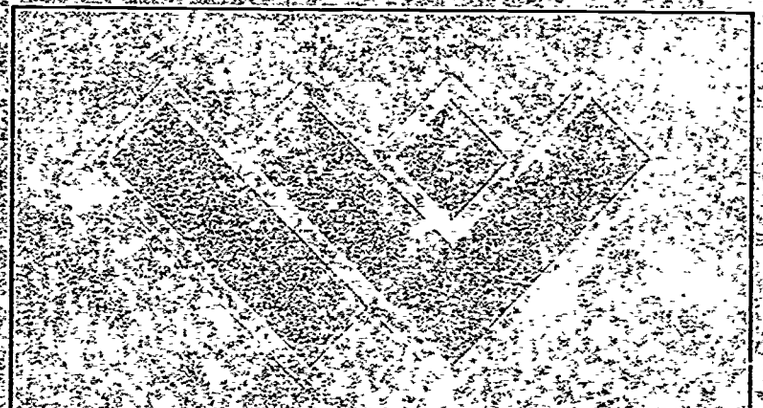
DOCUMENT RESUME

ED 071 335 EM 010 480

TITLE	Introduction to Psychology and Leadership. Leadership Management Course; Application of PERT to Research and Development in Education.
INSTITUTION	Naval Academy, Annapolis, Md.; Westinghouse Learning Corp., Annapolis, Md.
SPONS AGENCY	National Center for Educational Research and Development (DHEW/OE), Washington, D.C.
REPORT NO	TP-6-7
BUREAU NO	BR-8-0448
PUB DATE	16 May 69
CONTRACT	N00600-68-C-1525
NOTE	55p.; See also EM 010 418 and EM 010 419
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Autoinstructional Aids; *Cost Effectiveness; Critical Path Method; Curriculum Design; Curriculum Development; Educational Accountability; Evaluation; Individualized Curriculum; Individualized Instruction; Individual Psychology; Instructional Design; *Leadership Training; Management Education; Military Training; *Multimedia Instruction; Performance Criteria; Psychology; Social Psychology

ABSTRACT

The application of the Performance Evaluation and Review Technique (PERT) to the multimedia leadership course development project (see EM 010 418, EM 010 419, and EM 010 484 for the final report) is summarized in this report. The development of the system and the problems encountered in its operation are discussed. Charts showing the critical path for Phase I of the project and a specific task breakdown for one department are included. EM 010 418 through EM 010 447 and EM 010 451 through EM 010 512 are related documents. (Author/RH)



Westinghouse Learning Corporation

LEADERSHIP MANAGEMENT COURSE

APPLICATION OF PERT TO RESEARCH AND DEVELOPMENT IN EDUCATION

CONTRACT NO. N00600-68-C1525

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LEADERSHIP MANAGEMENT COURSE

APPLICATION OF PERT TO RESEARCH AND DEVELOPMENT IN EDUCATION

Contract No. N00600-68-C-1525

Abstract

This report summarizes the application of the Performance Evaluation and Review Technique (PERT) to the multi-media course development project. The development of the system and the problems encountered in its operation are discussed. Charts showing the critical path for Phase I of the project and a specific task breakdown for one department are included.

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I. INTRODUCTION

During the last decade, several major systems have been developed to improve scheduling procedures, resource management, and cost control of complex programs. A multiplicity of these management systems has been developed by the military services or by major contractors working with the Department of Defense and National Aeronautics and Space Administration. Generally, these systems are derivations of the "Critical Path Method" (CPM) or "Performance Evaluation and Review Technique" (PERT).

As the multi-media course development contract, for the United States Naval Academy (USNA), required both an extensive research effort and an experimental materials preparation program, the development of an integrated management system for the project was undertaken.

It was necessary to use a system which would enable the most efficient determination of:

- time estimates for completion of any and all parts of the project.
- resource requirements (manpower and other resources) for any and all parts of the project.
- the effect of schedule shifts or delays on resources, project costs, and delivery dates.
- the effect of variation in sequence or inclusion of project tasks on resources, schedules, and project costs.

- on-going performance evaluation which could be used to continually readjust resource, time, and cost estimates for the project.

It was decided that the PERT time system could best be adapted to form the basis of the planning and control systems for the multi-media project.

The PERT system, initially developed in 1958, has proved to be a useful tool in planning and evaluating projects in development and construction. Most of these projects have been concerned with the development and construction of weapons and military materiels.

A careful review of the literature would yield no indication that the PERT system had ever been applied to a large-scale project concerned with development and research in the field of educational psychology.

The application of such a system to any research and development project is based on the presumption that sufficient experience with the activity exists to permit the activities involved to be identified. Since many similar systems have been used extensively for efforts in technical writing and materials preparation, considerable information was available for the establishment of a large portion of the procedural steps involved in the project. On the other hand, many of the research activities were relatively new and no adequate systematic outline of procedures had been developed to serve as a model for the project. In general, developmental projects in education and projects which are primarily concerned with research in any field have not been

repeated in sufficient quantity to establish a generalized procedural model.

It was believed, however, that a careful analysis of the work necessary for the accomplishment of each milestone would lead to the development of a general list of procedural steps. It is important to note that regardless of how well (or ill) defined the work tasks are, deviations from the general model will occur.

Developmental activities are relatively new to the field of education. The problem involved in the multi-media contract was the production of a particular kind or type of product, from the initial planning stages through the development of prototypes which can be used for future production models.

Because no generally agreed upon procedures exist for the development of a multi-media course at the college level, the extant procedures for preparing programed instructional materials and film strips were used as a guide.

The research aspect of the project can be divided into three major areas: (1) evaluation, (2) experimentation, and (3) validation.

The general nature of the evaluation research involves the use of existing data and the collection of new data to answer specific questions and hypotheses. Attempts were made to secure valid and reliable information from the USNA files, by the careful examination of historical records and contemporary progress reports. Additional data was to be collected by an extensive testing program at the USNA. In developing the network of activities associated with the development and compilation of student data,

the development of the original hypotheses was among the first steps taken. A common fault in this type of research is the inadequate consideration of the purpose for the study and how the data will eventually be analyzed. Only after the hypotheses are established, can the collection, storage, and manipulation of the data be adequately defined.

Experimental research is quite common in the fields of education and psychology. The general procedure is similar to that used in evaluation research. Initially, hypotheses are established. These hypotheses lead to the specification of variables which are to be manipulated, and the development of an experimental design.

The unique aspect of this project is the interdependency between the experimental design and the development of course materials. In order to evaluate the effects of various media and presentation design elements on the student's learning style, it was necessary for the research design to set the parameters for the development of the materials. For this reason, interaction between the two major paths of the network was required in all phases of the project.

Validation of materials after implementation was not considered in the first phase of the project. This aspect of the research effort is to be developed in Phase II.

Although the primary reason for the development of the PERT time system was to ensure the effective management of the multimedia contract, a secondary outcome of the system was important to Westinghouse Learning Corporation (WLC). If the PERT time

system could be shown to effectively control the multi-media course development project, it would be extended to other major projects of similar nature within WLC. For this reason, the cost of developing and implementing the system was considered a developmental project within WLC, and was not charged against the USNA contract.

A description of the developed system and the problems encountered in its operation are believed to be of sufficient interest to be presented in detail. It is hoped that such a report will enable other contractors to avoid the major pitfalls encountered by WLC.

II. DEVELOPMENT OF THE SYSTEM

A. OVERVIEW

The accuracy of any management system is a function of the precision and clarity of the original work specifications. The total project must first be defined and then subdivided into a series of major units of work. Each of these units represent milestones of accomplishment toward the completion of the project. Milestones represent key network events that are necessary to achieve the total project objectives.

The important steps in the PERT system, as it was developed for the multi-media course development project, are discussed in this section.

The PERT system includes two major cycles: the planning cycle and the implementation and control cycle.

The planning cycle includes:

- definition of project objectives.
- specification o milestones for the project.
- breakdown of tasks.
- further breakdown within organizational departments.
- definition of resources.
- development of a cost-accounting system.
- construction of the networks.
- estimation of time and resources for each task.
- development of delivery schedules for all milestones.

The implementation and control cycle includes:

- development of all data processing requirements.
- implementation of cost-accounting system.
- comparison of actual expenditures in time and resources to projected expenditures.
- updating of PERT network.
- revision of schedules and budget.

B. THE PLANNING CYCLE

1. Definition of Project Objectives

The first step in developing the PERT management system is to define the objectives of the project. These objectives should include a statement of all deliverable documents for the contract. To accomplish this step, a careful review was made of the proposal, the "Multi-Media Course Development Paper", the "Program Data Book", and all other written and verbal communications between WLC and the USNA.

The multi-media course development project had three major objectives:

a. The development of a multi-media course in leadership for the USNA. This course was to include the most recent advances in the field of educational technology and was to be fully validated in the classroom.

b. A comprehensive research program to evaluate the effectiveness of various media and presentational forms with respect to variables including cost,

student achievement, and administrative difficulties. Relationships between individual learning styles and subsequent performance in the instructional environment were to be carefully studied. The outcome of the research effort would be the establishment of guidelines for use in developing the best possible prescription for any student, based on his individual characteristics and the possibilities of the course of study.

c. The primary long-range objective was the design, development, and verification of a model which could be used for the development of a superior educational system for secondary schools.

2. Specification of Milestones

The major milestones for Phase I were initially defined as: (1) the research and evaluation plan, (2) the content outline, (3) the terminal objectives, (4) the enabling objectives and test items, (5) the presentation design, (6) the segment documentation packages, and (7) the actual material for the first one-half of the course (this included instructional material, student manuals, and teachers' guides).

In addition, progress reports were to be submitted monthly and quarterly. Additional milestones were believed to be important for the fulfillment of the contract objectives, but were not part of the critical path for the workflow of course construction and the research

effort. These milestones include: (1) the development of a cost-accounting system, (2) the development of a rationale for media selection, (3) the development of the rationale for sequencing, and (4) a series of technical papers which included topics such as course description, course strategy, course development model, and cost effectiveness.

3. Breakdown of Tasks

The specification of tasks served as the basis for construction of the PERT network. The actual task breakdown began with the construction of the course development model. The development of this model and the task definition began at the most general functional level. The subdivision of the functions continued until a level was reached at which the complete resource requirement could be completely specified. All tasks necessary for the accomplishment of each milestone were delineated. Care was taken to ensure that these tasks were consistent with the work statements presented in the original proposal.

After the tasks were specified, their interrelationships were defined.

Up to this point, the relationships between the course development model and the structure of the PERT network were quite similar. At this point, however, it was necessary to assign responsibility for the specific tasks to departments or units of operation in the customers'

organization. From this point on, the development of the PERT network began to reflect the organizational structure and specific resource availability of the customer and, therefore, deviated sharply from the general model.

4. Task Breakdown Within Orgnizational Departments

Each department in the organization identified a number of steps within any task that was assigned to it. An example of this type of detail is presented in the chart on page 28. This chart shows a breakdown of the steps involved in the production of a unit of material. The extent and number of these smaller subdivisions depended upon the amount of detail needed by the department manager to plan and control his work. In this particular project, the extremely tight schedule made it necessary to detail work to the extent that resources could be estimated to the nearest man-day.

Another variable which influenced the extent to which the steps in any task were identified was the number of departments and different personnel in the contractor's organization which were responsible for the accomplishment of that task. For example, the drafting of a report was usually broken down into two smaller steps -- editing and typing -- for assignment of responsibility to different sections. On the other hand, the development of test norms, which was a much larger task, was not broken down since the responsibility for the various steps involved rested with a single section in the contractor's organization.

As the structure of the step breakdown is defined, the interfaces between any of the various steps should be identified. Interfaces are defined as the transfer of information from one part of the network to another. If this transfer of information is shown on the chart by a dotted line, the transfer does not consume time or resources.

5. Definition of Resources

Closely related to the breakdown, with respect to organizational structure, is the definition of resources. The computer program which was developed for the PERT Network* allowed for the specification of ten professional "resource" categories.

These categories included: editor, secretary, project coordinator, writer, analyst, illustrator, research assistant, research associate, production and control manager, and subject matter expert. For each step in the network, the number of man hours required for each resource was specified.

After the specification of resources and man hours had been completed, manpower loading for any given project-day was determined. Charts showing the overall requirements for each of the professional resources were developed.

*The program was developed by the Dikewood Corporation, Albuquerque, New Mexico.

Figure 1 on the following page shows the manpower for a typing support staff for each project week.

These charts were analyzed by the management of each department to shift resources in order to alleviate the problems of excessive manloading or idle manpower. Highly irregular loading patterns would indicate a need for additional hiring, overtime, or possibly a rescheduling of the activities listed in the PERT network.

6. Development of a Cost-Accounting System

The cost-accounting system, developed for the multi-media project, has been discussed in detail in the technical paper TP-6.5. One aspect of this system which was alluded to, but not presented in its entirety, was the relationship of the cost-accounting system to the PERT network. The code structure for the accounting system was devised in such a way that costs could be isolated for any professional resource (limited to the ten previously mentioned) working on any step in the network. This aspect of the project was necessary for the feedback, updating, and control of the system.

All costs could be summarized with respect to any given milestone, resource, or organizational department. In this way, the actual man hours spent for any activity could be directly and immediately compared to the projected hours for that activity. Variations in the actual and the projected man hours served as a basis for revisions of projected costs and milestone schedules.

Resource Type: Typist

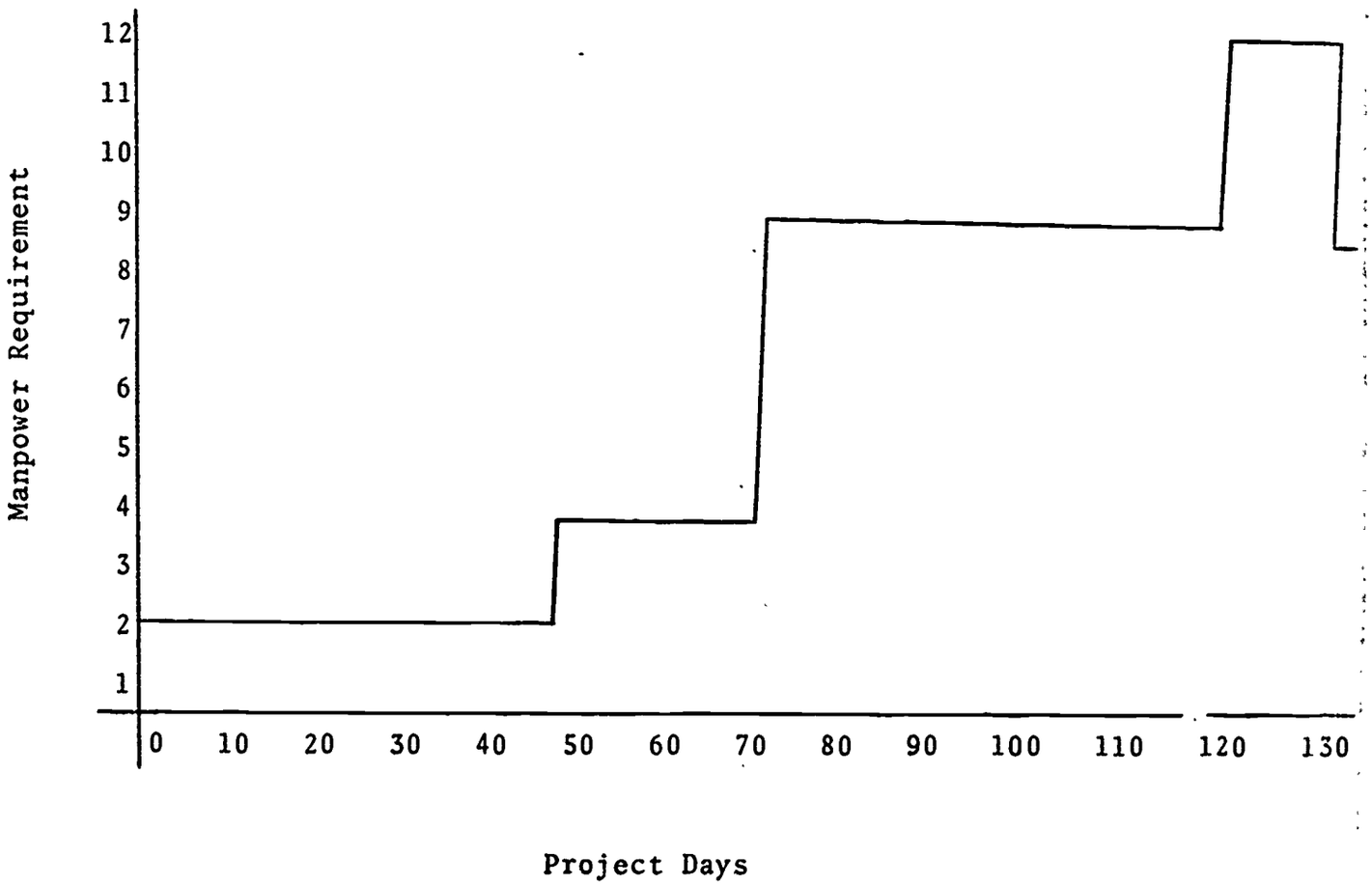


Figure 1 - Showing Manpower Requirement for Typing During the 130 Days of the Project

7. Construction of the Network

The network is the graphic representation of the project plan. It shows the plan, which has been established to reach each milestone, along with the interrelationship and interdependence of the project steps.

A network is composed of events and activities. Events is the term used when referring to the start or completion of an activity. These do not consume time or resources. Events are points in time which signal the initiation or completion of an action.

Generally, events in a network are represented by the use of circles. For purposes of reference, these circles were assigned specific numbers in this project. In addition, the event was considered to represent the completion of the step which directly preceded it.

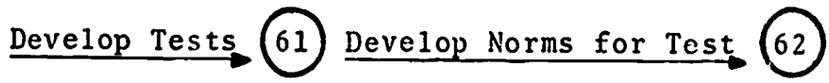


Figure 2 - Example of a Portion of the PERT Network

For example, in Figure 2, number 62 represented the completion of the development of norms for the tests. Number 61 represented the completion of the tests, rather than the start of the development of norms. The resources, time, and costs of the project were itemized by these numbers. An example of a computer print-out form is presented in Figure 3, on the following page.

Events	SME	Secretary	Editor	Writer	Analyst	Manager	Coordinator	Research Assistant	Research Associate	Illustrator	Costs
61	0	0	0	0	0	0	0	1	2	0	$132.23
62	0	0	0	0	0	1	0	0	0	0	69.35
63	0	0	0	0	0	0	1	1	1	0	130.87
64	0	1	0	0	0	0	0	0	0	0	20.35
65	-	-	-	-	-	-	-	-	-	-	-
66	-	-	-	-	-	-	-	-	-	-	-
67	-	-	-	-	-	-	-	-	-	-	-
68	-	-	-	-	-	-	-	-	-	-	-
69	-	-	-	-	-	-	-	-	-	-	-
70	-	-	-	-	-	-	-	-	-	-	-
71	-	-	-	-	-	-	-	-	-	-	-
72	-	-	-	-	-	-	-	-	-	-	-
73	-	-	-	-	-	-	-	-	-	-	-
74	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	-	-
76	-	-	-	-	-	-	-	-	-	-	-
77	1	0	1	6	2	0	1	0	0	1	526.23

Figure 3. Example Computer Print-Out Which Itemized Resources and Costs by Events (Numbers Represent Man Days)

An activity is a task or step in the project for which the use of specific resources for a period of time can be delineated. An activity is the actual work that takes place between two events. An activity is represented on the network by an arrow connecting one event with another. There are also dummy activities which are represented by dotted arrows or lines. These activities do not consume time or resources. An example of a network showing events, activities and dummy activities is shown in Figure 4. Note that the flow of the network always moves from right to left. One essential requirement of the computer program was that the event (or circle) at the beginning of an activity must always have a smaller number than the event at the end of the activity. The number assigned to the events do not necessarily indicate the order in which they occurred in the project. For example, in Figure 4, event 7 does not necessarily occur after event 8.

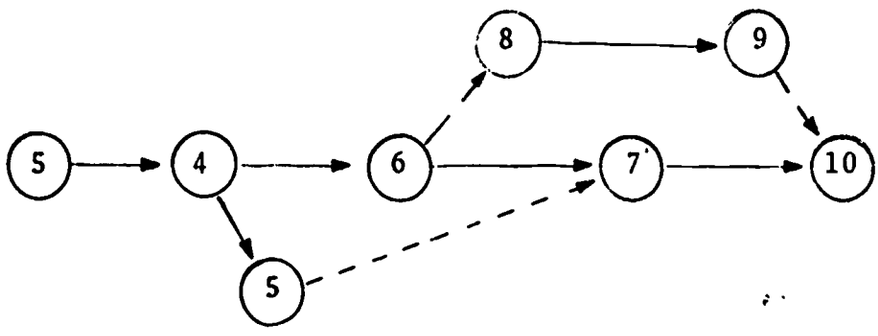


Figure 4 - Illustration of the Relationship of Events to One Another

In the PERT network designed for the multi-media project, the use of a number of different types of construction was required.

A series construction was used when the successive activities or steps were dependent or progressive. See Figure 5 below.

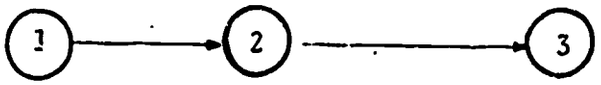


Figure 5 -- Series Construction

When two or more activities could have taken place at the same time, but were constrained by a common previous activity and concluded in a common end activity, a parallel construction was used, as in Figure 6 below.

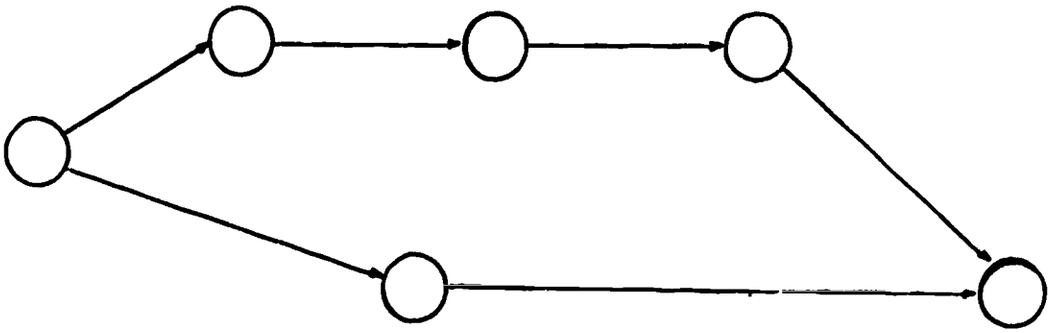


Figure 6 -- Parallel Construction

Other types of activities are illustrated in Figure 7 below. While Figure 6 shows several activities which are constrained by a preceding event, Figure 7 shows a number of activities which end in a common event.

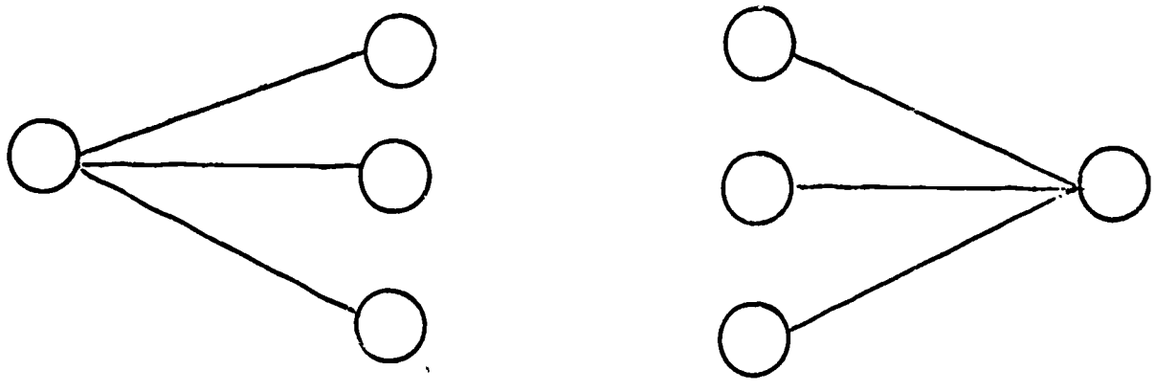


Figure 7 -- Activities Beginning or Ending in a Common Event

A number of variations and combinations of these constructions were used. It should be noted that a multiple start point could have been used with this network. It is always necessary to tie these multiple beginnings together with dummy arrows so that all events be connected to comply with the requirements for the data processing system. An additional idiosyncrasy of the PERT network, as a product of the data processing system, was the use of 999 in the final event circle. The particular program developed had the capacity to handle 999 events. Consequently, 999 was used to indicate that a particular activity ended at the completion

of the project (in this case, Phase I). In some cases this eliminated the need for long dummy arrows which would detract from the major path of the work flow.

8. Estimation of Time and Resource Requirements

As previously mentioned, the resources or man hours were specified for each step or activity in the project effort. This, of course, directly effected the times which were assigned, but did not completely determine them.

There are two generally accepted methods for establishing time estimates for each activity in the network. The most common approach requires the establishment of three time estimates; the other requires the use of only one time estimate. By using the first method, the optimistic, most likely, and pessimistic times for each activity are specified. The "expected" time is then computed from the formula "$t_e = \frac{\text{opt.} + 4\ (\text{m.l.}) + \text{p}}{6}$".

For this particular project only one time estimate was used.

Once the time estimates for each step were determined, the longest time path through the network was calculated. This path is called the critical path, since the total project time is dependent on this path. All other paths on the network are called slack paths. In the PERT network shown in this paper, many of the slack paths have been eliminated. These paths consist of repetitions of a section of the chart which begins

with the preparation of the enabling objectives, and ends at the final delivery of materials for various chapters. The critical path is shown for chapters X and Y. X and Y represent those chapters which require the longest time for completion.

Although only one estimate of time was used, the fixed beginning and termination of the contract allowed for the computation of slippage time. The time required for the completion of the critical path was calculated forward from the initial date and backwards from the termination date of the contract. This calculation yielded the maximum amount of "slippage" time that could occur without affecting the final delivery date, as specified by the contract.

9. Development of Delivery Schedules

By analyzing the manpower loadings and the total worktime required for each activity, the delivery schedule from each milestone was developed. Initially, three times were indicated for delivery of each milestone. They were:

- delivery to USNA.
- return to WLC with recommended revisions.
- final delivery to USNA.

All three times were indicated on the schedule because the amount of turn-around time alloted for the USNA to review materials was critical to the completion of the contract. Figure 8, on page 22, shows a

hypothetical schedule which could have been developed for the multi-media materials development contract.

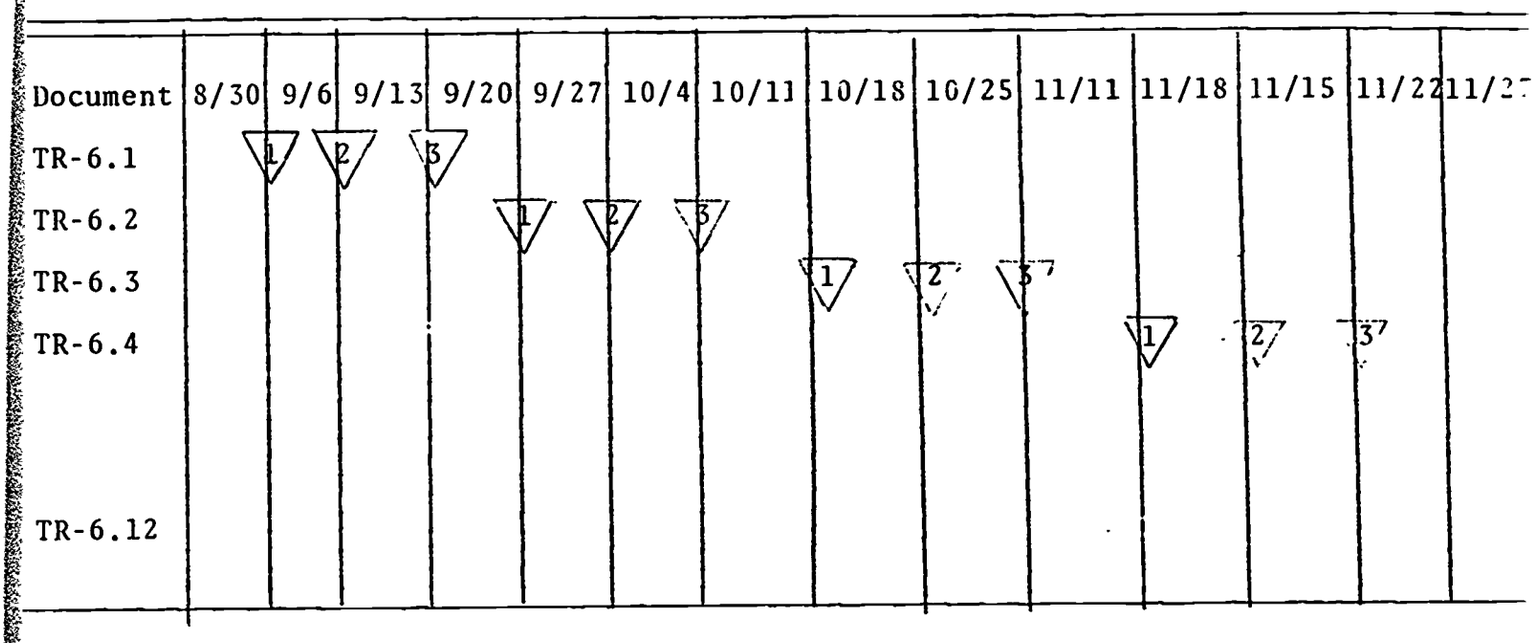
C. THE IMPLEMENTATION AND CONTROL CYCLE

The control cycle for any project is one of the most important functions of the PERT network. For the multi-media course development project, a special cost-accounting system was developed by WLC in such a way that it could satisfy corporate budget processing requirements and feed directly into the PERT system. Each activity in the PERT network was assigned a unique budget number. This number identified the activity and the functional group to which it belonged. In addition, the charge numbers used on time cards reflected the resource which was involved in the activity. Direct labor costs, travel, living expenses, etc., were all charged to a specific activity. With this system, a weekly read-out was obtained which listed the expenditures to date for each activity. These expenditures could be compared to the predicted man-hour requirements for the project. In this way, the network was continually reviewed and updated.

New account numbers and new activities could be assigned whenever necessary. The entire schedule could be changed in a few minutes. The computer program which was used to manipulate the PERT network was not sophisticated enough to update the network when major task changes were made. This was especially true of those changes affecting the critical path of the network.

Schedule for Document Delivery

Leadership - Phase 1



1 Delivery to USNA

2 Return to WLC with recommended revisions

3 Final delivery to USNA

Figure 8 -- Example Schedule of Milestones for Phase I of the USNA Multi-Media Project

In general, the control cycle can be summarized in four major steps.

- Implementations of the cost-accounting system
- Comparisons of actual expenditures in time and resources to projected expenditures
- Continual updating of the PERT network
- Revision of the milestone schedules and budget for the project

Although the initial development and implementation of the system required an extensive effort, the automation of the control cycle allowed for a great deal of information to be processed with a limited amount of time and expense.

III. EVALUATION OF THE SYSTEM

The PERT management network represented an ideal system for the planning and control of the project. However, five months after the beginning of Phase I, it became increasingly evident to WLC that the use of the PERT system for allocation of resources and estimation of deadlines was no longer effective. After a careful examination of the project, there appeared to be four factors which continually caused problems in the management of the effort and eventually led to the abandonment of the PERT/cost system. It should be emphasized at this time that it is not the purpose of this paper to be critical of any element involved in the multi-media course development project. Rather, it is hoped that in pointing out the problem areas, potential difficulties with future projects of this type can be avoided.

A. CONTROL OF ACTIVITIES

A management system such as PERT assumes that all activities can be assigned reasonable estimates of time and resources. It also assumes that all activities can be brought under the control of the contractor by manipulating the resources or time involved. In most developmental projects where PERT has been used successfully, the interaction with the contractor, i.e., review points, occurs at the termination of a long chain of activities. In a materials development project such as the multi-media project, continued interaction with the contractor was required.

One way to look at this problem is to consider the difficulty that would occur if one department in an organiza-

tion was not scheduled by the PERT system but had a vital part in the development of the materials. The requirement for continual interaction with the customer and multiple sign-off points made the accurate specifications of the customers time on the project essential. Without this control, the careful scheduling of resources and time around undefinable blocks of time was not feasible.

In order to efficiently schedule a project of this type, a contractual aggreement would need to be established which would specify the amount of turn-around time necessary for each submittal. The establishment of such events, prior to the project start, would be advantageous to both the customer and the contractor.

B. DEPENDENCY OF APPROVALS

A second problem which served as both the major reason for the development of the PERT system and the major reason for its abandonment was the interdependency of the milestones. In almost every case, the approval of one milestone was necessary before the work on the following milestone was begun. This requirement, in combination with a limited time deadline, posed a major problem for both the contractor and the customer. For example, the course outline served as a basis for the terminal objectives, which in turn served as a basis for the evaluating objectives, etc., on through the presentation design, segment documentation, and materials preparation. Therefore, the approval of the course outline was essential for work to progress from the contractor's point of

view. The customer, however, was hesitant in making a hasty decision on a document which would serve as a basis for the entire project. This problem was never resolved. Consequently, milestones were not approved and dependent milestones were delayed. The first milestone of the project, the content outline, was informally submitted in August, 1968, and after multiple revisions, it has not yet been completely approved, as of the writing of this report, May, 1969.

When this type of dependency relationship is inherent in a project, an agreement should be reached between the customer and the contractor as to the maximum time allotted for approval and revision before the final delivery dates and project costs are significantly affected. The slack time in the PERT network is an excellent way to estimate this type of effect.

C. NATURE OF THE COURSE

The third problem is more specific to this project and may have limited potential for generalization to other projects. It will be mentioned, therefore, but not considered in any detail. The problem concerns the content of the course itself: "What is leadership?" A simple answer to this question is impossible. Leadership is a complex concept which can be defined in many different ways. This lack of tangibility caused many of the time delays which have been discussed in this section.

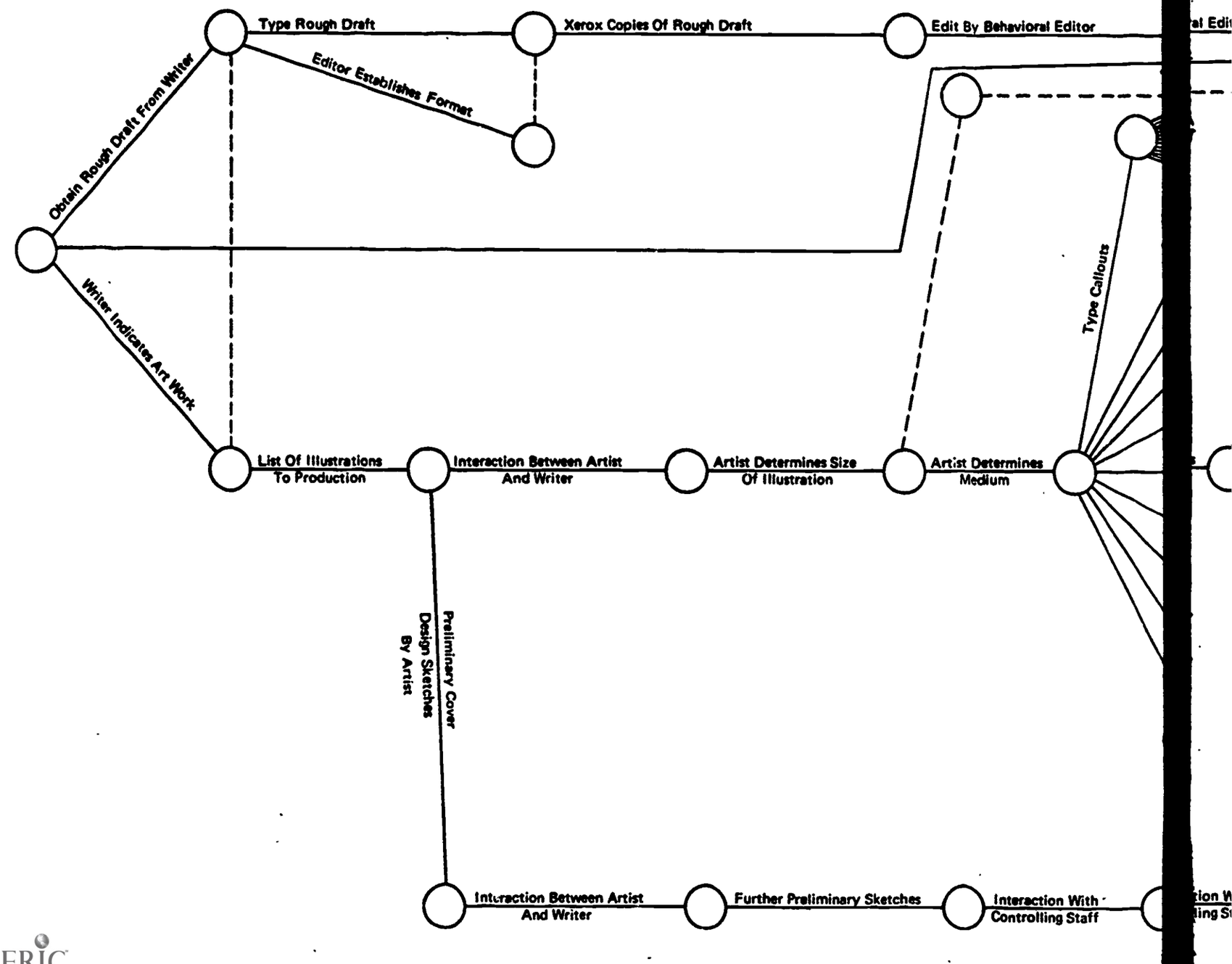
D. NATURE OF THE CONTRACT

The management system developed for a specific project is a function of the precision and clarity of the original specification of the work to be completed. Because of the lack of clarity of the initial contract, the PERT network was based on milestones which the contractor believed to be the best representation of the customer's requirements; however, agreement was never officially reached as to the items which would constitute total delivery for Phase I of the project. This lack of agreement on project milestones, which formed the basis for the PERT network, caused major changes in the actual path of the system. Since this type of change could not be handled by the data processing program, the man hours required for rescheduling all activities became prohibitive. The major value of the system was lost when deviations from the initial path were so extensive that they could not be automatically updated.

The solution to this problem is simple in theory, but difficult in practice. A clear statement of the work to be accomplished and the milestones to be reviewed by the customer should be included in the contractual agreement. This is especially true if the project is a developmental one and if the contract references multiple source documents which yield varying information concerning the project.

IV. CHART SHOWING BREAKDOWN OF TASKS FOR PRODUCTION DEPARTMENT

PERT CHART OF PRODUCTION AND CONTROL DEPARTMENT (BSD)



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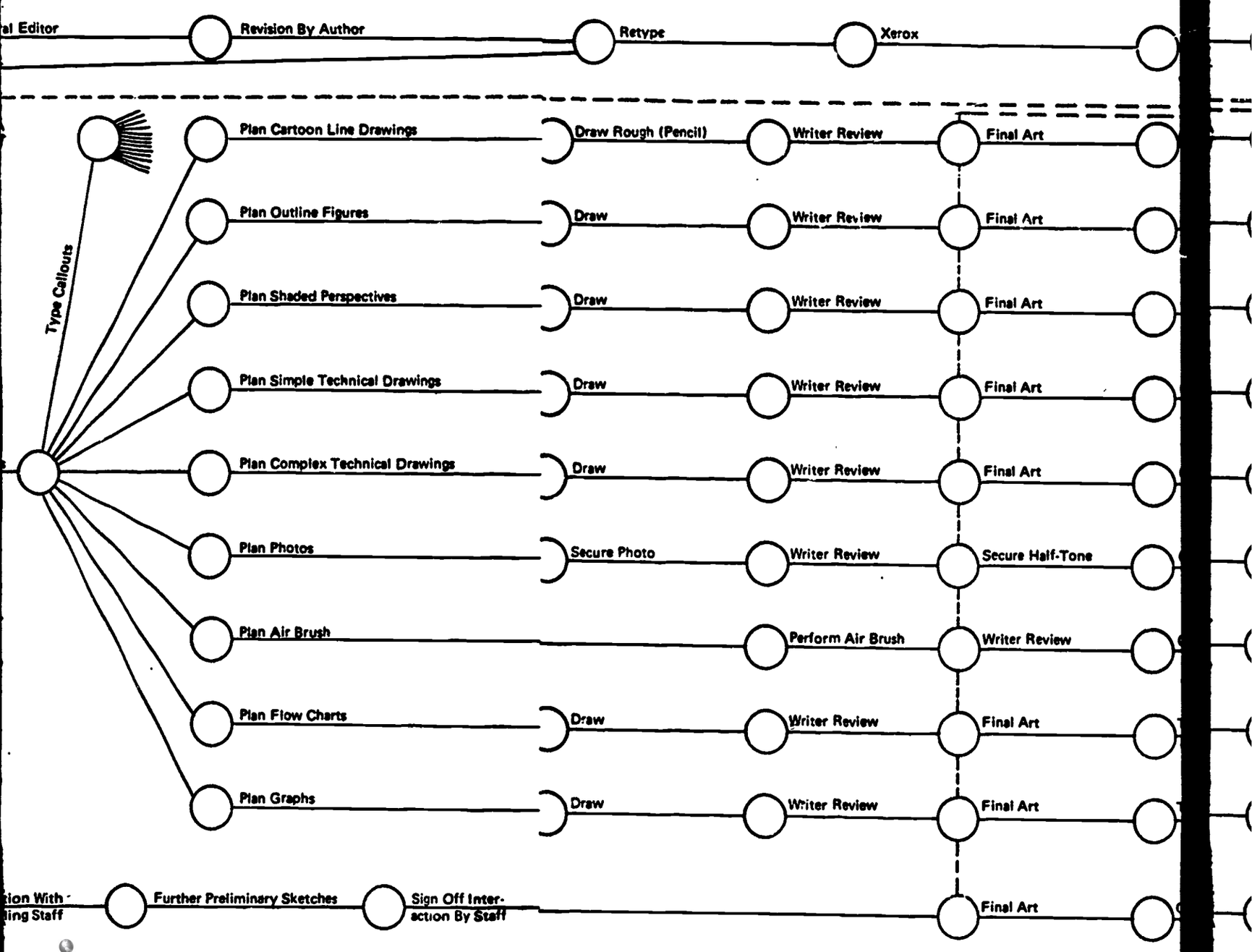
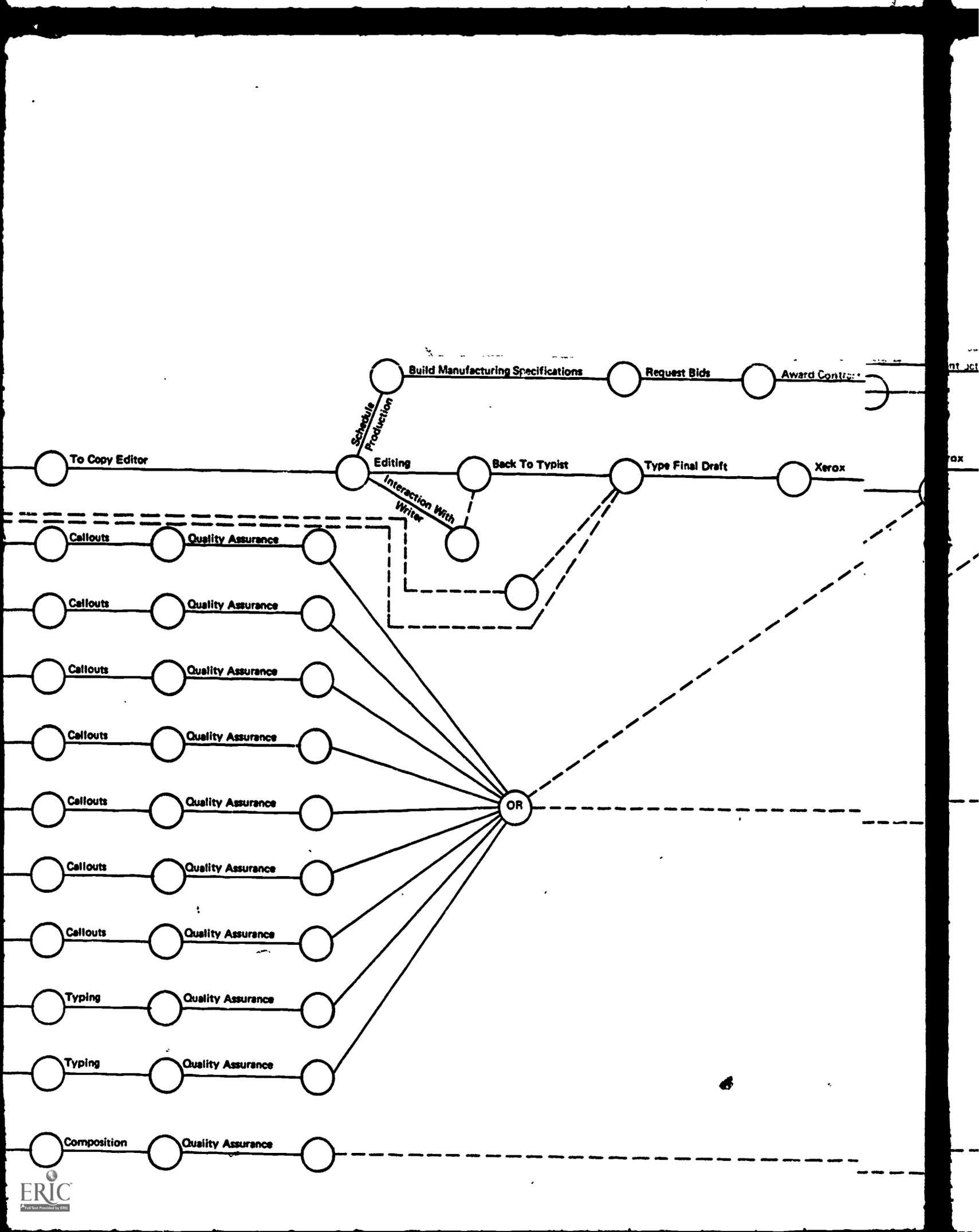
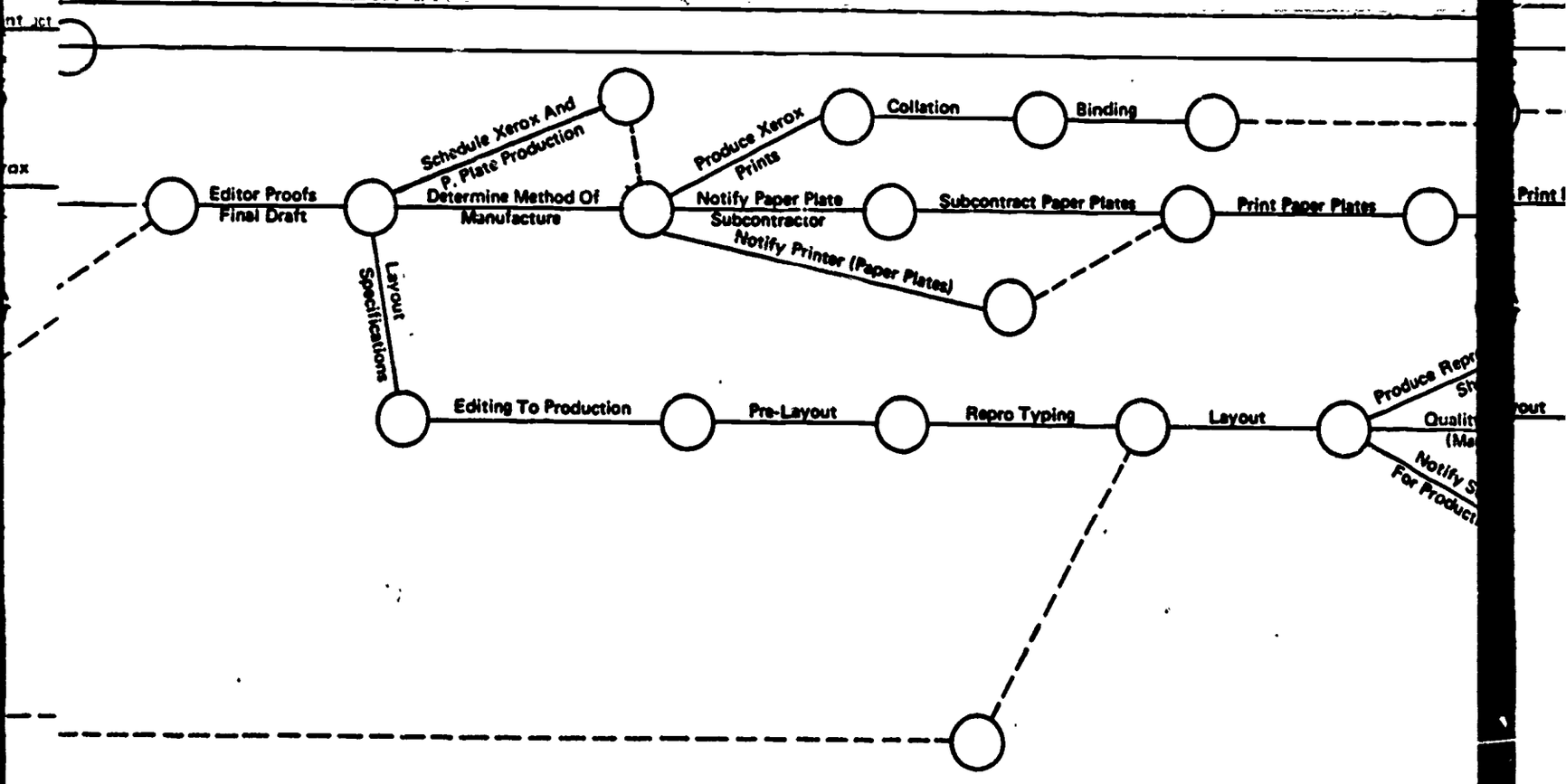
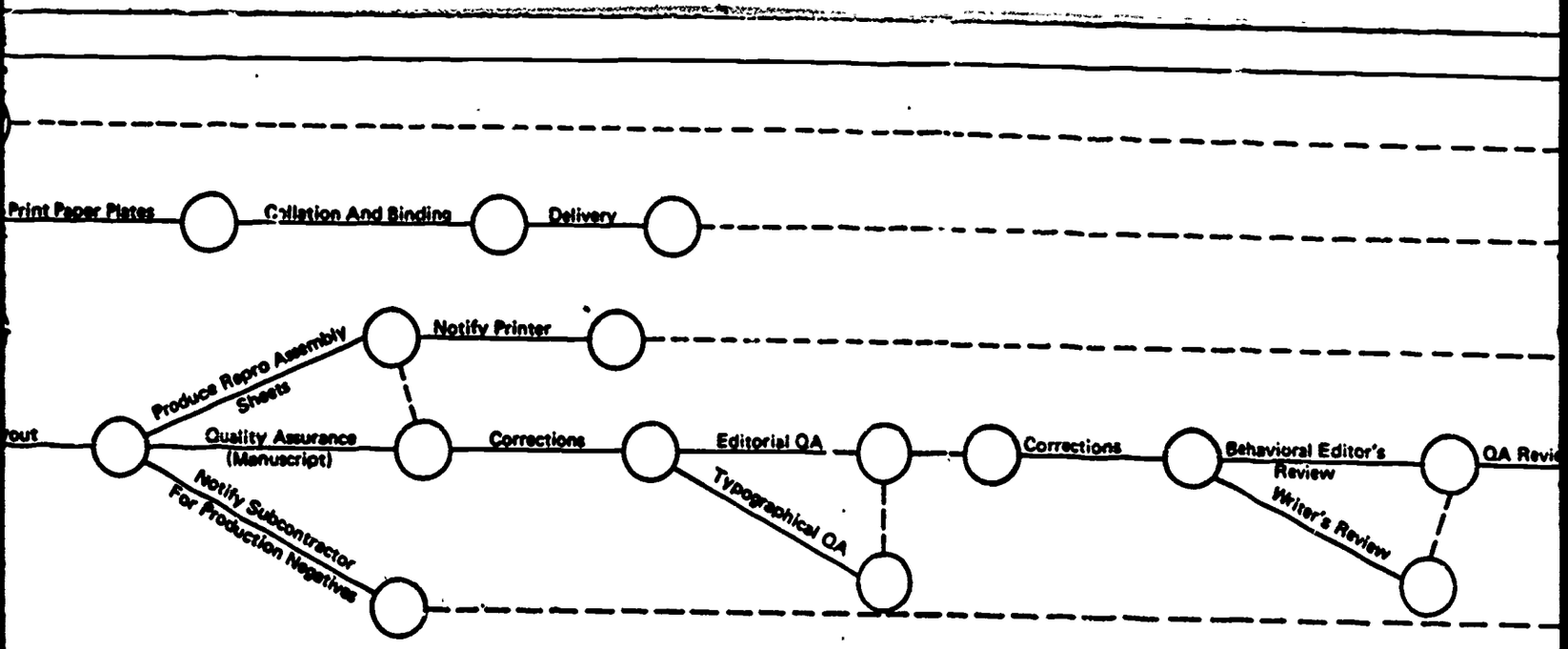
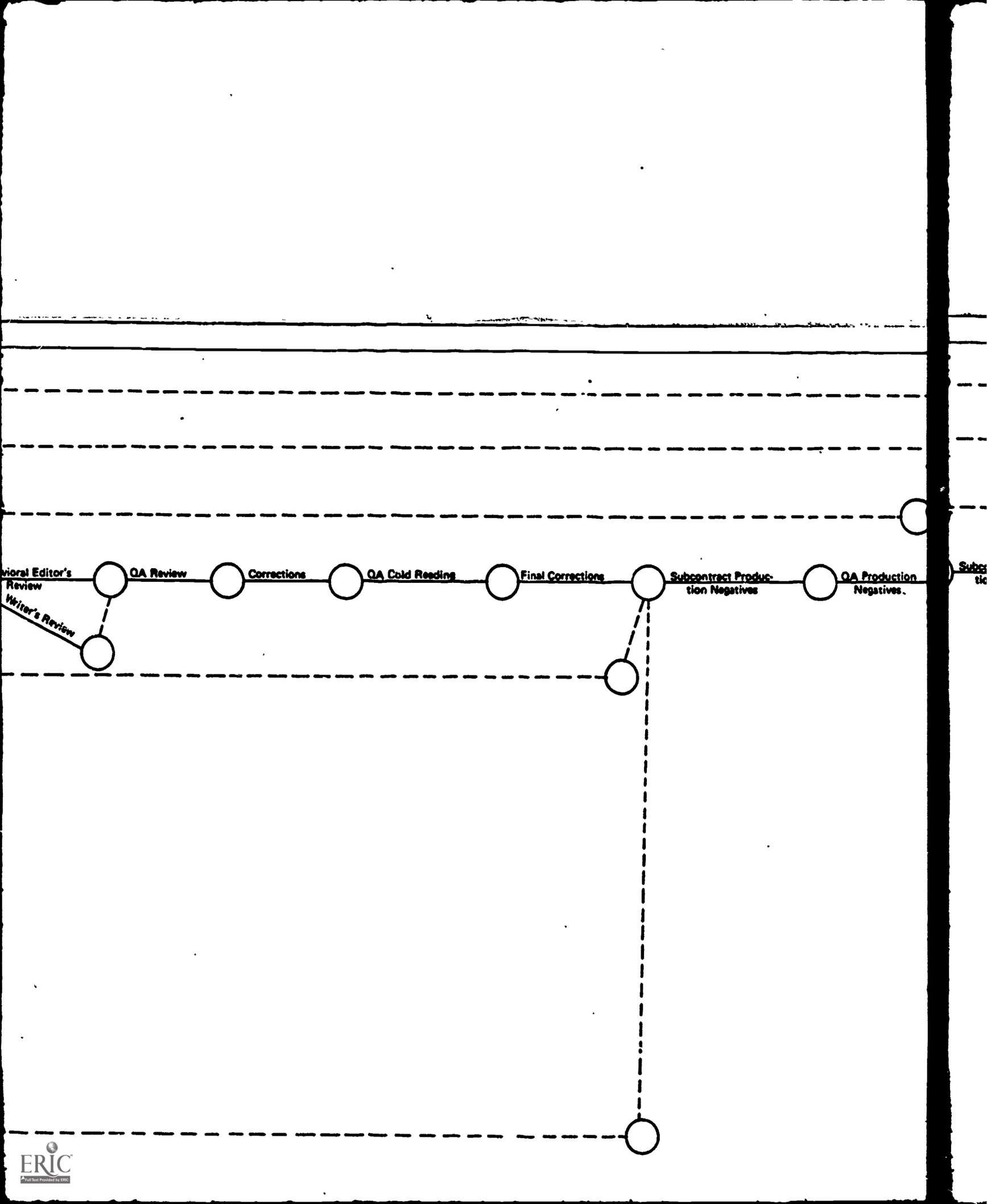
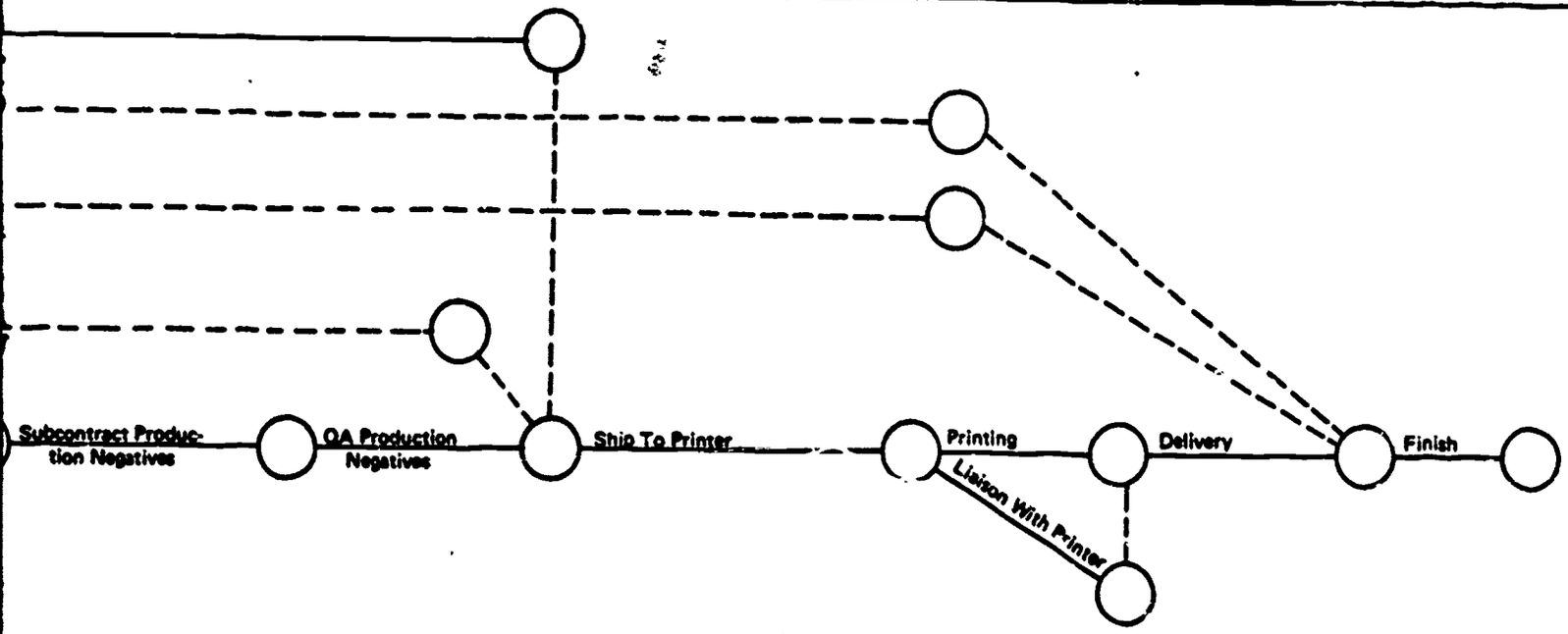

al Editor
Revision By Author
Retype
Xerox
Type Callouts
Plan Cartoon Line Drawings
Draw Rough (Pencil)
Writer Review
Final Art
Plan Outline Figures
Draw
Writer Review
Final Art
Plan Shaded Perspectives
Draw
Writer Review
Final Art
Plan Simple Technical Drawings
Draw
Writer Review
Final Art
Plan Complex Technical Drawings
Draw
Writer Review
Final Art
Plan Photos
Secure Photo
Writer Review
Secure Half-Tone
Plan Air Brush
Perform Air Brush
Writer Review
Plan Flow Charts
Draw
Writer Review
Final Art
Plan Graphs
Draw
Writer Review
Final Art
ion With
ing Staff
Further Preliminary Sketches
Sign Off Inter-
action By Staff
Final Art


Build Manufacturing Specifications
Request Bids
Award Contract
Schedule Production
To Copy Editor
Editing
Back To Typist
Type Final Draft
Xerox
Interaction With Writer
Callouts
Quality Assurance
Callouts
Quality Assurance
Callouts
Quality Assurance
Callouts
Quality Assurance
Callouts
Quality Assurance
Callouts
Quality Assurance
Callouts
Quality Assurance
Typing
Quality Assurance
Typing
Quality Assurance
OR
Composition
Quality Assurance

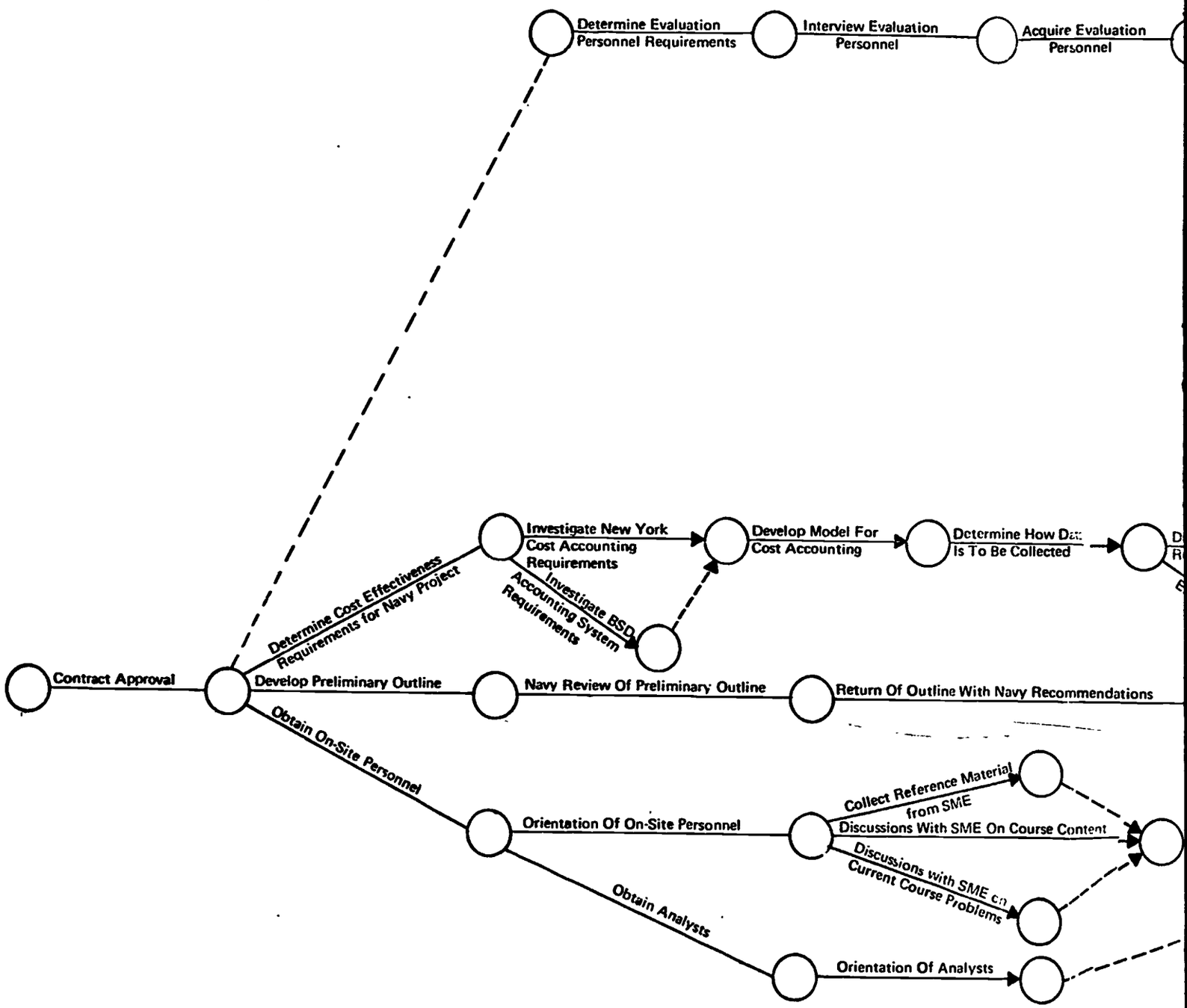

Editor Proofs Final Draft
Schedule Xerox And P. Plate Production
Determine Method Of Manufacture
Produce Xerox Prints
Collation
Binding
Notify Paper Plate Subcontractor
Subcontract Paper Plates
Print Paper Plates
Notify Printer (Paper Plates)
Layout Specifications
Editing To Production
Pre-Layout
Repro Typing
Layout

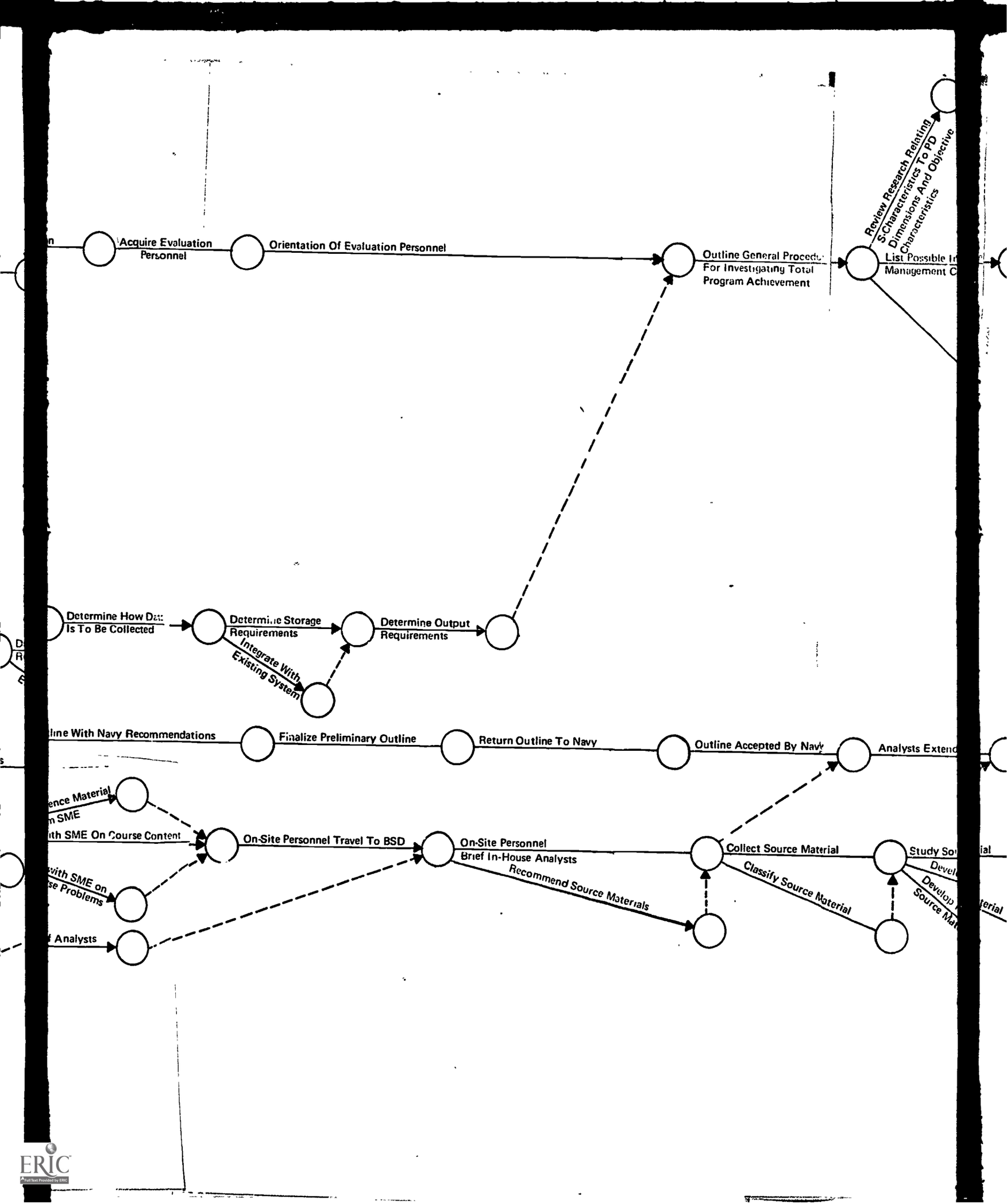

Print Paper Plates
Collation And Binding
Delivery
Produce Repro Assembly Sheets
Notify Printer
Quality Assurance (Manuscript)
Corrections
Editorial QA
Corrections
Behavioral Editor's Review
Typographical QA
Writer's Review
Notify Subcontractor For Production Negatives

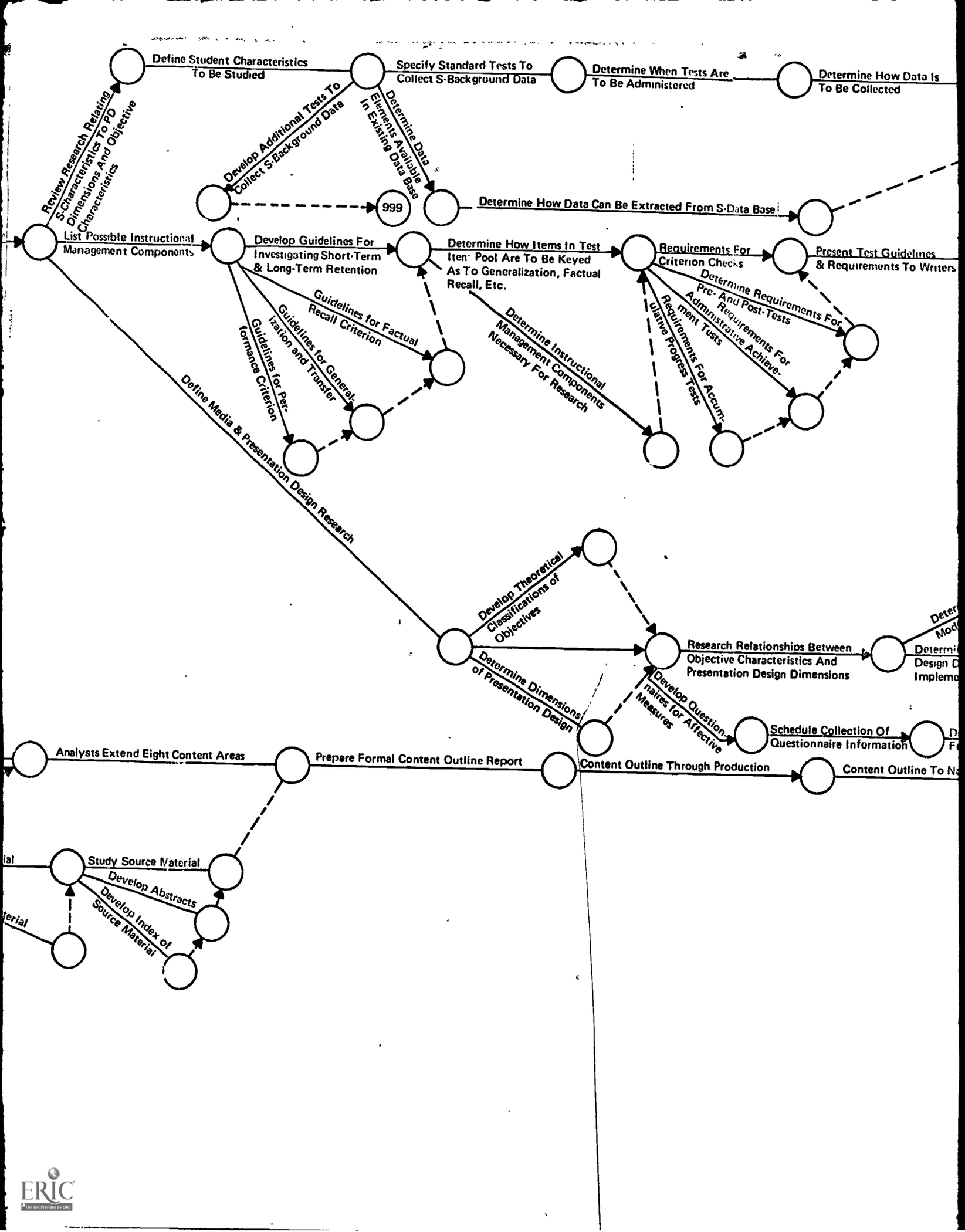

vioral Editor's Review
QA Review
Corrections
QA Cold Reading
Final Corrections
Subcontract Production Negatives
QA Production Negatives.
Writer's Review

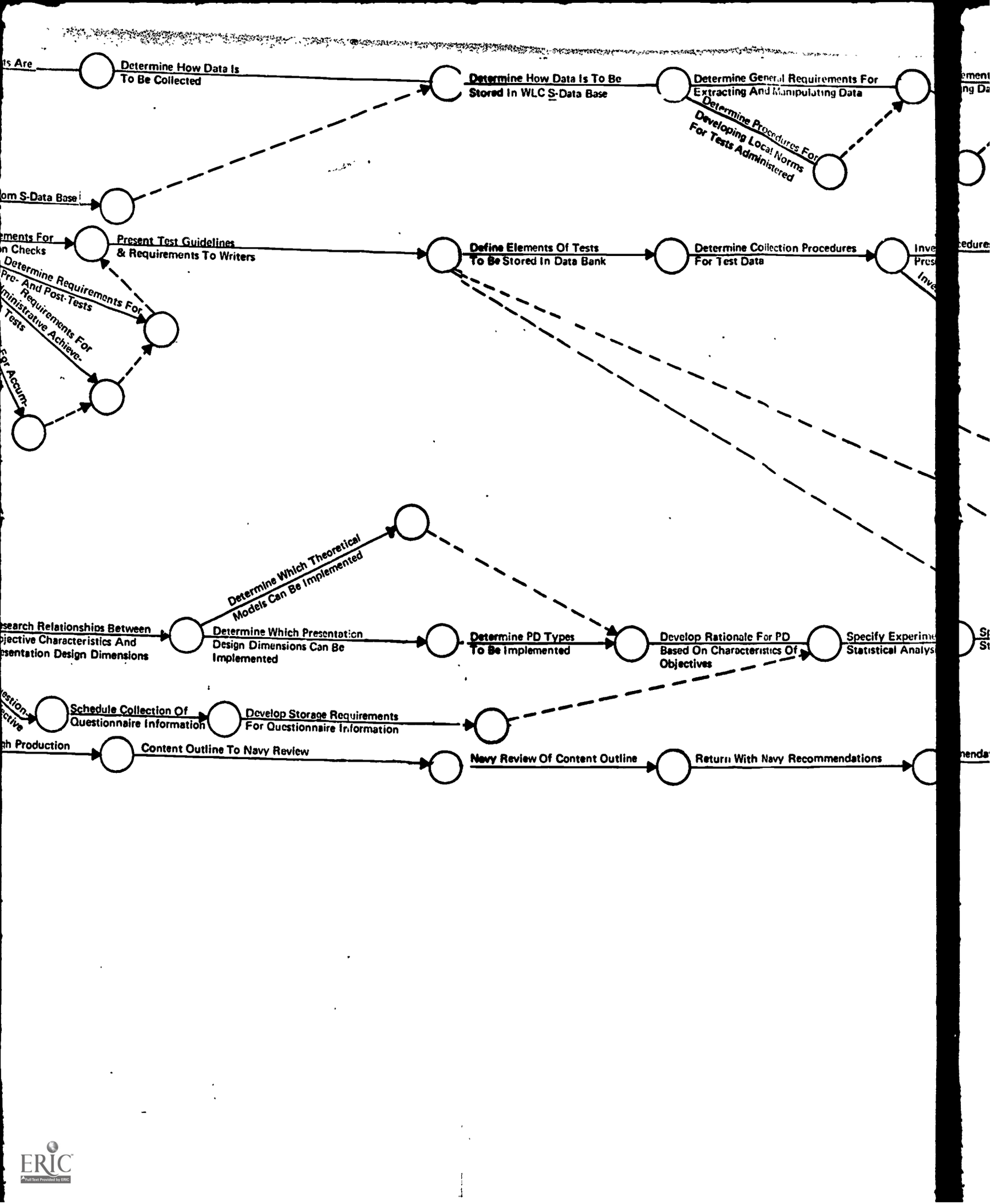

Subcontract Production Negatives
QA Production Negatives
Ship To Printer
Printing
Liaison With Printer
Delivery
Finish

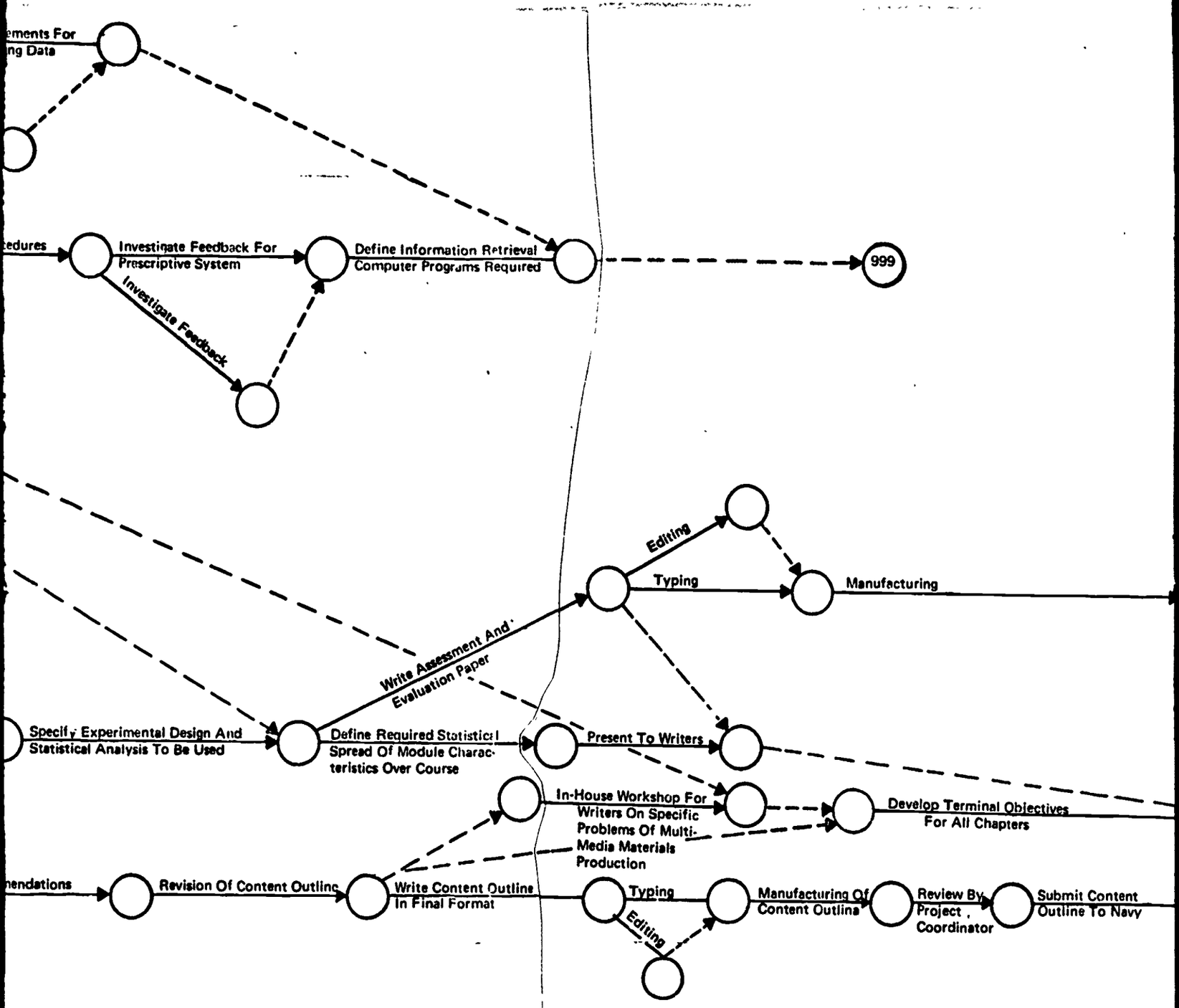
V. CHART SHOWING CRITICAL PATH FOR THE USNA MULTI-MEDIA PROJECT


Determine Evaluation Personnel Requirements
Interview Evaluation Personnel
Acquire Evaluation Personnel
Investigate New York Cost Accounting Requirements
Develop Model For Cost Accounting
Determine How Dat
Is To Be Collected
Determine Cost Effectiveness Requirements for Navy Project
Investigate BSD Accounting System Requirements
Contract Approval
Develop Preliminary Outline
Navy Review Of Preliminary Outline
Return Of Outline With Navy Recommendations
Obtain On-Site Personnel
Orientation Of On-Site Personnel
Collect Reference Material from SME
Discussions With SME On Course Content
Discussions with SME on Current Course Problems
Obtain Analysts
Orientation Of Analysts


Acquire Evaluation Personnel
Orientation Of Evaluation Personnel
Outline General Procedu
For Investigating Total
Program Achievement
Review Research Relating
S Characteristics To PD
Dimensions And Objective
Characteristics
List Possible In
Management C
Determine How Dat
Is To Be Collected
Determine Storage
Requirements
Determine Output
Requirements
Integrate With
Existing System
line With Navy Recommendations
Finalize Preliminary Outline
Return Outline To Navy
Outline Accepted By Navy
Analysts Extend
ence Material
n SME
ith SME On Course Content
with SME on
se Problems
f Analysts
On-Site Personnel Travel To BSD
On-Site Personnel
Brief In-House Analysts
Recommend Source Materials
Collect Source Material
Classify Source Material
Study So
ial
Devel
Develop
Source Ma
terial


Define Student Characteristics To Be Studied
Specify Standard Tests To Collect S-Background Data
Determine When Tests Are To Be Administered
Determine How Data Is To Be Collected
Review Research Relating S-Characteristics To PD Dimensions And Objective Characteristics
Develop Additional Tests To Collect S-Background Data
Determine Data Elements Available In Existing Data Base
999
Determine How Data Can Be Extracted From S-Data Base
List Possible Instructional Management Components
Develop Guidelines For Investigating Short-Term & Long-Term Retention
Determine How Items In Test Item Pool Are To Be Keyed As To Generalization, Factual Recall, Etc.
Requirements For Criterion Checks
Present Test Guidelines & Requirements To Writers
Guidelines for Factual Recall Criterion
Guidelines for Generalization and Transfer
Guidelines for Performance Criterion
Determine Instructional Management Components Necessary For Research
Determine Requirements For Pre- And Post-Tests
Requirements For Administrative Achievement Tests
Requirements For Accumulative Progress Tests
Define Media & Presentation Design Research
Develop Theoretical Classifications of Objectives
Research Relationships Between Objective Characteristics And Presentation Design Dimensions
Determine Dimensions of Presentation Design
Develop Questionnaires for Affective Measures
Schedule Collection Of Questionnaire Information
Analysts Extend Eight Content Areas
Prepare Formal Content Outline Report
Content Outline Through Production
Study Source Material
Develop Abstracts
Develop Index of Source Material


ts Are
Determine How Data Is To Be Collected
Determine How Data Is To Be Stored In WLC S-Data Base
Determine General Requirements For Extracting And Manipulating Data
Determine Procedures For Developing Local Norms For Tests Administered
om S-Data Base
ements For n Checks
Present Test Guidelines & Requirements To Writers
Define Elements Of Tests To Be Stored In Data Bank
Determine Collection Procedures For Test Data
Determine Requirements For Pre- And Post-Tests
Requirements For Administrative Achieve- Tests
For Accum-
Determine Which Theoretical Models Can Be Implemented
search Relationships Between jective Characteristics And sentation Design Dimensions
Determine Which Presentation Design Dimensions Can Be Implemented
Determine PD Types To Be Implemented
Develop Rationale For PD Based On Characteristics Of Objectives
Specify Experim Statistical Analys
estion ctive
Schedule Collection Of Questionnaire Information
Develop Storage Requirements For Questionnaire Information
gh Production
Content Outline To Navy Review
Navy Review Of Content Outline
Return With Navy Recommendations


ements For
ng Data
edures
Investigate Feedback For
Prescriptive System
Define Information Retrieval
Computer Programs Required
999
Investigate Feedback
Editing
Typing
Manufacturing
Write Assessment And
Evaluation Paper
Specify Experimental Design And
Statistical Analysis To Be Used
Define Required Statistical
Spread Of Module Charac-
teristics Over Course
Present To Writers
In-House Workshop For
Writers On Specific
Problems Of Multi-
Media Materials
Production
Develop Terminal Objectives
For All Chapters
endations
Revision Of Content Outline
Write Content Outline
In Final Format
Typing
Editing
Manufacturing Of
Content Outline
Review By
Project
Coordinator
Submit Content
Outline To Navy
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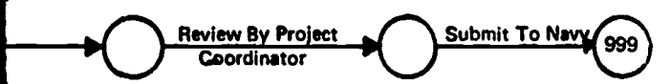
Review By Project Coordinator
Submit To Navy
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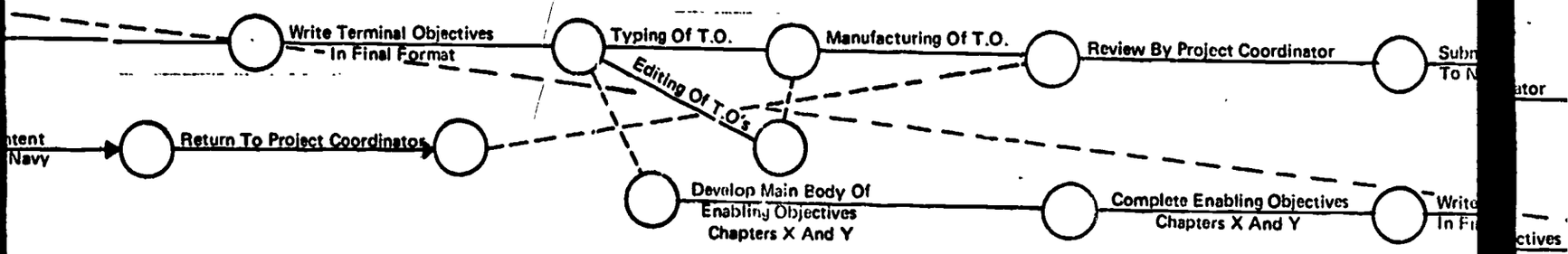
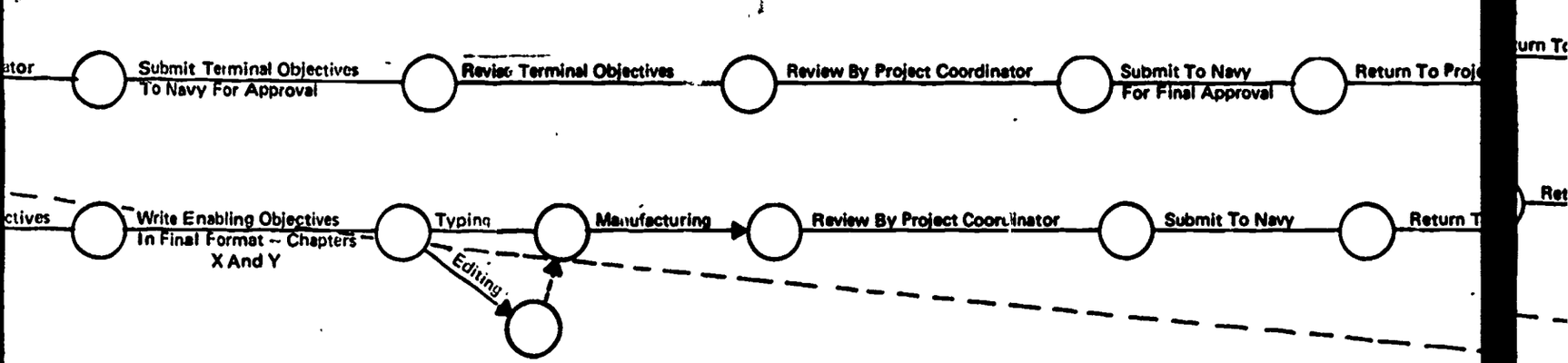
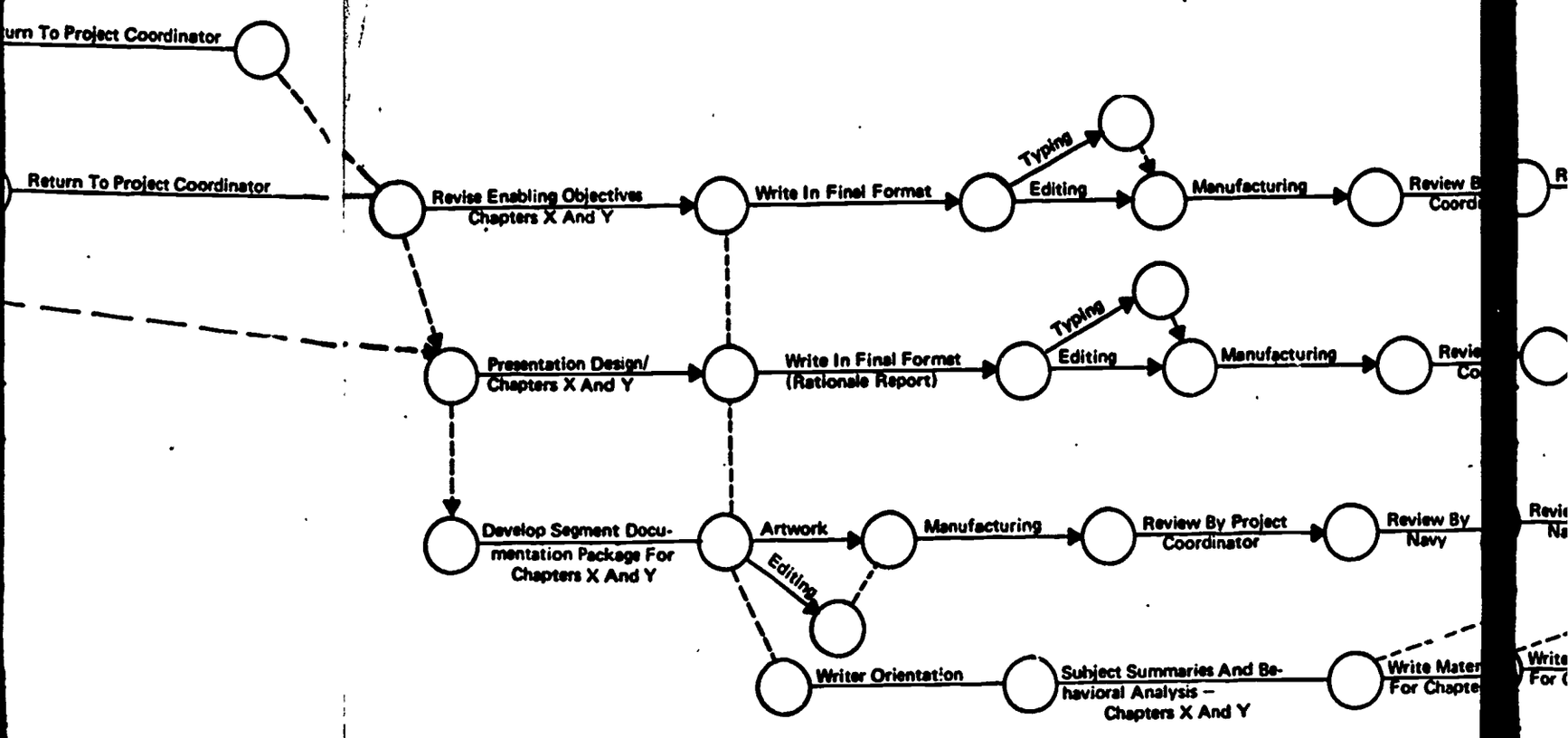
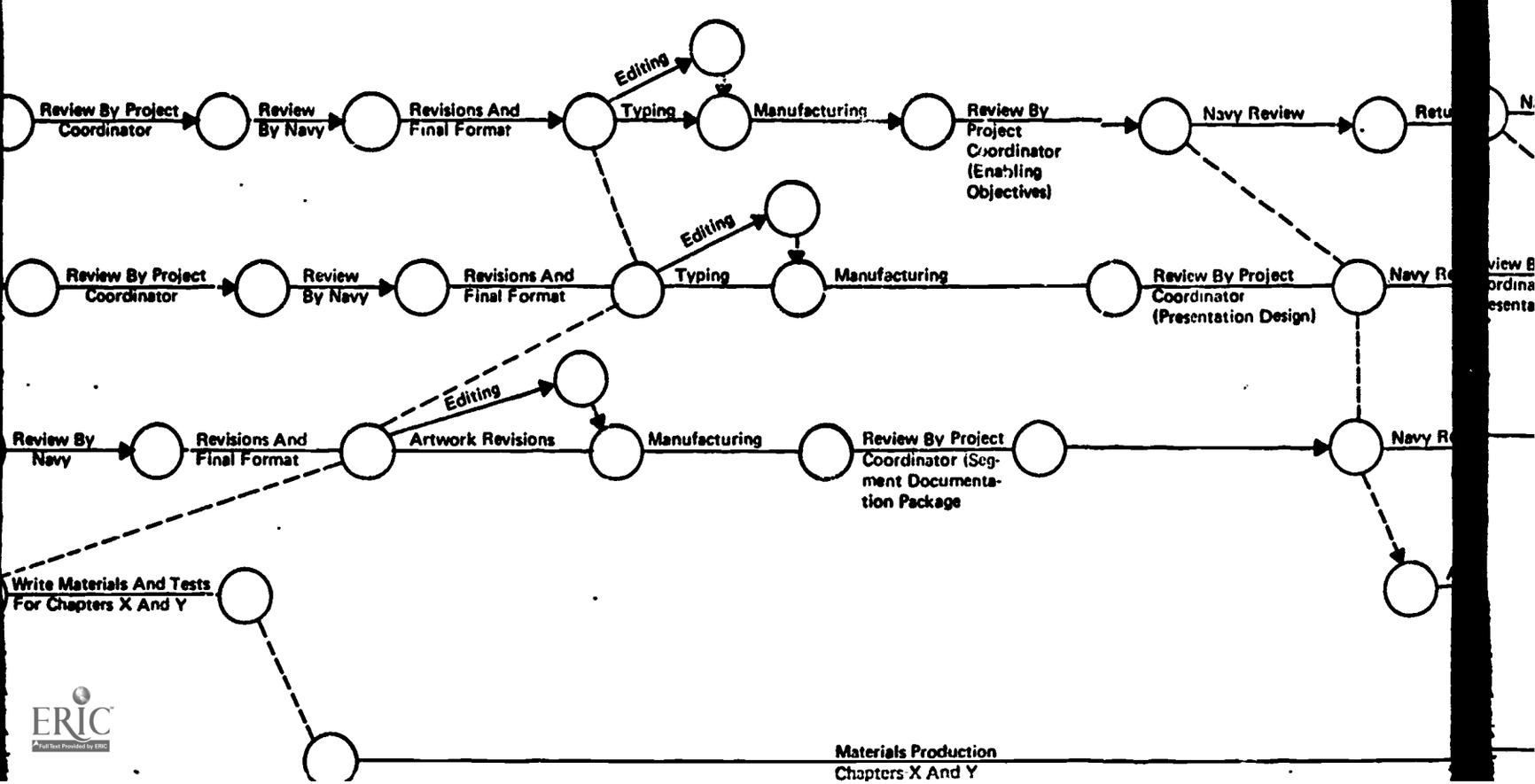
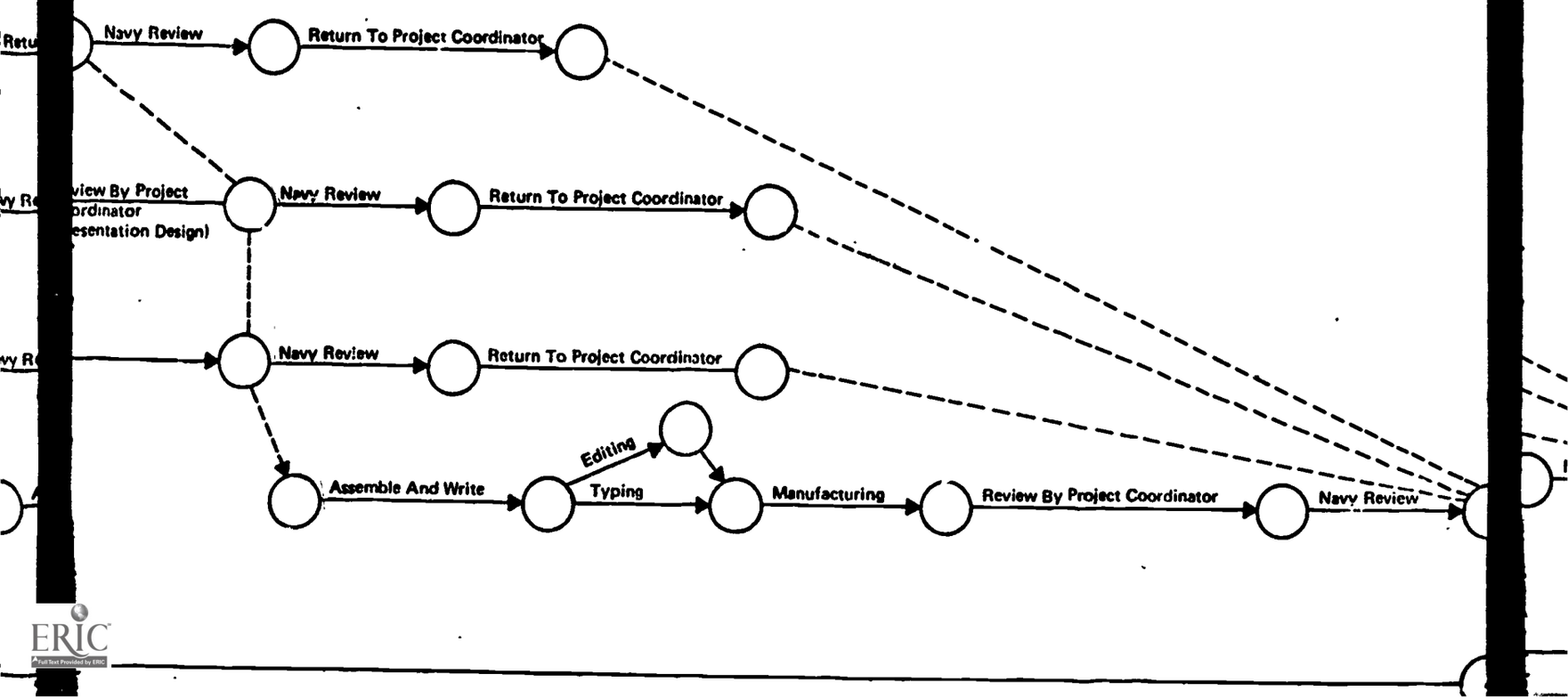
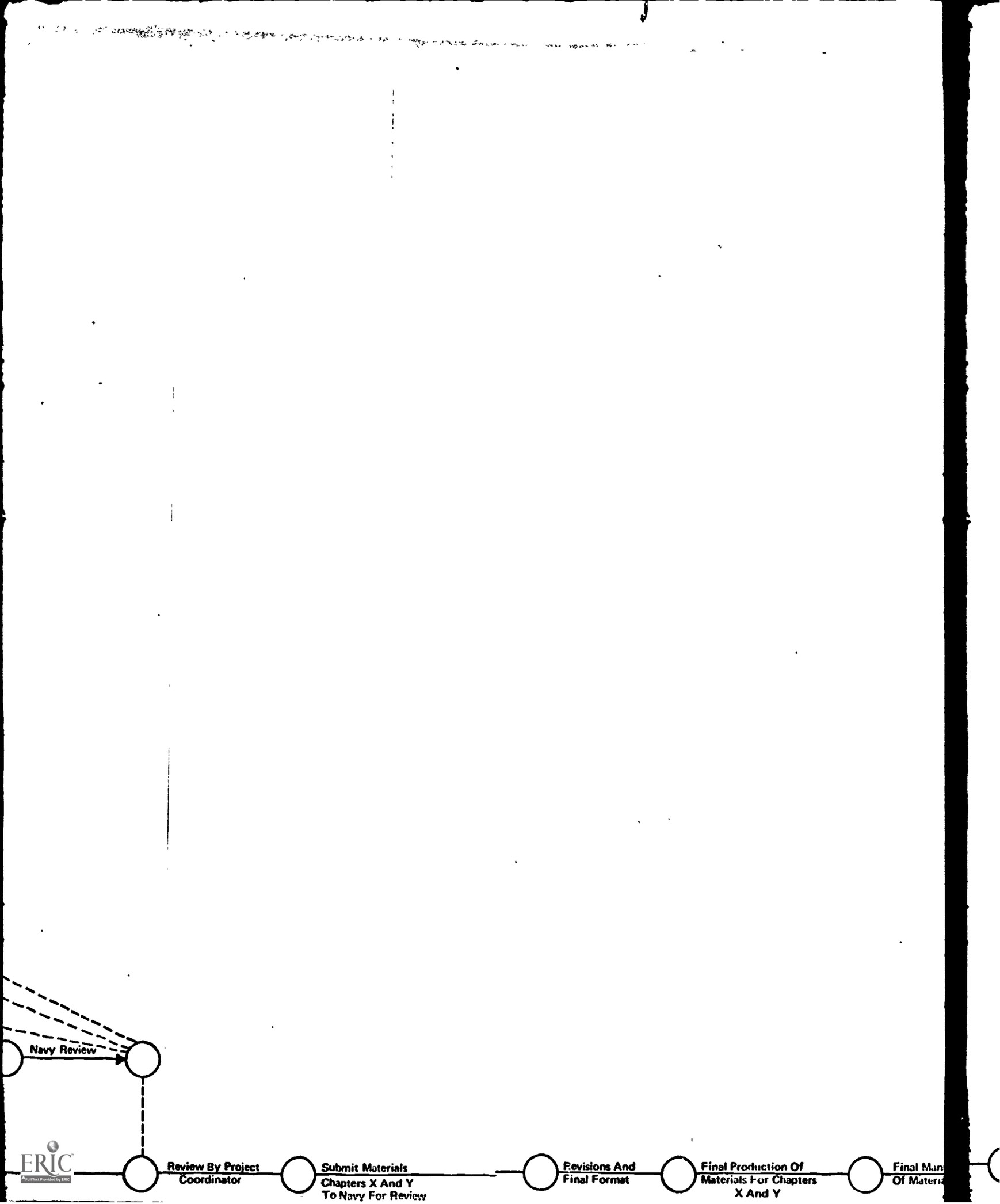

Write Terminal Objectives In Final Format
Typing Of T.O.
Manufacturing Of T.O.
Review By Project Coordinator
Editing Of T.O.'s
Return To Project Coordinator
Develop Main Body Of Enabling Objectives Chapters X And Y
Complete Enabling Objectives Chapters X And Y


ator
Submit Terminal Objectives To Navy For Approval
Revise Terminal Objectives
Review By Project Coordinator
Submit To Navy For Final Approval
Return To Proj
urn To
ctives
Write Enabling Objectives In Final Format ~ Chapters X And Y
Typing
Editing
Manufacturing
Review By Project Coordinator
Submit To Navy
Return T
Ret


urn To Project Coordinator
Return To Project Coordinator
Revise Enabling Objectives Chapters X And Y
Write In Final Format
Typing
Editing
Manufacturing
Review B
Coordi
Presentation Design/ Chapters X And Y
Write In Final Format (Rationale Report)
Typing
Editing
Manufacturing
Revie
Co
Develop Segment Documentation Package For Chapters X And Y
Artwork
Editing
Manufacturing
Review By Project Coordinator
Review By Navy
Revie
Na
Writer Orientation
Subject Summaries And Behavioral Analysis – Chapters X And Y
Write Mater
For Chapte
Write
For C


Review By Project Coordinator
Review By Navy
Revisions And Final Format
Editing
Typing
Manufacturing
Review By Project Coordinator (Enabling Objectives)
Navy Review
Review By Project Coordinator
Review By Navy
Revisions And Final Format
Editing
Typing
Manufacturing
Review By Project Coordinator (Presentation Design)
Review By Navy
Revisions And Final Format
Editing
Artwork Revisions
Manufacturing
Review By Project Coordinator (Segment Documentation Package
Write Materials And Tests For Chapters X And Y
Materials Production Chapters X And Y


Navy Review
Return To Project Coordinator
Navy Review
Return To Project Coordinator
Navy Review
Return To Project Coordinator
Editing
Assemble And Write
Typing
Manufacturing
Review By Project Coordinator
Navy Review


Navy Review
Review By Project Coordinator
Submit Materials Chapters X And Y To Navy For Review
Revisions And Final Format
Final Production Of Materials For Chapters X And Y
Final Man
Of Materi