HONEYWELL EDP

SOFTWARE MANUAL

SERIES 200

PERT TIME C

GENERAL SYSTEM: SERIES 200/OPERATING SYSTEM - MOD 1 (TAPE RESIDENT)

SUBJECT: Description of and Instructions for Using PERT Time C - a program for Management Control of Project Activities.

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FOREWORD

This manual describes the capabilities and flexibility of Honeywell's PERT Time C program and contains instructions for using and operating the program. The manual is written with three types of readers in mind:

1. The manager who reviews, evaluates, and acts upon the output reports resulting from computer analysis.
2. The coordinator who prepares PERT networks and data for computer entry.
3. The Honeywell Series 200 console operator who runs the PERT Time C program.

No previous programming knowledge on the part of the user is assumed or necessary. Simple, column-by-column instructions for preparation of the input cards (Section III) enable anyone having moderate familiarity with PERT terminology to make full use of both the computer's and the program's capabilities.

Of primary interest to managers will be Sections I (Introduction) and II (Program Description and Capabilities). Sections III (Program Input) and IV (Program Output) concern the PERT coordinator. The console operator will find instructions for running the program in Section V.

ACKNOWLEDGMENT

The source of the PERT Time C program is the Nippon Electric Company, with whom Honeywell has a working agreement for the manufacture and distribution of Honeywell computers in Japan.

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SECTION I
INTRODUCTION

PERT Time C is a Honeywell Series 200 program which aids management in controlling the sequence of physical activities that are required to complete a major project. It represents a significant step toward an integrated management control system encompassing the variables of time, resources, and technical performance. PERT Time C is based on the principle that a small percentage of a project's activities control the schedule for the entire project. Therefore, proper handling of these critical activities — once they are recognized — will facilitate the achievement of project objectives in a more direct and economical manner.

THE SIX STEPS FOR USING PERT TIME C

Development of the project through network analysis by PERT Time C consists of six steps: establishment of objectives, development of plans, determination of schedules, analysis of the network, evaluation of progress, and decisions and actions of management. Usually, developing a network is simplified by first establishing the major events or checkpoints that must be reached. Each supporting activity is then added to the network, and its interaction with other activities is indicated in terms of the activities that must precede it, the activities that succeed it, and the activities that can be performed concurrently with it. The set of activities that must be finished (and events which must have occurred) before any other given activity can begin is exhibited by the network. Thus, the network defines the relationships of any given task to the needs of the total project, ensuring that the project is fully planned. All derivative plans and activities contribute directly to the desired objectives of the project.

Establishment of Objectives

The determination and definition of prime as well as supporting project objectives is the initial and most important step in PERT Time C.

Development of Plans

Given the assignment of an objective, the next step is the development of a plan. The planning function sets forth the nature, sequence, and interrelationships of the prime and supporting objectives. A network or pictorial description, showing the interrelationships of all required activities and events, is created. An activity is a time-consuming element of a network, such as a process, job, task, or procurement cycle. It is represented by an arrow. An activity cannot begin until all preceding (i.e., prerequisite) activities have been completed.

The beginning or ending of an activity is called an event. An event may be the product of one or more activities, such as the completion of a subassembly, the award of a contract, the acceptance of a test mode, etc. An event is a specified instant in time and cannot be considered accomplished until all activities leading to it have been completed. In the network diagram, events are represented by circles or some other convenient symbol (e.g., rectangles, hexagons, etc.) and are labeled with simple numbers or alphanumeric codes. For additional clarity, network diagrams usually include a brief description of either each event or each activity. Activities can be identified by the event labels; for example, if an arrow connects event (i) to event (j), the represented activity is identified as activity (i, j).

Time estimates are assigned to the activity arrows, representing the expected time for the performance of the activity. Generally, three time estimates are made for each activity (optimistic, pessimistic, and most likely), although a single time estimate may be used. The effectiveness and accuracy of PERT Time C depend directly on the correctness of the network logic and the exactness of the time estimates.

Determination of Schedules

Scheduling is the translation of the plan, with its elapsed-time estimates, into calendar time. The manager establishes schedule dates representing the planned accomplishment of any objective and produces a calendar time-phased plan consistent with the estimated completion dates for these objectives.

Analysis of the Network (Program Operation)

Mathematical analysis of the network by the computer determines activity time relationships from which the time schedule may be evaluated. These computations will determine such things as the expected duration of each activity and of the entire project, the earliest or latest times that an activity can start or finish without prolonging the duration of the overall project, the amount of time that an activity must be accelerated in order to meet specified schedule dates, the amount of time that the start or finish of an activity entering an event can be delayed without interfering with the earliest possible starting dates of activities leaving this event, and the number of men in each skill category required for each working day of the project.

Evaluation of Progress

The project manager can control the progress of the project by periodic re-evaluation and review of the computational results, initiating corrective action if necessary. The evaluation and review will determine the current project status and isolate significant deviations from the scheduled plan, thus enabling the manager to expedite activities in the critical path and replan the network in order to meet specified dates. Throughout the project, a constant check on the status of each activity is made by comparison of estimated times with actual times.

Decisions and Actions of Management

In replanning the network, time estimates will necessarily change and the critical path must must be recomputed.

Deviations from the scheduled plan may require only a change in schedule. Deviation could, however, require a change in plans, or even a change in objectives. By concentrating on the most important current or forecasted problems, management can expend its efforts toward achieving the maximum potential returns relative to the assigned objectives. In actuality, this is the focal point in the whole program. If management heeds the indications of the various reports and initiates corrective action, the program is a dynamic tool.

The incorporation of change is achieved by a recycling of the management process to provide a revised scheduled plan (see Figure 1-1).

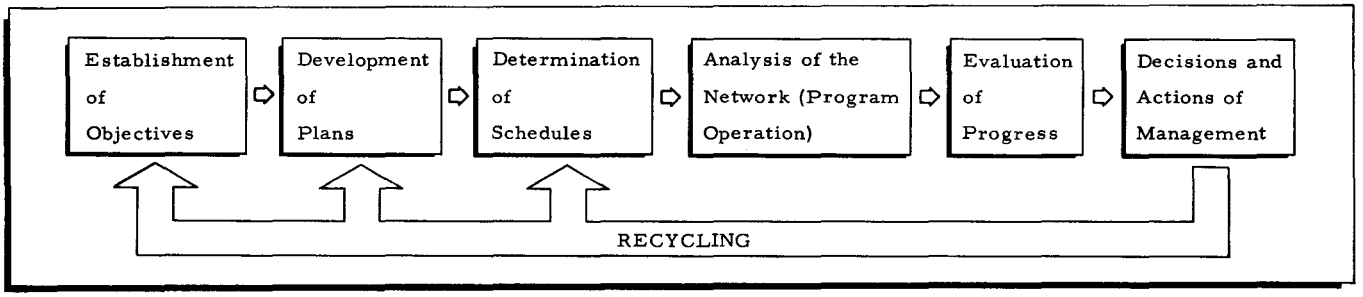


Figure 1-1. PERT Time C System Cycle

SECTION II
PROGRAM DESCRIPTION AND CAPABILITIES

The advantages of PERT Time C lie in its ability to analyze networks of great complexity quickly and accurately, culminating with the focusing of attention on those activities upon which the completion of the project most critically depends.

The program has a variety of capabilities that can be easily adapted by the user to suit specialized reporting requirements. Although it contains many of the capabilities found in larger scale PERT programs, it is unique in that it can calculate the number of workers required each workday for five craft categories. The program computes schedules for 5-, 6-, or 7-day work-weeks.

CAPACITY

PERT Time C is capable of processing networks containing up to a maximum of 2,000 activities. Both activity-oriented and event-oriented networks can be processed. Event numbers may be assigned in random order. If Calendar Time is used, the project may not exceed 2,000 working days, but if Absolute Time is used, it may not exceed 4,095 time units.

COMPUTATIONS

The program automatically performs a large number of calculations in processing a PERT network and provides management with timely, pertinent information on which to base operational decisions. The various computational abilities of PERT Time C are described in detail on the following pages. The program reads either cards or card images from tape and makes use of binary pseudo numbers in its computations.

Activity Expected Times

PERT Time C provides the option of using either a single time estimate for activity duration or three time estimates (representing the optimistic, pessimistic, and most likely times), as predicted by the persons most familiar with each activity. When the use of three estimates is specified, PERT Time C first computes for each activity a statistically weighted average called "activity expected-time" (t_e). Computations are made according to the standard PERT formula:

$$t_e = \frac{a + 4m + b}{6}$$

Where: a = the optimistic time estimate,

b = the pessimistic time estimate, and

m = the most likely time estimate.

The above times are all stated in working days. When only one time estimate is to be used, the program will substitute it as the t_e value. This flexibility provides the user with alternatives in the time domain.

Earliest Start and Earliest Finish

The earliest completion time for an event is given as T^E and the earliest completion time for the entire project is T^E_{END}. Having computed t_e for each activity, the program proceeds through the network calculating the Earliest Start ($ES_{i,j}$) and Earliest Finish ($EF_{i,j}$) times for each activity. Calculations of these variables involve forward computations from the start of the project, the purpose being to find the earliest times that each activity can start and finish. After repeating the process for each activity, the program arrives at the last event of the network and calculates T^E_{END}.

EARLIEST START

The Starting Date of the project is taken as the basis for these calculations. $T^E_{START} = 0$ is given as the Earliest Start of the project. Since no activity leaving an event can begin until all activities entering it have been completed, the Earliest Start of all activities leaving an event will equal the time it takes to complete the most time consuming path entering this event.

Consider the isolated portion of a network shown in Figure 2-1, and event 4 of that network, with three activities entering it and one activity emanating from it. The largest of the three possible values for completing the paths entering event 4 will govern the beginning of activity (4, 5). Calculating all three possible values of Earliest Start ($ES_{i,j}$) for event 4 (T^E_4) we find that:

along path (1, 4) $T^E_4 = (T^E_1) + t_e\ (1, 4) = 15 + 5 = 20$,

along path (2, 4) $T^E_4 = (T^E_2) + t_e\ (2, 4) = 20 + 2 = 22$, and

along path (3, 4) $T^E_4 = (T^E_3) + t_e\ (3, 4) = 17 + 6 = 23$.

Since the largest value of Earliest Start for event 4 is 23, this value is used to compute the Earliest Starts for successive events. Thus, the Earliest Start for event 5, (T^E_5), is given by $T^E_5 = T^E_4 + t_e\ (4, 5) = 23 + 1 = 24$.

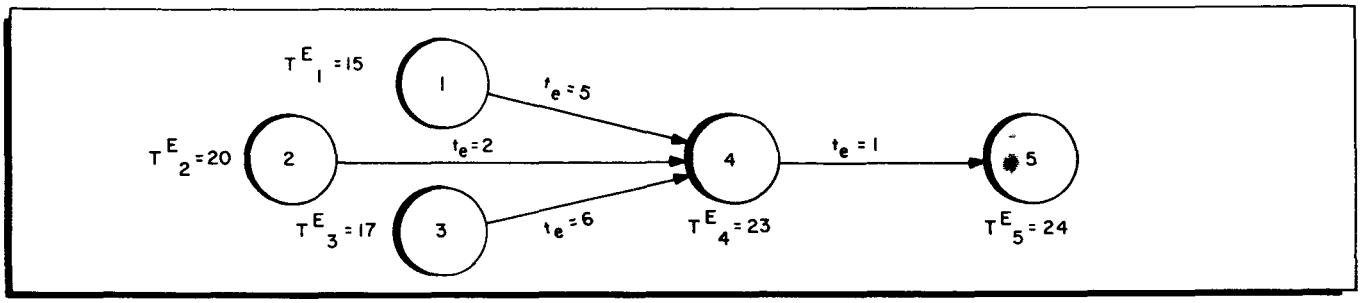


Figure 2-1. Calculation of Earliest Start When Several Activities Enter One Event

Notice that if more than one activity emanates from an event, they all have the same Earliest Start (i.e., $ES_{i,j} = T^E_i$).

EARLIEST FINISH

After having computed the Earliest Start for an event, the program computes the Earliest Finish ($EF_{i,j}$) of activities leaving this event. This value is given by the formula:

$$EF_{i,j} = T^E_i + t_e\ (i,j).$$

The Earliest Finish times for the activities illustrated in Figure 2-1 are given as:

$$EF_{(1,4)} = T^E_1 + t_e\ (1,4) = 15 + 5 = 20,$$

$$EF_{(2,4)} = T^E_2 + t_e\ (2,4) = 20 + 2 = 22,$$

$$EF_{(3,4)} = T^E_3 + t_e\ (3,4) = 17 + 6 = 23, \text{ and}$$

$$EF_{(4,5)} = T^E_4 + t_e\ (4,5) = 23 + 1 = 24.$$

Notice that the

$$T^E_4 = \max \begin{bmatrix} EF_{(1,4)} \\ EF_{(2,4)} \\ EF_{(3,4)} \end{bmatrix} = 23.$$

Actual Dates

If an Actual Date ($AD_{i,j}$) has been imposed upon an activity, this value is substituted as the Earliest Finish of this activity

$$EF_{(i,j)} = AD_{(i,j)}$$

and the expected duration (t_e) is altered as follows:

$$t_{e(i,j)} = AD_{(i,j)} - ES_{(i,j)}.$$

This has the effect of displaying in the output the actual duration of an activity rather than its expected time.

Latest Start and Latest Finish

After having determined the Earliest Finish times for the entire project, the program proceeds to calculate the Latest Start ($LS_{i,j}$) and Latest Finish ($LF_{i,j}$) times for each activity. Calculation of these variables involves backward computations from the end of the project. The purpose is to find the latest times that each activity must start and finish without causing the overall project to slip.

LATEST FINISH

The Earliest Finish times (T^E_{END}) are taken as the basis for these calculations. The last event is set at time T^E_{END} (i.e., the latest finish time for the event), T^L_{END} is set equal to the earliest completion time for the event T^E_{END}, and calculation is backwards from the end event. The T^L of the Preceding Event of an activity cannot be calculated until T^L for all Succeeding Events immediately following it have been determined. If an event is immediately succeeded by more than one activity, the smallest T^L_i is used to compute the Latest Finish times for activities preceding this event.

Consider an event succeeded by three separate activities and preceded by one (see Figure 2-2). Since each succeeding activity has a Latest Finish time, we can calculate the Latest Finish ($LF_{i,j}$) for event 2 (T^L_2) by calculating all three possible values as follows:

If event 3 is to occur on time, $T^L_2 = (T^L_3) - t_e\,(2,3) = 15-5= 10$,

If event 4 is to occur on time, $T^L_2 = (T^L_4) - t_e\,(2,4) = 20-2= 18$, and

If event 5 is to occur on time, $T^L_2 = (T^L_5) - t_e\,(2,5) = 17-6= 11$.

The smallest of the three values of T^L_2 is 10. Consequently, this value is used to compute the Latest Finish for activities preceding event 2. In Figure 2-2, the Latest Finish time for event 1 is 9.

$$T^L_1 = (T^L_2) - t_{e(1,2)} = 10- 1 = 9$$

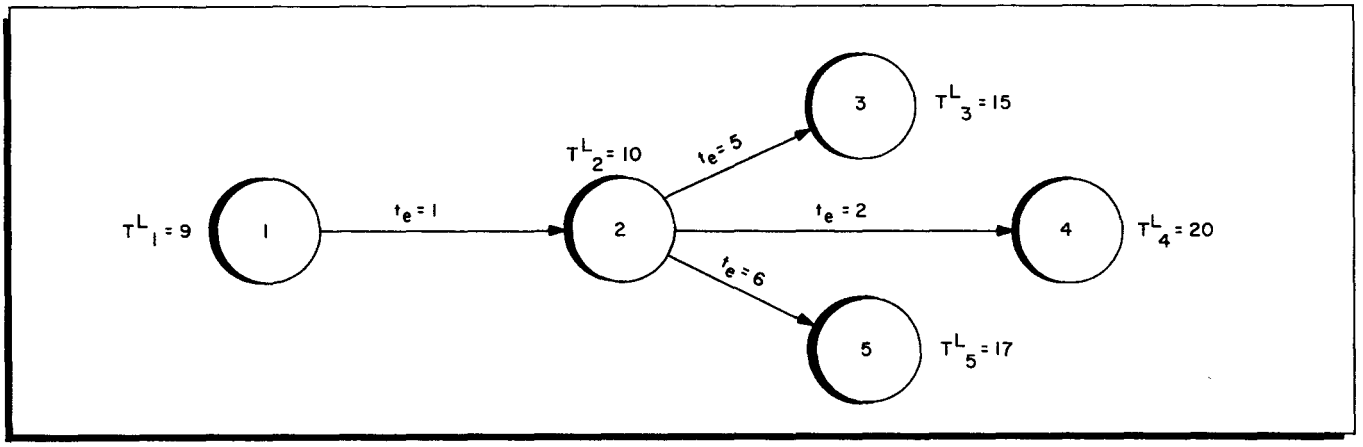


Figure 2-2. Calculation of Latest Finish When Several Activities Emanate From One Event

Notice that if more than one activity enters an event, they all have the same Latest Finish time.

LATEST START

After having computed the Latest Finish for an event, the program computes the Latest Start ($LS_{i,j}$) of preceding activities. This value is given by the formula:

$$LS_{(i,j)} = T^L_j - t_{e(i,j)}$$

The Latest Start times for the activities in Figure 2-2 are given as:

$$LS_{(2,3)} = T^{L}_{3} - t_{e(2,3)} = 15-5 = 10,$$

$$LS_{(2,4)} = T^{L}_{4} - t_{e(2,4)} = 20-2 = 18,$$

$$LS_{(2,5)} = T^{L}_{5} - t_{e(2,5)} = 17-6 = 11, \text{ and}$$

$$LS_{(1,2)} = T^{L}_{2} - t_{e(1,2)} = 10-1 = 9.$$

The Critical Path

The maximum time available to perform activity (i, j) is $T^{L}_{j} - T^{L}_{i}$, where $T^{L}_{j} - T^{L}_{i} = t_{e\ i,j}$. If $T^{L}_{j} - T^{E}_{i} = t_{e\ i,j}$, the time available to perform the activity equals the time expected to perform the activity. The activity is said to be "critical." If the scheduled completion date of the project is equal to the calculated project duration, T^{E}_{END}, there will be at least one unbroken chain of critical activities connecting the beginning and end of the project. This chain of critical activities is called the "Critical Path" and determines the project duration.

Primary Slack

A measure of the criticalness of an activity can be obtained by taking the difference between the time available and the expected duration time of the activity.

$$PS_{i,j} = (T^{L}_{j} - T^{L}_{i}) - t_{e\ i,j}.$$

This amount of time is called "Primary Slack" ($PS_{i,j}$) or "Total Float." The Primary Slack is the amount of time that the start or finish of an activity can be delayed without prolonging the duration of the project. If the Primary Slack of activity (i, j) is used up, the activities leaving event j can no longer start at the earliest possible time. Activities with Primary Slacks of zero are said to be on the Critical Path.

Secondary Slack

Primary Slacks are calculated on the assumption that all late starting times of activities are computed by setting the Latest Finish time of the entire project equal to the Earliest Finish time of the entire project. There are times, however, when certain activities, or the entire project, must be completed by specified Schedule Date(s). The Secondary Slack ($SS_{i,j}$) for each activity is calculated based on all the Schedule Dates specified by the user. When no Schedule Date is specified for a particular activity, its Secondary Slack is calculated according to the same formula as for Primary Slack. But when a Schedule Date ($SD_{i,j}$) is given for activity $A_{i,j}$, the formula becomes:

$$SS_{i,j} = (X_j - T^{E}_{i}) - t_{e\ i,j}$$

where $X_j = \min \left\{ SD_{i,j},\ T^{L}_{j} \right\}$

and the formula for the Latest Start time of the activity becomes

$$LS_{i,j} = X_j - t_{e\ i,j}.$$

It can be seen that such a $LS_{i,j}$ could influence the Secondary Slack of some or all activities which precede the activity.

Free Float

Primary Slack gives the amount of time that the start or finish of an activity can be delayed without prolonging the duration of the project. The question arises as to how long the start or finish of an activity (i, j) can be delayed without retarding the earliest possible starting date of tasks leaving event j. This variable is called "Free Float" ($FF_{i,j}$). If activity (i, j) is the only one entering event j, then ($FF_{i,j}$) = 0:

$$FF_{i,j} = T^E_j - T^E_i - t_{e\ i,j}.$$

Manpower Accumulation

The purpose of the manpower computation is to determine the number of men in each of five skill categories that will be required on each working day of the project. The Earliest Start and Earliest Finish times are used as the basis for this calculation.

FINAL OUTPUT REPORTS

Since all of the above mentioned calculations are of interest to managers in analyzing progress, they are shown in the final output reports generated by the program. For each activity, the following results are given:

1. t_e activity expected time,
2. $ES_{i,j}$ the Earliest Starting time for the activity,
3. $EF_{i,j}$ the Earliest Finish time for the activity,
4. $LS_{i,j}$ the Latest Starting time for the activity,
5. $LF_{i,j}$ the Latest Finish time for the activity,
6. $PS_{i,j}$ Primary Slack $\left[(T^L_j - T^E_i) - t_e\right]$,
7. $SS_{i,j}$ Secondary Slack $\left[(SD_{i,j} - T^E_i) - t_e\right]$,
8. $FF_{i,j}$ Free Float $\left[(T^E_j - T^E_i) - t_e\right]$,
9. $SD_{i,j}$ Schedule Date, if any, and
10. $AD_{i,j}$ Actual Date, if any.

Sample output formats are illustrated in Section IV.

Arrangement of Final Output Reports

In addition to generating final output reports containing all the above information as well as activity titles and descriptions, PERT Time C is capable of arranging the output results in

any or all of several optional sequences. The output is usually sorted in six different sequences for easier analysis. Results can be arranged according to their Primary Slack values such that activities with the most critical values appear first and those with the least critical values appear last. This arrangement makes it relatively simple for a manager to pinpoint trouble areas — existing or potential; it also indicates non-critical activities from which resources might be profitably deployed to some more urgent phase of the project.

Reports can also be sequenced chronologically by Earliest Finish or Latest Finish. Such arrangements alert the project manager or expediter to all activities which should be completed by a particular date or which cannot be permitted to slip beyond a certain date. Another option sorts activities by department code and ranks them in order of most critical slack values, Earliest Finish values or Earliest Start values. This indicates to each department manager the status of activities in his own department and pinpoints the most critical jobs.

Additional Reports

Other optional reports produced by Honeywell's PERT Time C program are a Manpower Accumulation Chart and a Bar Chart. The Manpower Accumulation Chart is in the form of a table. One table for each of five craft types can be produced and may be easily displayed as a histogram of manpower requirements for the project.

A Bar Chart may be produced for each department. These charts will display all activities for the department which are within 90 days (or time units) of the Reporting Date. This is the current date when the input deck is submitted for a computer run. The department manager may use these charts as work sheets.

ROUTINE REPORTS

Reports that may be of interest to the user are generated by the PERT Time C program on a routine basis. They are:

1. Listings of network errors.
2. A listing of the entire network, conveniently presented in the same format as the input cards, to be used subsequently as a "markup" sheet when preparing changes or additions to the network. This simplifies the procedure of replanning a network and reduces the effort involved.

CALENDAR CONVERSIONS

If Calendar Time base is selected, the system uses the "Project Start Date" as the reference, and PERT Time C automatically converts the Earliest Start, Earliest Finish, Latest Start, and Latest Finish values from numbers of workdays to actual calendar dates. The user need only specify a 5-, 6-, or 7- day workweek, the Starting Date and the day of the week of that

date. In addition, up to 150 additional holidays can be specified for the entire duration of each project. The calendar generated may include up to 2,000 actual working days. If Calendar Time base is not selected, the project may extend to 4,095 time units.

ERROR DETECTION

During the first reading of the input deck, the program detects input errors. The source of the error is indicated on the markup listing produced by the high speed printer.

SECTION III

PROGRAM INPUT

Input to PERT Time C is on punched cards. A complete deck represents one network and is composed of five different types of cards: a Console Call card, a Header card, two kinds of detailed data cards, and an End card. The purpose, function, and format of each type is explained in this section as well as the sequence in which they must be arranged prior to program operation.

CONSOLE CALL CARD

The first card of the deck - the Console Call card - must have PERTTIME punched in columns 1 through 8. A 0 punch in column 9 indicates a tape unit assigned to the system binary run tape, and an asterisk (*) in column 18 defines this as a call card. The rest of the card remains blank (see Figure 3-1).

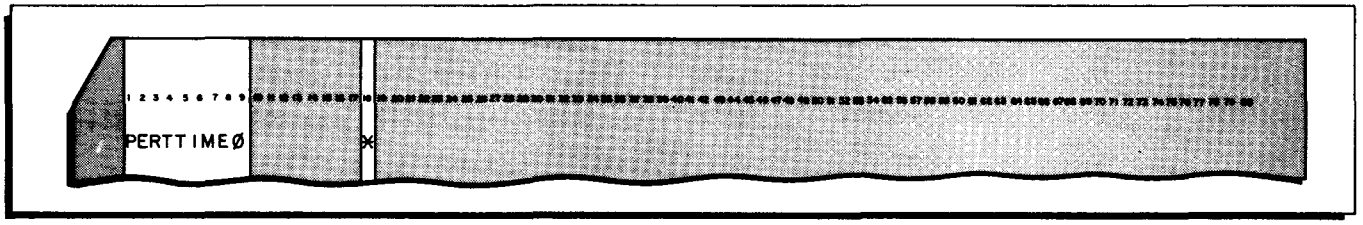
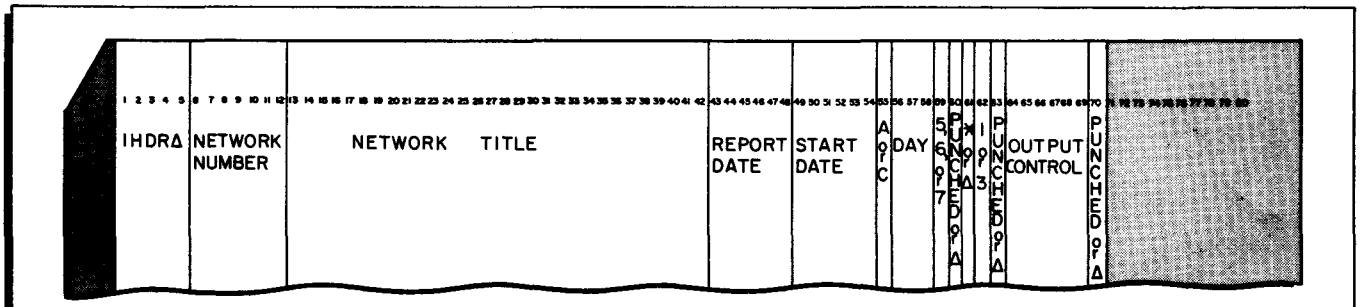


Figure 3-1. Console Call Card

HEADER CARD

The second card of the input deck, or the Header card, is used to identify the network and to control processing of the data cards and output reports. Its format and its specific coding entries are illustrated in Figure 3-2.



Columns 1- 5: 1HDRΔ identifies the Header card.

Columns 6-12: Network Number. A 7-digit code (any combination of alphanumeric and special characters) identifies the network.

Figure 3-2. Header Card

Columns 13-42:	Network Title. This field appears in the header line of printed output (any combination of alphanumeric and special characters).
Columns 43-48:	Report Date. This is the current date when the input deck is submitted for a computer run. There are two possible forms. If column 55 contains a C, denoting Calendar Time, the Report Date must be a legitimate calendar date and take the form YYMMDD. Also, it must not exceed 2,000 working days from the Start Date. If column 55 contains an A, denoting Absolute Time, the field is numeric and right-justified, with either blanks or zeros leading. It must not exceed 4,094 time units. The Report Date is always later than the Start Date.
Columns 49-54:	Start Date. This must be a calendar date, denoting the start of the project. It is a numeric field in the form YYMMDD.
Column 55:	Output Time Base. This column contains either an A or a C, denoting either Absolute Time or Calendar Time (see Report Date).
Columns 56-58:	Day of the Week. When Calendar Time base is used, this field specifies the day of the week on which the Start Date falls. It contains three alphanumeric characters, which are an abbreviation of a day of the week. When a five day workweek is specified (column 59), SAT or SUN cannot be used as the Start Date. Accordingly, SUN cannot be used when the workweek is six days. This field is ignored if column 55 specifies Absolute Time.
Column 59:	Workweek. A numeric 5, 6, or 7 specifies a 5-, 6-, or 7-day workweek respectively.
Column 60:	Topological Ordering. If $i < j$ for every activity $A_{i,j}$, this column remains blank. Otherwise, this column must contain a punch.
Column 61:	Manpower Accumulations. An asterisk in this column requests accumulation of workers by craft for each activity. A blank causes the program to skip accumulations.
Column 62:	Time Estimates. A numeric 1 specifies a single time estimate factor; a 3 denotes a triple time estimate for each activity.
Column 63:	Absolute Time Output. Any punch in this column requests Absolute Time base as well as Calendar Time base output (a C in column 55). If Absolute Time has already been specified (an A in column 55), this column must be blank.

Figure 3-2 (cont). Header Card

Columns 64-69: Output Control. Any punch in a column of this field will generate the designated final output report ordered by a specific sort. A blank does not produce a report. The reports are sorted according to the following keys:

	Major	Minor
64	Primary Slack	Preceding Event
65	Earliest Finish	Preceding Event
66	Latest Finish	Preceding Event
67	Department	Primary Slack
68	Department	Earliest Finish
69	Department	Earliest Start

Column 70: Bar Chart. Any punch in this column will produce a Bar Chart for each department showing activities that will be active within 90 workdays following the Report Date. A blank in this column does not produce a chart.

Columns 71-80: Blank.

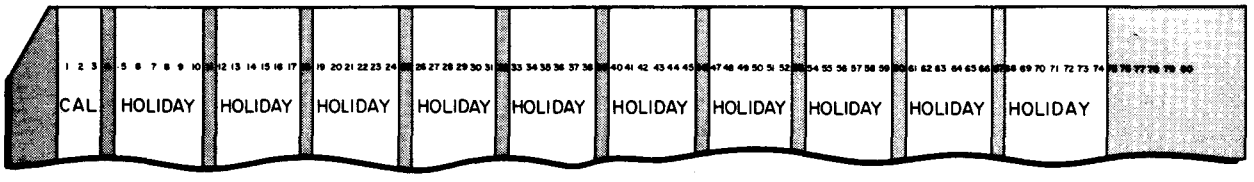
Figure 3-2 (cont). Header Card

DATA CARDS

The two kinds of detailed data cards are Calendar Holiday and Activity.

Calendar Holiday Cards

Calendar Holiday cards are used in Calendar Time base to specify holidays (i.e., nonworking days during the workweek other than those inferred by the designated workweek). Their format is illustrated in Figure 3-3. Calendar Holiday cards are ignored for projects using Absolute Time base.



Columns 1- 3: CAL. This identifies the Calendar Holiday card.

Column 4: Blank.

Columns 5-10: Holiday. This numeric field specifies a holiday in the form YYMMDD and is Calendar Time base.

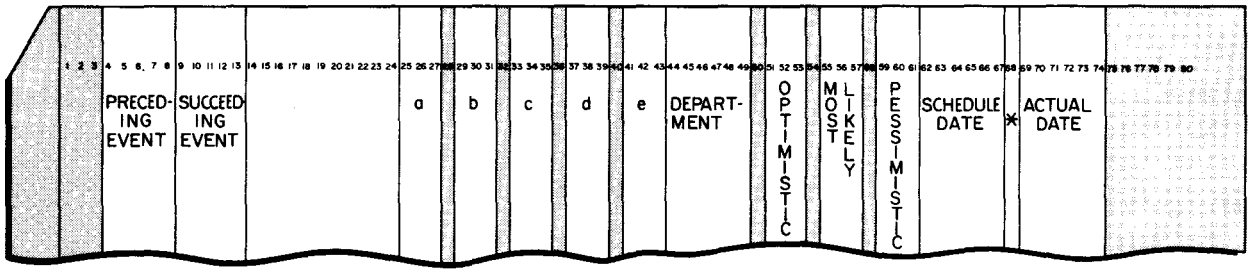
Figure 3-3. Calendar Holiday Card

Column 11:	Blank.
Columns 12-74:	This field repeats the columns 5-11 order, allowing for up to ten holidays per card. A total of 150 holidays are permitted within a 2,000 workday period. The holidays must be in chronological order.
Columns 75-80:	Blank:

Figure 3-3 (cont). Calendar Holiday Card

Activity Cards

Each Activity card contains all of the information pertaining to one activity. A complete deck represents an entire network. A network may not have more than 2,000 activities, including a unique Start Activity and a unique End Activity (see Figures 3-7 and 3-8). Included on the Activity card are the activity title or description, the Preceding and Succeeding Event numbers defining the activity, the time estimates, and the Schedule and Actual completion Dates. The format is illustrated in Figure 3-4.



Columns 1- 3:	Activity Card Identification. This field remains blank.
Columns 4- 8:	Preceding Event Number (i). This numeric field must be right-justified. Leading blanks are permitted.
Columns 9-13:	Succeeding Event Number (j). This numeric field must be right-justified. It also must be greater than the Preceding Event number when column 60 of the Header card (Topological ordering) is blank. Leading blanks are permitted.
Columns 14-43:	Activity Description. The entire 30 columns may be filled with alphanumeric characters if manpower accumulation has not been requested (by a blank in column 61 of the Header card). If manpower accumulation has been requested, columns 25-43 are divided into five subfields (of 3 right-justified numerics) containing the number of men each craft required for the activity. (Accordingly, columns 14-24 still may be filled with alphanumeric characters.)
	25-27 Number of workers in craft a.
	28 Blank.

Figure 3-4. Activity Card

29-31 Number of workers in craft b.

32 Blank.

33-35 Number of workers in craft c.

36 Blank.

37-39 Number of workers in craft d.

40 Blank.

41-43 Number of workers in craft e.

Regardless of the number of crafts required for an activity, columns 25-27 must always be filled first. For example, if designated "craft a" is not utilized for the entire project, "craft b" must be called "craft a" and coded in columns 25-27. A similar move to the next available subfield to the left must be made for any subsequently utilized craft.

Columns 44-49: Department Code. This 6 alphanumeric character field, identifying the department, is used for departmentally sorted outputs (including the Bar Chart).

Column 50: Blank.

Columns 51-61: Time Estimates. This may be either a triple time estimate, which will be averaged, or a single time estimate. If the single time estimate is used (specified by a 1 in column 62 of the Header card), the estimate must be punched in the $m_{i,j}$ field (columns 55-57). Format of the time estimates fields is numeric.

51-53 Optimistic time estimate ($a_{i,j}$) is ignored if the time factor is 1.

54 Blank.

55-57 Most likely time estimate ($m_{i,j}$) is always required.

58 Blank.

59-61 Pessimistic time estimate ($b_{i,j}$) is ignored if the time factor is 1.

Columns 62-67: Schedule Date. This is the date on which the activity is expected to be finished. If the project is in Calendar Time, a legitimate calendar date later than the Start Date must be used. The date should be expressed in the form YYMMDD. When Absolute Time is used, the Schedule Date is a right-justified numeric character with leading zeros or blanks permitted. It must not exceed 4,094 time units.

Figure 3-4 (cont). Activity Card

Column 68:	Secondary Slack. An asterisk in this column indicates that the Schedule Date will be used to calculate Secondary Slack.
Columns 69-74:	Actual Date. This is the date on which the activity was completed. This date may be Calendar (form YYMMDD) or Absolute (right-justified numeric with leading zeros or blanks permitted) in agreement with the specified time base. It is subject to the same time limitations as other dates.
Columns 75-80:	Blank.

Figure 3-4 (cont). Activity Card

END CARD

The End card signifies the end of the input deck. The word END appears in columns 1 through 3 and the rest of the card may be blank. (See Figure 3-5.)

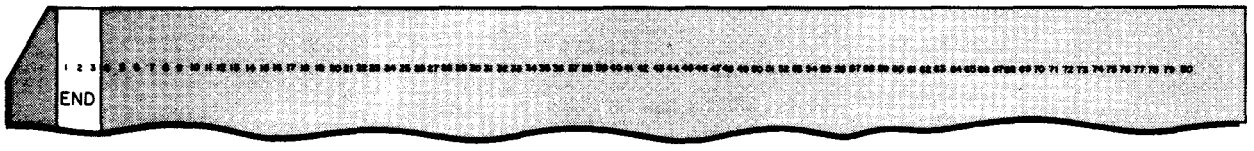


Figure 3-5. End Card

SEQUENCE OF INPUT CARDS

The input cards must be arranged in the sequence shown in Figure 3-6 and stated below. If the card-image tape is used for input, the only card required is the Console Call card.

1. Console Call card.
2. Header card.
3. Calendar Holiday cards (if desired).
4. Activity cards.
5. End card.

IDENTIFICATION OF START AND END EVENTS

The Activity cards of an input deck must contain two special cards. One is a unique Start Activity card, with a Preceding Event number of 0 (see Figure 3-7). The other is a unique End Activity card, with a Succeeding Event number of 99999 (see Figure 3-8). It is recommended that these be the first and last cards respectively of the Activity card portion of the input deck.

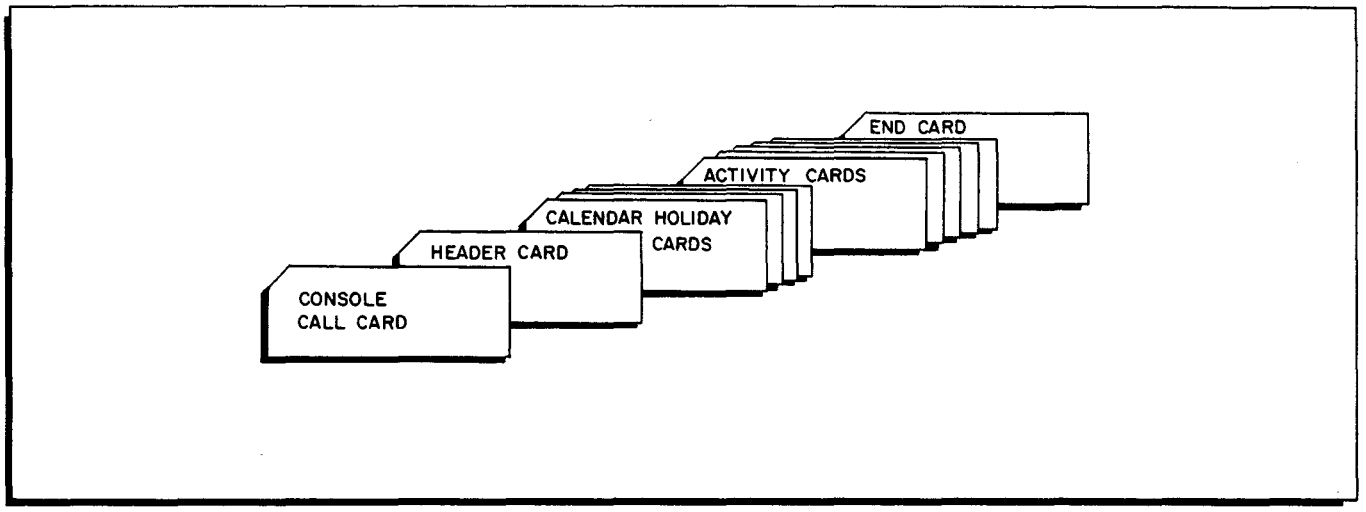


Figure 3-6. Sequence of Input Cards

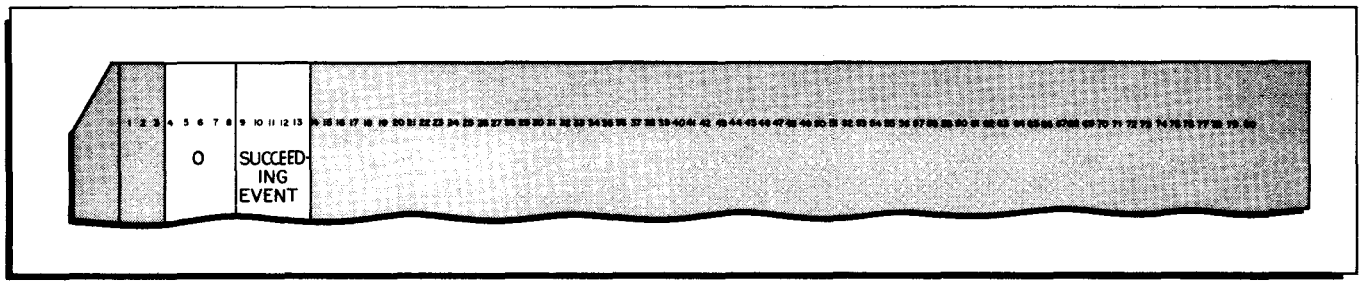


Figure 3-7. Start Event

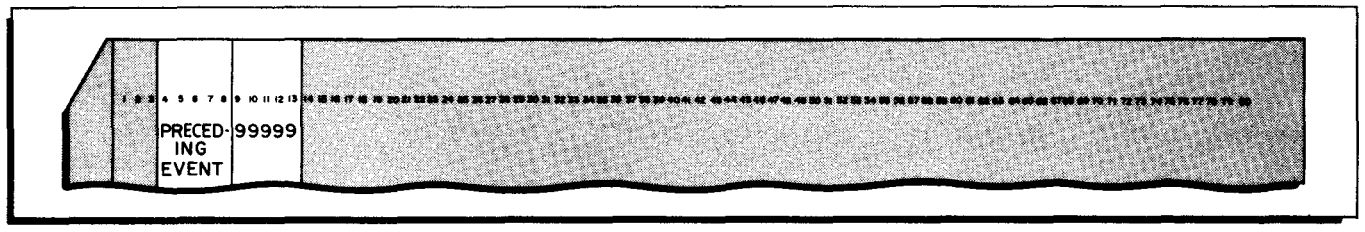


Figure 3-8. End Event

SECTION IV

PROGRAM OUTPUT

TYPES OF OUTPUT

For each network processed, PERT Time C delivers a varied and comprehensive group of output reports through which a complete project analysis may be made. The output is generated in three categories - printed input listing, printed error listing, and final output reports.

Printed Input Listing

These direct transcriptions of the input cards are used for markup. Samples of the two types - Calendar Holiday listing and Activity listing - are shown in Figures 4-1 and 4-2 respectively.

The page heading for the printed input listing contains the network title and number. Calendar Holidays listing consists of the transcribed calendar card, produced at the rate of one card per printed line, and the input error types found in the card. Since holidays are not processed for Absolute Time base, this list appears only when Calendar Time is used. Activity listing prints the entire network in the order of appearance in the input deck. Related errors are printed on the same line as the event number.

Printed Error Listing

Network Break and Network Loop errors are listed separately from input errors. An example of both network errors appears in Figure 4-3. A sample printed error listing which contains Network Breaks is illustrated in Figure 4-4. Network Loops would appear in the same manner, but would always be designated by two event numbers.

```
                    HONEYWELL PERT TIME CALENDAR HOLIDAYS LISTING
                         THE NETWORK TITLE APPEARS HERF          NETWORK NO.   TEST27
                                                                 ERROR

CAL 660531
CAL 660704
CAL 660905
```

Figure 4-1. Sample of Calendar Holidays Listing

HONEYWELL PERT TIME ACTIVITY INPUT LISTING PAGE 001

THE NETWORK TITLE APPEARS HERE NETWORK NO. TFST27

EVENT NO. I	EVENT NO. J	DESCRIPTION	CRAFTS A	CRAFTS B	CRAFTS C	CRAFTS D	CRAFTS E	DEPT CODE	TIME ESTIMATES A	TIME ESTIMATES M	TIME ESTIMATES B	SCHD DATE	SEC SLK	ACTL DATE	ERROR
00000	00019	DUMMY START												660223	
00019	00027	STUDY APT	2	1		1		DEPT09	005	009	019			660305	
00019	00030	DESIGN			3		2	DEPT11	006	014	025			660308	
00019	00061	SYSTEM APT	1	1		1	2	DEPT09	009	012	017			660305	
00061	00030	DRAW SPECS	2	3		1		DEPT09	007	011	019				
00061	00084	APPLY TASK		2		2	1	DEPT22	005	007	018				
00030	00081	PLAN EDUC			3			DEPT11	001	002	009				
00030	00070	COBOL AQU	3	1	1			DEPT14	012	019	033	660419	*		
00030	00047	MANUALS APT				3	2	DEPT11	005	006	012	660428	*		
00070	00084	COBOL DTU		4				DEPT09	013	021	029				
00084	00047	TEST APT	1			1	3	DEPT11	008	012	021				
00081	00056	MATERIALS			4	2		DEPT11	002	002	002				
00047	00056	DISTRIBUTE	2	1		1		DEPT09	004	006	007				
00056	99999	DUMMY END										660506	*		
00027	00030	STUDY PMC	2	1		3		DEPT09	011	017	031				

Figure 4-2. Sample of Activity Listing

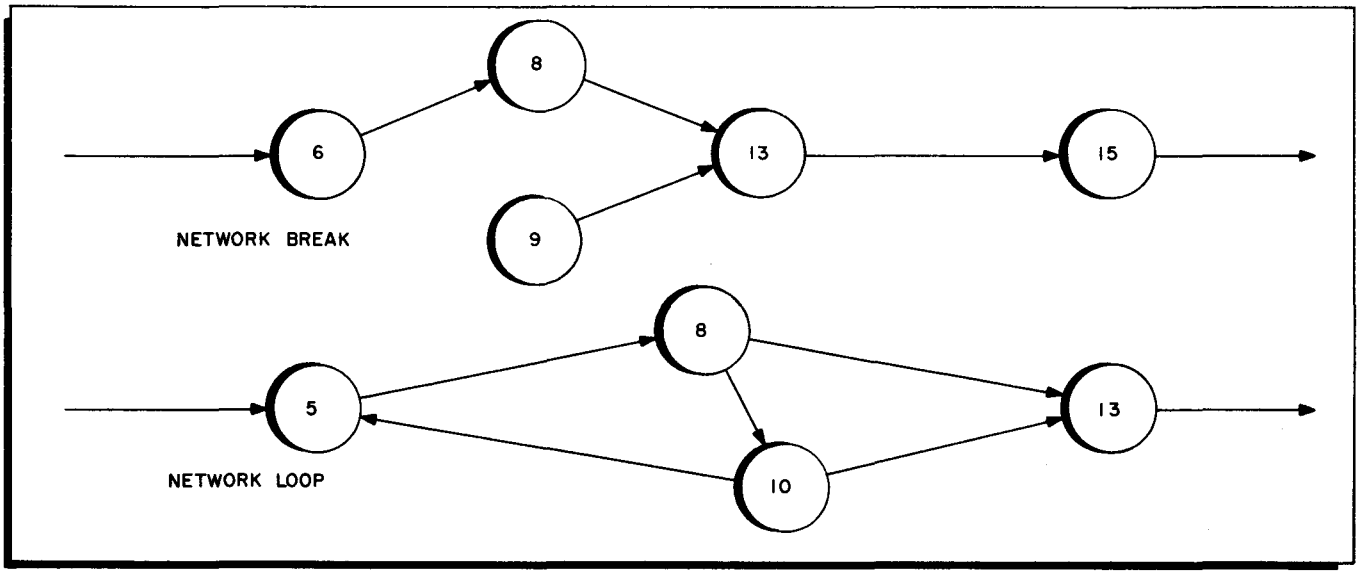


Figure 4-3. Network Errors

:LIST OF NETWORK ERRORS PAGE 1

THE NETWORK TITLE APPEARS HERE START DATE 660223

NETWORK NO. TEST27

ERROR	EVENT I	EVENT J	DESCRIPTION
:NETWRK-BREAK		01070	THIS EVENT DOES NOT APPEAR AS A PRECEDING EVENT¤
:NETWRK-BREAK		01070	THIS EVENT DOES NOT APPEAR AS A PRECEDING EVENT¤
:NETWRK-BREAK	01090		THIS EVENT DOES NOT APPEAR AS A SUCCEEDING EVENT¤

Figure 4-4. Sample of Printed Error Listing

The page heading for the printed error listing contains the Start Date in addition to the network title and number. Network Break catalogues all Preceding Events which are not Succeeding Events as well, and Succeeding Events which are not Preceding Events. Network Loop lists activities which loop back to former Preceding Event numbers. A simple descriptive statement reiterates the cause of the error.

Final Output Reports

The final output reports indicate the results of the calculations and the status of each activity. They provide information about progress to date and anticipated future progress. The sequencing of the reports varies with the Output Control (punches in columns 64-69 of the Header card as shown in Figure 3-2 on page 3-1), but the layout on the printed line is the same for each report. Figures 4-5 through 4-11 illustrate the six sequences possible for a final output report. These samples are in Calendar Time. Similar reports may also be produced in Absolute Time. Figure 4-6 is an example of one of the reports produced when the calculations are in Absolute Time.

Two special types of final output reports may be produced. Bar Charts (generated by a punch in column 70 of the Header card) are graphs showing activities for a given department which are active within 90 work days following the Report Date. Manpower Accumulation Charts (requested by an asterisk in column 61 of the Header Card) show the number of men required for a given craft on any day of the project. A sample Bar Chart and a sample Manpower Accumulation Chart appear in Figures 4-12 and 4-13 respectively.

HONEYWELL PERT TIME OUTPUT — PAGE 001

THE NETWORK TITLE APPEARS HERE — REPORT DATE 660309 / START DATE 660223 / NETWORK NO. TEST27

OUTPUT SEQUENCE

PRIMARY SLACK--PRECEDING EVENT NO.

(CALENDAR DATE)

EVENT NO. I	EVENT NO. J	DESCRIPTION	CRAFTS A	B	C	D	E	DEPT CODE	T EST	EARLIEST START	EARLIEST FINISH	LATEST START	LATEST FINISH	SCHD DATE	SLACK FF	SLACK PS	SLACK SS	ACTUAL DATE
00000	00019	DUMMY START							000	660223	660223	660223	660223		000	000	-033	660223
00019	00027	STUDY APT	2	1		1		DEPT09	007	660223	660304	660223	660304		000	000	-033	660305
00027	00030	STUDY PMC	2	1		3		DEPT09	018	660304	660330	660304	660330		000	000	-033	
00030	00070	COBOL AQU	3	1	1			DEPT14	020	660330	660427	660330	660427	660419*	000	000	-033	
00047	00056	DISTRIBUTE	2	1		1		DEPT09	006	660615	660623	660615	660623		000	000	-033	
00056	99999	DUMMY END							000	660623	660623	660623	660623	660506*	000	000	-033	
00070	00084	COBOL DTU		4				DEPT09	021	660427	660526	660427	660526		000	000	-033	
00084	00047	TEST APT	1			1	3	DEPT11	013	660526	660615	660526	660615		000	000	-033	
00019	00061	SYSTEM APT	1	1		1	2	DEPT09	007	660223	660304	660303	660314		000	006	-027	660305
00061	00030	DRAW SPECS	2	3		1		DEPT09	012	660304	660322	660314	660330		006	006	-027	
00019	00030	DESIGN			3		2	DEPT11	009	660223	660308	660317	660330		016	016	-017	660308
00030	00047	MANUALS APT				3	2	DEPT11	007	660330	660408	660606	660615	660428*	047	047	014	
00061	00084	APPLY TASK		2		2	1	DEPT22	009	660304	660317	660513	660526		050	050	017	
00030	00081	PLAN EDUC			3			DEPT11	003	660330	660404	660616	660621		000	055	022	
00081	00056	MATERIALS			4	2		DEPT11	002	660404	660406	660621	660623		055	055	022	

Figure 4-5. Sample of Final Output Report in Primary Slack - Preceding Event Sequence

HONEYWELL PERT TIME OUTPUT — PAGE 001

THE NETWORK TITLE APPEARS HERE — REPORT DATE 660309 / START DATE 660223 / NETWORK NO. TEST27

OUTPUT SEQUENCE

PRIMARY SLACK--PRECEDING EVENT NO.

(DURATION TIME)

EVENT NO. I	EVENT NO. J	DESCRIPTION	CRAFTS A	B	C	D	E	DEPT CODE	T EST	EARLIEST START	EARLIEST FINISH	LATEST START	LATEST FINISH	SCHD DATE	SLACK FF	SLACK PS	SLACK SS	ACTUAL DATE
00000	00019	DUMMY START							000	00000	00000	00000	00000		000	000	-033	00000
00019	00027	STUDY APT	2	1		1		DEPT09	007	00000	00007	00000	00007		000	000	-033	00007
00027	00030	STUDY PMC	2	1		3		DEPT09	018	00007	00025	00007	00025		000	000	-033	
00030	00070	COBOL AQU	3	1	1			DEPT14	020	00025	00045	00025	00045	00039*	000	000	-033	
00047	00056	DISTRIBUTE	2	1		1		DEPT09	006	00079	00085	00079	00085		000	000	-033	
00056	99999	DUMMY END							000	00085	00085	00085	00085	00052*	000	000	-033	
00070	00084	COBOL DTU		4				DEPT09	021	00045	00066	00045	00066		000	000	-033	
00084	00047	TEST APT	1			1	3	DEPT11	013	00066	00079	00066	00079		000	000	-033	
00019	00061	SYSTEM APT	1	1		1	2	DEPT09	007	00000	00007	00006	00013		000	006	-027	00007
00061	00030	DRAW SPECS	2	3		1		DEPT09	012	00007	00019	00013	00025		006	006	-027	
00019	00030	DESIGN			3		2	DEPT11	009	00000	00009	00016	00025		016	016	-017	00009
00030	00047	MANUALS APT				3	2	DEPT11	007	00025	00032	00072	00079	00046*	047	047	014	
00061	00084	APPLY TASK		2		2	1	DEPT22	009	00007	00016	00057	00066		050	050	017	
00030	00081	PLAN EDUC			3			DEPT11	003	00025	00028	00080	00083		000	055	022	
00081	00056	MATERIALS			4	2		DEPT11	002	00028	00030	00083	00085		055	055	022	

Figure 4-6. Sample of Final Output Report in Primary Slack - Preceding Event Sequence (Absolute Time Base)

HONEYWELL PERT TIME OUTPUT PAGE 001

THE NETWORK TITLE APPEARS HERE

REPORT DATE 660309
START DATE 660223
NETWORK NO. TEST27

OUTPUT SEQUENCE

EARLIEST FINISH--PRECEDING EVENT NO.

(CALENDAR DATE)

EVENT NO. I	EVENT NO. J	DESCRIPTION	CRAFTS A	B	C	D	E	DEPT CODE	T EST	EARLIEST START	EARLIEST FINISH	LATEST START	LATEST FINISH	SCHD DATE	SLACK FF	SLACK PS	SLACK SS	ACTUAL DATE
00000	00019	DUMMY START							000	660223	660223	660223	660223		000	000	-033	660223
00019	00027	STUDY APT	2	1		1		DEPT09	007	660223	660304	660223	660304		000	000	-033	660305
00019	00061	SYSTEM APT	1	1		1	2	DEPT09	007	660223	660304	660303	660314		000	006	-027	660305
00019	00030	DESIGN			3		2	DEPT11	009	660223	660308	660317	660330		016	016	-017	660308
00061	00084	APPLY TASK		2		2	1	DEPT22	009	660304	660317	660513	660526		050	050	017	
00061	00030	DRAW SPECS	2	3		1		DEPT09	012	660304	660322	660314	660330		006	006	-027	
00027	00030	STUDY PMC	2	1		3		DEPT09	018	660304	660330	660304	660330		000	000	-033	
00030	00081	PLAN EDUC			3			DEPT11	003	660330	660404	660616	660621		000	055	022	
00081	00056	MATERIALS			4	2		DEPT11	002	660404	660406	660621	660623		055	055	022	
00030	00047	MANUALS APT				3	2	DEPT11	007	660330	660408	660606	660615	660428*	047	047	014	
00030	00070	COBOL AQU	3	1	1			DEPT14	020	660330	660427	660330	660427	660419*	000	000	-033	
00070	00084	COBOL DTU		4				DEPT09	021	660427	660526	660427	660526		000	000	-033	
00084	00047	TEST APT	1			1	3	DEPT11	013	660526	660615	660526	660615		000	000	-033	
00047	00056	DISTRIBUTE	2	1		1		DEPT09	006	660615	660623	660615	660623		000	000	-033	
00056	99999	DUMMY END							000	660623	660623	660623	660623	660506*	000	000	-033	

Figure 4-7. Sample of Final Output Report in Earliest Finish - Preceding Event Sequence

HONEYWELL PERT TIME OUTPUT PAGE 001

THE NETWORK TITLE APPEARS HERE

REPORT DATE 660309
START DATE 660223
NETWORK NO. TEST27

OUTPUT SEQUENCE

LATEST FINISH--PRECEDING EVENT NO.

(CALENDAR DATE)

EVENT NO. I	EVENT NO. J	DESCRIPTION	CRAFTS A	B	C	D	E	DEPT CODE	T EST	EARLIEST START	EARLIEST FINISH	LATEST START	LATEST FINISH	SCHD DATE	SLACK FF	SLACK PS	SLACK SS	ACTUAL DATE
00000	00019	DUMMY START							000	660223	660223	660223	660223		000	000	-033	660223
00019	00027	STUDY APT	2	1		1		DEPT09	007	660223	660304	660223	660304		000	000	-033	660305
00019	00061	SYSTEM APT	1	1		1	2	DEPT09	007	660223	660304	660303	660314		000	006	-027	660305
00019	00030	DESIGN			3		2	DEPT11	009	660223	660308	660317	660330		016	016	-017	660308
00027	00030	STUDY PMC	2	1		3		DEPT09	018	660304	660330	660304	660330		000	000	-033	
00061	00030	DRAW SPECS	2	3		1		DEPT09	012	660304	660322	660314	660330		006	006	-027	
00030	00070	COBOL AQU	3	1	1			DEPT14	020	660330	660427	660330	660427	660419*	000	000	-033	
00061	00084	APPLY TASK		2		2	1	DEPT22	009	660304	660317	660513	660526		050	050	017	
00070	00084	COBOL DTU		4				DEPT09	021	660427	660526	660427	660526		000	000	-033	
00030	00047	MANUALS APT				3	2	DEPT11	007	660330	660408	660606	660615	660428*	047	047	014	
00084	00047	TEST APT	1			1	3	DEPT11	013	660526	660615	660526	660615		000	000	-033	
00030	00081	PLAN EDUC			3			DEPT11	003	660330	660404	660616	660621		000	055	022	
00047	00056	DISTRIBUTE	2	1		1		DEPT09	006	660615	660623	660615	660623		000	000	-033	
00056	99999	DUMMY END							000	660623	660623	660623	660623	660506*	000	000	-033	
00081	00056	MATERIALS			4	2		DEPT11	002	660404	660406	660621	660623		055	055	022	

Figure 4-8. Sample of Final Output Report in Latest Finish - Preceding Event Sequence

HONEYWELL PERT TIME OUTPUT — PAGE 002

THE NETWORK TITLE APPEARS HERE — REPORT DATE 660309 / START DATE 660223 / NETWORK NO. TFST27

OUTPUT SEQUENCE

DEPARTMENT--PRIMARY SLACK

(CALENDAR DATE)

EVENT NO. I	EVENT NO. J	DESCRIPTION	CRAFTS A	B	C	D	E	DEPT CODE	T EST	EARLIEST START	EARLIEST FINISH	LATEST START	LATEST FINISH	SCHD DATE	SLACK FF	SLACK PS	SLACK SS	ACTUAL DATE
00019	00027	STUDY APT	2	1		1		DEPT09	007	660223	660304	660223	660304		000	000	-033	660305
00027	00030	STUDY PMC	2	1		3		DEPT09	018	660304	660330	660304	660330		000	000	-033	
00070	00084	COBOL DTU		4				DEPT09	021	660427	660526	660427	660526		000	000	-033	
00047	00056	DISTRIBUTE	2	1		1		DEPT09	006	660615	660623	660615	660623		000	000	-033	
00019	00061	SYSTEM APT	1	1		1	2	DEPT09	007	660223	660304	660303	660314		000	006	-027	660305
00061	00030	DRAW SPECS	2	3		1		DEPT09	012	660304	660322	660314	660330		006	006	-027	

Figure 4-9. Sample of Final Output Report in Department - Primary Slack Sequence

HONEYWELL PERT TIME OUTPUT — PAGE 002

THE NETWORK TITLE APPEARS HERE — REPORT DATE 660309 / START DATE 660223 / NETWORK NO. TFST27

OUTPUT SEQUENCE

DEPARTMENT--EARLIEST FINISH

(CALENDAR DATE)

EVENT NO. I	EVENT NO. J	DESCRIPTION	CRAFTS A	B	C	D	E	DEPT CODE	T EST	EARLIEST START	EARLIEST FINISH	LATEST START	LATEST FINISH	SCHD DATE	SLACK FF	SLACK PS	SLACK SS	ACTUAL DATE
00019	00061	SYSTEM APT	1	1		1	2	DEPT09	007	660223	660304	660303	660314		000	006	-027	660305
00019	00027	STUDY APT	2	1		1		DEPT09	007	660223	660304	660223	660304		000	000	-033	660305
00061	00030	DRAW SPECS	2	3		1		DEPT09	012	660304	660322	660314	660330		006	006	-027	
00027	00030	STUDY PMC	2	1		3		DEPT09	018	660304	660330	660304	660330		000	000	-033	
00070	00084	COBOL DTU		4				DEPT09	021	660427	660526	660427	660526		000	000	-033	
00047	00056	DISTRIBUTE	2	1		1		DEPT09	006	660615	660623	660615	660623		000	000	-033	

Figure 4-10. Sample of Final Output Report in Department - Earliest Finish Sequence

HONEYWELL PERT TIME OUTPUT — PAGE 002

THE NETWORK TITLE APPEARS HERE — REPORT DATE 660309 / START DATE 660223 / NETWORK NO. TFST27

OUTPUT SEQUENCE

DEPARTMENT--EARLIEST START

(CALENDAR DATE)

EVENT NO. I	EVENT NO. J	DESCRIPTION	CRAFTS A	B	C	D	E	DEPT CODE	T EST	EARLIEST START	EARLIEST FINISH	LATEST START	LATEST FINISH	SCHD DATE	SLACK FF	SLACK PS	SLACK SS	ACTUAL DATE
00019	00027	STUDY APT	2	1		1		DEPT09	007	660223	660304	660223	660304		000	000	-033	660305
00019	00061	SYSTEM APT	1	1		1	2	DEPT09	007	660223	660304	660303	660314		000	006	-027	660305
00061	00030	DRAW SPECS	2	3		1		DEPT09	012	660304	660322	660314	660330		006	006	-027	
00027	00030	STUDY PMC	2	1		3		DEPT09	018	660304	660330	660304	660330		000	000	-033	
00070	00084	COBOL DTU		4				DEPT09	021	660427	660526	660427	660526		000	000	-033	
00047	00056	DISTRIBUTE	2	1		1		DEPT09	006	660615	660623	660615	660623		000	000	-033	

Figure 4-11. Sample of Final Output Report in Department - Earliest Start Sequence

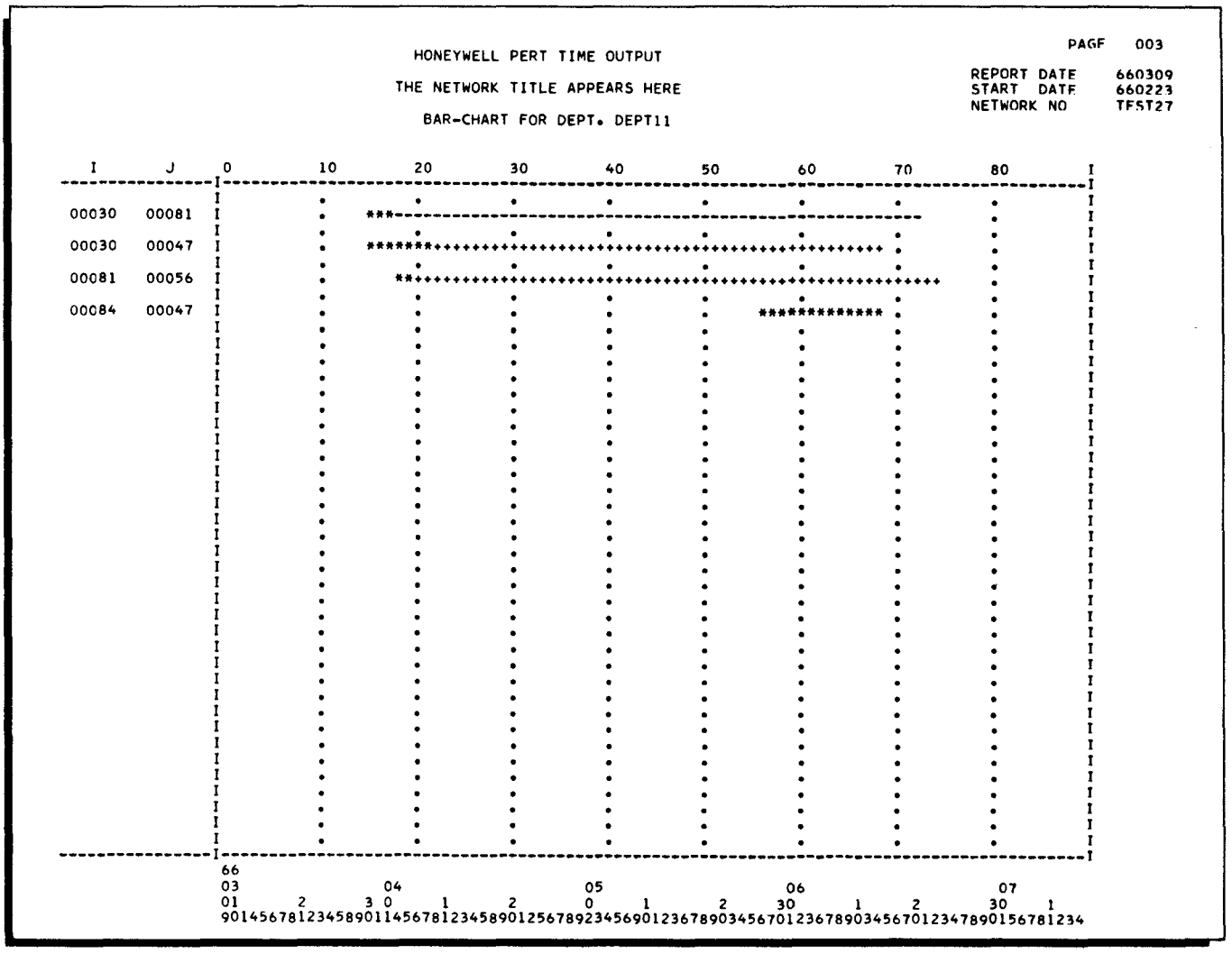


Figure 4-12. Sample of Bar Chart

PAGE 001

HONEYWELL PERT TIME OUTPUT

THE NETWORK TITLE APPEARS HERE

NUMBER OF WORKERS IN CRAFT A

REPORT DATE 660309
START DATE 660223
NETWORK NO. TFST27

STARTING ON CAL.	ABSOLUTE	NO. OF WORKERS	STARTING ON CAL.	ABSOLUTE	NO. OF WORKERS	STARTING ON CAL.	ABSOLUTE	NO. OF WORKERS
660223	0000	0003						
660304	0007	0004						
660322	0019	0002						
660330	0025	0003						
660427	0045	0000						
660526	0066	0001						
660615	0079	0002						
660623	0085	0000						

Figure 4-13. Sample of Manpower Accumulation Chart

The page heading for the final output reports indicates the sorting sequence, the network title and number, the Time base (Absolute or Calendar), the Report Date, and the Start Date. The column headings and their definitions are displayed in Table 4-1.

Table 4-1. Column Headings and Definitions for Final Output Reports

Heading	Definition
Event Number I	Contains the Preceding Event number of the activity.
Event Number J	Contains the Succeeding Event number of the activity.
Description	Contains the title or description of the activity.
Crafts	A, B, C, D, and E indicate the number of men working on the activity from each craft.
Department Code	Contains the code of the department serving the activity.

Table 4-1 (cont). Column Headings and Definitions for Final Output Reports

Heading	Definition
Time Estimates	Contains either the time ($t_{e(i,j)}$) estimated on a one time estimate or the time averaged on a three time estimate basis. However, if an Actual Date is submitted, it is used to adjust this entry.
Earliest Start	Contains the earliest time that the activity can start.
Earliest Finish	Contains the latest time that the activity can finish.
Latest Start	Contains the latest time that an activity can start without delaying the entire project.
Latest Finish	Contains the latest time that an activity can finish without delaying the entire project.
Schedule Date	Contains the date (either Calendar or Absolute) on which the activity is expected to be finished. Obtained directly from the Activity card. An asterisk following this date denotes secondary slack.
Slack	
FF	Free Float - the difference between the Early Finish of this activity and the Early Start of the next activity.
PS	Primary Slack - the difference between the Early Finish and Late Finish for the activity.
SS	Secondary Slack - the difference between the Early Finish and the Schedule Date.
Actual Date	Contains the date of a completed activity in either Calendar or Absolute Time. Obtained directly from the Activity card.

The page headings for the Bar Charts and the Manpower Accumulation Charts contain the network title and number, the Report Date, and the Start Date. In addition, the department designation and the craft designation are indicated on the appropriate chart.

In the Bar Chart, each character position represents one workday. The asterisks represent the activity execution period between the Earliest Start and Earliest Finish for each activity. Free Float is shown by crosses (+) and the sum of crosses and dashes (-) represents the Primary Slack. If an activity is currently active at the start or finish of this report, a C appears on the activity line at the appropriate limit of the graph. If the activity is not currently active, an I will appear.

The Manpower Accumulation Chart shows both a Calendar and Absolute Start Date as well as the number of men required. A graphic representation of these charts can easily be made (see Figure 4-14).

PRINTING PROCEDURE

To facilitate one of the basic usages of the output reports, those which are sorted by department (e. g., Bar Charts) are printed using a new page for each department. This allows the department to easily obtain the reports which pertain only to its own interests. Other reports (those sorted on a nondepartment key) may contain information relative to more than one department on the same page. The information is printed consecutively and advances to a new page only upon the advent of a new sorting sequence.

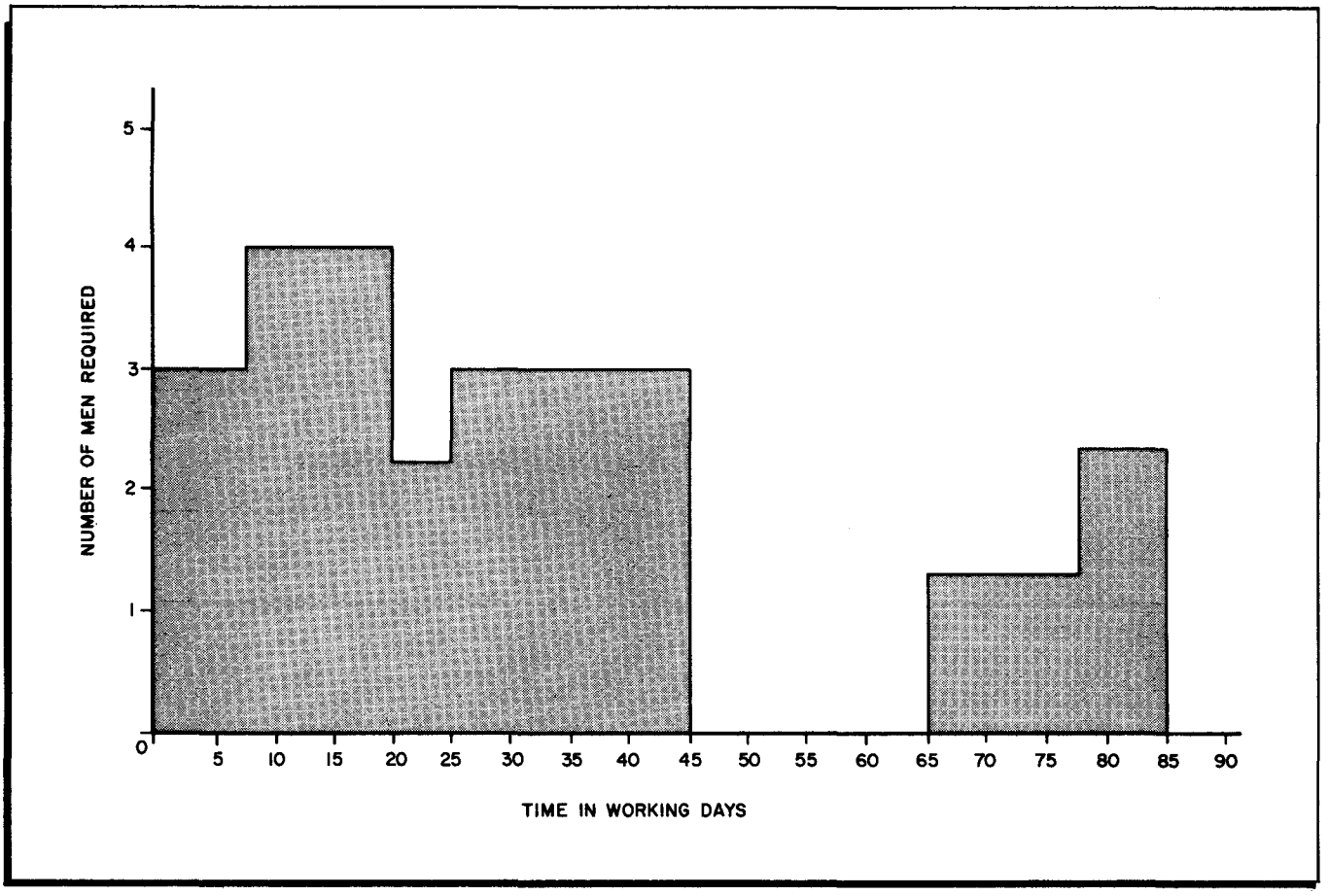


Figure 4-14. Histogram of Manpower Accumulation for Craft A

SECTION V
OPERATING INSTRUCTIONS

HARDWARE REQUIREMENTS

The PERT Time C program can be used with any Series 200 central processor. The following minimum system components are required:

12K characters of memory,

Advanced Programming Instructions,

One card reader,

One high speed printer, and

Four magnetic tape units (1/2-inch).

An extra magnetic tape unit and a console typewriter may be utilized, if available.

ASSOCIATED SOFTWARE REQUIREMENTS

PERT Time C requires the following Series 200/Operating System - Mod 1 (Tape Resident) programs:

Easycoder Assembler C and

Tape Sort C.

OPERATION SEQUENCE

PERT Time C is composed of ten separate but dependent programs which function in three phases: input, calculations, and output. After the first program is loaded by the operator, the subsequent programs are automatically loaded and run in sequence. The phases are illustrated in Figures 5-1 through 5-3 and are summarized below.

Phase I reads the input cards, checks for errors, network breaks and loops (producing error listings if necessary), generates Activity and Calendar Holiday listings, and produces the Phase II input tape. If requested, the events are topologically ordered. The three operating programs are PERTTIme, CONSEC, and TOPOLO.

Phase II computes Earliest Start and Finish, Latest Start and Finish, Free Float, and Primary and Secondary Slack. It also calculates the manpower accumulation for each day (for the first 2,000 working days) for each craft and produces the Phase III input tape. The three operating programs are FORWDC, BCKWDC, and CRAFTC.

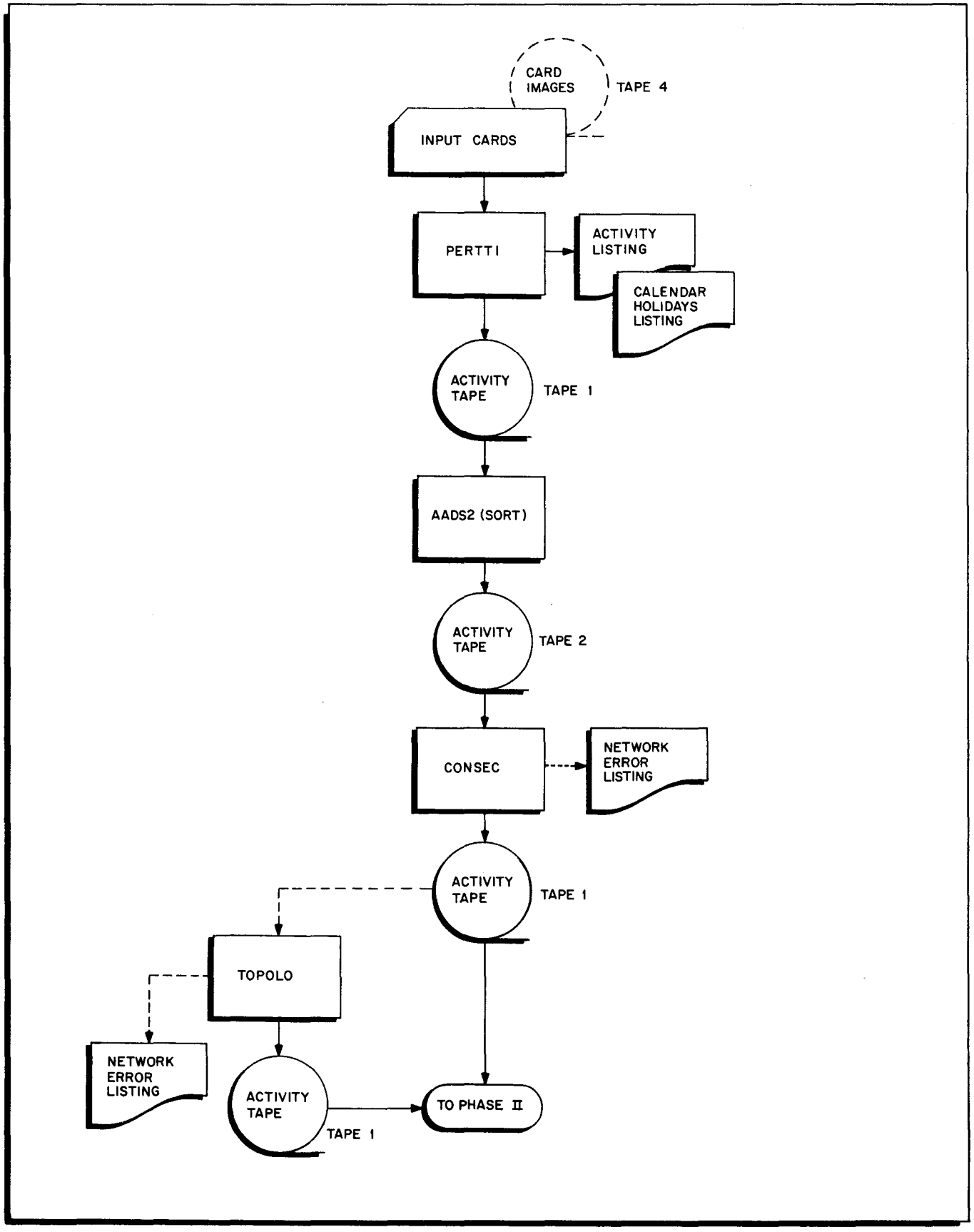


Figure 5-1. PERT Time C Operation Sequence - Phase I

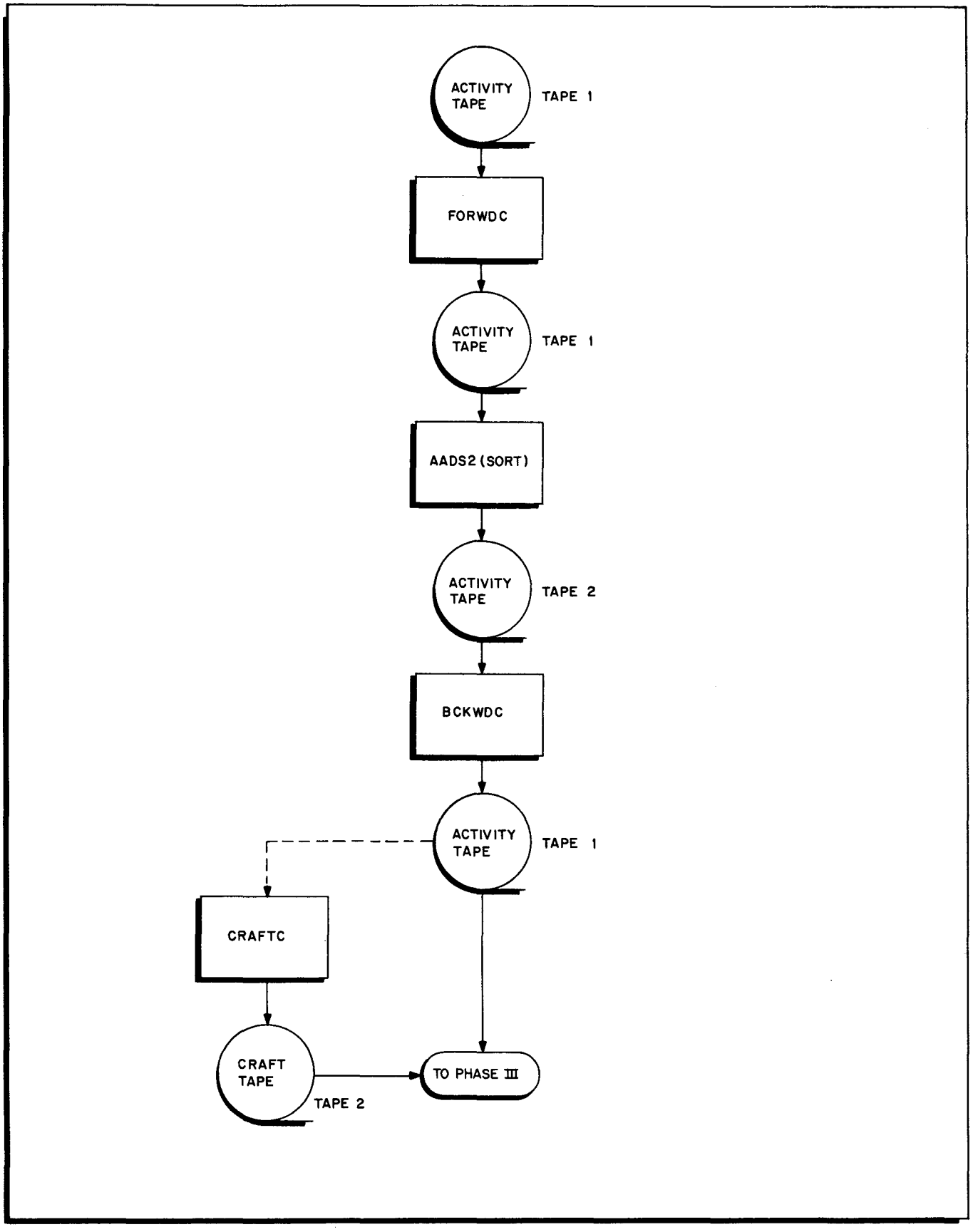


Figure 5-2. PERT Time C Operation Sequence - Phase II

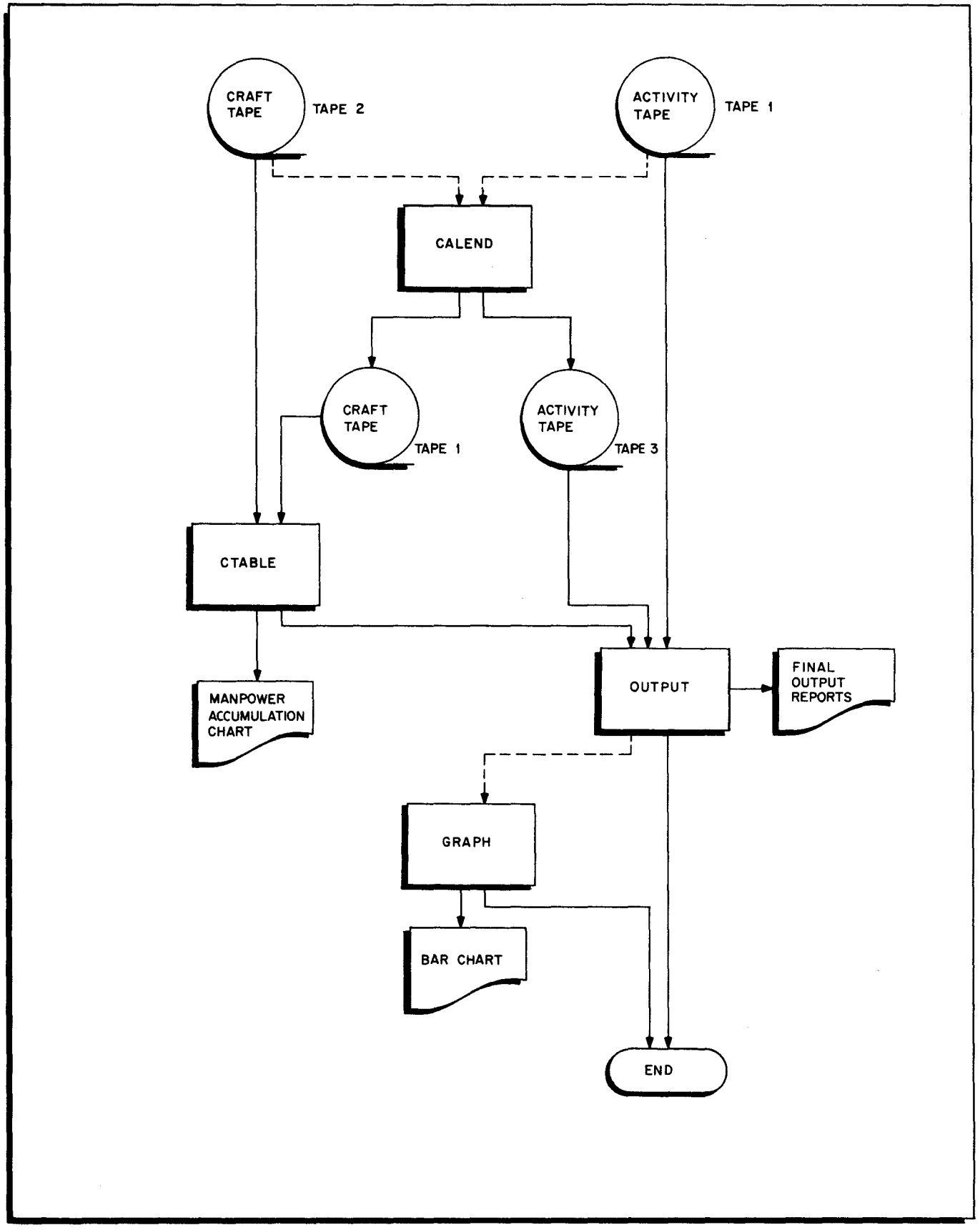


Figure 5-3. PERT Time C Operation Sequence - Phase III

Phase III prints the requested output reports. Summaries of specific reports appear in Section IV. The four operating programs are CALEND, CTABLE, OUTPUT, and GRAPH.

LOAD AND RUN INSTRUCTIONS

The programs are loaded and executed automatically under the control of the Mod 1 Tape Resident Operating System. The following operator actions are required:

1. Mount the BRT containing PERT Time C programs on tape unit 0, and mount work tapes on tape units 1, 2, and 3.
2. Mount card-image tape (if used) on tape unit 4.
3. Load card reader with input deck arranged as shown in Figure 3-6, or with Console Call card if card-image tape is used.
4. Initialize the printer.
5. Set the appropriate SENSE switches. If card-image tape is used, set SENSE switch 1 ON. If a console typewriter is available, set SENSE switch 4 ON. (If no console typewriter is available, messages will be printed on the printer.)
6. Load program from BRT (see software manual Tape Loader-Monitor C, Order Number 221).

End-of-Job Halt

The end-of-job halt is octal 7777 in the A- and B-address registers.

ERROR PROCEDURES

Peripheral Read/Write Errors

If an error occurs while reading cards, a message is typed and the program automatically halts. If an error condition results while reading or writing a tape, the program backspaces and attempts the read or write again. This cycle is continued until either no error condition exists or 32 cycles have been made. If the error condition has cleared, the program is continued in normal sequence; if an error condition still exists after 32 cycles have been made, the program prints an error message and halts.

When the halt occurs, the operator should check Table 5-1 for the corresponding A- and B-address register codes displayed and for the message printed or typed on the console typewriter. The corrective action that can be taken is indicated in the table. If the A- and B-address registers display and the message cannot be located in Table 5-1, the error may have occurred in the Tape Sort C program. In this case, the error procedures to be followed are noted in the software bulletin Tape Sort C and Collate C, Order Number 018.

Data Format and Data Formulation Errors

Possible input deck and data formulation errors (such as Network Breaks and Loops) are given in Tables 5-1 and 5-2. The recommended corrective action is also briefly explained in these tables.

Table 5-1. PERT Time C Error Halts

A Address	B Address	Printer (or Console) Message	Type of Error	Corrective Action
00000	0001t	:40 t RD ER□	Uncorrectable read error on tape unit t.	Press RUN to re-enter program, or change tape and start from beginning.
00000	0002t	:00 t WR ER□	Uncorrectable write error on tape unit t.	Press RUN to re-enter program, or change tape and start from beginning.
00002	00014	:40 4 RD ER CARD IMAGE TAPE READ ERROR ON DRIVE 4. CHANGE TAPE AND START FROM BEGINNING□	Uncorrectable read error on tape unit 4.	Rewrite card-image tape and start from beginning
00003	00021	:00 1 WR ER CANNOT WRITE HDR RECORD, CHANGE TAPE NO. 1 AND START FROM BEGINNING□	Uncorrectable write error on tape unit 1.	Change tape and start from beginning.
00005	00021	:00 1 WR ER CANNOT WRITE EOF RECORD, CHANGE TAPE NO. 1 AND START FROM BEGINNING□	Uncorrectable write error on tape unit 1.	Change tape and start from beginning.
00007	00110	:41 0 RD ER HEADER CARD READ ERROR. START FROM BEGINNING□	Card reader error.	Clear reader, start from beginning.
00010	00110	:41 0 RD ER CARD READ ERROR RESTACK CARDS AND PRESS RUN□	Card reader error.	Clear reader, restack cards beginning with error card, and press RUN.
00004	00021	:00 1 WR ER TAPE WRITE ERROR CHANGE TAPE NO. 1 AND START FROM BEGINNING□	Uncorrectable write error on tape unit 1.	Change tape and start from beginning.
00000	04001	:LIST OF NETWORK ERRORS ACTIVITY (I) - (J) IS IN A NETWORK LOOP□	There are one or more loops in the network; activities listed are in the loop.	Change network to eliminate the loop(s) and start from beginning.
		or		
		:NETWORK BREAK (J) THIS EVENT DOES NOT APPEAR AS A PRECEDING EVENT□	The events (J) listed have no Preceding Events in the network.	Change network so that all events except the first (00000) have Preceding Event and start from beginning.
		or		
		:NETWORK-BREAK (I) THIS EVENT DOES NOT APPEAR AS A SUCCEEDING EVENT□	The events (I) listed have no Succeeding Events in the network.	Change network so that all events except the last (99999) have Succeeding Events and start from beginning.
00000	04002	:PROJECT DURATION IS OVER 4094 DAYS AND PERT CALCULATIONS CANNOT BE CONTINUED. PLEASE CORRECT YOUR NETWORK AND START FROM BEGINNING□	The total project length is greater than 4,094 days.	Change network to reduce project length and start from beginning.
00000	04100	:HEADER CARD ERROR 0 CORRECT AND START AGAIN□	1HDR card not the first card of input deck.	Insert 1HDR card so that it is the first card of deck and press RUN.
00000	04200	:HEADER CARD ERROR n CORRECT AND START AGAIN □ :I CANT GO ON BECAUSE OF INPUT ERRORS□	Error found in 1HDR card n = 1: Illegal calendar date in a date field. n = 2: Report Date before Start Date. n = 3: Number of years between Report Date and Start Date greater than or equal to 9. n = 4: Number of working days between Report Date and Start Date greater than 2,000. n = 5: High order column of Report Date field is not a 0 or blank (Absolute Time only). n = 6: Illegal punch in any column of any numeric field. n = 7: Report time greater than or equal to 4,095 time units. n = A: Day of week (columns 56-58) not a correct abbreviation of one of the days of the week. n = B: Time base (column 55) not an A or a C. n = C: Workweek (column 60) is not a 5, 6, or 7. n = D: Day of week (columns 56-58) not correct for workweek (column 60). n = E: Manpower accumulation (column 61) not an asterisk or a blank.	Correct error indicated and start from beginning.

Table 5-1 (cont). PERT Time C Error Halts

A Address	B Address	Printer (or Console) Message	Type of Error	Corrective Action
00000 (cont)	04200	:HEADER CARD ERROR n CORRECT AND START AGAIN␣ :I CANT GO ON BECAUSE OF INPUT ERRORS␣	n = F: Column 63 not blank when calculations in Absolute Time (column 55). n = G: Number of time estimates (column 62) not a 1 or 3.	
00000	04200	:EITHER THERE IS NO STARTING EVENT OR THERE ARE MORE THAN ONE START-ING ACTIVITY␣ and/or :EITHER THERE IS NO ENDING EVENT OR THERE ARE MORE THAN ONE ENDING ACTIVITY␣ and/or :TOO MANY ACTIVITIES␣	(1) There is no event labeled 0 or (2) there is more than one activity which has its Preceding Event labeled 0. (1) There is no event labeled 99999 or (2) there is more than one activity which has its Succeeding Event labeled 99999. The total number of activities is greater than 2,000.	Correct error indicated and start from beginning.
00000	04200	:I CANT GO ON BECAUSE OF INPUT ERRORS␣	Error found in Calendar Holidays card or Activity card; an * n will appear on the same line as the card in error in the Calendar Holidays listing or the Activity listing. n = 0: A card does not have CAL or ΔΔΔ in columns 1-3 within holiday or activity part of deck. n = 1: Illegal calendar date in any date field n = 2: Any date before Start Date. n = 3: Number of years between any date and Start Date greater than or equal to 9. n = 4: Number of working days between any date and Start Date greater than 2,000. n = 5: High order column of any date field is not a 0 or a blank (Absolute Time only). n = 6: Illegal punch in any column of any numeric field. n = 7: Any time field greater than or equal to 4,095 time units. n = 8: There are more than 150 holidays. n = 9: Any holiday date before the previous holiday date given.	Correct error indicated and start from beginning.
00000	05000	(None)	SENSE switch 2 is ON.	Turn SENSE switch 2 OFF and press RUN.

Table 5-2. PERT TIME C Error Messages Without Halts

Printer (or Console) Message	Explanation
PROJECT DURATION IS OVER 2000 DAYS. THERE WILL BE NO CALENDAR OUTPUT.	The total project length is greater than 2,000 working days; if calendar output has been requested, it will be suppressed, but absolute time output will be printed. To obtain calendar output, the project length must be reduced to less than 2,000 working days.
NUMBER OF WORKERS IN CRAFT n WILL BE CALCULATED ONLY OVER THE FIRST 2000 DAYS.	The total project length is greater than 2,000 working days; if manpower accumulation has been requested, it will be calculated only for the first 2,000 days. To get accumulation for the entire network, the total length must be reduced to less than 2,000 working days.
*******MULTIPLE DEFINED*******	This message is printed on the output reports in place of the activity title or manpower estimates if the activity is a duplicate entry in the input deck. The program tests for activities that have identical Preceding and Succeeding Event numbers. It will accept the first entry and disregard the others.

APPENDIX A

GLOSSARY OF TERMS

Active Activity:	An activity in progress, i.e., an activity with its Preceding Event completed, but its Succeeding Event not completed.
Activity (ij):	A time-consuming element of a network represented by an arrow. It points in the direction of work flow, and its tail and head are connected to separate nodes (representing events) which represent the beginning and end, respectively, of the activity. Every activity can be uniquely designated by a pair of event numbers (i, j), where i is the number of the event at the tail of the arrow representing the activity and j is the number of the event at the head of the arrow.
Activity Expected Time (t_e):	A single best estimate or a single statistically weighted "most probable" time of activity duration, based on the optimistic (a), pessimistic (b), and most likely (m) estimates. There is a fifty percent chance that the actual completion time for the activity will prove to be shorter than t_e and a fifty percent chance that it will prove to be longer.
Activity Times:	Estimates of elapsed time necessary to complete an activity in a specified manner. Either a single estimate or three time estimates may be given for each activity: optimistic, pessimistic, and most likely.
Actual Date (AD):	The date on which the completion of an event or activity was accomplished.
Bar Chart:	A graphic representation of the timings for each activity.
Beginning Event:	That event which establishes the beginning of the actual work that occurs during an activity.
Critical Path:	That particular sequence of activities in a network which imposes the most rigorous time constraint in the accomplishment of the end event; the most time-consuming path.
Earliest Start of event i: (T^E_i)	The cumulative sum of the activity expected times (t_e) over the most time-consuming path leading to the event i, i.e., the earliest time event i can start.
Earliest Start Time (ES):	The earliest time an activity can start.
Earlist Finish Time (EF):	The earliest time an activity can finish.
End Event:	That event which signifies the completion of a network.

Event:	A meaningful, specified accomplishment in the program plan, recognizable as a particular instant in time. Events are not time-consuming and are normally represented in the network by circles or rectangles.
Free Float (FF):	The amount of time an activity can be delayed assuming that all activities entering at the beginning event of the activity start as early as possible and allowing all activities beginning at the end event of the activity to start as early as possible.
Inactive Activity:	An activity not in progress at a given time.
Latest Finish Time ($LF_{i,j}$):	The latest time an activity (i, j) can finish without delaying the Earliest Finish of the entire project (T^E_{END}).
Latest Finish Time (T^L_i):	The latest time an event can occur without delaying the completion of the total project.
Latest Start Time ($LS_{i,j}$):	The latest time an activity can start without delaying the entire project.
Major-Minor:	Terms used to indicate the major and minor sorting keys. Output is sorted according to the major key, but in the event that two items have the same major key, they are sorted and sequenced according to the minor key.
Most Likely Time (m):	An estimate of most probable time of activity duration, which (1) would reasonably be expected to occur by the person best qualified to judge and (2) would occur most often if the activity could be repeated numerous times under exactly the same conditions.
Negative Secondary Slack:	The amount of time the start or finish of an activity must be decreased in order to meet specified Schedule Dates.
Network:	A diagrammatic representation of a program or project plan that shows the sequence and inter-relationships of finite events in the plan to achieve end objectives. Activities are represented by arrows joining events in the network.
Optimistic Time (a):	An estimate of the minimum activity duration time such that if the activity were repeated 100 times this would be the least time it would take to complete it.
Pessimistic Time (b):	An estimate of the maximum activity duration time such that if the activity were repeated 100 times this would be the maximum time it would take to complete it.
Positive Secondary Slack:	The amount of time the start or finish of an activity can be delayed (increased) in order to meet specified Schedule Dates.

Preceding Event:	That event which establishes the beginning of the actual work that occurs during an activity.
Primary Slack (PS):	The amount of time that the start or finish of an activity can be delayed without prolonging the computed early finish time of the entire project T^E_{END}.
Project Start Date:	The calendar time designated as the beginning of the total project.
Report Date:	The date when data is submitted for a computer run. The Report Date must occur after the Start Date.
Schedule Date (SD):	A predetermined calendar date established by a project manager or other authority to fix in time the planned accomplishment of an event.
Slack:	The amount by which T^E can slip before it equals T^L; a measure of the schedule flexibility. Slack = $T^L - T^E$.
Starting Event:	That event which signifies the beginning of a network.
Succeeding Event:	That event which denotes the accomplishment of an activity.

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