis of these matrices. Conclusions were then incorporated into a synthesized, tailored project management technique for instructional development.

The procedures for the case study method analysis are driven by the content of the interviews. The following plan was developed:

1. A case record was created for each case, based on each function of the selected project management techniques, for example, planning, estimating, scheduling, and controlling.

2. Each case was examined and problem areas highlighted. The problem areas were examined further to determine if the cause was evident, or if the problem was a symptom of other causes.

3. Variables were categorized by phases in accordance with the established functions.

4. Matrices were developed and a comparison process was used to cross check information and identify variables which may not be evident in one classification or category system.

5. The findings were developed.

6. A follow-up interview was conducted to fill-in gaps as necessary. The opinion of a second researcher verified this researcher's findings. This is the method that case studies use to validate their findings. The second researcher has a similar background to the primary researcher and was used only to verify and decide which information needed to be inquired about in the follow-up interviews.

7. The results were finalized.

Finally, the implications of the research were compiled resulting in a synthesized project management technique specifically tailored for instructional development projects. This technique includes a method for accounting for each of the project management functions.

Summary

The case study methodology used to derive variables which provide a foundation for further research are described in this chapter. The methods employed by the researcher include the development of an interview guide, and in-person, audio-taped interviews with the project personnel of four cases (including the pilot interview).

Four cases were selected for the study based on the pre-established criteria. Patton's (1980) taping procedures and interview principles were used during the interview process. Personnel holding the key positions of project manager and instructional designer were interviewed for each case.

Data analysis involves comparing and contrasting data through the development of matrices. This process continues until the data is most satisfactorily reconciled. Validity in the analysis of the case data is achieved by using another researcher to independently review the interview transcripts, suggested matrices, comparisons, and derived findings. When differences occurred in the findings between this researcher and the validating researcher, additional data were collected to support or dismiss the analysis being questioned.

CHAPTER IV

DESCRIPTION AND RESULTS

This chapter describes the results from the analyses of data from four (including the pilot interview) instructional development projects. The instructional development projects are from the areas of business and industry. This chapter is divided into three sections. The sections address each of the three specific research questions. Sections one and two focus on data gleaned from library research, with supporting evidence from case study interviews. The third research question is primarily answered from the case study research, with supporting data from the literature. Following each question, the results are presented and discussed. A summary of the results is presented at the end of this chapter.

Data Collection and Analysis

The results from researching the first broad question and the two specific questions generated from it, come from data gathered in previously existing research. Data relevant to each research question are organized and presented in summary matrices following the discussion of the findings. The results of the data analysis are presented for each of the specific research questions.

The second broad question and the specific question drawn from it are discussed with respect to the results of the case studies, and additional support from the literature.

Again, pertinent information is presented in the form of matrices following the discussion. This organization will facilitate the development of a synthesized project management technique specifically tailored for instructional development projects.

The model design and analysis literature proved useful in providing a process for developing a synthesized, tailored project management technique for instructional development projects.

Rubenstein (1975) outlined the following steps for the early stages of the modeling process. First, establish the purpose of the model. The purpose of the synthesized tailored project management technique is to track and control resources in instructional development projects, so that the instructional product can be developed efficiently and effectively.

Secondly, Rubenstein suggests listing the possible elements, for example, observations, measurements and ideas, that may relate to the purpose. At this stage, Rubenstein does not eliminate remote ideas as they may prove useful in a closer examination of the the elements.

The third step is to select the elements from the second step that are relevant to the purpose outlined in step one.

During step four, the elements are aggregated and grouped together as Rubenstein writes, "by the virtue of the strong connections between them." Basically, this step is a classification process.

The fourth step is repeated until a technique consisting of seven chunks (plus or minus two) surfaces. This is the process that will be used in answering the third specific research question.

According to Lowther and Saltinski (1975) models (or in this case the information may be applied to a technique) should be designed to include the following:

- Input provisions
- Direction and/or sequence of information flow
- Interaction-synthesis sectors
- Constraints
- Output provisions
- Self-regulatory mechanism

The synthesized, tailored project management technique will be developed to include a mechanism for handling these items.

Selected Project Management Techniques

Seven project management techniques were selected for this study. Gantt charts and milestone charts are representative of bar and discrete point charts. Five network project management techniques were investigated. Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) represent the classic dichotomy between network diagrams. Precedence Diagramming Method (PDM) brings another factor into focus with the concept of lead-lag time. Decision Critical Path Method (DCPM) is another version of CPM, actually diagramming options that must be chosen among all possible options. The last project management technique, Graphic Evaluation and Review Technique (GERT) is a variation on PERT and provides a looping mechanism for tasks that are cyclic in nature.

Each of these techniques have been considered in responding to the research questions. The first broad question and the two specific questions stemming from it have been answered primarily from the literature. Each technique has some literature available that enabled their inclusion in the response to the first broad question.

The second broad question has also been answered with respect to all seven selected project management techniques; however, the four cases developed were unable to include all seven of the selected project management techniques. Three of the techniques, PDM, DCPM, and GERT were not found to be used in the instructional development arena. The reasons for their absence have been sought in the follow-up interviews with the four companies that were interviewed. However, certain aspects of each of these techniques were used by the project managers who were interviewed. The synthesized, tailored project management technique does include some aspects of these techniques as deemed appropriate. This information was taken from the advantages outlined in the literature and information gathered in the follow-up interviews.

Case Descriptions

The training programs of four companies were involved in this study. The first, Company P, is a major manufacturing company where the interview guide was piloted. Since the interview guide for this interview did not change significantly in the subsequent interviews, the data was included in the results as appropriate.

Company A is a high technology systems and equipment company. Company B is a computer systems company, that provides data processing services to a wide variety of customers. Company C provides training, communication, and tools to increase customer satisfaction to their parent company, a major manufacturing company.

All of the instructional development teams regularly produced training manuals that were used in conjunction with stand-up classroom instruction. (Two companies also produced video instruction, and one of these teams also developed computer-based instruction (CBI). The subject matter varied among the companies from leadership/management training to technical training (including computer software), and customer satisfaction training.

The average turnaround time for an instructional development project, from the beginning planning stages to the delivery of the first class, was between two and three months. (Company P was well outside this time at 12 months; however, it was stated that once the process really started, after political issues were resolved, a project could be completed in three to six months.)

The hours of instruction that the classes deliver range from eight to 40 hours. The size of the target audience ranged from 50 to 2,500 people. The larger groups were classes targeted on a national basis.

The project managers had five to 12 years of experience managing instructional development projects. Although one project manager only averages five instructional development projects a year, the other three developed between 12 and 15 projects per year. With one exception, all had formalized instructional development models upon which to base the instructional development process. The exception, the project manager at company C, developed the fewest hours of instruction; however, the company does not mandate a particular *formal* instructional development model. The project managers at this company all have degrees in instructional development and employ individual instructional development models even though their management does not require the use of a specific model.

By virtue of the purposeful sampling procedures, all four companies used one or more of the selected project management techniques. Table 1 lists the various techniques that each company employed; however, it is important to note that elements of other selected project management techniques could be found. No one technique was used in its pure form, but rather each was adapted and used in conjunction with components of other project management techniques that are not listed in the matrix. These are pointed out in the results as appropriate.

In order to provide a snapshot of each of the organizations involved in the research, the demographic data from the case descriptions are summarized in Table 1.

Results

Data analysis results are provided for each of the three specific research questions included in the study. Data relevant to each research question is summarized in the form of matrices. The information in each matrix is expanded in a discussion preceding each matrix.

Broad Research Question

How do selected project management techniques differ in their functions, specific purposes and components?

Each of the selected project management techniques have the same general purpose; to control the allocation of resources while meeting project objectives. All of the techniques control resources through a set of functions, generically defined as: (a) planning, (b) estimating, (c) scheduling, and (d) controlling. This set of functions is common to all of the selected projected management techniques as shown in Figure 15.

The first function consists of planning, a continual process throughout the project's life cycle. The process includes determining which tasks must be done to meet project

Table 1

Demographic Data Summary

Characteristics	Company P	Company A	Company B	Company C
Years managing training projects	12	7	5	9
Average number of projects per year	12	15	14	5
Average hours of instruction per class	40	24	24	12
Average number of attendees per class	1,500	1,025	600	1,500
Average turn-around time in months	12	3	2	2.5
Type of training	Leadership	Technical	Computer	Management and Customer Satisfaction
Type of media regularly produced	Training manuals Video	Training manuals Video CBI	Training manuals	Training Manuals
Type of instruction	Stand-up	Stand-up CBI Video	Stand-up	Stand-up
Instructional Development Model	Yes	Yes	Yes	No
Which project management technique(s) are used?	Gantt charts	Gantt charts Milestone charts CPM	Gantt charts PERT	Gantt charts Milestone charts PERT*

* This team used characteristics of DCPM and PDM, although when asked the interviewee did not list these as project management techniques used by the company.

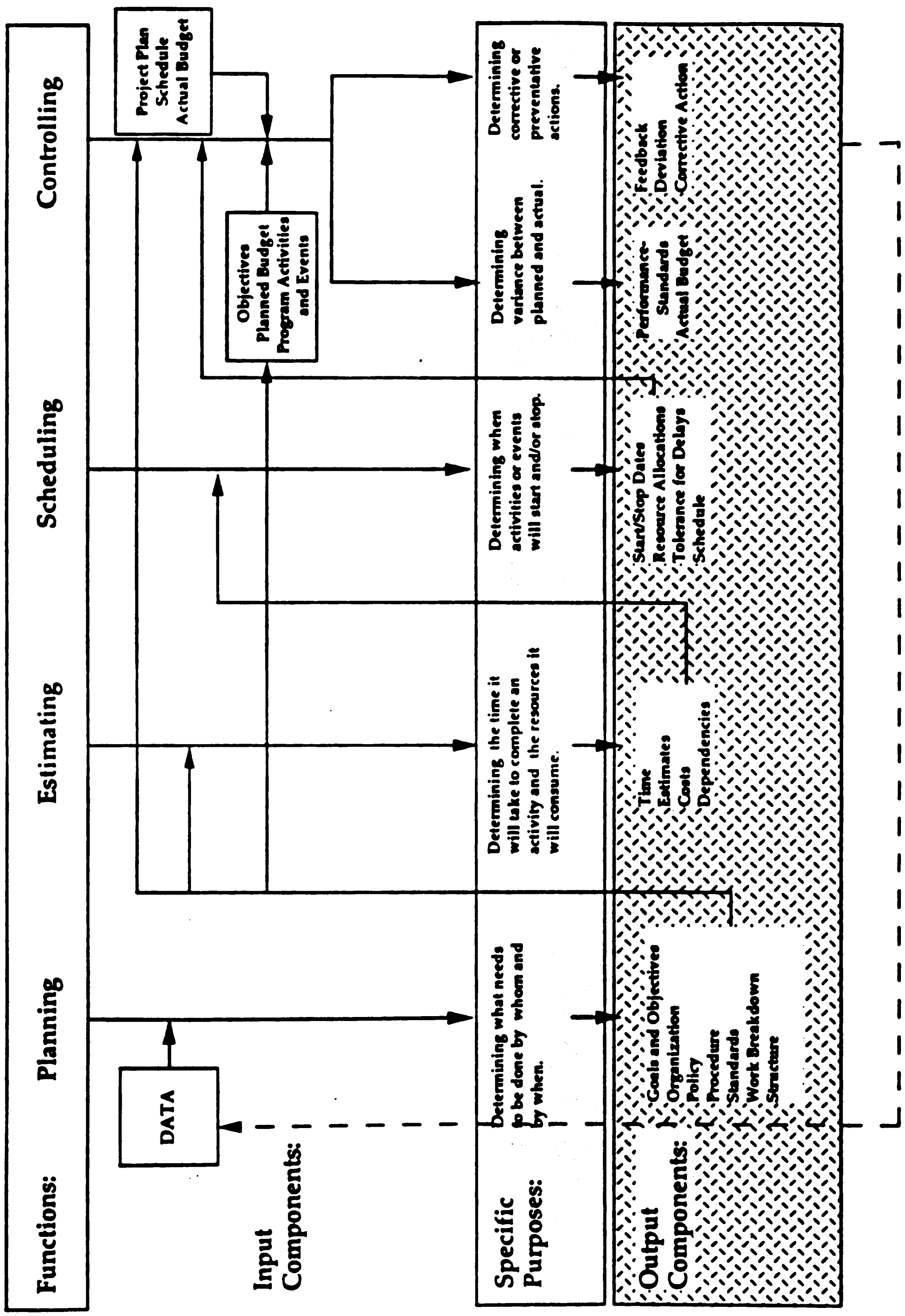


Figure 15

Project Management Technique

objectives, communicating these ideas to others for appropriate action, within an appropriate timeframe, and the effective use of resources over an entire project life cycle.

Variables relevant to resource planning include: time, money, machines, personnel, and materials. The allocation of time and monetary resources result in a schedule of activities and a budget. Human resource matrices and manpower loading charts are the results of personnel planning. Materials become tied to a budget. When new materials are purchased or physical resources are allocated to different activities over the project life cycle, the changes must be reflected in the budget (Roman, 1986).

Estimating is a function resulting in an educated guess of the necessary time and/or cost to complete a specific task. It includes determining the resources an activity will consume.

Scheduling determines when activities will begin and end, or accomplishments are due. Estimates of the time required to perform each task (based on assumed personnel, equipment requirements, and availability) are channelled to the scheduling function. Basic scheduling computations, such as earliest and latest allowable start and finish times for each activity and the result, are used to identify the critical path and slack or float time associated with the non-critical paths.

Controlling is a preventative or corrective action used to resolve conflict through analysis and evaluation. The project plan is central to controlling. Time, money, personnel, and material resources are monitored so that projects are implemented according to plan, in order to avoid large deviations between projected and actual resource consumption (Roman, 1986). Checking progress against the schedule, assigning and scheduling resources, and analyzing the effects of delays, are necessary for major network schedule changes and network revisions.

Each function is composed of a specific set of purposes that determine the output of the function, as presented in the middle row of Figure 15. For example, verification and decision-making are the two specific purposes within the controlling function. The specific purposes each employ two types of components; input and output. Each of these specific purposes and input-output components are emphasized to varying degrees, depending on the selected project management technique.

The first broad question is divided into two specific questions. The information used to answer these specific questions is summarized to answer the broad question.

Specific Research Question 1

How are selected project management techniques different or similar in their support of project management functions?

As mentioned, the project management functions are: (a) planning, (b) estimating, (c) scheduling, and (d) controlling. Each function relates to the others, so the functions are not independent. Each project management technique studied emphasizes the various general functions to different degrees. For example, PERT emphasizes the controlling function. Considering alternatives and making action plans (decisions) based on alternatives is central to this technique. In contrast, Gantt charts highlight theplanning function. They are not used for considering alternative actions, but rather to plot specific activities or events against time or money. Each of the selected project management techniques supports the project management functions to varying degrees. The following discussion outlines those similarities and differences.

The Planning Function

Project planning includes defining the project's goals and objectives; generally, outlining the purpose of the project and stating exactly what the project is to accomplish. The planning function provides a strategy for accomplishing the project's goals and objectives. Usually, this includes schedules, containing deadlines, in addition to a budget with cost constraints. For example, the project schedule shows the project requires 12 weeks for its completion, and the project deadline states the project must be completed by June 1. The budget limits the dollars spent to $125,000. These items are the output of the planning function and become the input for the controlling function.

In the planning function, a component common to all selected project management techniques, is the determination of a set of activities or tasks composing the project. These activities must be completed in order to complete the project; therefore, the project's entire scope must be outlined. The requirements for its successful completion must also be stated. For example, the requirements for an instructional development project might include the following general activities:

- Needs Analysis
- Design
- Development
- Implementation
- Evaluation

After the project definition, the actual work to be completed during the project is specified. This set of tasks is often referred to as the Work Breakdown Structure (WBS). The project plan will include a verbal summary of the WBS.

Elements of a typical WBS for an instructional development project are shown in Figure 16. It includes all of the major activities the project encompasses and their subactivities. The purpose of the WBS is to identify each major activity that must be performed to meet the project requirements.

To create the WBS all major activities that make up the project are identified. For example, in Figure 16, the major activities are needs analysis, design, development, implementation and evaluation. Subactivities below each

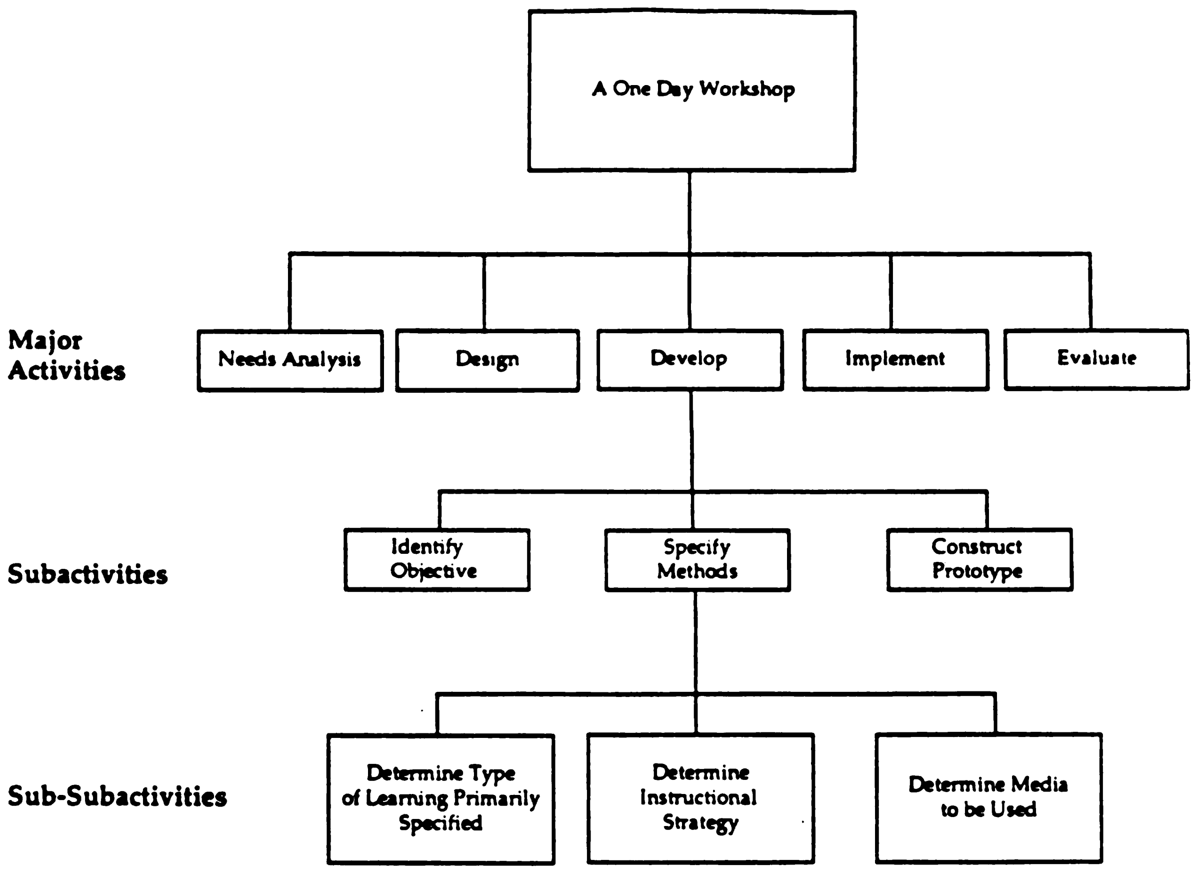


Figure 16

A Work Breakdown Structure for an Instructional Development Project

major activity must be identified. For example, the major activity, development, is composed of several subactivities; identifying objectives, specifying methods, and constructing prototypes. Each subactivity is a discrete task with a specific duration. In order for the WBS to be complete, all activities must be included. When all of the stated activities are complete, the entire project is also complete. The WBS provides a complete list of the tasks needed to finish the project.

After the project has been defined through requirements and objectives, the WBS is specified. A project activity chart is then created from the WBS. The project activity charts list the activities and their durations. Another chart, the Project Activity Precedence Chart is then created, to identify which activities must precede others. These two charts may be combined into one chart as shown in Figure 17.

This chart is used for sequencing and scheduling. The precedence information feeds into the sequencing process. The duration information is obtained as a result of the estimating process. This will then feed into the scheduling function.

The WBS is essential to the first phase of planning for an instructional development project. In most instances, the major tasks are similar; conduct a needs analysis, write instructional objectives, through the construction of a prototype, and evaluation.

Figure 17

Project Activity Precedence Chart

Activity Item Identification	Task	Precedence	Duration (Days)
A	Needs Analysis	None	10
B	Design	A,E	15
C	Develop	A,B,E	25
D	Implement	A,B,C,E	15
E	Evaluate • Formative • Summative	A,B,C,D,E	30

The differences in the ways that each of the selected project management techniques handle the planning function is discussed in the following sections.

Gantt Chart Planning

Gantt charts allow for planning at the macro level. Begin and end dates for the entire project are planned. A WBS is completed in concordance with the project objectives. The sequencing of the tasks are then planned.

Milestone Chart Planning

Milestone charts employ the planning function similar to Gantt charts. Milestone charts additionally require checkpoint dates to be planned. These are dates when progress will be assessed and decisions will be made as a result.

CPM Planning

The CPM plans the optimum use of resources and the most efficient manner in which to complete the project at the least cost. The tasks that compose the project are defined and their technical dependencies are shown in the form of a network diagram. There are several alternative methods of networking, (1) arrow, (2) node, and (3) precedence. Moder, Phillips and Davis (1983) write that planning is the most important step in the CPM procedure. It is a disciplined approach to express a network plan for the project. This largely accounts for the benefits of CPM as a project management tool. The network diagram simulates the alternative means of completing a project.

PERT Planning

PERT is strong in the area of planning. The ability to plan and optimize resources in order to achieve a goal within time and cost constraints is its major strength. Planning is critical to create a valid network. The network represents a major contribution to the definition of a complex project. The network development and critical path analysis reveal interdependencies and problem areas not necessarily obvious in conventional planning methods.

DCPM Planning

The system concept of equifinality is evident in the DCPM project management technique. The technique considers, during the planning phase, many different paths to reach the same goal. For example, in the needs analysis phase of an instructional development project there are several methods of gathering information on the target population; in-person interviews, telephone interviews, and written answers to survey questions. Overall, in any given project, there are several alternatives for completing some of the tasks. With DCPM these alternative methods are included in the planning function and are carried into the scheduling function (Weist and Levy, 1977).

PDM Planning

The project activity and precedence chart is particularly important to the planning function of this project management technique. The critical factor in the use of this technique is that those using the technique must plan for all types of relationships, not just finish to start relationships (FS) as in the Project Activity and Precedence Chart (Figure 17). For example, a start to start (SS) relationship in an instructional development project is the use of formative evaluation. The formative evaluation cannot start until N days after the development has begun.

GERT Planning

GERT allows you to plan for possible failures. For example, in an instructional development project, the pilot course may result in major revisions of certain portions of the course, or the entire course may need major reworking. For example, a self-paced course using a training manual is heavily dependent on target students' ability to read. If it is discovered during the pilot that the target population was not able to read at the level which the course was developed, the GERT technique provides feedback for the necessary changes resulting from the unpredictable outcomes. GERT also allows for planning on-going types of processes, as in the case of instructional development projects for formative evaluation.

The planning function data for the techniques are summarized in Table 2. The plus sign (+) under a technique indicates that the item is present in the technique indicated. The minus sign (-) indicates that it is absent in that technique. For example, all of the techniques provide some type of overview of the project at the macro level, but only the network diagrams show a specific level of detail in the chart. Note that a major difference between Gantt and the other techniques is that it does not provide for determining precedence.

The Estimating Function: Cost and Time

Estimating is fundamental to planning. Both time and costs are estimated in this function and are interrelated. An extension in time usually involves an increase in cost.

Estimating Costs: Budgeting

A budget is a financial expression of an organizational policy, a control mechanism, a standard for comparison, and a baseline for the difference between planned and actual costs.

Budget approval through the management chain provides a means of obtaining resources. The budget is a plan approved by management for the allocation of resources. However,

Table 2

The Planning Function Summary

	CPM	DCPM	Gantt	GERT	Milestone	PDM	PERT
Project Purpose	+	+	+	+	+	+	+
Work Breakdown Structure	+	+	+	+	+	+	+
Determines Precedence	+	+	-	+	-	+	+
Macro Level	+	+	+	+	+	+	+
Specific Level	+	+	-	+	-	+	+
Alternative Methods	+	+	-	-	-	-	-

Legend: + indicates the feature is present in the technique - indicates the feature is absent

within an instructional development project the outcome of the allocation process is often unsatisfactory to the managers who must work under the given budget constraints.

The degree to which different activities of an organization are supported by the allocation of resources is a measure of the importance placed on that activity. It is the output of the planning function and the input to the control function.

The budget is the gathering and presentation of cost data. In on-going operations, historical data is typically available. For projects which are one-time events, the historical time and cost data is not necessarily available. In the beginning of a project no on-going budgets are available to use as a base, although there may be budgets and audit reports from similar projects available to provide guidelines.

Estimating a budget is important since overfunding can lead to waste and lax management, while underfunding a project hinders the accomplishment of the project's objectives and causes frustration in the team members.

The differences in the ways that each of the selected project management techniques handle the estimating function is discussed in the following sections.

Gantt Chart Budgeting

Gantt charts use the option of dollar increments, rather than time to track costs. An example is shown in Figure 18. In this example the budget is plotted below the center in

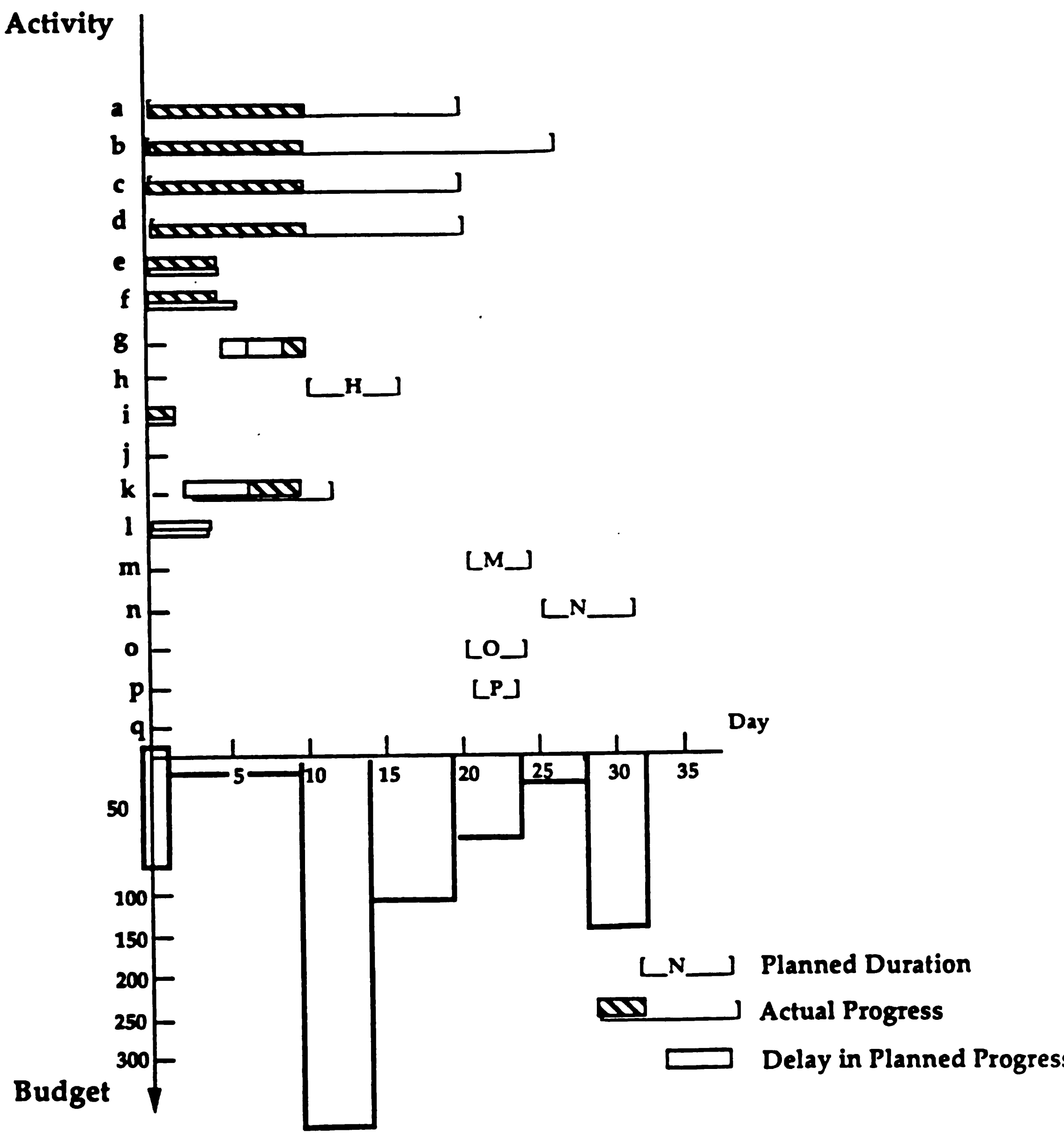


Figure 18

Relating the Budget to the Gantt Chart Schedule relation to the task time durations. The completion of Task H, for example, correlates to the consumption of $300.

Milestone Chart Budgeting

Milestone charts are not mentioned in the literature with respect to budgeting. They are used primarily as a controlling tool against project time durations.

CPM Budgeting

Critical Path Method accounts for budgeting by calculating from the activity data the cost of doing each task. Included in the data, each activity is assigned a completion time that will occur at its most efficient pace and a "crisis" completion time (Weist and Levy, 1977). Associated costs needed to carry out the activity are calculated. If some critical activities are shortened to their corresponding crisis times, then the corresponding direct cost must be calculated in this manner. It is possible to calculate the cost of completing a project within various total times. Indirect costs are overhead cost allocated on basis of total project time. Fixed costs per project decreases as project time decreases. CPM primary analytical emphasis is in determining program strategy which will satisfy schedule requirements at a minimum cost (Dooley, 1964).

PERT Budgeting

PERT accounts for budgeting through PERT/Cost budgeting procedures. The PERT/Cost technique was developed during 1959 to 1962 by PERT and CPM users. The Department of

Defense and the National Aeronautics and Space Administration jointly issued a manual, DOD and NASA Guide, PERT/Cost Systems Design, focused on the cost control aspects of the "PERT-type systems." The PERT/Cost system was based on the WBS. The DOD and NASA Guide outlined the system as:

> End Item Subdivisions. The development of the work breakdown structure begins at the highest level of the program with the identification of project end items (hardware, services, equipment or facilities). The major end items are then divided into their component parts (e.g., systems, subsystems, components), and the component parts are further divided and subdivided into more detailed units....The subdivision of the work breakdown continues to successively lower units, reducing the dollar valued and complexity of the units at each level, until it reaches the level where the end item subdivisions finally become manageable units for planning and control purposes. The end item sub-divisions appearing at this last level in the work breakdown structure are then divided into major work packages (e.g., engineering, manufacturing, testing). (p. 27)

Each task of the WBS is costed, and then task costs are accummulated based on the budget type employed by the organization.

DCPM Budgeting

DCPM accounts for budgeting in the planning and scheduling functions. It uses the lowest cost alternative in choosing among equally feasible methods. Weist and Levy (1977) write:

> If we could obtain the usual estimates for job durations, and in addition could obtain estimates for total job costs and time-related project overhead cost, we could calculate the duration of the project and then the total project cost (sum of all job costs plus project cost based on project duration). A simple comparison would yield the lowest cost alternative, but, as always, other factors not included in this analysis

> would also have to be weighed before the final choice would be made. (p. 149)

PDM Budgeting

Although PDM could make use of PERT/Cost or the CPM budgeting features, the literature does not discuss any specific options. Scheduling, rather than budgeting is the central issue in this project management technique. One possible budgeting advantage is that since precedence relationships are not only finish to start, smaller units are estimated. This may allow for more accurate budgeting estimates.

GERT Budgeting

According to Edward Clayton and Laurence Moor (1972) cost may be included in the GERT project management technique. In order for GERT to be effective in handling costs they must be a linear function of time. If costs are non-linear with respect to time, cost estimates can be made using the average realization times of the nodes.

The estimating function data for costs is summarized in Table 3.

Estimating Time

Traditionally, time estimation is done through single or multiple point estimates. Single point estimates are made based on one-time. Multiple point estimates are done by estimating more than one-time for the same task. Usually, some combination of optimistic, pessimistic, and most likely time estimates are generated individually. Then, a calculation, either an averaging process or a more complex

Table 3

The Estimating Function: Budget and Cost Information Summary

	CPM	DCPM	Gantt	GERT	Milestone	PDM	PERT
Method	Time/Cost Tradeoffs	Time/Cost Tradeoffs	Tasks may be plotted against dollar amounts	same as PERT/Cost	None Present	same as PERT/Cost	Determine costs for each task

formula, as in the case of PERT, is performed on the individual time estimates to arrive at one estimated time that is used in the scheduling function.

James Hershauer and Gabriel Nabielsky (1972) suggest the following nine situations for the knowledge associated with activity times:

- Certainty -- Same Activity

Certainty regarding activity time based on repeated historical precedent with the same activity.

- Certainty -- Similar Activity

Certainty based upon historical data analysis of similar activities.

- Risk -- Mode and Range Only

Uncertain distribution of activity times. Only the mode and range are estimated. This is the standard method of estimation in PERT.

- Risk -- Common Distribution

It is assumed that a particular distribution accurately represents the times for all activities in the network.

- Objective Risk

Implies that the determination of probability distribution is done in an objective manner. Each activity should have a sufficient amount of historical data for fitting the correct type of distribution and the correct distribution parameters.

• Subjective Risk

Involves an expert's estimate of both the type of distribution and its parameters for each activity. This is an effective method in the GERT project management technique.

• Uncertainty -- Mode Only

One is uncertain about the time, but will make a single point estimate based on what a possible mode of distribution might be. The general shape and other parameters of the activity-time distribution cannot be estimated.

• Uncertainty -- Range Only

A range of possible activity times can be made, but not a most likely value.

• Subjective Uncertainty

Only the vaguest idea of what activity time durations might be.

Hershauer and Nabielsky (1972) emphasize that there is no one best method of time estimation. The method depends on the situation. If situational differences are not recognized, there is a large margin for error in time estimation.

Time estimation in project management is primarily concerned with the degree of certainty or uncertainty about the time that any given task may take. Hershauer and Nabielsky practically defines certainty as the situations in which a single point estimate provides "a high degree of reliability." When reliability is high, there is no reason to be concerned with probability. They define uncertainty as a "situation in which one can neither make a point estimate with 'a high degree of reliability,' nor anticipate the degree of risk that might be involved" (p. 17).

Gantt Chart Estimating Time

Gantt charts usually are estimated with single point, most likely estimates. The shortest, longest, and average completion times are not considered as part of the estimate. They do not account for the uncertainty involved in performing a task.

Milestone Chart Estimating Time

Traditionally milestone charts are estimated with single point estimates.

CPM Estimating Time

Accurate estimate of the total project data depends on accurate estimates of activity-time data. CPM eliminates need and expense of careful time estimates for *all* jobs:

Instead the following procedure can be used:

> • Given rough time estimates, construct a CPM graph of the project.
>
> • Then those jobs that are on the critical path (together with jobs that have very small total slack, indicating that they are nearly critical) can be more closely checked, their times re-estimated, and another CPM graph constructed with the refined data.
>
> • If the critical path has changed to include jobs still having rough time estimates, then the process is repeated.
>
> In many projects studied, it has been found that only a small fraction of jobs are critical; so it is likely that refined time studies will be needed for relatively few jobs in a project in order to arrive at a reasonable accurate estimate of the total project time. CPM thus can be used to

> reduce the problem of Type I errors at a small total cost. (Levy, Thompson, Wiest; 1963; pg. 69)

PERT Estimating Time

Activity time estimates are as accurate as any, and should not be changed unless a new application of resources or a trade-off in goals is determined. Estimates should not be biased by an arbitrarily established schedule. Time estimates for each activity in PERT are three-way. They are required to gauge the "measure of uncertainty" intrinsic in the probabilistic nature of many "development-oriented" "non-standard" tasks. However, for reporting purposes, the three estimates are reduced to a single expected time (Te) and a statistical variance (S2).

Each activity in the network incorporates three estimates in order to arrive at an expected value. These three estimates; most probable, pessimistic, and optimistic time estimates are combined in a weighted formula to give a time estimate that will be used in the PERT diagram.

The most optimistic completion time includes a minimum amount of time. It assumes everything will go according to plan without difficulty. A qualified person is asked, "What is the shortest time needed to complete this activity?" It assumes everything will go right the first time.

The most pessimistic completion time assumes an unusual amount of "bad luck." It is a best guess of the maximum amount of time it would take to complete the activity, even under an initial failure and a need to restart. It does not account for strikes or fires unless these types of occurrences are an inherent risk.

The most likely completion time would occur when many experienced personnel estimate the same task or if the activity was repeated many times under similar conditions.

Slack time is the extra time available for all events and activities not on the critical path. Negative slack occurs when a calculated end date does not meet a program date objective. Often times, this program date has been established prior to the scheduling activity, often on an arbitrary basis.

PERT's distinguishing factor is that it enables project staff to make probabilistic estimates about the likelihood of completing specific tasks or even the entire project within a specified time period. It assumes that the time it takes to complete a task is a unimodal distribution. One can calculate the expected time to complete a task [t(e)] by plugging in values for a, b, and m into the following equation, where "a" is an optimistic estimate, "b" is a pessimistic estimate and "m" is the most likely value:

$$t(e) = \frac{a + 4m + b}{6}$$

Standard deviation for the beta distribution is calculated as follows:

$$\frac{b - a}{6}$$

To complete the PERT network, the expected time values [t(e)] are used to calculate the earliest start time for a task, the earliest finish time, the latest start time, and the latest finish time. By estimating standard deviation of all the activities taken together on the critical path, and assuming a normal distribution for the time to complete the critical path activities, one can make probabilistic estimates regarding how likely the project can be completed in a given period of time.

DCPM Estimating Time

DCPM like CPM estimates are based on single point estimates. Since rough estimates are used, there is some uncertainty.

PDM Estimating Time

Estimating time in the PDM project management technique is a single point estimate approach. Lead-lag times account for some uncertainty, by associating a minimum duration of time that must pass between start and/or finish points specified in the relationship.

GERT Estimating Time

According to the research done by Hershauer and Nabielsky (1972) GERT is particularly suitable in objective and subjective risk situations. The PERT system of time estimation can be applied to GERT and includes the maximum number of recycle loops that might be expected to occur in practice. The estimating function data for time is summarized in Table 4. GERT and PERT both use multiple point time estimates and this is indicated by the plus sign (+) in the columns under these techniques.

Table 4

The Estimating Function Summary: Time Information

	CPM	DCPM	Gantt	GERT	Milestone	PDM	PERT
Single point estimates for each task	-	+	+	-	+	+	+
Multiple point estimates (for each task)	-	-	-	+	-	-	+
Certainty	-	-	-	-	+	+	-

Legend: + indicates the feature is present in the technique - indicates the feature is absent

The Scheduling Function

Scheduling converts the project plan into a functional timetable. It becomes the fundamental basis for monitoring and controlling the project activity. It becomes the major tool for managing projects (Meredith and Mantel, Jr.; 1985).

The differences in the ways that each of the selected project management techniques handle the scheduling function is discussed in the following sections.

Gantt Chart Scheduling

Gantt charts (Figure 6) are most commonly used as a scheduling tool. Planning and scheduling while using Gantt charts are done simultaneously, according to Moder, Phillips, and Davis (1983). Each task is listed vertically along the left side of the chart and the bars indicating the schedule are listed horizontally against scheduled dates.

Milestone Chart Scheduling

Milestone charts are weak in the scheduling area because the technique does not illustrate dependent relationships. Milestone charts are more useful for controlling.

CPM Scheduling

CPM is strong in the scheduling function. In contrast to Gantt charts, where the planning function is tied to the scheduling function, the scheduling function is separate from the planning function. Its strength lies in critical path use. The critical path in a network is defined as the series of tasks taking the longest completion time. There is no slack time on the critical path. If the schedule slips on the critical path, the entire project will be affected. Activities off the critical path have some slack associated with them, and can tolerate some slippage. Non-critical tasks have some flexibility in the scheduling of their start times.

Assuming the project has one personnel resource, begin at the left of the network to calculate earliest start time. Work to the right in calculating earliest start times on the critical path first, then determine earliest start times on non-critical tasks.

The latest start times work right to left subtracting from the total the amount of time it takes to perform a task. First, complete items on the critical path. Those items not on the critical path are calculated right to left. Finally, slack time is calculated.

The formula for calculating slack time is as follows:

Slack = Late Start - Early Start

For items on the critical path, slack is always equal to zero. If additional personnel resources are used, then there is the possibility of more parallel activities. Activities containing slack time may be rescheduled so that various resources can be used to their maximum efficiency.

PERT Scheduling

PERT is strong in the area of scheduling. The following items were outlined by Moder, Phillips, and Davis (1983) as ways in which limited resources affect slack time in a schedule:

• Resource constraints reduce the total amount of slack in a schedule.

• Slack time depends on both precedence relationships *and* resource limitations.

• Early and late start schedules are typically not unique. This means that slack values are not unique. These values depend upon the scheduling rules used for resolving resource conflicts.

The critical path in a resource constrained schedule may not be the same continuous chain of activities as occurring in the unlimited resources schedule. A continuous chain of zero-slack activities *may* exist, but since activity start times are constrained by resource availabilities, as well as precedence, relationships this claim may contain different activities.

DCPM Scheduling

The DCPM emphasizes the interface between the scheduling and planning function. Traditionally, decisions were made among alternative methods of performing tasks during the planning function. Since the choice among alternative job methods involves scheduling considerations, the DCPM technique is designed to facilitate the analysis of these choices (Crowstone and Thompson, 1967).

PDM Scheduling

The lead-lag factor is critical to PDM scheduling. The lead-lag factor is a minimum time that must separate begin and/or end times in the precedent relationship. An example of scheduling a start to start (SS) factor. An instructional development example is that of formative evaluation. The course must be partially written for formative evaluation to occur, but the course should be evaluated before it is completed. The lead-lag factor could be appropriate number of days into the development, before evaluation could begin.

GERT Scheduling

GERT allows for project uncertainty in the project schedule. The duration of tasks and the actual tasks in the network may vary. The scheduling function is regulated by probabilistic nodes, branching, and feedback loops. (See Chapter II for a discussion of specific nodes.)

The scheduling function data is summarized in Table 5. Note that neither Gantt nor milestone techniques include the use of early start/late start and early finish/late finish scheduling methods.

The Controlling Function

The controlling function is based on four basic elements:

- The plan
- Status
- Tolerance
- Recovery mechanism

The first element in controlling is the project plan. In system terms the project plan serves as a mechanism for maintaining system stability; the desired steady state. It

Table 5

The Scheduling Function Summary

	CPM	DCPM	Gantt	GERT	Milestone	PDM	PERT
Early Start/Late Start and Early Finish Late Finish	+	+	-	+	-	+	+
Network	+	+	-	+	-	+	+
Critical Path	+	+	-	+	-	+	+

Legend: + indicates the feature is present in the technique - indicates the feature is absent

is similar to the thermostat used to regulate room temperature by establishing a set of acceptable boundries.

The second element is the measure of current status, similar to a thermometer. There must be some method to objectively measure where the project stands. In managing projects this is done by the project manager.

The tolerance is the amount of acceptable deviation from the schedule. Although a room temperature of 70 degrees is preferable, 68 degrees is tolerable. In the project management terms, the tolerance is measured in terms of the float available in the critical path.

The fourth element, referred to as a recovery mechanism, is a method for the system to maintain its stability, for example, an air conditioner or a furnace changes the room temperature to within the established boundries. In project management terms recovery may be accomplished by obtaining additional resources or the reallocation of existing resources.

Control also contains an additional personnel element. Professionals may view the controlling function negatively.

> There are psychological problems associated with control insofar as most people, especially highly educated and specialized professionals, balk at being "controlled". Most professionals feel being "controlled" has a denigrating connotation and are unhappy about the prospect of operating in an environment where they feel their activities are closely monitored. On the other hand, few of these same professionals would be willing to accept operational (i.e., project) responsibility without having some procedural process that would give them reasonable assurance that the activities they were responsible for was proceeding in accord with

> planned objectives and inferred or formal legal commitment. (Roman, 1986, p. 255)

This comment was confirmed in the pilot interview. The interviewee was asked, "How do you use the task list or Work Breakdown Structure to monitor and control the project?" Examples of their responses were, "Having your people accept the responsibility and agree to some extent to be accountable for their actions; I don't like the words *control* and *monitor*, but they accept their responsibilities that they intend to keep and I don't monitor for report cards; they give me the information, and ask for help when they can't make it, and maybe they can help somebody else, that's the way I like to run." Without a clear understanding of the purpose of the control function it may be ineffective. Generally, controlling follows the project plan and monitors the project's progress against the project plan. If the project is defined by distinct measurable tasks, then controlling, through (a) monitoring, (b) decision-making, and (c) adjusting simply means tracking the work that has been accomplished.

The problem in monitoring is not having clearly defined activities whose progress can be measured. Both time and monetary resources must be measured. Planned or budgeted time or cost versus the actual time or money consumed is central to monitoring a project's progress. Accurate, up-to-date reports are the basis of decisions in the controlling function.

In the scheduling and controlling functions, frequent updating is necessary in order to provide an accurate picture of the current state of the project.

Some project management techniques do not account for controlling budgets, or when they do, the corporation doesn't use the project management technique in that way. For example, Gantt charts may plot activities against time or money; however, Company P did not use Gantt charts for plotting money for budgets, but rather only for scheduling (time). The lack of costing information is often mentioned when discussing project management techniques.

As managers direct the use of resources to reach the objective, the resource usage should be monitored carefully. Deviations from planned usage should be checked against project progress. Exception reports are generated if the rise in resources doesn't equal the accomplishments. Variances forecast significant departure from the budget. It is a warning for corrective action.

The differences in the ways that each of the selected project management techniques handle the controlling function are discussed in the following sections.

Gantt Chart Controlling

Gantt charts are strong in the area of controlling time, since they reveal at a glance the project schedule. They illustrate planned versus actual progress for the tasks listed in the WBS, in an effective and easy to read format. These tasks are displayed against a horizontal line depicting either time or money. Since Gantt charts do not show interdependencies between events and activities, controlling project costs is difficult (Kerzner, 1984). Gantt charts indicate the actual current status for each set of tasks compared to the planned progress for each task in the set.

Since both planned and actual progress information is available, Gantt charts are useful in expediting the sequencing of tasks and the reallocating of resources among tasks. In general, Gantt charts are useful in keeping track of the project's overall status or "the big picture."

Large amounts of information can be included in Gantt charts by color coding responsibilities. Symbols can depict (Roman, 1986): (a) scheduled start date, (b) actual start date, (c) scheduled termination date, (d) actual termination date, (e) critical technical milestones, (f) budgeting milestones. If the chart is too complete, it undermines the technique's simplicity, which is its major strength.

Milestone Chart Controlling

Milestone charts are strong in the area of controlling, as are Gantt charts. Milestone charts indicate tasks that are on the critical path, or milestones. Scheduled and achieved milestones can be referenced easily in relation to the current date. These milestones provide predetermined checkpoints for feedback control (Meredith and Mantel, Jr.; 1985).

CPM Controlling

As the project is underway the critical path is a guide to activity completion in the correct sequence and on schedule. Since starting and finishing times are rarely exact, the plan and schedule is an important link to the critical path. The following steps are concerned with updating a schedule; however, they do not include dealing with cost revision:

1. Indicate actual progress in the network.
2. Revise the network logic or time estimates of uncompleted activities (as appropriate).
3. Recompute basic schedule of earliest and latest allowable times.
4. Revise the scheduled activity start times and indicate the new critical path.

PERT Controlling

The controlling function of PERT is the other main focus of the PERT project management technique. PERT is strong in the area of controlling. The emphasis on controlling is through periodic status reports.

Information on activity start, duration, and finish dates is entered into the PERT system to determine the extent to which the project is being carried out according to plan. It is useful for the team to see the impact of schedule slippages on the course of the project. An analysis of specific slippages may require rescheduling of the entire project and certain tasks may require the elimination of slack time. If the PERT analysis is tied to financial data, the impact of schedule slippages can provide insight into increased project costs.

DCPM Controlling

In the DCPM project management technique controlling is closely tied to planning and scheduling. The choice between alternatives is usually based on the lowest cost and the control mechanism is adhering to the choices made after planning and scheduling have been completed.

PDM Controlling

PDM is primarily a scheduling technique. There is no information in the literature on its ability to track project control.

GERT Controlling

The GERT project management technique uses a very complex networking scheme. Although the feedback loops are present as a control mechanism, GERT is too complex to be used as an effective control tool (Meredith and Mantel, Jr.; 1985).

The controlling function data is summarized in Table 6. Note that the common factor for all of the techniques is that they control for time.

The following section is a result of information gleaned from the literature concerning the advantages and disadvantages of the selected project management techniques.

Table 6

The Controlling Function Summary

	CPM	DCPM	Gantt	GERT	Milestone	PDM	PERT
Planned vs. Actual Easy to See	-	-	+	-	+	-	-
Controls costs	-	+	-	+	-	-	+
Controls time	+	+	+	+	+	+	+
Controls quality	-	-	-	+	-	-	+

Legend: + indicates the feature is present in the technique - indicates the feature is absent

Specific Research Question 2

In terms of advantages and disadvantages, how do project management techniques differ in emphasis with respect to their specific purposes?

Each of the selected project management techniques was designed with features to solve specific problems in the project management process. This has resulted in the development of unique aspects in each of the project management techniques. Each technique is evaluated in terms of their advantages and disadvantages. The advantages and disadvantages will then be used to form conclusions and recommendations for the use of each technique or the use of certain aspects of each technique in the instructional development process.

Gantt Chart Advantages and Disadvantages

The advantages of Gantt chart usage can be summed up as overall ease of use. The literature cites the following three specific areas that are handled easily with Gantt charts:

- Construction
- Maintenance and modification
- Readability

The construction of a Gantt chart is straight forward when following these basic steps:

1. Determine the beginning and ending dates for the entire project.

2. List the tasks that must be completed in order to complete the objectives of the project.

3. Sequence the tasks in the order they will be performed.

4. Divide the time schedule for the overall project into smaller time increments, for example, days, weeks, or months.

5. Draw a bar across the time dimension to indicate beginning and ending times for individual tasks. Figure 6 is an example of a Gantt chart.

Gantt charts are easy to maintain and modify as long as the list of tasks remains unchanged and there are no major modifications in the overall project schedule. For example, if the duration of the project, and the project beginning and ending dates remain unchanged, then the charts are easy to update. If the list of tasks change, and the sequencing is altered, then the entire schedule may be effected.

Although Gantt charts contain a lot of information, they require no training to understand, since the bar chart format is easily understood. The project plan, schedule and progress toward the project objectives are shown together graphically on one chart. Special symbols may be used to highlight critical dates.

The overall advantage in ease of use results in some inherent problems. Since planning and scheduling are considered simultaneously, the technique has not been successful with large scope projects. The simplicity of the technique precludes sufficient detail to discover schedule slippages in a timely manner. This is especially true of tasks that have long time durations (Moder, Phillips, Davis; 1983). When project elements have slipped, it does not necessarily indicate that the entire project is behind schedule (Kerzner, 1984). If a project does fall behind schedule, Gantt charts do not easily handle major schedule modifications.

Although Gantt charts depict the project at the macro level, if it is necessary to understand information beyond a cursory level, a WBS is required.

Gantt charts do not illustrate dependency relationships between events and activities. The illustration of dependency relationships is critical to controlling project costs, without which there is little predictive value (Kerzner, 1984).

Since Gantt charts can not show the results of early or late start times for tasks, they are not a good tool to use in compensating for lateness. Additionally, the technique does not lend itself to performing sensitivity analysis. The uncertainty involved in performing an activity by estimating shortest, longest, and average completion time is not available to perform this analysis.

The advantages and disadvantages of Gantt charts are summarized in Table 7.

Table 7

Gantt Charts Advantages and Disadvantages

Advantages	Disadvantages
Easy to construct	Simplicity precludes enough detail to quickly detect schedule slippages
Easy to read and understand	Does not use sensitivity analysis
Easy to maintain and modify	If major tasks change, schedule is difficult to change
	Not successful in large scope projects
	Does not show interdependencies
	Difficult to compensate for lateness
	Does not reflect the project status as a "whole"
	Requires WBS to see beyond the macro level
	Does not include personnel resources
	Does not control costs well

Milestone Chart Advantages and Disadvantages

The advantages to milestone charts, like Gantt charts are summarized by ease of use. They are easy to construct, maintain, and modify, while being easy to read and understand.

Milestones are specific checkpoints to compare planned schedule and budget items against project actuals. These milestones make milestone charts (Figure 7) an advantageous control tool (Harrison, 1981).

The disadvantages are also similar to those found with Gantt charts. If the project needs to be understood past a gross level, other information found in the WBS and Project Activity and Precedence Chart is needed.

Dependency relationships are not shown through milestone charts nor are sequential relationships. Personnel resources must also be tracked through other means.

The advantages and disadvantages of milestone charts are summarized in Table 8.

Advantages and Disadvantages of Network Diagrams

According to Moder, Phillips, and Davis (1983) some of the advantages to using networks in planning and controlling projects include the following:

> 1. *Planning* Critical path methods first require the establishment of project objectives and specifications, and then provide a realistic and disciplined basis for determining how to attain these objectives, considering pertinent time and resource constraints. It reduces the risk of overlooking tasks necessary to complete a project, and also it provides a realistic way of carrying out more long-range and detailed planning of

Table 8

Milestone Charts Advantages and Disadvantages

Advantages	Disadvantages
Easy to construct	Personnel resources must be tracked through other means
Easy to understand	Additional information is necessary to see beyond macro level
Easy to maintain and modify	Doesn't show interdependencies

projects, including their coordination at all levels of management.

2. *Communication* Critical path methods provide a clear, concise, and unambiguous way of documenting and communicating project plans, schedules, and time and cost performance.

3. *Psychological* Critical path methods, if properly developed and applied can encourage a team feeling. It is also very useful in establishing interim schedule objectives that are most meaningful to operating personnel, and in the delineation of responsibilities to achieve the scheduled objectives.

4. *Control* Critical path methods facilitate the application of the principle of management by exception by identifying the most critical elements in the plan, focusing management attention on the 10 to 20 percent of the project activities that are most constraining on the schedule. It continually defines new schedules, and illustrates the effects of technical and procedural changes on the overall schedule.

5. *Training* Critical path methods are useful in training new project managers, and in the indoctrination of other personnel that may be connected with a project from time to time. (p. 19)

One major advantage of network project management techniques over Gantt and milestone charts is the interdependencies among tasks shown on the network. Valuable information is available concerning planning, the integration of plans, time studies, scheduling, and resource management. Networks provide information on the following:

- The impact of late starts.
- The impact of early starts.
- The cost of a crisis program.
- The planning slippage.

According to Kerzner (1985) the primary advantage of a network is to eliminate crisis management by providing a picture of the entire project.

Another major advantage to networks is that through *resource loading* resources can more efficiently distribute resources over the course of a project. In planning projects, information is easily gleaned concerning resource requirements over the course of the project. The only requirement is that resources associated with each project activity be listed separately on the network.

CPM Advantages and Disadvantages

An advantage to CPM is its disciplined way of making detailed time estimates and the sequencing of project elements for computing schedules. The network format effectively uses more detail than bar charts. The advantage is in using time estimates and schedule analysis.

CPM is useful in focusing attention on activities critical to project time. The effects of shortening various activities enable users to evaluate *costs of a crisis* easily.

The major disadvantage of the technique is that it presupposes enough past experience with the tasks being performed to make accurate single point estimates. The estimating technique does not employ any way to deal with uncertain task durations or provide any time averaging techniques.

The advantages and disadvantages of CPM charts are summarized in Table 9.

Table 9

Critical Path Method Advantages and Disadvantages

Advantages	Disadvantages
Technique focuses on "critical" activities	Requires skill and knowledge to develop
Ability to evaluate costs associated with crash projects	Arrow diagram is difficult to communicate
Shows interdependencies	Presupposes experience with tasks
	Does not show progress against plan, changes create new plan
	No manpower planning available
	Assumes unlimited resources
	In larges projects, difficult to find the optimum path through network

PERT Advantages and Disadvantages

There are several major advantages in the use of the PERT project management technique. The technique allows for a large amount of information in a well organized format.

Although the large amount of planning necessary to create a major network may at first appear to be a disadvantage, the network and critical path analysis uncover interdependencies and potential problem areas. The planning aids in determining potential problem areas that may require additional attention to remain on schedule. The probability of meeting specific deadlines, by developing alternative plans, is an option that can be exercised by examining standard deviations and the probability of accomplishing a given task.

Areas that are marked as possible problems can be evaluated by taking resources from less critical activities. Resource and performance trade-offs can be determined and the network reworked as appropriate.

The detailed project schedule is limited. It does not consider resource availabilities during the scheduling function. Unlimited resources are assumed to be available with only precedence requirements constraining start and finish times. A disadvantage is the schedule may be unrealistic when resource constraints are considered. The complexity of time and cost constraints adds to the difficulty of implementing PERT.

The arrows only represent time and not quality. Cost information is only contained in PERT/Cost. There is no looping allowed to provide feedback.

The advantages and disadvantages of PERT are summarized in Table 10.

DCPM Advantages and Disadvantages

Traditionally, alternative methods for completing various job tasks are evaluated during the planning stages. The advantage to the DCPM project management technique is the consideration of scheduling implications before the final choices are made. For example, in an instructional development project, the instruction may be equally suited to stand-up instruction or instructional video. In considering the scheduling and interdependencies of the video production time limitations make the video alternative an unfeasible choice.

The disadvantage to the DCPM technique is the difficulty in evaluating all of the possible alternatives in large projects. Twenty independent decision nodes each with three alternate choices (assuming that there are not two on the same path in the network) would result in three and half billion alternatives to consider (Weist and Levy, 1977).

The advantages and disadvantages of DCPM charts are summarized in Table 11.

Table 10

Program Evaluation and Review Technique Advantages and Disadvantages

Advantages	Disadvantages
Planning reveals problem areas	Assumes unlimited resources
Network shows interdependencies.	Considering resources constraints the schedule may be unrealistic
Evaluate resources and performance trade-offs	Technique is expensive to maintain due to resource constraints
	Technique is difficult to implement due to resource constraints
	Does not show planned versus actual as a control tool
	Arrows only represent time
	Looping back not allowed

Table 11

Decision Critical Path Method Advantages and Disadvantages

Advantages	Disadvantages
Scheduling implications of alternative jobs are included	Large projects require computers to evaluate all possible combinations

PDM Advantages and Disadvantages

The traditional method of completing one job before succeeding jobs can begin (finish to start [FS] relationships) has been considered limiting by some project managers. PDM allows for three additional types of relationships: (a) finish to finish (FF), (b) start to start (SS), and (c) start to finish (SF). Additionally lead-lag times (a minimum duration of time that must separate start/finish points in the relationships) are associated with each of the relationships. (See Chapter Two for a complete discussion of the relationships.) For example, an instructional development team could begin working on a students' training manual for a specific course. After a particular portion of the manual is complete, another group in the instructional development team begins working on the instructor's guide. This is an example of a finish to finish relationship.

There are two disadvantages associated with this technique, both resulting from the increased number of relationships. It is more difficult to find the critical path and there is an increased chance of creating loops; looping is not allowed in this technique.

The advantages and disadvantages of PDM charts are summarized in Table 12.

Table 12

Precedence Diagram Method Advantages and Disadvantages

Advantages	Disadvantages
Provides three additional relationships	Increased chance of creating loops which are not allowed
Allows for associated lead-lag times	Difficult to find critical path

GERT Advantages and Disadvantages

GERT is a generalized network that incorporates branching and looping developed by Alan Prisker. According to (Moder, Phillips, Davis; 1983) the main advantage of this type of node scheme is that it eliminates the need for dummy arrows to correct false dependencies.

GERT is the one project management technique that allows arrows to represent time, cost, and/or reliability.

A disadvantage of GERT is that it is difficult to use as a control tool due to the feedback loops.

The advantages and disadvantages of GERT charts are summarized in Table 13.

The following two research questions will be answered primarily from the results of the case study interviews. The second broad research question is as follows:

> **Which combination of these components, from across selected project management techniques, can be applied most efficiently and effectively to instructional development projects?**

The following question is the third specific question and is posed as a result of the second broad question:

Specific Research Question 3

> **Which components, from across selected project management techniques, could most**

Table 13

Graphic Evaluation and Review Technique Advantages and Disadvantages

Advantages	Disadvantages
Includes looping which provides feedback	Looping makes the diagram difficult to read
	Loops represent time, cost, and reliability (too much information makes the diagram difficult to read)
	Difficult to use as a control tool

logically be incorporated into a new, synthesized project management technique, to more effectively track and control instructional development resources?

The results from the case study interviews are presented in the discussion below. The numbered and bold questions correspond to the numbered questions in the interview guide. When two questions are presented together, the results following were too intertwined to understand in presenting the results separately. The questions were asked one at a time during the interview to correspond to Patton's interviewing principle of asking singular questions. This procedure was recommended so that the interviewee would not become confused as to the question they were answering or to have to choose between answering several questions. This principle ensures a clear and complete response to each question. However, the data results can be presented more clearly by combining some questions.

In Chapter Five, the conclusions drawn from the results presented below will provide the major elements that will be incorporated into a proposed synthesized project management technique. Those conclusions and a model for a synthesized project management technique will provide an answer to the second broad research question and the third specific research question.

PLANNING AND SCHEDULING

Following are the results to the Interview Guide questions (Appendix D) concerning the planning and scheduling functions.

18. What criteria do you use in determining whether or not to use a project management technique?

There are three basic criteria for determining whether or not to use a project management technique. First the technique must provide status of the overall project and secondly, it must report the current status of the project. Finally, the technique must deal with the complexity of the project. Each of the companies studied always used some form of a project management technique for all instructional development projects. The types of techniques they used varied according to the company, which was a result of the purposeful sampling process. Some companies used more than one technique, depending on the situation. For example, each of the companies interviewed use Gantt charts for looking at the overall status of the project. They were used as macro level communication tools, both to upper management and to the client or the customer of the project. They were also used by the project team as a project overview for "how the project was going." The Gantt chart was pasted on the wall, so that the whole team could see the overall project status.

Similarly, milestone charts were also used to communicate the status of a project to management and customers. They visually illustrate the current status of the project.

Some teams used network diagrams illustrated in CPM or PERT under certain circumstances. The criterion for going to a network diagram is due to the complexity of the project. The project leader in Company A summed up the trend that is evident in the data across all of the companies, "One of the criteria is how complex the project is. We always do a project plan. We always have a statement of work, we always have a work breakdown structure, breaking down the project into the tasks and a minimal timing chart [that's a Gantt chart]. Now, if we find we need to show relationships between the activities because the dependencies are very critical and we have to then gauge those and watch those [that are critical] very closely, then we'll do a critical path diagram."

19. How do you modify the project management technique you are using according to the development time, size of the project, type of the project, or the cost of the project?

A project management technique was used even if the project was small or taking up a short time frame (defined as less than two weeks). The modification occurred in the type of project management technique used. If the project was small or short in duration, it was not seen as necessary to complete a network type of technique. The network technique is used only when the project was large enough to involve several people and interdependencies were critical. Those groups whose primary technique was a network-based technique, regularly dealt with large projects, but those that did not use network techniques also dealt with large projects. This points to a fourth criterion, project size, as a factor in deciding whether or not to use a project management technique.

20. Do you often have more than one instructional development project in progress simultaneously?

All of the project managers indicated that they usually had more than one instructional development project in progress concurrently. This was one of the reasons that was indicated for always using a project management technique.

21. Do you always use a project management technique for Instructional Development projects?

22. If not, what criteria do you use in determining whether or not to use a project management technique?

All of the interviewees indicated that they always used some type of project management technique for instructional development projects. Company C also did other types of projects for their customers, including research projects in the form of customer satisfaction surveys and interviews. A project leader for the company said, "For some kind of little finite research thing, if somebody wants us to do a survey or that kind of thing, all you may have to do is do the survey and give them a tally, then we wouldn't use a project management technique, but for any instructional design project we would use it."

23. If you use a manual project management technique,are there any things the method doesn't account for and how do you keep track of them outside the confines of the system?

The consensus across the groups is that they did not use their project management technique to keep track of costs. All of the companies used a separate spreadsheet to account for their costs and although the spreadsheet was used in conjunction with the technique, it was not an *integrated* part of any of the techniques. Even the companies that used PERT as their selected project management technique, did not use the PERT/Cost system to track costs. In companies A and C the project costs were tracked against a project by the accounting department and the instructional development group was provided with reports to verify and check expenses. In other companies, the project manager tracked their costs in an electronic spreadsheet within the instructional development departments.

Another predominate issue is the experience of the project manager. If a project management system doesn't keep track of a particular aspect of the project, then the experience of the project manager becomes critical. When the interviewee at Company C was posed with Question 23 above, they responded with, "That's really a function of experience and that the more times you've got a project under your belt, the better you are at troubleshooting and thinking ahead and knowing what all these little pieces are."

24. In reference to the instructional development used, which stage of the instructional development model do you create or set-up the project management plan?

Are there different purposes at different stages of the set-up? (Upfront for costing, after project begins for resource management)

Each of the project managers indicated that the project plan was created initially during the proposal stage of the project. Each of the departments provided training to internal customers; however, their customers within the company still needed an upfront cost to determine if they would employ their internal training group. The project management begins, in determining the cost for a project bid. In the upfront costing, tasks and materials must be defined. This is the beginning of the project plan. It continues to evolve and change until the completion of the project.

The interviewee in Company A pointed out the evolution of the project plan. "Actually, the project plan is an evolving thing. The initial one is identified once the proposal has been awarded and based on all of the information that was submitted into the proposal. As the work begins and as that project plan has to be modified and altered, it then continues to be updated and made into a more comprehensive statement of what the work is to be [done]."

Company C responded, "I do it right out of the chute. In order for the proposal to be accepted the client would want to see some of your ideas on what would go into that particular course. So, you've thought a little bit about what's happened, but when the project is sold, one of the first things I would do is design specifications that include a detailed outline including content, method and associated time frames. I would then go through after the client buys into it and do the project management scheduling."

25. Referring to the instructional development model used, in which stage(s) of the instructional development model do you revise the project management plan?

The revision of the project plan was not dependent upon the instructional development model that was employed, but rather particular time frames. Companies B and P indicated that as the changes occurred they were included in the project plan immediately. Company A tended to hold back and incorporate the changes every two weeks. They found this to be adequate, especially on their larger projects that lasted several months to a year.

The interviewee at Company C revises the plan daily at the production end of the project; however, in answering the following question, they said that in the end of the project the plan had been internalized and was not worth revising. As they indicated in the interview this is somewhat contradictory.

26. When do you feel it is useful or worth it to revise the project management plan and when do you feel it is more trouble than it is worth?

The places that interviewees indicated the project plan was not revised when the project is:

- Ahead of schedule
- In its final stages

It was agreed that when things got ahead of schedule, the project plan was usually not revised, because that just meant that the project would be finished on time. No attempt was made to revise the project plan to reflect an early finish.

When a project is very close to completion it is not necessary to revise the project plan. The interviewee at Company C indicated that when the project is "Down to the wire and things are skewed a little bit, now these dates are looming on me, I'm not going to sit down and take that chart and redo it. I've got that chart internalized so much by then that it's here, but its really going to happen here and so on." This indicates the closer a project is to completion the less likely a project manager is to revise the project plan. Since most of the plan has already been executed, the effort to revise is considered unnecessary.

27. What percentage of the total project effort do you think is devoted to planning?

The range of time spent on planning was 5 to 20 percent of the total time devoted to the project. Each of the interviewees agree that the more planning the better; however, there is some contradiction in this philosophy. Comments were made indicating that time spent in planning was taking away from design and development time.

28. Do you include problem areas in the project plan? (an outline of those areas that could pose problems and their possible solutions)?

There were a wide range of responses to this question: no problems included at all or no written problems; written objectives included in the project plan to avoid a problem, and building alternative designs to provide ready solutions to problems as they might arise.

One interviewee said they did not include problems areas in their project plan. Another indicated that the problem areas were something that they carried around in their head. They said, "I think what happens in my case is I learn those pitfalls and I do anything possible to avoid them." Again the emphasis is on the importance of experience.

Company A looks at problems inherent in the project, "As part of the project plan, while writing our objectives, what are some of the problems we might encounter. Once I identify what the problem would be, then we write an objective to "cure" the problem. Additionally, we try to capture those lessons learned, so that we in fact can incorporate those objectives to take care of those problems after the fact. Let's say that one of the problems is that, because of the timing of the requirements the client has, that the project must be done by X amount of time. Everyone is going to have to be very responsive in what they do; therefore, one of the things that I'm concerned about is turnaround time on any of the drafts. I make an objective stipulating to the client that in order for us to meet the deadlines, they will have a one week turnaround time on any of the drafts. So I create an objective around that problem, then enforce that objective up front so that I try to anticipate problems."

29. If a member of the project team finishes their work early, what do you do with them?

One interviewee indicated that they never finished early. Others indicated that if someone did finish their portion of the project early, they would either work on another portion of the same project or move on to another project depending on the circumstances.

30. Have you found that you can shorten the project time by revising the network diagram (PERT or CPM)?

None of the interviewees found that they could shorten the duration of the project by revising a network diagram. When the researcher inquired as to the reasons, they indicated that they had never tried to use the technique for that purpose.

31. Which project management technique are you currently using?

The answer to this question is summarized in Table 1 the Demographic Data Summary on page 120.

32. What pitfalls do you see in the planning phase of the project management technique you are currently using?

There were four pitfalls associated with the planning phase. These pitfalls include the following:

- Lax project managers
- Project manager dependent techniques
- The technique's inability to forecast problems
- Lack of computers

There isn't anything in the management system that requires the technique to be used. As one interviewee put it, "That's why you hire good people and every once in a while you get someone who becomes lax." Thus, the ability of the management system to tolerate this "laxness" is a pitfall.

The project management technique is only as good as the person using it; there is nothing foolproof with the technique. Effective project management is dependent upon the project manager. This pitfall can be explained in terms of delivering a training product. An instructor guide is written, and the more detailed the guide, the more likely the training product will be delivered consistently across classes. However, stand-up training is dependent upon the instructor choices in the delivery. For example, if the instructor does not follow the instructor's guide and begins to get "creative," the class may become a siginificantly different class.

The instructional development team from Company B said the pitfall for the planning stage of the project management techniques that they employed did not allow them to forecast problem areas.

Company C did not have computerized project management tools to use in their office. Computer usage was done on the interviewee's own time away from the office. The interviewee from this company believed this to be a pitfall. Since, they have a computer at home, they often use their home computer to manage their instructional development projects.

33. What pitfalls do you see in the scheduling phase of the project management technique you are currently using?

There are two basic pitfalls associated with the scheduling function of project management techniques. These include the following:

- Not allowing for easy modifications
- Inaccurate time estimates

Another pitfall indicated was that the scheduling must allow for modifications. As one interviewee indicated, you can plan and schedule, but you can always be pulled off schedule with a problem and changes are necessary.

Time estimations are another pitfall that feed into the scheduling process. If the time estimates that are not accurate, then scheduling problems result. This problem is summarized further with respect to the questions on estimations.

34. How would you characterize your success rate in using this project management technique?

Each of the interviewees characterized their project management technique to be successful. Two of the companies characterized their success rate as highly successful. A third interviewee characterized theirs as being somewhat successful. One interviewee said, "Although the project management technique was never 100 percent accurate, it put things in perspective; allows you to operate to a plan and achieve things that at first seemed unachievable." Another project manager said, "Things go spiralling off into never, never land without the project plan." This indicates some type of project management technique is necessary to do a project, regardless of the overall degree of success of the technique.

35. If the project management technique was not successful, what area did it handle less than adequately?

Two project managers indicated that their technique handled the area of time less than adequately and the project went "overtime." One interviewee said, "The model was set up at the beginning to work a 40 to 50 hour week. If you run into snags, that time might double, because all you looked at was the milestones."

Another project manager indicated the difficulty in managing training projects is in managing several simultaneously. Then project management becomes very complex, because there are lots of overlapping tasks and you have to keep track of all of those tasks. The project manager indicated, "I use the tools that help me accomplish my goals and it would not otherwise be happening."

36. If the technique was successful for your instructional development project, please comment, by providing reasons why you think it is successful.

Generally two reasons were cited for making the project management technique successful. The first was that it provided a basis for good communications, and secondly, it adds discipline to the process. The project management technique enables all the players to understand the goals of the project. As one interviewee put it, "The project management technique provides an orderly way to progress through the project. Both the people writing the material and the customer know exactly what their responsibilities are and what they must do."

37. Is there a project management technique or elements of the technique that you have found to be unsuccessful for instructional development?

38. Why? What area of the technique was not working for the instructional development project?

Three of the four case study interviewees indicated that outside of the responses indicating specific pitfalls, there were not elements of the project management techniques that they found to be unsuccessful for instructional development project. The fourth interviewee indicated that the statistical formulas used to create true PERT estimates, using optimistic, pessimistic and most likely times were useless for instructional development projects. They felt that the probability and statistics involved in this technique did not add sufficient value to the instructional development projects.

39. Assuming that time can not be added, what have you done to meet a deadline?

Adding resources was the common response to this question. Adding money and personnel (both internal or external) were common answers. Although the question indicated that time could not be added, working overtime was a common response. The consensus was not to add time by extending the final due date, but to work days, nights, and weekends to finish the project.

The original objectives of the course remained in tact according to the respondents. Since there was usually some type of written agreement stating what the course objectives would include for the stated price, the objectives have to be completed to satisfy the contract. The exception to this is if the client wants to make substantial changes in the scope of the project. This may result in a renegotiation of the written agreement.

40. Which resources do you track through the project management technique that you use?

The resources tracked through the project management technique used were cost, personnel, and time. Facilities, materials, equipment, and quality were not tracked through the project management technique.

41. What pitfalls do you find in your cost estimation procedure?

The agreement here was that it is very difficult to get a good estimate of the manpower time. Since personnel is usually the single largest cost associated with an instructional development project, the problem in the estimation process is cyclical. Instructional developers are professionals who believe that taking work home and working nights and weekends is just the nature of the work. In the corporations surveyed, when an instructional developer logs time against a particular project, it usually only counts if it is during "normal" working hours. If manpower ran over, it fell into the cliche rampant in corporate cultures of "doing whatever it takes to get the job done." This works for the immediate project, but it causes another problem when the same group of people go back to historical data to estimate hours needed for the next instructional development project.

42. Do you use the project management technique as a means of costing?

The project management technique was not used as a means of costing. The interviewee from Company A summed up the use of the project management technique across all of the companies, "I really use it as more of a work plan, as a planning tool, when you really sit down and look at how I do it. I worked on a project with another executive and we did a milestone list and we did the estimated costs off that and I did find that to be a good way to do it." Although many had tried to use the task list to track costs, more often than not the costs were tracked in a spreadsheet according to a traditional functional object budget.

43. Do you keep a running tab of costs (over or under)?

In the two companies where a running tab was kept of costs, both over and under budget, the actual tally was done by the accounting department.

44. Is the project management technique useful to keep track of costs?

None of the project managers interviewed used the project management technique for keeping track of their costs. When asked how costs were tracked in a project, the accounting department in half the cases took over this job. In the other cases an electronic spreadsheet was used to track costs. The electronic spreadsheet was used in conjunction with the project management technique, but it would not be accurate to say that it was part of the selected project management technique.

45. What pitfalls do you find in your time estimation procedure?

Again, the point brought up here, as with the emphasis in the estimation of costs, is the issue of personnel. The biggest pitfall in the time estimation procedure here is pointed out by the interviewee from Company A; "I suppose the toughest problem, is when you deal with people's time. Once you identify what the effort days or hours are, it is leveraging your resources to accommodate that or hire people to accommodate that."

Another interviewee agreed with this, "If I thought it was going to take 10 days to do something; then, I'd plan 15." Estimation of the time a given task will take is one of the largest problems. Each of the companies used a slightly different ruler when deciding on the time it would take to develop one hour of instruction.

46. What steps do you take to make controlling costs easier?

Track the time spent on any given project and turn the time into the accounting department. In turn, the accounting department issues tracking reports. Company B sends out weekly reports of charges made to particular project numbers. These reports are then checked and verified with other members of the project team. Another method of controlling project costs are weekly meetings of the project team. This aids in keeping people informed of the progress of the team in relation to time and costs.

47. Do you also use these steps to control other project parameters, such as performance?

None of the project managers used the steps in controlling costs for other project parameters.

48. (This question is applicable if the interviewee uses PERT or CPM.) Do you use the PERT/CPM network to estimate costs? If so, how?

The companies using PERT and CPM techniques did not use PERT/Cost or emphasize the use of CPM for tracking costs.

49. Which processes in the project management technique do you feel to be the most important to instructional development? (Have these prioritized 1 - 7, 1 = most important.)

Based on an average between the actual case studies (this question was added as a result of the pilot study), the planning function was considered the single most important function. The average score for planning was 2 with a range of one to three.

Organizing the project and estimating the tasks were second in importance. Organizing had an average score of 2.5, with ranges from one to three in importance. Estimating had a score of 2.6 with a range of one to five.

Goals and objectives were next (the goals and objectives of the project, not necessarily the goals and objectives of the instruction) with a score of 3. The range in importance was between 1 and 4.

Scheduling was next with an average of 4. The range was two and seven. The interviewee who rated scheduling a seven believed that if everything is planned out and estimated well, the scheduling will just fall into place.

Controlling, ranges from four to six, and evaluating, with ranges between five and seven, were very close with averages of 5.3 and 5.6 respectively.

50. How well does your project management technique deal with each of the processes below? Rate each one as satisfactorily or unsatisfactorily.

Two of the three groups rated their project management techniques as handling each of the items (goals and objectives, planning, organizing, estimating, scheduling, controlling, evaluating) satisfactorily. One interviewee believed their project management technique to handle estimating and evaluating unsatisfactorily.

ESTIMATING

51. How do you normally estimate the time needed to complete a project?

Company C always sets the delivery date for the first class and then the project plan is planned backward from that date.

Company B follows the same path as Company C about half the time. The other times, they have been able to establish their objectives, decide on a plan and then set a date to deliver the training. The project manager from Company B believes this is the preferable method of setting up the project plan, because the delivery dates tend to be more realistic than planning backward from a delivery date.

Company A's project manager states that it depends on the project. For example, "if the project has a firm benchmark and it has to hit a certain event, then I work it backwards. However, if it is something that has loose time parameters (when the client must have the product), then I work it forwards. It depends on the project itself and the milestones involved. Sometimes, if there is a milestone that has to happen on a given date, I might work it both ways. If a certain activity, for example, is that we could do some analysis work for a client, because right before Christmas and the first couple of weeks of the year, the attendance was really high. So, we are going to have a lot of people available then and the work tapers down and the availability of individuals for interview would be much greater at that time. Activities that we had to do before getting to that point and we had lots of activities to do afterwards, we said because of the time and place of that particular event and then we worked the project this way (forward) and this way (backward)." So, the situation may determine what time frame and how to handle that time frame.

52. Do you use data from previous projects to base your time estimates?

Three of the four companies always used data from previous projects to base their time estimate. Company B uses data from previous projects most of the time.

53. What type of estimates are your time estimates based on?

Three of the four companies use multiple point estimates to estimate activity time. Company A uses single point estimates to estimate activity time.

54. If you use multiple point estimates, which ones do you use?

Although three of the interviewees used multiple point estimates to develop their activity time, none of them used a true PERT formula. The worst case estimate was included and averaged with either a base case estimate or a most likely estimate.

55. Which tasks in the Instructional Development model that you are currently using are you able to estimate most accurately (both in scheduling and budgeting)?

56. How does this effect the scheduling of these tasks?

Company A believed they could estimate activities like needs analysis most accurately. They found auxiliary activities that they had no control over to be the most difficult to estimate and schedule accurately. For example, printers may meet their agreed upon deadline, but the job may be wrong and need to be redone, which in turn holds up the entire project.

For Company B creating task lists and writing objectives from the task lists are the easiest to estimate and as a result these activities are the easiest activities to plan.

Company C had an internal print staff through desktop publishing and found the most accurately estimated tasks to be: design, development, and printing.

A common thread with Company A is depending on outside sources to complete their tasks accurately and on time. This had a negative effect on scheduling. In this company, the research information from customers and clients for needs analysis and customer satisfaction surveys made it difficult to keep on schedule.

57. **What pitfalls do you see in the estimating phase of the project management technique you are currently using?**

One pitfall is that if everything does not happen in the estimated time frames the entire project can fall behind. If you are locked into a due date then most often the pilot evaluation is often overlooked.

Another pitfall in the estimation phase is the use of inaccurate historical data. Since professionals do not often track their "overtime" as part of the project, often when the data is used for the next project it is not a true portrayal of the time actually consumed by the project.

CONTROLLING

58. What pitfalls do you see in the controlling phase of the project management technique you are currently using?

Since instructional development is a labor intensive type of project, controlling costs really means controlling the amount of hours spent on the project. If some activities do not happen within the correct time frame, it is necessary to add manpower, usually in the form of overtime.

59. How do you use the task list or Work Breakdown Structure to monitor and control the project?

The WBS is used in Company B as a comfort level. If milestones are completed on time, then the project manager believes things are going well. If the team is falling short on the milestones, then they must quickly revise the plan.

The WBS is not only viewed as a planning function, but also it is viewed as a monitoring device, since all of the individual tasks are listed there.

60. How do you assure "breadth of communication" in a project?

Frequent status reports to upper management and the client from the instructional development team is the most common method of communication. Additionally, weekly team meeting were the norm in all of the companies.

CRISIS PROJECTS

61. What forces brought about the crisis characteristic of the project?

The most frequent reason cited for crisis project characteristics was poor planning on the part of management or new government regulations. When the training function is another department within the same company, training is often overlooked until the system or project is about to be implemented. It is pointed out that it would be much easier to implement the project, if training was involved in the beginning of the overall project, instead of waiting until the project or system is near implementation.

New government regulations were cited as a frequent cause of crisis training, especially in the area of safety training.

62. Do crisis projects cause you to use a different project management technique than you would within "normal" time frames?

63. If yes or sometimes, which project management technique would you use under crisis circumstances?

In three out of four cases crisis projects caused the project manager to use different project management techniques than they would within "normal" time frames.

In general most of the planning was eliminated in crisis projects. One interviewee believed that planning went down to a maximum of five percent. For one project manager the instructional development model became the only project management technique used. In another company the major milestones were assigned target dates, but as one project manager put it, "You are just in 'do it' mode." Whatever the process, systematic planning was essentially ignored under crisis conditions.

64. Why? What is the reason or reasons for the change?

Lack of time was cited as the major reason for the change. In this type of project the consensus was that planning took away from the time one could spend on the project.

SOFTWARE

65. Do you use a computerized project management technique? If yes, What are the names of the project management tools that you use?

All of the project managers used some type of computer software to manage their projects to some extent. One interviewee did not have a computer available at work so they were limited in using project management software. Many of the interviewees use some type of spreadsheet program, either Lotus 1-2-3 or Multiplan to create Gantt charts. They have been doing this for several years, when project management software was less readily available. MacProject, MicroSoft Project, and Timeline are the three project management software packages currently being used by the groups.

66. How long have you been using this software?

67. Have you used other project management software in the past?

68. Why did you change to your current software?

The range in using any particular software was from three months to four years.

Only one project manager had used other project management software in the past; that they were no longer using. The reason they changed to their current software was they became employed by a different company.

69. Do you feel one was easier to use for instructional development projects?

70. What were the reasons that one software was easier to use than others?

Since most of the interviewees (with the exception of one) have not used a variety of project management software this question has a limited response. Only one person had used a variety of project management software and they did not find any perceptible difference in ease of use for instructional development projects.

71. What steps do you take on project start-up to begin using the project management software?

Information on resource constraints is gathered. The WBS, along with time estimates of tasks, dependencies and durations are gathered before the project management software is started.

72. How long does it usually take to do the initial setup of the project management software?

The initial start-up time varied in range from one hour to two days. The project manager in the pilot study said it took two to fours weeks.

73. **Have you used any project management software on other types of projects?**

None of the persons interviewed in the study had used project management software for other types of projects.

74. **Which ones were used on which types of projects?**

This question was not applicable given the responses to the previous question.

75. **Do all work equally well for any type of project?**

This question is also not relevant given that none of the interviewees had used project management software for other types of projects.

76. **Does the software you use really do what you need it to do? If not, where is it lacking?**

The only negative response was that they felt the display chart was difficult to read. All of the other project managers were satisfied with their software.

77. **After the initial input, (manual or computerized) do you actually go back and revise the project management chart periodically? If so, how often? During what stages of the ID process?**

The revision of the project plan was not dependent upon the instructional development model that was employed, but rather particular time frames. Companies B and P indicated that as the changes occurred they were included in the project plan immediately. Company A tended to hold back and incorporate the changes every two weeks. They found this to be adequate, especially on their larger projects that lasted several months to a year.

The interviewee at Company C revises the plan daily when at the production end of the project; however, in answering the following question they said that at the end of the project the plan had been internalized and was not worth revising. As they indicated in the interview this is somewhat contradictory.

78. What do you like most about the project management technique you are using?

The responses varied from easy modification of events, to the fact that it helped to plan and organize the project. The project management technique also allowed them to better estimate costs from the WBS.

79. What do you like least about it?

The lack of extensive reporting features is the thing least liked about the project management technique in use. The interviewees also requested an integrated system.

80. What types of reports do you need to generate?

All of the companies need to generate Gantt charts and budget reports. Others needed to additionally generate PERT, CPM and Milestone charts.

Summary

Chapter IV describes the results from the data analysis of four instructional development projects. The three sections of the chapter addressed the three specific research questions. Sections one and two focus on data gleaned from library research, with supporting data from case study interviews. The third research question was primarily answered from case study research, with supporting data from the literature. After each question the results were presented and discussed.

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND REFLECTIONS

This concluding chapter contains four major sections: (1) a summary of the study, (2) conclusions, (3) recommendations for future research, and (4) reflections.

Summary of the Study

Training products must be quickly introduced to be economically advantageous to the corporation. This has emphasized a problem in the instructional development process, broadly based in the allocation of resources. What tools are available to an instructional developer to aid in the timely design, development, and production of a particular training product? If ineffectual project management causes product delay, the delivered product may be less than effective. The results of missed deadlines in the corporate environment mean lost profits.

The purpose of this study was to collect baseline data concerning problem variables affecting the management of instructional development projects. This data will provide direction for future research in the area of allocating resources to instructional development projects. The problem variables, which affect time and cost resources allocated to the development of instructional products, are important for further research in the application of project management techniques to instructional development projects.

A search of the systems literature shows that systems exist along a continuum between open and closed architectures. In order to maintain its stability, an open system allows a continuous flow between itself and the environment. This stability is referred to as maintaining a *steady state*. Closed systems maintain system stability through *equilibrium*. Systems naturally tend toward increasing disorder, which is referred to as *entropy*. Systems may tend toward increased organization or *negative entropy* by mechanisms such as feedback, a process of *homeostasis*. Several subsystems in a single system may compete for the same resources, and this is termed *allometry*. The more integrated the subsystems, the more synergistic the effect. The synergy may be accomplished through many different methods. Increased alternatives to the same goal are referred to as *equifinality*.

A search of the philosophy of technology literature shows that due to the accelerating rate of technological change in today's society, it is necessary to become proactive in order to function efficiently and effectively. Project management is an important tool in directing events rather than reacting to them.

Technological change has resulted in the movement of society through two major eras; an agricultural era and an industrial era. We have arrived at a third, the information era. A philosophy of technology has developed. Three basic views of the philosophy of technology are held. Those holding the pessimistic view argue that industrial workers have been ousted from their jobs through technological advances that leave them unskilled in a technologically advanced job market. An optimistic viewpoint, most often held by scientists and engineers, sees technology as providing solutions to societal problems. Finally, the third viewpoint considers technology as a neutral tool that can be positive or negative depending on its use.

While it is certainly true that technology affects societal values, societal values in turn affect technology. American culture values efficiency and it has become critical to the survival of American corporations and institutions. Efficiency is critical to instructional development. If an instructional product is not delivered on time it may cause cost over-runs, and/or inconvenience clients.

A search of the model design and analysis literature shows that there are three processes used to develop systems models: (a) an entirely new model may be built from scratch, (b) an existing model may be adapted or modified to fit a specific set of concerns, and (c) a new model may be developed from a synthesis of existing models. This research uses a synthesis of existing models to create a tailored project management technique which will be used to better track and control instructional development resources.

A search of the instructional development literature shows that there are three instructional development models dealing to some extent with resource allocation: (a) Control

Data's Education Project Model, (b) Tuckman's and Edwards' Systems Model for Instructional Design and Management, and (c) the Instructional Development Institute Model. Each of these models deal to some extent with the management of instructional development projects; however, a more detailed project management model is necessary to more completely handle the project management concerns of the instructional developer.

A search of the project management literature finds two basic types of project management techniques. The first type, non-network techniques like Gantt charts and milestone charts provide a macro view of the project. The second basic type of project management techniques are network-based diagrams. The selected project management techniques that are network-based include: (a) CPM, (b) PERT, (c) DCPM, (d) PDM, and (e) GERT. Five network-type project management techniques were investigated in the field. CPM and PERT represent the classic dichotomy between network-type diagrams. PDM brings another factor into focus with the concept of lead-lag time. DCPM is a more developed version of CPM, actually diagramming options from which to choose. The last project management technique, GERT is a variation on PERT and provides a looping mechanism for tasks that are cyclic in nature.

The case study methodology used to derive the problem variables provides a foundation for further research. It is described in Chapter III. The methods employed by the researcher included the development of an interview guide, and in-person, audio-taped interviews with the project personnel of four separate training programs (including the pilot interview).

Four companies were selected for the study based on the pre-established criteria. Patton's (1980) taping procedures and interview principles were used during the interview process. Personnel holding the key positions of project manager and instructional developer were interviewed.

Data analysis involved comparing and contrasting data through the development of matrices in order to answer Research Question A. A synthesis of the answers to the interview questions provided the findings to the case study research used to answer Research Question B. Validity in the analysis of the case data was achieved by using another researcher to independently review the interview transcripts, comparisons, and derived findings. When differences occurred in the findings between this researcher and the validating researcher, additional data were collected to support or modify the analysis being questioned.

Chapter IV described the results from the data analysis of interviews for four instructional development projects. The three sections of the chapter addressed the three specific research questions. Sections one and two focus on data gleaned from library research, with supporting data from case study interviews. The third research question was primarily answered from case study research, with supporting data from the literature. After each question the results were presented and discussed.

Research Questions, Conclusions, and Recommendations

Following are the research questions the conclusions address. Each broad research question is answered by responding to the specific research questions. The conclusions and recommendations for further research associated with each research question, follow the appropriate question.

Research Question 1: How are selected project management techniques different or similar in their support of project management functions?

Conclusions

Conclusion Number 1: The problems occurring in different instructional development projects, generally are not properly *documented*, resulting in inaccurate use of historical data as a means for estimating time and costs for new projects.

One reason mentioned for the lack of accurate time and cost estimates is the lack of ways to track potential problems. When Company B's project manager was asked which area the technique handled less than adequately (Response to Question 35) the reply was, "The technique was set up at the beginning to work a 40 to 50 hour week. If you run into snags and so forth that time might double because all you looked at was the milestone. You have to have this piece out on Monday and it might be planned to get that out in 40 hours, but the reality is 80 or 90." He also indicated that hours outside the range of a 40 hour work week were not included in their estimates. If a class is planned using 44 hour of development per hour of instruction (for lab courses), it is an accurate number if everything goes as planned, however he says, "When the documentation isn't complete, or you couldn't get a hold of the subject matter expert or the customer didn't return things, then it wasn't very accurate. If everything went OK it was a pretty accurate time. I used to think that was only typical of this company, but that's the way a lot of people work who do training development. You get locked into a big project ahead of time as far as due dates and amount of money you could spend on it, then you have to live with the dollar amount of the initial proposal."

A partial solution to correcting inaccurate estimates might be to provide a checklist of problems commonly occurring at different stages of instructional development projects, so that their effects can be included in time and cost estimates, up front.

Recommendations for Further Research

A useful study would identify the common problems occurring at different stages of instructional development for the purpose of designing a checklist (as input to the estimation process).

This checklist of potential problems could serve as a troubleshooting technique in the development of future instructional development projects. For example, the checklist could include a point concerning the length of the project duration when it is greater than one year, the rate of inflation should be added to direct and indirect cost items.

Research is also needed to identify and test different procedures of documenting problems in instructional development projects (to increase the likelihood that the possibility of such problems will be considered in future project estimations).

> **Conclusion Number 2: The lack of an accurate project log, with easily *retrievable* data, on problems occurring during a project, inhibits ready use in estimating time and cost for new projects.**

One interviewee indicated that they had a whole library of data collected from previous projects, but there was not a system in place to identify or retrieve specific information from it for future projects.

A proposed synthesized project management technique should not only include a method for tracking problems through a log, but also indicate a systematic way for information retrieval. An electronic, computerized information retrieval system (database) would provide a means of accessing logged data quickly and easily.

Recommendations for Further Research

Design and test competing means for recording and retrieving data on problems occurring at different stages of instructional development projects.

Conclusion Number 3: Use of data from previous projects is not satisfactory for estimating new projects because certain actual costs are omitted from the estimate.

It is a common practice to fail to incorporate both actual and predicted time estimates in project data. This prevents the use of past project data from being effective in predicting new project costs.

Each of the interviewees mentioned a value predominate in today's corporate culture that precipitates this problem. The cliche of "whatever it takes to get the job done" is representative of this value. One interviewee said, "As far as controlling costs, everybody's expected to do whatever it takes to get the job done, so you depend on that heavily." Another said, "There is a high degree of espirit d'corps for somebody who can deliver fast and good and all that kind of stuff, people who are good soldiers." Another said, "It's just part of [the] job!"

With this value engrained in the workers of corporate America, time estimates may be inaccurate, but the job will still be completed on time and within budget even though the actual completion time was longer than estimated. This attitude reflects a cyclical problem in the estimating and controlling phase.

Three of the companies used data from previous projects all of the time. The fourth indicated that they used previous data most of the time (Response to Question 52). However, since the data tracking method from previous projects does not accurately account for all of the time spent on the project, there is a problem with using these estimates in future projects. As one project manager said, "We have some really exacting ways of estimating. I guess some of what happens is our history that we collect on a given project or activity is somewhat skewed because of the fact that often times we'll do things at home on the weekends and we don't include that, and because all of our project time is tied to our time sheets which is tied into the client, we don't bill our clients for that time."

The synthesized project management technique must include a method for tracking "actual" hours spent on a project so that accurate information will be available for planning future projects.

Recommendations for Further Research

Design and test competing means for tracking "actual" hours and costs associated with instructional development projects.

Conclusion Number 4: Instructional developers need a mechanism to ensure reallocation of resources, when parts of a project are completed earlier than their original estimations.

The companies' overall line may be positively affected by revising the project schedule with personnel who complete tasks early. Saving time and money on the current project will ultimately lessen the negative effects of projects that do not stay on track.

The synthesized technique should include a method for revising the project plan when team members finish early, or when the project is ahead of schedule, to have the best resource advantage.

Recommendations for Further Research

To design and test a task summarizing procedure that would make clear the float or slack available in a network, and the options relative to the resources due to float or slack.

Conclusion Number 5: Crisis projects generally are based on significantly less planning time than are projects with systematically determined completion times.

Each of the project managers agreed that planning was critical to give the project structure. The amount of the total project time devoted to planning ranged from five to 20 percent. Planning decreased to a maximum of five percent of the overall project time during the development of crisis training. It was felt that planning took away from the actual development time of the project itself during crisis periods. The synthesized project management technique should include a minimum amount of planning information that is necessary for all projects.

Recommendations for Further Research

Future research projects should compare the percentage of total time spent planning on both types of projects. The goal of the research is to discover if the difference in planning time is actual or only a perceived difference. If the project development time is shorter, the actual planning time will be shorter without changing the percentage of total project planning time.

Another aspect of the further research should be to discover what items (if any) in planning are actually decreased during a crisis project. How is the planning function modified in this general situation? What are the effects on the project? Are there more problem areas as a direct result of the lack of planning? Determine what dependent variables result from "less" planning time.

If there is in fact less time spent on planning during crisis projects, research should be done to determine factors that can make planning an aid to crisis projects, rather than a perceived hindrance.

Conclusion Number 6: When instructional developers are using formulae that do not provide accurate estimations of project time and costs, they should turn to those which do.

The interviews of developers using PERT networks indicated that rather than using a true PERT estimation formula, they used a modified version. There were two versions used. One was to simply decide on an optimistic completion time and a pessimistic completion time and calculate an average.

$$\frac{\text{Optimistic Estimate} + \text{Pessimistic Estimate}}{2}$$

The second option was to average a most likely completion time estimate with either a pessimistic *or* a optimistic estimate. The true PERT estimation formula is as follows:

$$\frac{\text{Optimistic Estimate} + 4\ (\text{Most Likely}) + \text{Pessimistic Estimate}}{6}$$

This can be illustrated in a scenario where developers estimate the time it would take to develop a task list for instructing users to create an electronic spreadsheet. An optimistic completion time for developing the task list is two days, the most likely estimate is four days, while pessimistically it could take as long as ten days.

In the first calculation, the average of the optimistic and pessimistic time is 6 days. In the second calculation the result of averaging the most likely and pessimistic is 7 days, while using the optimistic estimate the result is 3 days. In using the recommended PERT formula the result is 3.7 days.

In any of the illustrations the result is off from the PERT estimate by at least 25 percent. This is an example of real data estimates, and in two of the three cases the instructional developer who used the shortened version would have ended up estimating too much time which can also be an issue when bidding on projects where the lower bid is usually most competitive.

Recommendations for Further Research

Further research should track the short-cut estimates normally made by instructional developers and compare those against those calculated through recommended PERT formulae. The purpose is to determine if there is a significant difference between the estimates, and if so, to note which estimates are more accurate.

Research Question 2: In terms of advantages and disadvantages, how do project management techniques differ in emphasis with respect to their specific purposes?

Conclusions

Conclusion Number 7: Because instructional developers find the more complicated networks (DCPM, PDM, and GERT) too time consuming, they fail to take advantage of options that would make time and cost estimates more effective.

Aspects of PERT and CPM are often considered too time consuming and complicated to use. This researcher could find no instructional development projects where DCPM, PDM, and GERT techniques were being used. Follow-up questions indicate that instructional developers either are not aware of these techniques or do not feel they are practical for the instructional development process. While true PERT time estimations were considered too complicated for their utility, these techniques are even more complicated to use.

Recommendations for Further Research

Further research should include a statistically significant sample of instructional development teams to determine if any instructional development teams are using these techniques. Secondly, the research should discover how the calculations are being handled (manually or by computers), and specify any software being used. Finally, a close examination of the project management techniques used by a statistically significant sampling of instructional development teams should be completed to determine which features from these techniques are being use. It should also include a measure of how effective they are for the instructional development process.

Conclusion Number 8: Instructional developers should continue developing networks with instructional development team members and to share network modifications on updates with team members as an important means of communication.

Network charts, PERT and CPM provide a visual display of the interdependencies of a project. Since most instructional development projects are dependent on teams where interdependencies are critical, the network diagram is important to the instructional development project.

Recommendations for Further Research

Further research should look at how all of the features of these techniques can be incorporated into an instructional development project, rather than just the limited partial applications they appear to have currently. For example, the incorporation of the PERT multiple point time estimation procedures may be an important tool to instructional developers. This aspect is a part of the technique not currently being used to its potential.

Conclusion Number 9: Instructional developers should continue developing and sharing Gantt and milestone charts and their modifications on updates with upper management, clients, and customers as an important means of communication.

Since Gantt charts are macro level process oriented displays, they are particularly useful as communication tools. They are easy to read, so they are useful for those interested in the overall status of the project, for example, upper level management or customers and clients. Often times Gantt charts are made into wall charts, so that the entire team can view the current project status at a glance. For a more detailed working chart that shows dependencies, another type of project management technique is necessary.

Milestone charts are also appropriate for the same purposes, functioning as an effective communication tool.

Recommendations for Further Research

Further research should investigate the effects of, and process of applying Gantt and milestone charts to the communication process.

> **Conclusion Number 10: Instructional developers should have continuous access to cost and time changes in order to reallocate resources in a timely manner.**

Controlling costs is a function most often tracked by the accounting department. Since personnel costs are the major costs in an instructional development project they must be tracked closely. Because regular tracking of time and cost factors are done by the accounting department, instructional developers may be uncertain (for a week at a time) of project actual time and costs and thus, lose the advantage of reallocating resources because of changes in slack or float. Personnel most often turn in project hours charged against particular projects. Reports are then received from the accounting department usually on a weekly basis, to be verified by the project manager. This may not be frequent enough in large projects, as the project can take a major turn for the worse within a single work week.

Recommendations for Further Research

Further research should look at ways in which the project management techniques' budgeting features can be effectively employed by instructional developers. Instructional developers often use electronic spreadsheets to track their costs and interface with the corporations functional object budgets; but there were no methods found in place for interfacing the accounting spreadsheet information with the project management technique being used by instructional developers. The project management techniques' budgeting feature is a potential method of adding efficiency to the instructional development project manager's cost controlling function.

> **Conclusion Number 11: Instructional developers should have available electronic time and cost management techniques, rather than manual ones, since the former are more likely to be used.**

All of the project managers interviewed have used at least one type of project management computer software, but only one had experience on several types. They found the software to be useful for their projects and did not offer any major criticism of the software packages. Generally, they felt the software did what they needed it to do. Those who had to resort to manual project management techniques indicated frustration at not having electronic alternatives.

Recommendations for Further Research

In addition, further research should evaluate personal computer software to discover what features of GERT, PDM, and DCPM are available in personal computer software packages. If computer software were available, it may make the use of these techniques more likely.

A Model for a Synthesized Project Management Technique

Research Question 3: Which components, from across selected project management techniques, could most logically be incorporated into a synthesized project management technique, designed to better track and control instructional development resources?

Conclusions

Conclusion Number 12: A mechanism needs to be incorporated into a management network that shows the gain in time and cost of mutual use of resources across two or more separate resources.

All of the companies indicated that they had to manage resources across concurrently running projects (Response to Question 20). Equipment was not tracked by any of the project managers through their use of project management techniques. Adding this feature to the project management technique would allow the project managers to better track all of their resources.

Recommendations for Further Research

Further research should include how both projects in similar phases and those in different phases, efficiently use the resources to work together. This might be done in economies of scale, volume discounts in printing, or in the use of rented equipment.

> **Conclusion Number 13: Because none of the management techniques were employed exactly according to their design, it is uncertain as to the effects of the individual adaptations.**

When a representative from each company was asked during the purposeful sampling process which project management technique was used in their company, each responded with a particular technique. During the interview process it was clear that each company used a features from the cited project management technique, but that was not the only technique used nor was it used in its "pure" form. For example, those companies using PERT did not use the recommended PERT computation for estimating the duration of tasks.

Recommendations for Further Research

Further research should compare adaptive use to the original design use of the technique in terms of their respective effects in managing instructional development projects.

Conclusion

> **Conclusion Number 14: The selected project management techniques have already begun a merging of characteristics, and begun forming another synthesized technique.**

Examination of various computer software package features made clear that, increasingly different project management techniques are being merged with others. For example, MacProject is primarily a network-type of project management software package; however, from the network a Gantt chart can be generated, automatically.

According to Lowther and Saltinski (1975) models (or in this case, the information may be applied to a technique) should be designed to include the following:

- Input provisions
- Direction and/or sequence of information flow
- Interaction-synthesis sectors
- Constraints
- Output provisions
- Self-regulatory mechanism

The synthesized, tailored project management technique is developed to include a mechanism for handling these items. The model is shown graphically in Figure 19. Each of the original functions; planning, estimating, scheduling, and controlling, serve a purpose in this model. Each of the components suggested by Lowther and Saltinski are also present.

Input Provisions

The input provisions are drawn from *conclusions one through three* that lead to the need for input of actual time spent on a project and the problem areas associated with a particular project. Both issues need to be addressed in the synthesized project management technique.

Planning

Each of the selected project management techniques included some use of the Work Breakdown Structure; however, when crisis projects developed, *conclusion five* states that these projects are based on significantly less planning time. In order to account for this, and provide a basis for some planning time, a "plug-in template" would be the guide for minimally necessary planning.

Estimating

Time data is provided by tested formulae using multiple point estimates (*conclusion six*). Multiple point estimates provide a more accurate picture of the possible time frames; however, in current systems, each point estimate is equally inaccurate due to the project manager's failure to track actual time. After data is collected using the proposed tracking system (see Controlling), various time estimates for a single category of tasks should fall out. They can then be averaged to get a most likely time to use in estimating costs and scheduling.

Actual historical time and cost data is considered from the log. The information is fed into a spreadsheet designed to interface with the traditional functional object budget.

Scheduling

Conclusions eight and nine suggest the continued use of Gantt charts and network diagrams in the communication

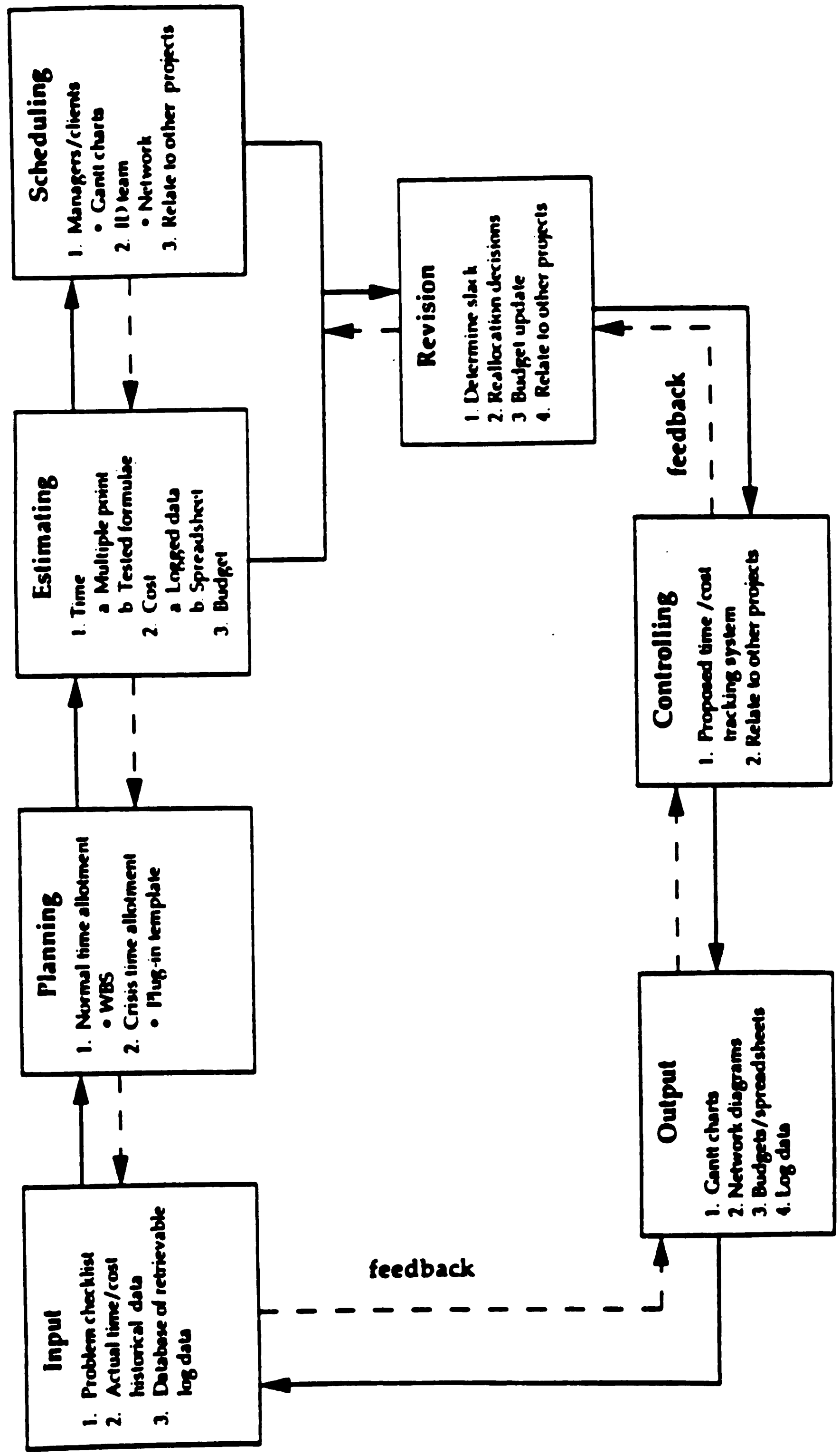


Figure 19

A Model for a Synthesized Project Management Technique process. Gantt charts specifically for upper management and clients and network diagrams among the instructional development team members.

Revision

Conclusions four and ten state that a mechanism is necessary for the reallocation of resources and the provision of continuous access to cost and time changes. The revision function provides this mechanism.

Controlling

In order to accurately track time and cost in instructional development projects, two separate tracking systems are necessary. The first system covers the current method of operation. What the instructional development teams are tracking in reality are "billable" hours, i.e., hours that can be actually charged back to the client for a project or contract. While it is certainly appropriate and necessary to track billable time, a second system is needed to track the "actual" time spent by staff on the project, as historical data. Every hour spent on the project needs to be tracked and categorized according to the general type of activity being performed. This will not only allow project managers to see the actual hours being spent, but also permits them to determine which types of activities can be estimated most accurately. Estimated times for each activity should also be recorded, so that a comparison can be made between projected versus actual. This information will feed into a tracking system for the second problem, which is the current inability to track potential problems. When provided with a history of estimated and actual times for various activities, companies could be better able to determine the accuracy of their estimations.

The recommendation to track the project estimates versus actual times will provide the data required to more accurately estimate task times and costs in future projects. When estimated time is more than actual time, reasons for this variance is noted in order to see if there are trends in the reasons projects are going over time. If there are common threads, then either problems can be anticipated and/or time estimates can be adjusted in the future. It may be that the estimated times are not off due to problems, but rather the activity simply takes longer as a general rule than estimated.

Overall, the new tracking system will account for the items shown in Table 14.

Scheduling, revision and controlling all interact across projects, so a mechanism needs to be available in these functions to gain the mutual use of resources across projects (*conclusion 12*).

Direction and/or Sequence of Information Flow

The flow of information is not linear, but rather system stability is maintained by a continuous flow of information among the functions as needed. The dynamic characteristic is demonstrated by the dotted feedback line in the model shown in Figure 19. As the literature illustrated, negative

Table 14

Proposed Time/Cost Tracking System

Tasks	**Estimated Time/Cost**	**Billable Time/Cost**	**Actual Time/ Cost**	**Billable Variance**	**Actual Variance**	**Reason for Variance**
Writing Objectives	1 day $400	1 day $400	2 days $800	0	1 day $400	SME not available
Graphics Production	5 days $2,000	5 days $2,000	7 days $2,800	0	2 days $800	Did not allow for rework

entropy is created in the system by feedback mechanisms, a process of homeostasis.

Interaction-synthesis sectors

There needs to be a major feedback loop to provide for reworking portions of the project. Each of the functions of planning, estimating, scheduling, and controlling need to have a method to provide interaction and feedback between the functions.

Since most instructional development project managers work on more than one project concurrently, the model should provide for interaction between instructional development projects that are sharing the same resources.

Constraints

A minimum of ten percent of the project time should be spent in planning, even under crisis circumstances. The project management technique should include a planning template that data may be "plugged into" when the time for planning grows too short for regular planning.

Output Provisions

The output provisions include the following:

- Gantt and milestone charts for communication to clients, customers and upper management.
- Network diagrams for use by the instructional development teams.
- Budgets in both planned and actual versions to control costs. This would be in some form of electronic spreadsheet.
- A log report to track project problems, generated from an electronic database, which includes various characteristics of the project so that project appropriate information can be retrieved.

Self-regulatory mechanism

A feedback control loop will connect the controlling function to the planning function to track planned costs and times against actual costs and times in the areas of budget and schedules.

Reflections

In my examination of the research and talking with project managers using the selected project management techniques, a number of other issues presented themselves. I do not have sufficient evidence that would justify placing them in my model; however, I think they are worth mentioning as personal reflections.

Project managers tend to concentrate on those aspects of time and cost about which they are especially knowledgeable, and give short shrift to areas where they are less experienced. When each project manager was asked which types of tasks they could estimate most accurately and how that effected their scheduling of the tasks (Questions 55 and 56), there was very little consensus across the companies. It appears that each group had things that they did especially well and that they could estimate those most accurately.

There is a need for research comparing time estimates where the subjects are not knowledgeable and where they have experience to determine and compare the processes that they go through in each case. This protocol analysis would help document the areas inexperienced developers overlook.

Another issue in the use of management techniques is the lack of personal computer software that can handle the types of calculations needed in these techniques. One of the reasons is that mini computers or mainframe computers are necessary in order to provide enough computer memory for the use of these techniques. This adds to the cost and availability of these techniques.

Following are two components that should be examined as potential components of a model of this kind:

1. Include a mechanism for recognizing situational differences in projects, so that the negative impact of errors in time estimations can be avoided.

2. Allow for the additional relationships found in the PDM project management technique. The start to start (SS) relationships are particularly useful in showing lead-lag time in things like formative evaluation and writing student manuals and instructor guides.

Summary

This chapter has provided a summary of the study. Conclusions have been drawn as a result of the study, and recommendations for future research have been provided. Finally, the research has been reflected upon and a list of components that should be included in a model of the synthesized technique have been outlined.

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APPENDICES

APPENDIX A

RELIABILITY AND VALIDITY CRITERIA

CRITERIA FOR RELIABILITY

The information on reliability and validity is taken from Borg and Gall (1983). "Reliability is the level of internal consistency or stability over time."

"A one-item test is susceptible to many chance factors and therefore, is not a "reliable" measure of the students' level of achievement in a given subject. If the research project is such that the research worker can expect only small differences between his experimental and control groups on a variable measured by the test, it is necessary that a test of high reliability be used. Conversely, if large samples are to be used and if the mean test scores are expected to differ materially for the experimental and control groups, the research worker may select a measure of relatively low reliability and still be reasonably sure that the test will discriminate adequately." "It is easier to establish the reliability of a test than to establish its validity."

CRITERIA FOR VALIDITY

"Validity is the degree to which a test measures what it purports to measure."

Concurrent Validity is "determined by relating the test scores of a group of subjects to a criterion measure administered at the same time or within a short interval of time. The distinction between concurrent and predictive validity depends on whether the criterion measure is administered at the same time as the standardized test (concurrent) or later, usually a period of several months (predictive)."

Construct Validity is "the extent to which a particular test can be shown to measure a hypothetical construct. It is an important factor to consider in planning a research study that proposed to test a hypothesis. Intelligence, anxiety and creativity are considered hypothetical constructs because they are not directly observable, but are inferred on the basis of their observable effects on behavior."

Content Validity is "the degree to which the sample of test items represents the content that the test is designed to measure. Systematically conducting a set of operations, for example defining in precise terms the specific content universe to be sampled, specifying objective, and describing how the content universe will be sampled to develop the test items. Usually appraised by an objective comparison of the test items with curriculum content. Important in selecting tests to use in experiments involving the effect of training methods on achievement."

Predictive Validity is "the degree to which the predictions made by a test are confirmed by the later behavior of the subjects. The prediction of success in various activities. Administer the test, wait until the behavior that has been measured occurs and then correlate the occurrence of the behavior with the scores of the subjects on the test."

SOURCES OF INVALIDITY

There are eight types of extraneous variables that if they are not controlled for in the experimental design may cause confusion with the effect of the experimental stimulus. These types are relevant to internal validity (Campbell and Stanley, 1963).

Experimental morality the differential loss of subjects from groups that will be compared.

History, in addition to the experimental variable, other occurrences between the first measurement and the second that may effect the experimental outcome.

Instrumentation changes in the calibration of a measuring instrument or changes in the observers may result in changes in the measurements obtained.

Maturation processes within the subjects that occur due to the passage of time, for example, growing older, becoming more tired, becoming hungrier.

Selection-maturation Interaction which in certain of the multiple-group, quasi-experimental designs may be mistaken for the effect of the experimental treatment.

Selection biases resulting in differential selection of respondents from the comparison groups.

Statistical regression taking new measurements on groups that have been selected due to their extreme scores. This results in bias, since the only way the results can vary is toward the mean.

Testing the effects of taking a test upon the scores of a second testing. The following factors may effect external validity.

Interaction of selection and experimental treatment the interaction effects of selection biases and the experimental treatment.

Interaction of testing and experimental treatment of the pretest may increase or decrease the subject's sensitivity to the experimental treatment and the results obtained from a pretested population may be unrepresentative of the effects of the experimental variable for the unpretested subjects. **Multiple-treatment interference** may occur when multiple treatments are applied to the sample subjects, due to the fact that prior treatment effects are usually not erasable.

Reactive effects of experimental arrangements preclude generalization about the effect of the experimental treatment upon persons being exposed to it in a non-experimental setting

APPENDIX B

SAMPLE ABSTRACT FORM

SAMPLE ABSTRACT FORM

This is a combination of Gentry's Media Research Report Format from Foundations of ESD Research (CEP 931B) and Borg and Gall's Research Article Evaluation (1983).

Reference: Complete reference for the research

Type of Project Management: Project Management type researched

Type of Research: Research type (category) for this specific research

Description: Abstracted description of this specific research

1. Broad purpose of research
2. Questions being answered or hypotheses being tested
3. Major procedures used to carry out research
4. Research outcome

   Were appropriate statistical tools used? Comment.

   Are result reported in clear terms? If not, give example.

   Does the researcher relate his results to the hypotheses or objectives?

   Are the conclusions supported by the results?

Validity and Reliability: Estimation and justification

Value to the Field: Estimation and justification. What are the main strengths and deficiencies of the research?

SAMPLE ABTRACT FORM

Reference:

Abernathy, William J. (1971). Subjective estimates and scheduling decisions. Management Science. Vol. 18, No. 2, B-80-B-88.

Type of Project Management: Network Scheduling Models For example: CPM, DCPM, GERT, PDM, and PERT

Type of Research: Descriptive

Description: Abstracted description of this specific research

1. This paper analyzes subjective estimation characteristics in a large development project and examines their effect on the scheduling problem. Since scheduling is affected by uncertainty, a better understanding of this would clarify the following choices:

   a. the selection of the original scheduling technique

   b. the selection of corrective measures

   c. the sequencing of activities

   d. the selection of replanning and rescheduling policies

The two general properties that affect results are: (1) the distribution of error and (2) the changes in error with reestimation over the course of the project. This project was selected because it offered "best effort" estimates as opposed to those based on "contractual numbers." The project represented:

- a network scheduling system that was used as the sole planning tool of engineers and managers.
- engineers responsible for the development, also prepared the estimates and were responsible for the validity of the estimates
- the schedule was reviewed weekly by the management and the data was of interest to the management

The project was the first-of-a-find project which took place over the period of a year, on a budget of more than ten million dollars. Since all of the technical objectives of the project were met, the project was considered a success by management as well as the customer.

2. Specific questions:

   a. How far before the time of activity start is the estimate made?

   b. When in the project is the estimate made?

   c. Is there an association in the error made in respect to this activity in the prior reporting period?

3. Data have been gleaned from interviews and the network scheduling records of a large development project. The network contained over 250 activities, with 187 being identified for analysis. The analysis was based on these activities being estimated in ten different reporting periods over the course of a year. Some activities were completed early in the project, so there are not ten estimates, while other activities were not included when their estimates were given after the start date.
4. The conclusion which must be reached from the available research results is that there is controversy concerning the presence of a significant learning phenomenon. The conclusion is supported by the results. This study supports the possibility of a learning phenomenon in estimating task duration, as opposed to previous research results in other studies that did not support this possibility. Since this is a single case, further research will be needed to determine the significance of the learning phenomenon.

This research used a multiple regression model. According to Borg and Gall (1983), multiple regression as a multivariate technique for determining the correlation between a criterion variable and some combination of two or more predictor variables. The statistic was used appropriately in this study.

Validity and Reliability: There is no evidence of that any of the 12 sources of invalidity were present.

Value to the Field: This study's value to the field is found in the need for further research. Previously it was accepted that there was no learning phenomenon during estimating tasks over the course of a project. This study found that this is not always the case, and that learning to do more accurate time estimates may take place over the course of a project.

APPENDIX C

INTRODUCTION OF THE STUDY TO THE CLIENT

4600 W. Britton Road #214
Perry, MI 48872
<DATE>

Dear <NAME>:

This letter is to confirm our appointment on <DATE> at <TIME> for an interview concerning project management techniques and instructional development. The purpose of this study is to collect information about factors that effect the management of instructional development projects. This data will be used to determine what conditions need to be included to maximize the use of selected project management tools.

A number of individuals like yourself who use project management techniques to track and control resources on instructional development projects, have agreed to participate. The process outlined below will be followed:

1. In-person interviews will be conducted with each member of the instructional design team.

2. Each interview will take approximately two hours depending on the staff member's role and the complexity of the project. All information will remain confidential.

3. After the initial interview, a follow-up telephone interview may be necessary for clarification or further detail on specific issues. This interview will also be scheduled at your convenience.

Would you please sign the consent form indicating your willingness to participate in the study. I have provided a stamped, self-addressed envelope for its return.

Thank you in advance for your time and cooperation. I will be happy to share the results of this study with you. If you have questions, please don't hesitate to contact me:

Amy J. Piper
4600 W. Britton Road #214
Perry, MI 48872
(517) 625-3004

Sincerely yours,

Amy J. Piper

Study: Project Management Techniques and Instructional Development

I consent to participate in this research project. I understand the time requirements and procedures as outlined in the attached letter. I understand that all identifying information will be kept confidential. I understand that the results of this study will be shared with me should I desire.

Date ____________________________

Signature ____________________________

APPENDIX D

INTERVIEW GUIDE

INTERVIEW GUIDE

PROJECT MANAGEMENT TECHNIQUES AND THE INSTRUCTIONAL DEVELOPMENT PROCESS

The recommended procedure for collecting case study data is an interview guide. The guide is adhered to only as a checklist, since it is desirable for the control of the conversation to remain with the interviewee. Therefore, the logical sequence outlined in the interview guide was not necessarily followed. The interviewer was responsible for assuring that all areas of interest were covered. Audio tapes of each session were reviewed to ensure accuracy of the interviewee responses. All projects did not contain all of the areas outlined in this guide. This study focuses on the areas contained in each project. Clarifying data and missing data were obtained through follow-up phone calls.

A. **IDENTIFYING DATA** (This information will be verbally recorded on the tape and in writing on the label of each tape.)

Date: _____/_____/90

Company: ______________________________

Interviewee: ______________________________

Team Position: ______________________________

Telephone: (_ _ _) _ _ _ -_ _ _ _

Address: ______________________________

Immediate Supervisor: ____________________

B. **INTRODUCTIONS** (Myself and the Study to Project Director or company contact.)

1. Elicit cooperation and consent.

2. Provide guarantee of confidentiality by presenting a copy of the study's introductory letter. (In many cases, this letter may have preceded the in-person interview.)

3. Ask permission to see products and documentation where appropriate.

C. TO SET THE INTERVIEWEE AT EASE ELICIT A DESCRIPTION OF THE PROJECT (All participants)

4. Size (in terms of hours of instruction, number of people trained, and total cost)of the project.

5. Content type.

6. Obtain the interviewee's assessment of the problematic areas (e.g., planning, estimating, scheduling, or controlling).

7. Determine interviewee terminology and definitions.

D. GENERAL INFORMATION

8. How long have you been managing training projects?
_____ months _____ years

9. How many instructional development projects are you involved with in an average one year period?
____ projects

10. What is the average number of hours of instruction each project delivers?
_____ hours

11. In any given project, what are the total number of people who would attend the instruction?
___ average number of people

12. What is the average amount of turnaround time for an instructional development project? (How much time do you usually have from the beginning planning stages of the project to the initial delivery of the project?)

E. INSTRUCTIONAL DEVELOPMENT

13. What categories of instructional development are you currently involved in? (For example, design, development, or evaluation)

14. What is the result of the training product? (For example, Computer Software Training, Management Training, or Sales Training)

15. Which types of instruction do you regularly produce?
___ Computer-Based Instruction (CBI)
___ Stand-Up Instruction
___ Video
___ Other (Please Specify)_____________

16. Which types of media are you regularly involved in producing?
    ___ Computer-Based Instruction (CBI)
    ___ Video
    ___ Other (Please Specify)____________

17. What instructional development model do you currently use? (Ask interviewee to provide a copy of the model graphic, or list the steps of the model, if they have one.)
    ___ Have Model
    ___ None

F. PROJECT MANAGEMENT

PLANNING AND SCHEDULING

18. What criteria do you use in determining whether or not to use a project management tool?
    ___ Time
    ___ Size of Project
    ___ Type of Project (Development or Revision)
    ___ Cost of Project

19. How do you modify the project management technique you are using according to the development time, size of the project, type of the project, or the cost of the project?

20. Do you often have more than one instructional development project in progress simultaneously?

21. Do you always use a project management tool for Instructional Development projects?
    ___ Yes
    ___ No

22. If not, what criteria do you use in determining whether or not to use a project management tool?

23. If you use a manual project management tool, are there any things the method doesn't account for and how do you keep track of them outside the confines of the system?

24. In reference to the instructional development model cited in question 17, please check the stage of the instructional development model in which the interviewee creates or sets-up the project management plan.

    Are there different purposes at different stages of the set-up? (Upfront for costing, after the project begins for resource management)

25. In reference to the instructional development model cited in question 17, please indicate the stage(s) of the instructional development model in which the interviewee revises the project management plan.

26. When do you feel it is useful or worth it to revise the project management plan and when do you feel it is more trouble than it is worth?

27. What percentage of the total project effort do you think is devoted to planning?

28. Do you include problem areas in the project plan? (an outline of those areas that could pose problems and their possible solutions)?

29. If a member of the project team finishes their work early, what do you do with them?
___ Calculate how they can shorten project
___ Move onto another project

30. Have you found that you can shorten the project time by revising PERT?

31. Which project management tool/technique are you currently using?
___ CPM
___ Flowcharts
___ Gantt
___ Milestone Charts
___ PERT
___ Other (Name)_____________

32. What pitfalls do you see in the planning phase of the project management technique you are currently using? (Elaborate on what they mean by planning.)

33. What pitfalls do you see in the scheduling phase of the project management technique you are currently using? (Elaborate on what interviewee means by scheduling. Does this include sequencing?)

34. How would you characterize your success rate in using this project management tool/technique?
___ Highly successful
___ Successful
___ Somewhat successful
___ Not successful

35. If the project management tool/technique was not successful, what area did it handle less than adequately? (Please check all that apply.)
___ Overtime
___ Over budget
___ Other (Please Specify)

36. If the tool was successful for your design/development project, please comment, by providing reasons why you think it is successful.

37. Is there a project management tool or elements of the tool that you have found to be unsuccessful for instructional development? (Please check those that apply.)
___ CPM
___ Flowcharts
___ Gantt
___ Milestone Charts
___ PERT
___ Other (Please Specify)_____________

38. Why? What area of the tool was not working for the instructional development project?

39. Assuming that time can not be added, what have you done to meet a deadline?
___ Add dollars to the budget.
___ Add personnel, either internal or external.
___ Modify the original objectives.

40. Which resources do you track through the project management technique that you use?
___ Cost
___ Facilities
___ Personnel
___ Quality/Quantity
___ Time
___ Equipment

41. What pitfalls do you find in your cost estimation procedure?

42. Do you use the project management tool as a means of costing?

43. Do you keep a running tab of costs (over or under)?

44. Is the project management tool useful to keep track of these?

45. What pitfalls do you find in your time estimation procedure?

46. What steps do you take to make controlling costs easier?

47. Do you also use these steps to control other project parameters, such as performance?

48. (This question is applicable if the interviewee uses PERT or CPM.) Do you use the PERT/CPM network to estimate costs? If so, how?

49. Which processes in the project management technique do you feel to be the most important to instructional development? (Have these prioritized 1 - 7, 1 = most important.)
___ Goals and Objectives
___ Planning
___ Organizing
___ Estimating
___ Scheduling
___ Controlling
___ Evaluating

50. How well does your project management tool deal with each of the processes below? Rate each one as satisfactorily or unsatisfactorily.
___ Goals and Objectives
___ Planning
___ Organizing
___ Estimating
___ Scheduling
___ Controlling
___ Evaluating

ESTIMATING

51. How do you normally estimate the time needed to complete a project?
_______Set a training delivery date and plan backward from that date to plan my project.
_______Establish the objectives, decide on a plan and then set a date to deliver the training.
___ Other (Please outline below.)

52. Do you use data from previous projects to base your time estimates?
___ Always
___ Sometimes
___ Never

53. What type of estimates are your time estimates based on?
___ Single point estimates
___ Multiple point estimates

54. If you use multiple point estimates, which ones do you use?
___ Optimistic
___ Most likely
___ Pessimistic

55. Which tasks in the Instructional Development model that you are currently using, are you able to estimate most accurately (both in scheduling and budgeting?

56. How does this effect the scheduling of these tasks?

57. What pitfalls do you see in the estimating phase of the project management technique you are currently using?

CONTROLLING

58. What pitfalls do you see in the controlling phase of the project management technique you are currently using?

59. How do you use the task list or Work Breakdown Structure to monitor and control the project?

60. How do you assure "breadth of communication" in a project?

Crisis Projects

61. What forces brought about the crisis characteristic of the project?
___ Acquisition/Allocation
___ Management
___ Merger
___ New Government Regulation
___ New Hires/Employee Attrition
___ New Product
___ Retraining
___ Other

62. Do crisis projects cause you to use a different project management tool than you would within "normal" time frames?
___ Yes
___ No
___ Sometimes

63. If yes or sometimes, which project management technique would you use under crisis circumstances?
___ CPM
___ Flowcharts
___ Gantt
___ Milestone Charts
___ PERT
___ Other (Please Specify)_____________

64. Why? What is the reason or reasons for the change?

G. Software

65. Do you use a computerized project management tool?
___ Yes
___ No

If yes, What are the names of the project management tools that you use?

Name___________________________
Version(s)_____________________
Publisher______________________

Name___________________________
Version(s)_____________________
Publisher______________________

66. How long have you been using this software?
_____ Months

67. Have you used other project management software in the past?
___ Yes
___ No

If yes, which? ________________________________

68. Why did you change to your current software?
___ Other wasn't working well
___ Upgrade to software
___ Other (Specify)

69. Do you feel one was easier to use for instructional development projects?
___ Yes
___ No

70. What were the reasons that one software was easier to use than others?

71. What steps do you take on project start-up to begin using the project management software?
___ Work Breakdown Structure
___ Time Estimates
___ Just boot-up and start

72. How long does it usually take to do the initial setup of the project management software?

73. Have you used any project management software on other types of projects?
___ Yes
___ No

74. Which ones were used on which types of projects?

75. Do all work equally well for any type of project?

76. Does the software you use really do what you need it to do?
___ Yes
___ No

If not, where is it lacking?

77. After the initial input, (manual or computerized) do you actually go back and revise the project management chart periodically?
___ Yes
___ No

If so, how often? During what stages of the ID process?

78. What do you like most about the project management tool you are using?

79. What do you like least about it?

80. What types of reports do you need to generate?
___ CPM Network
___ Gantt Charts
___ PERT Charts
___ Other (Specify)

END OF INTERVIEW GUIDE