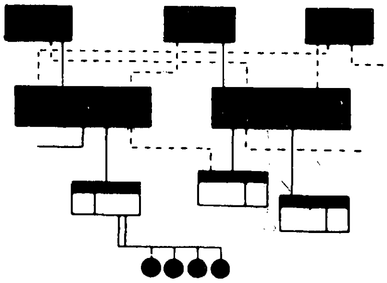
GENERAL ELECTRIC
COMPUTERS

GE-625/635
Pert/Time



GENERAL ELECTRIC

CPB-1139 TIP 600-875-[illegible]-123

GE-625/635
PERT/TIME

January 1966

GENERAL ELECTRIC
COMPUTER DEPARTMENT

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CONTENTS

APPENDICES

ILLUSTRATIONS

1. INTRODUCTION

GENERAL DESCRIPTION

GE-PERT/600 is a computer program compatible with the network model methods of USAF PERT (Program Evaluation and Review Technique) as outlined in the first two volumes of the U.S. Air Force PERT Series--Volume I, USAF PERT Time System Description Manual and Volume II, USAF PERT Time System Computer Handbook.

This manual describes the capabilities and flexibility of the GE-PERT/600 system and contains instructions for using the program. The user is assumed to be familiar with network model techniques; however, a brief synopsis of network modeling is presented in Appendix B.

Most parts of the GE-PERT/600 system are written in the FORTRAN language, except the topological numbering section. This section, described in detail in Appendix A, was written in machine language (GMAP) for program efficiency.

MINIMUM SYSTEM CONFIGURATION

Minimum system configuration requirements are:

Central processor with 32k core memory*--for PERT exclusive of the system software.
Card reader
Printer
3 utility tapes and disc or 10 tapes with no disc
Card punch

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*The programs can be recompiled for smaller memory requirements.

2. SYSTEM CAPABILITIES

The GE-PERT/600 system of schedule evaluation and project control provides a new flexibility in planning and in reporting progress; a flexibility consistent with dynamic project management.

The only network construction limitation is a maximum capacity of 10, 000 activities or events. In numbering the events of a network model, a user may employ up to eight digits (1 to 99, 999, 999) in random sequence, thus grouping event numbers according to the special requirements of his system. The program renumbers the events topologically, to facilitate internal calculations (see Appendix A), but retains the original numbers for printed reports.

Flexibility in the calendar routine permits the user to stipulate up to 500 holidays or vacation days (to permit scheduling for a number of years). If strikes, plant shutdowns, or other emergency conditions occur, the workdays missed may be entered as vacation days, to update future dates in the project and to reflect the days lost. In addition, a five-, six-, or seven-day workweek may be chosen at the user's option.

Further adaptability is evidenced in the output reports, which depend only on the creative thinking and planning of the user. By carefully considering the purpose of each report, its frequency and its distribution, the user can "build" his reports to suit his special needs. He may define the sort order for each report; include only interesting segments of a much larger report; include specific groupings; break the printing sequence at will and begin a new page with a new subtitle for distribution to foremen, managers, or other responsible overseers; or suppress information by request. He may request the short form activity report with compressed print lines. He may even decide to consider only the activities just completed, those in progress, or those scheduled for the future. In other words, all work completed prior to the current report can be omitted. Toward the end of the project, this could reduce output considerably.

The "scheduled date" option enables the user to decide the type of schedule he will attempt to follow. For example, he must answer the following questions:

1. If the scheduled date for an event is earlier than the expected completion date for that event, which date should be used in the calculations?
2. If the latest completion date is earlier than the scheduled date, which date should be used?

The user answers these questions and instructs the program through the initial cards described in detail in Chapter 3.

GE-PERT/600 uses the standard two-card USAF PERT input for initial entry of each activity of the network. First-line input, which contains essential predecessor event and successor event identification and time estimates for the duration of the activity, is required for program operation.

While second-line information is optional, activity descriptions greatly improve the readability of output reports; and the 18 alphanumeric characters of the activity code field offer numerous possibilities for special manipulation of reports, sorting resource requirements, responsibility grouping, etc.

Three time estimates are available for those activities for which the expected time or duration is uncertain. The user estimates optimistic time, and pessimistic time. The program, following the precedent set by earlier PERT systems, assumes a beta distribution (see Appendix C) to calculate the expected time for the activity. If a single time estimate for an activity is available, it may be used in the "most likely" field and the program will accept it without question.

Level codes, familiar to USAF PERT users, are employed to identify events by management levels for summary purposes; they may be any alphabetics (A to Z). The level code need appear only once for any event on either a predecessor or successor event notation.

The GE-PERT/600 system utilizes a special notation feature to expedite progress. As time passes and events are completed, the program focuses attention on those activities which should be in progress by flagging them with an asterisk on the activity report. To the foreman receiving his segmented report and perhaps unaware of the linkage to the entire project, this notation says: "Begin me now."

Error detection is one of the essential aspects of the integrated GE-PERT/600 system. As data cards are read, each card field is checked for possible errors. Diagnostics appear on the printer and any detected errors are listed below the card image. At the same time, accurate information is retained as each activity is written on the master file.

Transaction codes are used for additions and deletions to the master file and for changes to existing records on the file, to facilitate error corrections. The programmer refers to the error diagnostics printed below the card image to employ the proper transaction code. This eliminates the necessity for further reference to the original card entry which caused the error.

The GE-PERT/600 program also analyzes and prints the following errors in network logic for the user's study:

1. Circular parts of a network; that is, logical loops in which at least one event shows up as its own successor.
2. Completed activities with incomplete predecessor events.

The "type-of-run" option was created since several computer runs may be required before a user is completely satisfied with his schedule. It provides a list of changes made to a network since the last report. The user may stipulate the type of run, whether changes are to be retained and printed for combined output over several runs, or, when the schedule is perfected, whether the changes may be erased and the master file change flags reset for the next reporting period.

3. SYSTEM INPUT

CARDS

GE-PERT/600 employs four types of input cards:

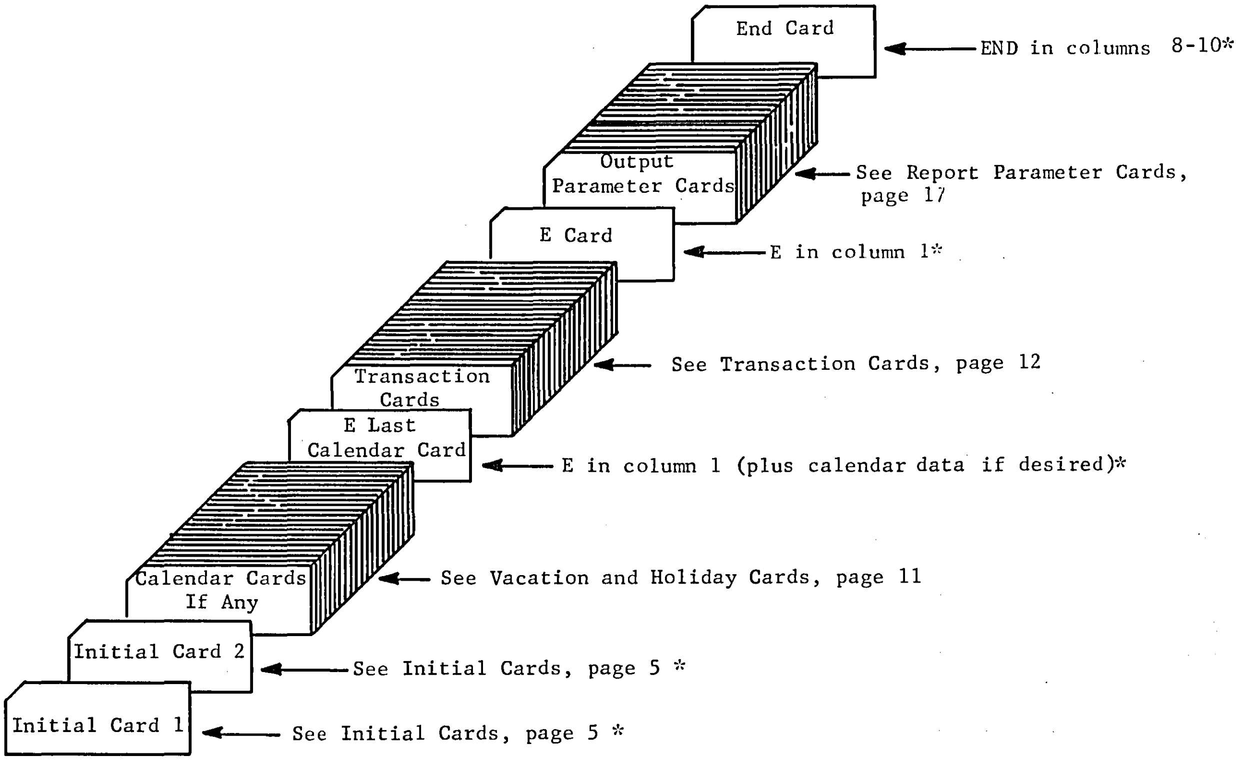
1. Initial cards
2. Vacation and holiday cards
3. Transaction cards
4. Report parameter cards

The input deck setup is shown in Figure 1. Initial cards and vacation and holiday cards are written on special coding sheet CE147 as shown in Figure 2. Transaction cards are written on special coding sheet CE148 as shown in Figure 3. Report parameter cards may be written on any 80-column coding sheet (see Report Parameter Cards for column layout).

Initial Cards

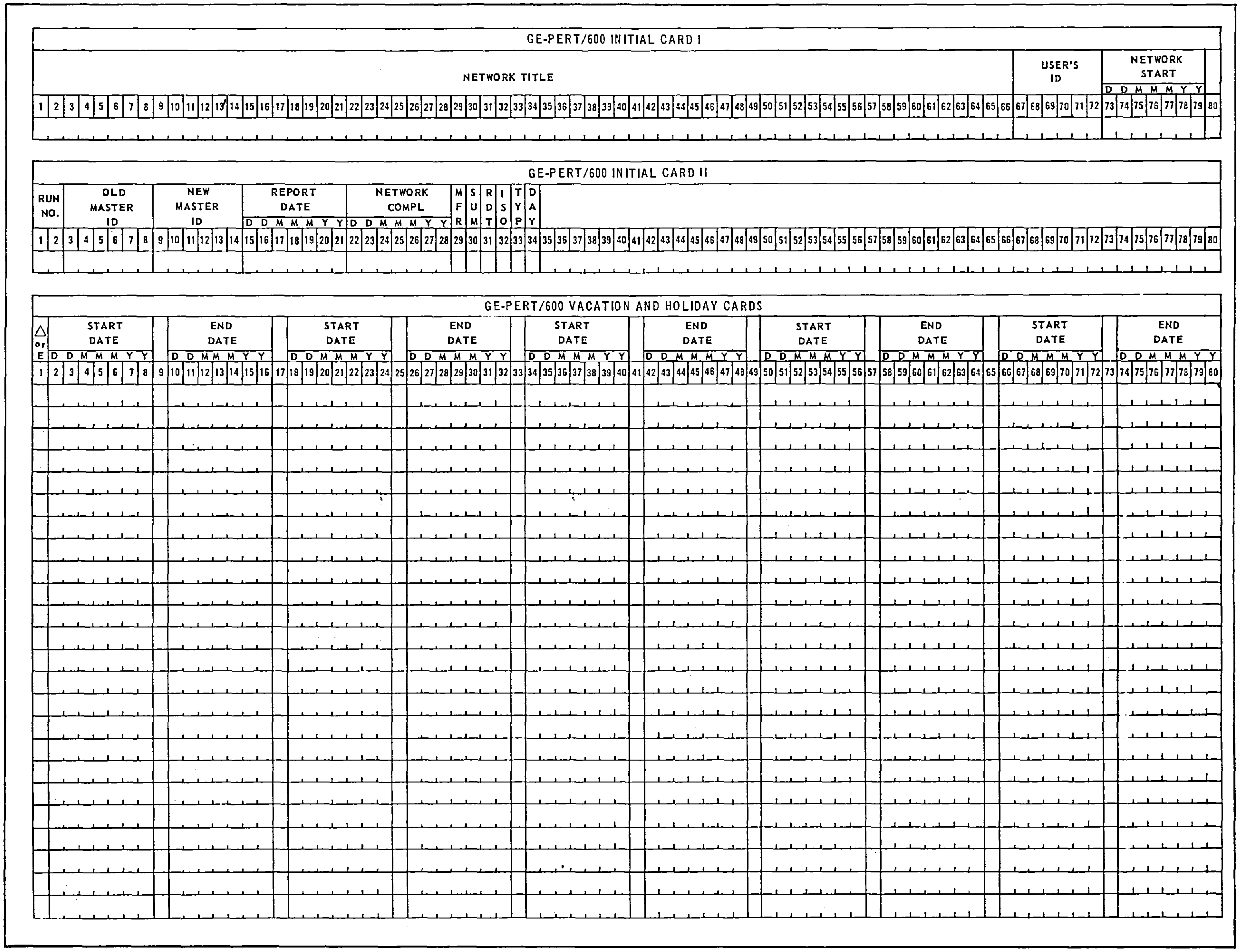
INITIAL CARD 1. This card contains the relatively stable network information which is not likely to change from month to month. The format of the card is as follows:

Columns	Information	Description
1-66	Network title	An identification which appears on all activity and event reports. It consists of a maximum of 66 characters.
67-72	User's identification symbol	The only input parameter which must remain constant throughout the life of a network. It consists of 6 characters.
 73-74 75-77 78-79	Network start date Day (numeric Month (alphabetic) Year (numeric)	The earliest date of the network. No network input date is allowed which occurs before this date. Also, any date which occurs more than 999.9 weeks beyond the network start will be rejected. The date is entered in day, month, year order. The month is one of the following alphabetic codes: JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, or DEC.
80	Blank	



* Must be present.

Figure 1. Input Data Deck



GE-PERT/600 INITIAL CARD I

NETWORK TITLE	USER'S ID	NETWORK START	
		D D M M M Y Y	
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66	67 68 69 70 71 72	73 74 75 76 77 78 79	80

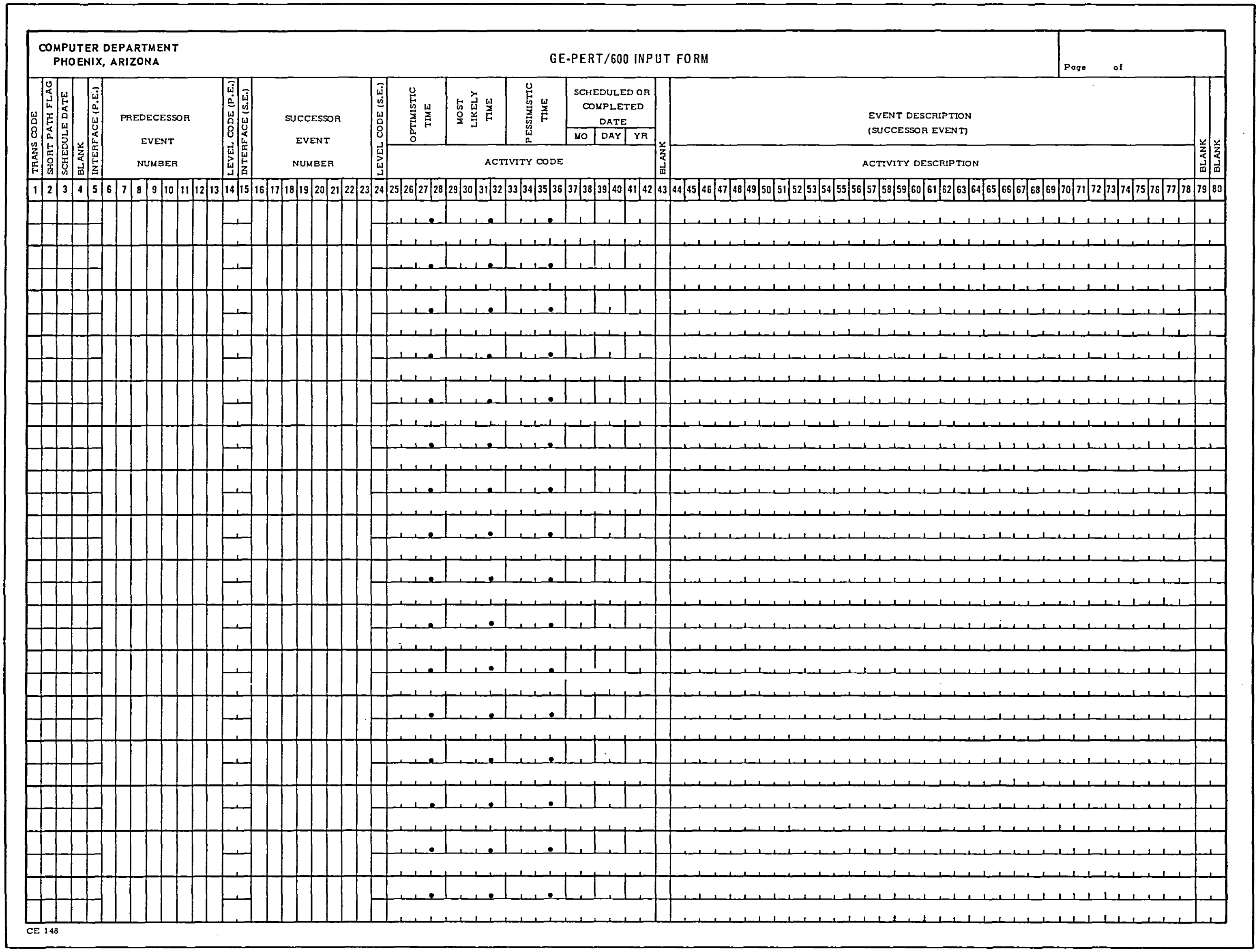
GE-PERT/600 INITIAL CARD II

RUN NO.	OLD MASTER ID	NEW MASTER ID	REPORT DATE	NETWORK COMPL	MFR	SUM	RDT	ISO	TYP	DAY	
			D D M M M Y Y	D D M M M Y Y							
1 2	3 4 5 6 7 8	9 10 11 12 13 14	15 16 17 18 19 20 21	22 23 24 25 26 27 28	29	30	31	32	33	34	35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

GE-PERT/600 VACATION AND HOLIDAY CARDS

△ or E	START DATE		END DATE		START DATE		END DATE		START DATE		END DATE		START DATE		END DATE		START DATE		END DATE
	D D M M M Y Y		D D M M M Y Y		D D M M M Y Y		D D M M M Y Y		D D M M M Y Y		D D M M M Y Y		D D M M M Y Y		D D M M M Y Y		D D M M M Y Y		D D M M M Y Y
1	2 3 4 5 6 7 8	9	10 11 12 13 14 15 16	17	18 19 20 21 22 23 24	25	26 27 28 29 30 31 32	33	34 35 36 37 38 39 40	41	42 43 44 45 46 47 48	49	50 51 52 53 54 55 56	57	58 59 60 61 62 63 64	65	66 67 68 69 70 71 72	73	74 75 76 77 78 79 80

Figure 2. Coding Sheet for Initial Cards



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GE-PERT/600 INPUT FORM

Page of

TRANS CODE	SHORT PATH FLAG	SCHEDULE DATE	BLANK	INTERFACE (P.E.)	PREDECESSOR EVENT NUMBER	LEVEL CODE (P.E.)	INTERFACE (S.E.)	SUCCESSOR EVENT NUMBER	LEVEL CODE (S.E.)	OPTIMISTIC TIME	MOST LIKELY TIME	PESSIMISTIC TIME	SCHEDULED OR COMPLETED DATE MO DAY YR	BLANK	EVENT DESCRIPTION (SUCCESSOR EVENT)	BLANK	BLANK
										ACTIVITY CODE					ACTIVITY DESCRIPTION		
1	2	3	4	5	6 7 8 9 10 11 12 13	14	15	16 17 18 19 20 21 22 23	24	25 26 27 28	29 30 31 32	33 34 35 36	37 38 39 40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78	79	80

CE 148

Figure 3. Input Coding Sheet

INITIAL CARD 2. This card contains the network information most likely to change from run to run

The format of the card is as follows:

Column	Information	Description
1-2	Run identification	This number must be equal to 01 for the initial run of the network. It may contain any value other than 01 for succeeding update runs. It is recommended, however, that the update run be numbered sequentially: 01 - Initial run 02 - First update run 03 - Second update run Etc.
3-8	Old master identification	This identification ensures that the old master file is being used. It must be equal to the master file identification symbol contained on the old master tape. It consists of 6 characters.
9-14	New master identification	A symbol written on the new master file to identify it for future update runs. For the initial run, this identification symbol <u>must</u> be equal to that used as the old master identification. Symbols for ensuing runs <u>may be</u> equal to the original symbol. This identification consists of 6 characters.
	Report date	The closeout date for all new data to the network. It is coded in the same manner as that used for the network start date.
15-16	Day (numeric)	
17-19	Month (alphabetic)	
20-21	Year (numeric)	
	Network completion date	A date used as the latest allowable date for all end events which have not been assigned a scheduled end date. (See Transaction Cards, page 12.) It is coded in the same manner as that used for the network start date and report date.
22-23	Day (numeric)	
24-26	Month (alphabetic)	
27-28	Year (numeric)	
29	Master file report option	An option specifying the type of master file report (if any) desired for this run. (See Master File Listing, page 25.) 0 - No master file report 1 - Master file report (changes not shown) 2 - Master file changes only 3 - Master file report with changes shown

Column	Information	Description
30	Summary report option	An option designating the level of summarization desired (if any) for this run. The level shown by the option generates a summary network containing that level and all levels above it. 0 - no network summary 1 - minimum summary A - summary to level A B - summary to level B ---- etc. Z - summary to level Z
31	Report date option	If requested, this option causes all expected dates (T_E), which occur previous to the report date, to be replaced by the report date. 0 - Option not requested 1 - T_R(report date) replaces T_E(expected date) when T_R is greater than T_E
32	Internal sort option	If set, this option causes an internal sort, to sort the transaction cards. This option can only be used if there are no more than 800 cards. 0 - Tape sort 1 - Internal sort
33	Type of run option	If set, this option causes the change codes contained on the old master file to be retained (see activity report). 0 - Change codes from previous runs not saved. 1 - Change codes left from previous runs will be retained and added to the changes specified for this run.
34	Number of days in workweek	A number defining the workweek for the calendar routine. The calendar accepts a five-day Monday-through-Friday-week, a six-day Monday-through-Saturday-week, or a seven-day Monday-through-Sunday-week. 5 - Saturdays and Sundays not in workweek 6 - Sundays not in workweek 7 - All days in workweek
35-80	Blank	

Vacation and Holiday Cards

The GE-PERT/600 calendar accepts a five-, six-, or seven-day week, with or without vacations or holidays. The length of the workweek is determined from initial card 2, column 34 (number of days in workweek). The holidays and/or vacations are entered via the vacation and holiday cards. If this data is not present, the program assumes that there are no vacations or holidays.

The calendar routine accepts up to 500 days of vacations and holidays. If the 500-day limit is exceeded in the middle of a specified holiday period, only those days occurring after this limit are excluded.

The format of these cards is as follows:

Column	Information	Description
1	Last card indication	An identification showing whether more cards follow. Blank - more vacations and holidays follow E - last vacation and holiday
	Start date for vacation	
2-3	Day (numeric)	
4-6	Month (alphabetic)	
7-8	Year (numeric)	
9	Blank	
10-16	End date for vacation	
17	Blank	
18-80	Start and end dates alternate to the end of a card. Every 8th column is blank.	

Notes:

1. The user enters a holiday (that is, a one-day vacation) by placing the date in both the start date and end date fields.
2. The user enters a vacation period by placing the first date of the vacation in the start date field and the last date of the vacation in the end date field.
3. The dates must occur in ascending time order.

4. As many vacation and holiday cards as needed may be used, provided the 500-day limit is not exceeded and the ascending time order rule is met. The last of these cards must contain an E in the first column.

5. If there are no vacation and holiday cards, a card with an E punched in column 1 must be included. All remaining columns of the card must be blank.

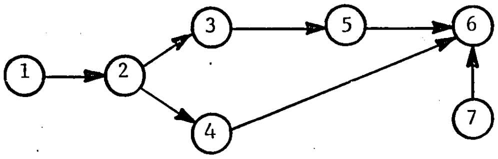
6. The base date of the calendar is January 1, 1945. Any date which contains a year value less than 45 will be assumed to occur after the year 1999.

Transaction Cards

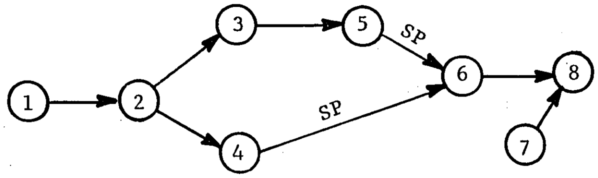
The transaction cards describe the activities and events which constitute the PERT network. The data on these cards is used to add, change, or delete the information on the master file. The following discussion describes the various types of data used on these cards.

- The transaction codes define the activity to be taken. Activity information is initially added to the master file via a 1 transaction code. Transaction codes 2, 3, 4, 6 and 8 are used to change the data on the master file. Transaction code 5 is used to delete an activity. The card format for transaction code 9 is different in several respects from that of the other codes. This code is therefore treated separately and referred to as second card input.

- The short path option is used to determine which of several parallel developments will require the shortest path to completion. No activities other than the parallel efforts are allowed to end on the event which is the end of the parallel efforts. Dummy activities can be introduced to make the tie in. For example, if the network shown below is changed to include short path flags,



a dummy activity 6-8 must be added, and activity 7-6 must be changed to 7-8.



- The scheduled date option is used to designate scheduled dates that are to be used in backward or forward computation.

- Predecessor and successor event numbers are specified. The interface flags used with predecessor or successor event numbers denote an event which is an interface with another network. Level codes are used to identify events for various levels of summarization.

- There are three time estimate fields; optimistic time, pessimistic time, and most-likely time. All time estimates are in weeks and tenths of weeks.

- The date field is used to enter scheduled dates or actual completion dates.
- The event title is associated with the event number appearing in the successor event field.

FIRST CARD INPUT. Input on the first card is as follows. This information is entered on the first line of the coding form.

Column	Code	Action	Description
1*	1	Make an initial entry	Causes a record to be added to the master file. All fields of the card are considered, except the scheduled date option. The master file record contains the transaction code until a completed date is added via a transmission code 4.
	2	Revise time estimates	If the optimistic, most-likely or pessimistic time field contains any legal value, this value will replace the value of the corresponding time field on the master file record.
		Change or delete interface code	This action works as follows: Condition of Interface Flag (Either Interface) — Action to Master File Counterpart Set — Changed 0 — Made blank neither of above — No action
		Change or delete level code	These fields are handled as the interface flags are handled. When a level code is changed, all records in which it appears must be changed to the new value.
		Change activity scheduled date.	If the contents of this field are nonblank, they are added to the master file.
	3	When using the 3 code, the predecessor event is blank and the successor event contains the event to which the add, change, or delete is applied.	
		Add or change scheduled date and scheduled date option	If a scheduled date is given, the date is placed in the master file record with the scheduled date option.
		Change only scheduled date option	The date must be reentered with the option, to change the corresponding master file record.
		Delete date option	Blanks must be used in the data field to delete the date option in the master file record.

* The transaction code in this column determines the disposition of the data contained on the card.

Column	Code	Action	Description
1 (cont.)	3 (cont.)	Delete scheduled date	Zeros must be placed in all columns of the scheduled date field to delete the scheduled date in the master file record.
		Add or change event title	If any character of the title field is not a blank, the title is placed in the master file record.
	4	Report activity completion date	The actual completion date is placed in the master file record. The transaction code itself is also entered.
	5	Delete an activity (remove record from the master file)	Only the beginning and ending event numbers are needed. (Care must be used in deletion to prevent creation of false start or end events.)
	6	When using the 6 code, the predecessor event is blank and the successor event contains the event to which the date and/or title is applied.	
		Add actual date and/or title to a start event of a network	If a date is present, it will be added to the master file record. If any character of the title field is not a blank, the title is placed in the master file record. A transaction code of 3 should be used to make only a title change. Note: This transaction code should not be used unless a completion date is present.
	7	Not used	
	8	Add or delete a short path flag of an activity	The contents of the short path flag field replace the contents of the short path flag field in the master file record.
2		Short path flag	This option determines which of several parallel developments will require the shortest path to completion. No activities other than the parallel efforts are allowed to end on the event which is the end of the parallel efforts. (Refer to page 12.) If this option is used, all terminal activities of parallel efforts must be flagged. Blank - No flag 1 - Short path flag
3		Scheduled date option	Designates scheduled dates that are to be used in backward or forward computation. Blank - Option not used. 1 - Scheduled date will replace the computed latest date (T_L) if scheduled date is earlier than the latest date. Program will continue using the selected date as the latest date.

Column	Code	Action	Description
3 (cont.)			2 - Scheduled date will replace the computed expected date (T_E), if scheduled date is later than the expected date. The program will continue using the selected date as the expected date. Note: This option can only be used on a transaction 3 card.
4		Blank	
5		Interface (predecessor event)	Used to denote a predecessor event which is to interface with another network. Blank - Not an interface I - Predecessor event is an interface.
6-13		Predecessor event number	Event numbers must be from one to eight numeric characters. Leading blanks are allowed. Zero is not a legal event number. The predecessor event number must contain a value unless the transaction code is 3 or 6.
14		Level code for predecessor event number	Used to identify predecessor events for various levels of summarization. A level code only has to be entered once for any event. Any letter of the alphabet from A to Z may be used. Blank may also be used.
15		Interface (successor event)	Used to denote a successor event which is to interface with another network. Blank - Not an interface I - Successor event is an interface
16-23		Successor event number	Event numbers must be from one to eight numeric characters. Leading blanks are allowed. Zero is not a legal event number. The successor event number must always contain a value.
24		Level code for successor event number	Used to identify successor events for various levels of summarization. A level code only has to be entered once for any event. Any letter of the alphabet from A to Z may be used. Blank may also be used.
25-28		Optimistic time in tenths of weeks (leave blank for single time estimate)	All time estimates are in weeks and tenths of weeks. A maximum of four digits may be used. If a single time estimate is used, it is placed in the most-likely time field.

Column	Code	Action	Description
29-32		Most likely time in tenths of weeks (also used for single time estimates)	All time estimates are in weeks and tenths of weeks. A maximum of four digits may be used. If a single time estimate is used, it is placed in the most-likely time field.
33-36		Pessimistic time in tenths of weeks (leave blank for single time estimates)	
		Scheduled date or completion date	Used to enter scheduled dates or actual completion dates. Dates appear in the form MMDDYY.
37-38		Month (numeric)	These dates are considered for calculation only if they appear on a transaction 3, 4 or 6 card.
39-40		Day (numeric)	
41-42		Year (numeric)	
			MM is a digit from 01 to 12 denoting the month; DD is a digit from 01 to 31 for the day of the month; and YY is the year value.
43		Blank	
44-78		Event description (successor event)	The event title consists of up to 35 alphanumeric characters. It is associated with the event number appearing in the successor event field. To include a title with a starting event of the network, a transaction code 3 or 6 must be used.
79-80		Blank	

SECOND CARD INPUT. For second card input transaction code 9 is used to add additional information to the master file record of a particular activity. This information is entered on the second line of the coding form.

The predecessor and successor event numbers of the activity must both be present. The activity code and activity title are added to the master file record which contains these numbers.

The format for second line input is as follows:

Column	Information	Description
1	Transaction code 9	This code must be used
2-5	Blank	
6-13	Use same data as on first line	
14-15	Blank	
16-23	Uses same data as on first line	
24	Blank	
25-42	Activity code	Up to 18 alphanumeric characters.
43	Blank	
44-78	Activity description	Up to 35 alphanumeric characters which describe the activity.
79-80	Blank	

Report Parameter Cards

The report parameter cards govern the contents of the event report and activity report. A list of the contents of these reports is given on pages 32, 33.

There are nine types of report parameter cards:

EVENT
ACTIVITY
SUPPRESS
INCLUDE
EXCLUDE
TITLE
BREAK
PRINT
END

Each report must start with an ACTIVITY or EVENT card and end with a PRINT card. These are the only required cards for a given report. The PRINT card concludes parameter processing for each report and may be followed by another EVENT or ACTIVITY card. An END card concludes all report processing.

One card is used for each card type, except the INCLUDE, EXCLUDE and BREAK types. For these types, one card is used for each parameter.

The format of the report deck is as follows:

Column	Information	Description
1-3	Report number	A 3-digit, user supplied number.
8-15	Card type	One of the following: EVENT, ACTIVITY, SUPPRESS, INCLUDE, EXCLUDE, TITLE, BREAK, PRINT, END.
16	Blank	
17-80	Parameters	The contents of these columns and their interpretation are described on the following page.

The following discussion covers the nine types of parameter cards. This information is summarized in Figure 4.

EVENT CARD. The EVENT card specifies the report sequence to be used for sorting data to produce an Event Report. If more than one field is used, they will be interpreted as most major to most minor, from left to right.

Parameters--Any or all of the following can be used:

EVENT-refers to event number
LEVEL-refers to level code
SLACK-the time difference between the latest date and the expected date (T_L - T_E)
    TE-expected date
    TL-latest date

ACTIVITY CARD. The ACTIVITY card specifies the report sequence to be used for sorting data to produce an Activity Report. If more than one field is used, they will be interpreted as most major to most minor, from left to right.

Parameters--Any or all of the following can be used:

SUCC-refers to successor event number
PRED-refers to predecessor event number
SLACK-the time difference between the latest date and the expected date (T_L - T_E)
    TE-expected date
    TL-latest date
ACODE Y_1, Y_2........ Y_n-refers to activity code and can include from 1 to 18 digits referring to character positions from left to right. Each digit specifies sort priority of that character position. Therefore, there are nine possible fields in the activity code.

Examples:

1. ACODE 00104302 indicates that the sort fields from most major to most minor would be character positions 3, 8, 6, 5.

2. SUCC, ACODE 01, TL, SLACK would yield a sort which would sequence the activity report first on successor event number, second on character position two of the activity code, third on the latest time, and fourth on activity slack.

Card Type (Col. 8-15)	Acceptable Parameters (Col. 17-80)	Interpretation
EVENT	EVENT, LEVEL, SLACK, TE, TL	Report sequence--any or all in order of most major to most minor.
ACTIVITY	SUCC, PRED, SLACK, TE, TL, ACODE Y_1, Y_2 ...... Y_{18}	Same as above; Y_n = 1 - 9.
SUPPRESS	DESC, CHANGE, SDATE, ACODE Y_1, Y_2 ...... Y_{18}, MCSLK	Fields to be omitted in each line. Y_n = 0 or 1.
INCLUDE/ EXCLUDE	One card for each line below: EVENT . LT. or . GT. W or . EQ. (List W) SLACK . LT. or . GT. A or . EQ. (List A) TE. LT. or . GT. B or . EQ. (List B) TL. LT. or . GT. B or . EQ. (List B) ACODE Y_1, Y_2 ...... Y_{18} . LT. or . GT. Z or . EQ. (List Z)	Include or exclude whole lines if condition exists. A = signed decimal number (1 to 7 digits) B = unsigned decimal number (1 to 8 digits) W = 1 to 8 digits Z = alphanumeric characters List = A, A, A, A etc. in ascending order. ACODE and EVENT may not occur on the same report.
TITLE	36 alphanumeric characters	Report title replaces last used.
BREAK	b̸b̸ ⟶	Break on any change in the major sort field and use no subtitle.
	36 alphanumeric characters	Break on any change in major sort field and use a subtitle consisting of the characters provided.
	One card for each value below: . EQ. V, 36 characters (more than one of these cards is reasonable)	Break when the major field equals V, and use 36 characters as subtitle.
	. GT. V, 36 characters (more than one of these cards is reasonable) Note: . EQ. and . GT. may not be mixed within a given report.	Break when major field is greater than V, and use 36 characters as subtitle.
PRINT	D_1D_2, SHORT, COMPL	$D_1 D_2$ = Number of times print is desired. This compressed form has one-line output. SHORT if fast activity option is desired. COMPL if completed events and activities to be omitted.
END		End of all report parameters.

Figure 4. Report Parameter Card Layout

SUPPRESS CARD. The field specifications on the SUPPRESS card represent data which is to be omitted on every line of an activity or event report.

Parameters--Any or all of the following can be used:

DESC-causes the last 12 characters of the activity or event description to be omitted.

CHANGE-causes omission of the change flag. (The change flag indicates that a change has occurred in the event or activity data appearing on the line that is flagged; the change indicated has occurred since the last time the flag was reset by an input card.)

SDATE-causes scheduled date data to be omitted.

ACODE-Y_1, Y_2.....Y_n-specifies positions to be omitted. For example, ACODE 01011 would cause fields 2, 4 and 5 of the activity code to be omitted. As with other uses of ACODE, all positions to the right of the rightmost most interesting position may be omitted.

MCSLK-causes the most critical slack value to be omitted.

INCLUDE AND EXCLUDE CARDS. The INCLUDE function causes the printing of only those lines whose data meet the parametric conditions. EXCLUDE causes all lines whose data meet the parametric conditions to be omitted. One card is used for each parameter. Both INCLUDE and EXCLUDE cards may be used. If a card overflows (this can occur with the .EQ. function) a second card of the same type can be used, repeating the parameter name. Where lists are used in the INCLUDE-EXCLUDE function the values must be in ascending order.

Parameters:

SLACK .LT. (or .GT.)A - specifies a condition of slack less than or greater than the signed decimal value A.

SLACK .EQ. (list) - allows a list of signed decimal values separated by commas, and detects the condition of equality to elements of the list. The include or exclude function will be executed for any one of the values in the list.

TE or TL - utilizes the functions described above (.LT., .GT. or .EQ.) for expected time or latest time, using one unsigned decimal value for greater than or less than and a list of unsigned values for equal to.

EVENT - utilizes the functions described above; the value is from 1 to 8 digits. This function applies only to the event report. The digits provided would be compared as a right-justified value and the parameter is assumed to have the same number of digits as the event number.

ACODE Y_1......Y_n .GT. (or .LT.) A, or .EQ. (list) - allows n from 1 to 18. Y_n is to be either zero or one. This function applies to activity reports.

Example:

ACODE 01101 .EQ. ABC, LMN will yield the INCLUDE or EXCLUDE function whenever character positions 2, 3 and 5 are equal to A, B and C, respectively; or L, M and N, respectively. Each group in the list must have the same number of characters as are specified in the Y_n notation.

TITLE CARD. The report title is composed of the 36 alphanumeric characters provided on the TITLE card.

BREAK CARD. When the BREAK card is used, a new print sheet will be started and a heading printed whenever the parametric conditions listed below are met. One card is used for each parameter.

Parameters

Field Blank - specifies that a break is to be made when the major field changes and no subtitle is to be used.

36 Alphanumeric Characters - specifies that a break is to be made when the major field changes, and the subtitle provided is to be used.

* . EQ. V, 36 characters - specifies that a break is to be made when the major field is equal to V and the subtitle provided is to be used.

* . GT. V, 36 characters - specifies that a break is to be made when the major field is greater than V, and the subtitle provided is to be used.

* Multiple cards may also be used with . GT. or . EQ. ; in this case, a break will occur when the major field is greater than or equal to each successive value, in order. The cards must be in ascending sequence. Cards must be all . GT. or all . EQ. ; they may not be mixed.

PRINT CARD. One PRINT card must be used as the last parameter card for each report. This card concludes the processing for each report.

Parameters:

DD - a 2-digit number specifying the number of printing runs.

Example:

When 20 copies are needed and four-part paper is being used, DD=5.

SHORT - indicates the "fast activity" option which provides for the deletion of critical path data from the activity report. This provides a faster run, if only activity reports are being requested. The data omitted is: critical predecessor, level code of critical predecessor, event slack, successor event expected date, level code of predecessor event, level code of successor event, and short path flag.

COMPL- indicates that events with an actual date and activities completed prior to the current run should be omitted.

END CARD. The END card concludes all report processing.

Sample Input Deck

A listing of a sample parameter deck and explanation of its contents are shown in Figure 5.

```
010    EVENT      SLACK, LEVEL
010    TITLE      BEARING PRODUCTION
010    PRINT
251    ACTIVITY   ACODE 110020300455000000, TE
251    TITLE      JOINT DEVELOPMENT
251    SUPPRESS   CHANGE, ACODE 001100011000111111, SDATE
251    EXCLUDE    ACODE 000000000000111111 .EQ.  SECRET, PROPRI
251    EXCLUDE    ACODE 11 .GT. 35
251    INCLUDE    SLACK .LT. 150
251    BREAK      .GT. 34
251    BREAK      .GT. 40
251    BREAK      .GT. 55
251    PRINT      SHORT, 05
003    ACTIVITY   TL, SUCC
003    PRINT      COMPL
410    EVENT      TE, EVENT
410    SUPPRESS   MCSLK, CHANGE, DESC
410    EXCLUDE    TE .EQ. 150, 250, 350
410    INCLUDE    TL .GT. 150
410    BREAK      .EQ. 175
410    BREAK      .EQ. 250
410    PRINT      05, COMPL
       END
```

Legend:

1. Report #010 - An event report ordered by slack and level code. One copy will be printed, since a number is not given on the PRINT card.

2. Report #251 - An activity report ordered by selected activity code fields and by TE. Selected fields of the activity code, change flags and scheduled dates will be suppressed. The INCLUDE and EXCLUDE cards are illustrated to omit activities of little interest from the report. The BREAK cards will initiate a new page when the major sort field (in this case, the first two columns of the activity code field) exceeds the values specified. The PRINT card specifies the short form activity report and five copies will be printed.

3. Report #003 - An activity report ordered by TL and successor event number. One copy of the report will be printed and activities completed prior to the present reporting period will be omitted.

4. Report #410 - An event report ordered by TE and event number. It further demonstrates the use of the BREAK card to segment the report and the use of the INCLUDE/EXCLUDE option to select specific areas of interest.

5. END Card - The END card signals the completion of the report section.

Figure 5. Sample Report Parameter Input Deck

MASTER FILES

GE-PERT/600 uses two master files for each computer run--the old master file and the new master file. The transaction 1, 3, 4 and 6 cards and any updates caused by the other transaction cards constitute these files. These appear in the master file in predecessor, successor event number order.

The old master file is the new master file of the previous update run. If the program sees that the run number is one (01), it knows that there is no old master and creates a dummy old master for its use.

The program creates the new master file by merging the contents of the old master file with the contents of the new transaction cards.

A record containing the information on the initial cards of the run (initial cards 1 and 2) heads each new master file. The program compares the user's ID and the old master's ID on the initial cards with the user's ID and the master's ID on the old master file. If there is no match, the program prints an error message and the run is terminated.

4. OUTPUT

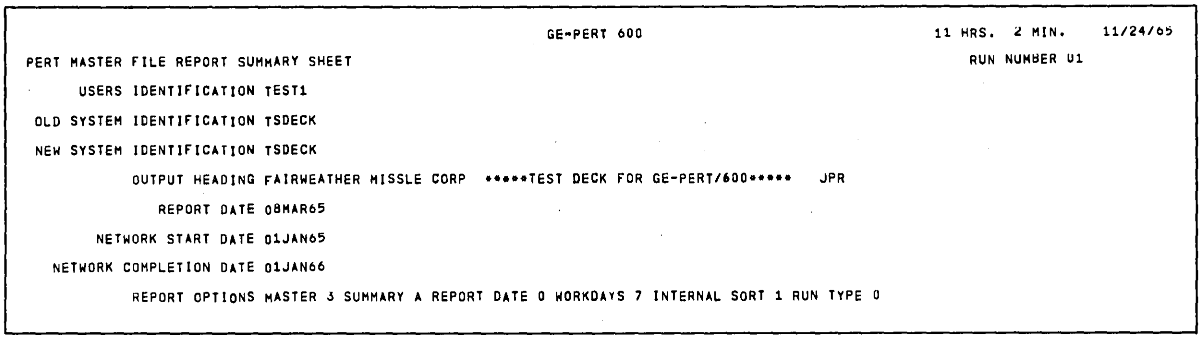
LISTINGS

Holiday and Vacation Card Listing

The holiday and vacation card listing is a series of print lines showing the contents of the holiday and vacation input cards.

Master File Summary Listing

The master file summary listing contains all the data entered via initial card 1 and initial card 2. If the network start date has changed on this run, the old network start date will also be printed. (See Figure 6.)



```
                                                  GE-PERT 600                                 11 HRS.  2 MIN.    11/24/65
PERT MASTER FILE REPORT SUMMARY SHEET                                                            RUN NUMBER U1
       USERS IDENTIFICATION TESTI
 OLD SYSTEM IDENTIFICATION TSDECK
 NEW SYSTEM IDENTIFICATION TSDECK
            OUTPUT HEADING FAIRWEATHER MISSLE CORP  *****TEST DECK FOR GE-PERT/600*****   JPR
               REPORT DATE 08MAR65
        NETWORK START DATE 01JAN65
   NETWORK COMPLETION DATE 01JAN66
            REPORT OPTIONS MASTER 3 SUMMARY A REPORT DATE 0 WORKDAYS 7 INTERNAL SORT 1 RUN TYPE 0
```

Figure 6. Master File Summary Listings

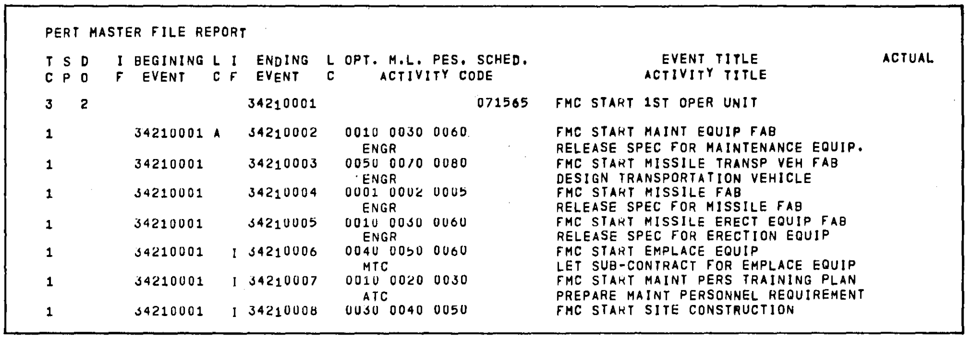
Master File Listing

The master file listing is generated via the option on initial card 2. (See page 9 .) This option may be set as follows:

0 = No master file listing
1 = Master file listing
2 = Master file listing with changes shown
3 = Master file listing of only those records with changes

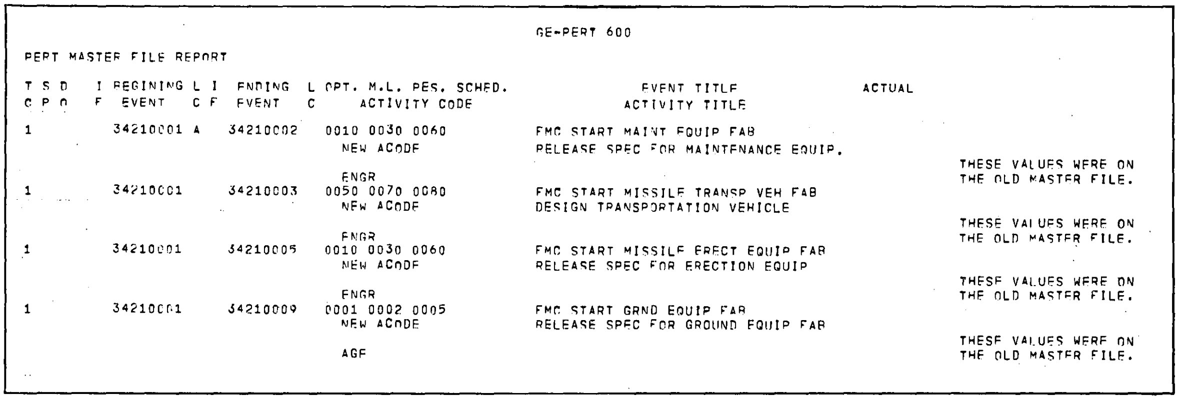
The master file listing contains the contents of each record of the master file as it appears after all updates.

The change listing contains those items in the master file record which have changed on this run. (These should not be confused with the change codes mentioned under activity report, page 32.) Refer to Figures 7, 8, and 9.



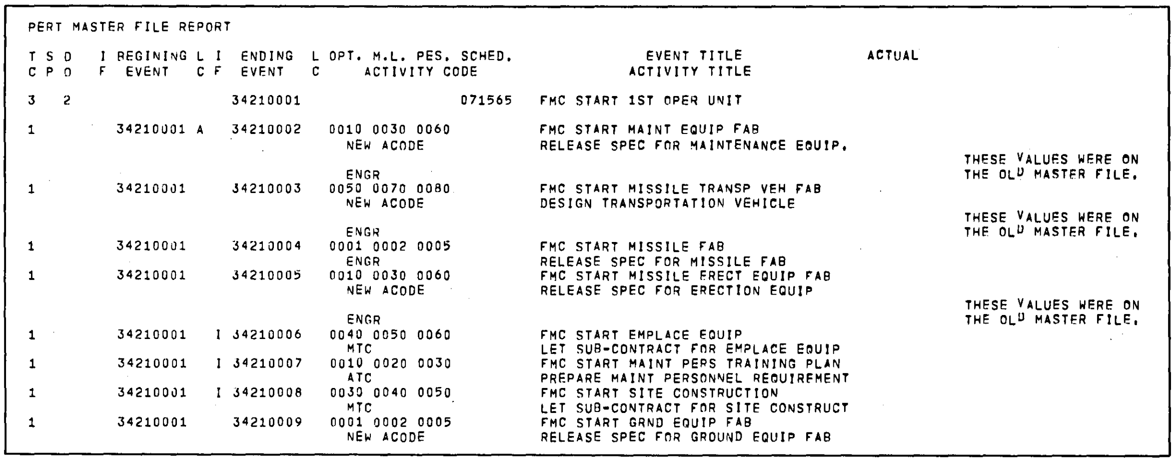
```
PERT MASTER FILE REPORT

T S D   I BEGINING L I  ENDING  L OPT. M.L. PES. SCHED.            EVENT TITLE             ACTUAL
C P O   F  EVENT   C F  EVENT   C      ACTIVITY CODE              ACTIVITY TITLE

3   2                   34210001                   071565  FMC START 1ST OPER UNIT

1         34210001 A    34210002  0010 0030 0060           FMC START MAINT EQUIP FAB
                                    ENGR                   RELEASE SPEC FOR MAINTENANCE EQUIP.
1         34210001      34210003  0050 0070 0080           FMC START MISSILE TRANSP VEH FAB
                                    ENGR                   DESIGN TRANSPORTATION VEHICLE
1         34210001      34210004  0001 0002 0005           FMC START MISSILE FAB
                                    ENGR                   RELEASE SPEC FOR MISSILE FAB
1         34210001      34210005  0010 0030 0060           FMC START MISSILE ERECT EQUIP FAB
                                    ENGR                   RELEASE SPEC FOR ERECTION EQUIP
1         34210001    I 34210006  0040 0050 0060           FMC START EMPLACE EQUIP
                                    MTC                    LET SUB-CONTRACT FOR EMPLACE EQUIP
1         34210001    I 34210007  0010 0020 0030           FMC START MAINT PERS TRAINING PLAN
                                    ATC                    PREPARE MAINT PERSONNEL REQUIREMENT
1         34210001    I 34210008  0030 0040 0050           FMC START SITE CONSTRUCTION
```

Figure 7. Master File Listing with No Changes



```
                                                  GE-PERT 600
PERT MASTER FILE REPORT

T S D   I BEGINING L I  ENDING  L OPT. M.L. PES. SCHED.          EVENT TITLE            ACTUAL
C P O   F  EVENT   C F  EVENT   C      ACTIVITY CODE            ACTIVITY TITLE

1         34210001 A    34210002  0010 0030 0060           FMC START MAINT EQUIP FAB
                                    NEW ACODE              RELEASE SPEC FOR MAINTENANCE EQUIP.
                                                                                          THESE VALUES WERE ON
                                    ENGR                                                  THE OLD MASTER FILE.
1         34210001      34210003  0050 0070 0080           FMC START MISSILE TRANSP VEH FAB
                                    NEW ACODE              DESIGN TRANSPORTATION VEHICLE
                                                                                          THESE VALUES WERE ON
                                    ENGR                                                  THE OLD MASTER FILE.
1         34210001      34210005  0010 0030 0060           FMC START MISSILE ERECT EQUIP FAB
                                    NEW ACODE              RELEASE SPEC FOR ERECTION EQUIP
                                                                                          THESE VALUES WERE ON
                                    ENGR                                                  THE OLD MASTER FILE.
1         34210001      34210009  0001 0002 0005           FMC START GRND EQUIP FAB
                                    NEW ACODE              RELEASE SPEC FOR GROUND EQUIP FAB
                                                                                          THESE VALUES WERE ON
                                    AGE                                                   THE OLD MASTER FILE.
```

Figure 8. Master File Listing of Changes Only



```
PERT MASTER FILE REPORT

T S D   I BEGINING L I  ENDING  L OPT. M.L. PES. SCHED.          EVENT TITLE            ACTUAL
C P O   F  EVENT   C F  EVENT   C      ACTIVITY CODE            ACTIVITY TITLE

3   2                   34210001                  071565   FMC START 1ST OPER UNIT

1         34210001 A    34210002  0010 0030 0060           FMC START MAINT EQUIP FAB
                                    NEW ACODE              RELEASE SPEC FOR MAINTENANCE EQUIP.
                                                                                          THESE VALUES WERE ON
                                    ENGR                                                  THE OLD MASTER FILE.
1         34210001      34210003  0050 0070 0080           FMC START MISSILE TRANSP VEH FAB
                                    NEW ACODE              DESIGN TRANSPORTATION VEHICLE
                                                                                          THESE VALUES WERE ON
                                    ENGR                                                  THE OLD MASTER FILE.
1         34210001      34210004  0001 0002 0005           FMC START MISSILE FAB
                                    ENGR                   RELEASE SPEC FOR MISSILE FAB
1         34210001      34210005  0010 0030 0060           FMC START MISSILE ERECT EQUIP FAB
                                    NEW ACODE              RELEASE SPEC FOR ERECTION EQUIP
                                                                                          THESE VALUES WERE ON
                                    ENGR                                                  THE OLD MASTER FILE.
1         34210001    I 34210006  0040 0050 0060           FMC START EMPLACE EQUIP
                                    MTC                    LET SUB-CONTRACT FOR EMPLACE EQUIP
1         34210001    I 34210007  0010 0020 0030           FMC START MAINT PERS TRAINING PLAN
                                    ATC                    PREPARE MAINT PERSONNEL REQUIREMENT
1         34210001    I 34210008  0030 0040 0050           FMC START SITE CONSTRUCTION
                                    MTC                    LET SUB-CONTRACT FOR SITE CONSTRUCT
1         34210001      34210009  0001 0002 0005           FMC START GRND EQUIP FAB
                                    NEW ACODE              RELEASE SPEC FOR GROUND EQUIP FAB
```

Figure 9. Master File Listing with Changes

DIAGNOSTICS

Holiday and Vacation Card Diagnostics*

Printout	Error Condition	Effect	Corrective Action
An error message showing an illegal pair of dates.	a. One or both of two vacation dates defining a holiday or vacation period are illegal; for example, 30FEB65, 12DOC71, 14OCTGH. b. The end date of the pair is less than the start date. c. Either date of a pair is less than the dates defined by the previous pairs.	The illegal dates are ignored.	Correct the dates for next run.
A "table full" message following a listing of each pair which passed the legality check.	Holiday or vacation table limit of 500 days is exceeded.	The dates are not used.	Define the reason for the overflow and take corrective action.

Transaction Card Diagnostics*

Printout	Error Condition	Effect	Corrective Action
A listing of all cards with illegal transaction codes.	Illegal transaction code--an alphabetic character, 0 or 7.	The entire card is ignored.	Correct the transaction code.
A listing of all cards with illegal event numbers.	Illegal event numbers--contain trailing blanks; an alphabetic character; a 0 or blank predecessor on a 1, 2, 4, 8, or 9 transaction code; or a 0 or blank successor on any card.	The entire card is ignored.	Correct the event number.
Diagnostic		Effect	Corrective Action
THE NUMBER OF LEVEL CODES AVAILABLE TO BE ASSIGNED TO CRITICAL PREDECESSORS HAS EXCEEDED 500. ONLY 500 WILL BE USED.		Only 500 level codes will be used.	None.

*If the program encounters any combination of 200 error cards, processing is discontinued.

Master File Diagnostics *

Printout	Error Condition	Effect	Corrective Action
Contents of an incorrect master file record. Illegal level codes, scheduled date option, time estimates, or date fields listed below the image of the master file record.	All errors found as card input merges with the old master file, except duplicate entries and updates of non-existent activities.	Each new master file record is written with the errors on it until the errors are corrected. Any erroneous fields are not passed through the calculations.	Correct indicated errors on the next run.
Contents of a card with "duplicate" message.	Duplicate entry--two update cards with the same event numbers and transaction codes, or a transaction 1 card with event numbers equal to those on some existing master file record.	The data on the card is ignored.	Remove the incorrect duplicate from the deck.
Contents of a card with "nonexistent activity" message.	Update is attempted on activity which does not exist on the master file.	The date on the card is ignored.	Find reason for error and eliminate it.

Report Parameter Diagnostics

Any error within the report parameter cards prevents the execution of that report.

Printout	Error Condition	Corrective Action
ILLEGAL PRINT PARAMETER FOR EVENT REPORT ———.	Parameter may be misspelled.	Check parameter list.
ILLEGAL PRINT PARAMETER FOR ACTIVITY REPORT ———.	Parameter may be misspelled.	Check parameter list.
ILLEGAL CARD ARRANGEMENT--ACTIVITY OR EVENT CARD MISSING.	An ACTIVITY or EVENT card does not precede all other parameter cards for a report. A card is out of order, or there are multiple PRINT cards.	Place cards in correct order.

---

*If the program encounters any combination of 200 error cards, processing is discontinued.

Additional master file diagnostic:

Printout	Error Condition	Effect	Corrective Action
WRONG MASTER TAPE MOUNTED RUN ABORTED	This error can be caused by any one of three conditions. 1. On initial card 1 the user's ID does not match the user's ID from the previous run. 2. On initial card 2 the old master ID does not match the new master ID from the last run. 3. There is a blank card somewhere after the $ EXECUTE control card and before the 2nd initial card	Run is aborted.	Check the user's ID. Check the old master ID. Check for a blank card somewhere between the $ EXECUTE control card and the second initial card.

Printout	Error Condition	Corrective Action
ILLEGAL CARD ARRANGEMENT-- MIXED REPORT NUMBERS.	Card for a new report number encountered. A PRINT card for previous report may be missing, or a card from another report may be out of place.	Place cards in correct order.
ILLEGAL CARD TYPE _____.	First three letters or card type (col. 8-10) do not match those of a permissible card type.	Check spelling.
PARAMETER LIST EMPTY.	Card columns 17-80 are blank. (Suppress card or INCLUDE/ EXCLUDE card is meaningless when parameter list is empty.)	Supply parameter or omit card.
ILLEGAL PRINT PARAMETER FOR SUPPRESS CARD.	Parameter may be misspelled.	Check parameter list.
ILLEGAL PRINT PARAMETER FOR BREAK CARD.	Parameters may be misspelled.	Check parameter list.
EXCEEDS LIMIT OF 50 BREAK CARDS.		Take a card out.
COMPARISON INCOMPLETE	.EQ., .LT., or .GT. not followed by a parameter to compare.	Put in value and resubmit.
EXCEEDS LIMIT OF 25 I/E CARDS.		Take out a card.
ILLEGAL PRINT PARAMETER FOR INCLUDE/ EXCLUDE CARD_____.	Parameter may be misspelled.	Check parameter list.
ILLEGAL TO HAVE MULTIPLE CARDS OF THIS TYPE.	There are multiple event activity, suppress, title or print cards.	Remove unnecessary card.
ILLEGAL PRINT PARAMETER FOR PRINT CARD _____.	Parameter may be misspelled.	Check parameter list.
PARAMETERS REPEATED-- NUMBER OF COPIES LACKING.	More than 2 parameters found, but no numeric digits.	Remove repeated parameter.
ILLEGAL CARD ARRANGEMENT--PRINT CARD MISSING.	END card encountered when report in progress is incomplete.	Insert PRINT card for completion.

Printout	Error Conditions	Corrective Action
ILLEGAL ACODE VALUE--NOT COMPATIBLE WITH MAJOR SORT.	Number of 1's in ACODE sort format not equal to number of digits in each item for ACODE comparison.	Check ACODE format and change as necessary.
ACODE FORMAT UNDEFINED COMPARISON IMPOSSIBLE.	The search for1's in the ACODE format yielded none. The format was either omitted or defined without any 1's.	Define format and resubmit.
ILLEGAL BREAK CARD--PREVIOUS BREAKS ARE BY COMPARISON.	A break card requesting a break on a change in the major field is rejected because it is preceded by break cards which use comparisons of values to determine break points.	Remove the BREAK cards which are inconsistent.
ILLEGAL FORMAT FOR PARAMETERS--ITEM LENGTH AND PUNCTUATION IN QUESTION.	Too many digits in parameter items.	Check spelling. May require punctuation.
FIELDS TO BE COMPARED TOO LARGE FOR MAJOR SORT KEY.	1. Level code exceeds 1 alphanumeric digit. 2. ACODE number exceeds 18 alphanumeric digits. 3. Another type of code exceeds 8 alphanumeric digits.	Check values and resubmit.
ILLEGAL LISTS. ONLY ONE ITEM PERMITTED FOR THIS COMPARISON	Comparison list for I/E card for a comparison other than .EQ.	Redefine list for .EQ. comparison.
ILLEGAL ACODE VALUE--ITEM LENGTH NOT COMPATIBLE WITH ACODE FORMAT.	The number of 1's defining the fields of interest is not equal to the number of digits in each item for comparison.	Check ACODE format.
ALPHABETIC DATA IN NUMERIC CODE FIELD.	An alphabetic is used in comparison other than that for a level code or an ACODE; for example, a minus on an item other than a slack.	Remove alphabetics and resubmit.
ILLEGAL REPORT/SORT/BREAK COMBINATION.	The type of report and the previous sort order will make the breaks frequent and erratic.	Possibly remedy--give sort order for this report.

Printout	Error Conditions	Corrective Action
ILLEGAL BREAK CARD--EARLIER BREAK CARD REQUESTS A BREAK ON ANY CHANGE IN MAJOR SORT FIELD.	1. More than one BREAK card asks for a break on change in the major sort field. 2. BREAK cards are inconsistent.	Check the manual.
ILLEGAL COMPARISON FOR BREAK CARD--. LT.	Only . GT. or . EQ. may be used on a BREAK card.	Redefine value for . GT. or . EQ.
ILLEGAL MIXTURE OF COMPARISONS FOR BREAK CARD--MUST BE ALL . EQ. or all . GT.	. EQ. and . GT. comparisons for BREAK cards are mixed on a report	Choose one comparison and make all cards consistent.
ERRORS PREVENT EXECUTION--REPORT #____.		Correct errors and rerun.
END OF RUN.	END card encountered.	Processing stops.

Network Diagnostics

Printout	Error Condition	Effect	Corrective Action
COMPLETED ACTIVITY PRECEDED BY EITHER AN INCOMPLETE ACTIVITY OR AN ACTIVITY WITH A LATER COMPLETION DATE.	Predecessor constrained by at least one incomplete activity.	The program assumes that the user failed to report all the completed activities. Normal calculation resumes.	Check network for unreported completed activities.
INCOMPLETE ACTIVITIES WITHOUT A START DATE OR A PREDECESSOR.	The user has supplied no information from which to base the T_E calculation.	If a network start date is encountered it will be used. Otherwise, the date 01JAN45 will be used.	Enter scheduled start date or check for missing predecessor activities.
NETWORK IS CIRCULAR.	An illogical network structure has been submitted in which one event shows up as its own successor.	All such circular conditions are indicated and processing halts.	Check for erroneous network construction or duplication of event numbers.

REPORTS

Event Report

The headings for both the event report and the activity report include the following items:

Network title
System identification
Network start date
Report number
Page number
User identification
Report date
Type of report (event or activity)
Most critical slack
Network completion date
Run number
Number of events in network
Number of activities in network
Report title
Sort sequence

The event report has the following columns:

Event description
Event level code
Critical predecessor (event number)
Level code of critical predecessor
Short path flag
Expected time
Expected date
Latest time
Latest date
Slack
Actual date
Scheduled date
Change code (in print position 132) *

*Change code--For both activity and event reports, the following symbols will be used for the change code:

N	New
C	Activity code
A	Actual date
T	Activity time (t_e)
S	Scheduled time
L	Level code
D	Activity description
E	Event description
I	Interface flag
F	Short path flag

Change codes may appear as a result of changes made either on this run or on a previous run. Changes made to this run will always be reflected by change codes unless suppressed by parameter request. Change codes from previous runs will be carried on the master file and will appear on activity and event reports unless deleted by Initial Card 2.

The event report change code reflects the condition of the group of activities which share the event as a successor. If only one activity in the group has a change code it will appear on the event report. If there is more than one the event report will show the change code of the activity with the greatest slack.

Activity Report

The headings of the activity report is the same as that for the event report.

The activity report (long form, 2 lines per activity) has the following columns:

- Predecessor event number
- Level code of predecessor event
- Successor event number
- Level code of successor event
- Expected time
- Expected date
- Latest time
- Latest date
- Activity time (t_e)
- Activity slack
- Scheduled date
- Critical predecessor (event number)
- Level code of critical predecessor
- Event slack
- Successor event expected date
- Current indicator (denoted by an asterisk in print position 124)
- Change code (in print position 127)*
- Short path flag
- Activity code
- Activity description
- Current activity (denoted by an asterisk in print position 131)

The activity report (short form, 1 line per activity) has the following columns:

- Predecessor event
- Successor event
- Activity code
- Activity description
- Expected time
- Expected date
- Latest time
- Latest date
- Activity time (t_e)
- Activity slack
- Scheduled date
- Current activity (denoted by an asterisk in print position 124)
- Current indicator (denoted by an asterisk in print position 131)
- Change code (in print position 132)*

Irrelevant data will be omitted from these reports for beginning events, events with actual dates, and completed activities.

*Change code--For both activity and event reports, the following symbols will be used for the change code:

N	New	L	Level code
C	Activity code	D	Activity description
A	Actual date	E	Event description
T	Activity time (t_e)	I	Interface flag
S	Scheduled time	F	Short path flag

Change codes may appear as a result of changes made either on this run or on a previous run. Changes made to this run will always be reflected by change codes unless suppressed by parameter request. Change codes from previous runs will be carried on the master file and will appear on activity and event reports unless deleted by Initial Card 2.

APPENDIX A
METHOD OF TOPOLOGY

GE-PERT topology is a mathematical approach which arranges the data in proper sequence for calculations and allows the user to number at random the events of his network.

The method is based on an article, Topological Sorting of Large Networks by Dr. A. B. Kahn, Communications of the ACM, November, 1962.

As larger network capacities and more digits for the event code are demanded, the topological method becomes increasingly difficult and time consuming. GE-PERT/600 offers a capacity of 10,000 activities with an 8-digit numeric event code to substantially reduce the amount of computer time necessary for the topology. Thorough loop detection is also accomplished.

The process is best explained by the use of an example. Consider the network shown in Figure 10.

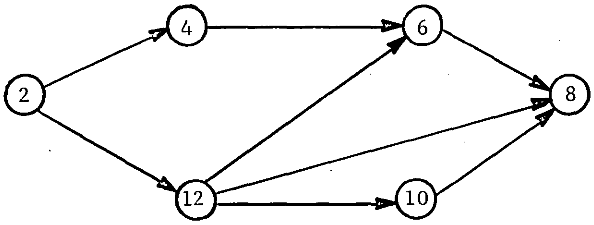


Figure 10. Sample PERT Network

The general aim is to "perfectly renumber" the given network. This is defined as follows:

1. If E events occur in the given network, they will be uniquely renumbered with all of the integers from 1 through E.
2. For all activities, the predecessor will be numerically smaller than the successor.

The first step in the procedure is to prepare the activity or event lists.

The input to the topology section is a numerical list of the activities in predecessor, successor order.

Activity List

Predecessor	Successor
2	4
2	12
4	6
6	8
10	8
12	6
12	8
12	10

A numerical list of all events can be prepared from the given activity input.

Event List

2
4
6
8
10
12

One basic question is asked throughout the procedure: "Are there any events which have no direct predecessor activities?"

If the answer is "yes" (as for event 2 at the beginning of the network shown in Figure 10), the following is done:

1. The event involved is renumbered with the next available topological sequence number. For event 2, this new number would be 1, as 2 is the first event of the network.
2. The event and all of its direct successor activities are logically "thrown out" of the system. In the example, this corresponds to throwing out event 2 and activities 2-4 and 2-12.
3. The number of direct predecessor activities for each successor event involved in the calculation (4 and 12 in the example) is reduced by 1. When this is done, events 4 and 12 each have no direct predecessor activities.

The basic question is asked again. The answer is now yes for events 4 and 12. Their new numbers would be 2 and 3. Events 4 and 12 and activities 4-6; 12-6; 12-8; and 12-10 would be thrown out.

Repeated applications of the above procedure eventually causes the basic question to be answered "no" for all events. Unless the network has a loop, this indicates that the renumbering is complete. In the sample problem, the events would be resequenced as shown on the following page.

Event Numbers	
Original Order	Topological Sequence
2	1
4	2
6	4
8	6
10	5
12	3

The original numbers are retained, and the new numbers are added to the activity records to be used for computational purposes. However, only the original numbers appear on the output.

The basic procedure described above may be performed through use of the information presented in the charts below:

Activity List

Predecessor	Successor	B
2	4	2
2	12	6
4	6	3
6	8	4
10	8	4
12	6	3
12	8	4
12	10	5

Event List

Event Number	C	D
2	0	1
4	1	3
6	2	4
8	3	E
10	1	5
12	1	6

The following discussion describes the use of this information.

Column C is a count of the number of direct predecessor activities for each event. Asking the basic question corresponds to searching column C for a 0 entry.

Column D points to the first of a group of activities within the activity list that will logically be thrown out when each event number is sequenced. It refers to positions in the predecessor list. The occurrence of a new number in the predecessor list indicates the beginning of a new group. Therefore, for event 2, the 1 in column D refers to the first position in the predecessor list; that is, event 2. In this case, column D indicates that activities 2-4 and 2-12 should be omitted. The number 4 in the third position in the predecessor list indicates the beginning of a new group.

Column B locates for each activity the event predecessor count which may be lowered at the time the activity is thrown out. It points to a number in the event number list (the successor event number of the activity) and indicates that the corresponding number in column C may be reduced by 1. As described above, after activity 2-4 has been thrown out, the number of direct predecessors for successor event 4 is reduced to 0. Column B indicates this as follows: The number 2 adjacent to activity 2-4 refers to the second position (event 4) in the event number list. This shows that the corresponding 1 in column C may be reduced to 0.

The actual predecessor, successor and event numbers do not have to be in core at the time of the topological sequencing. Therefore, the only information required at this time is:

A	B
0	2
1	6
0	3
0	4
0	4
0	3
1	4
1	5

C	D
0	1
1	3
2	4
3	E
1	5
1	6

Since the predecessor numbers are no longer available, column A becomes necessary to define the size of the group of activities to be thrown out. The first activity of a group is flagged with a 0 bit and all others are flagged with a 1 bit.

After an event has been thrown out, the original entry in column D is no longer necessary. Thus, it may be replaced by the topological sequence number. Column C must be replaced with a flag entry, so that it will not be picked up for sequencing again.

The basic process for the assignment of one topological sequence number is reviewed below:

1. A search of column C reveals that the first entry is a candidate (0 entry).
2. The column C entry is replaced by a sequenced flag F so that it will not be picked up again.
3. The column D entry locates the first of a group of activities which may logically be thrown out of the system (first entry in the activity list).
4. Column D is replaced by the next available topological sequence number (starts at 1).
5. Column A identifies two activities to be thrown out.
6. As each of the activities are thrown out, they locate a column C event predecessor count which may be lowered by 1 (second and sixth entries, as indicated by column B). At the completion of the first assignment, column C has been adjusted to

C
F
0
2
3
1
0

Now the second and sixth entries are candidates for resequencing. This corresponds to events 4 and 12.

The process is completed in the manner outlined above.

Note that the new numbers may be used as index values to greatly speed up the T_E and T_L calculations.

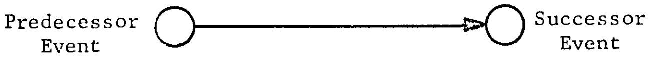
APPENDIX B
USAGE OF THE NETWORK MODEL

Project planning begins with the determination of project activities or jobs and their precedence relationships. This is simplified by the use of a graphic technique, the arrow diagram or project network model.

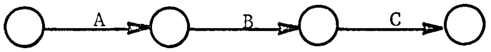
The arrow represents an activity or job to be done.

The circle represents an event or a point in time. ○

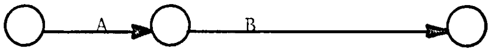
Each activity of a network must begin at an event, the predecessor event, and end at an event, the successor event.



In the illustration below, activity A must be completed before activity B can be started, and C may not start until B is completed.



Arrow length does not have significance. In the example below, activity A might require weeks to complete and activity B may require only a few days. Arrow length is chosen for convenience and clarity.



Figures 11, 12 and 13 indicate precedence relationships.

The network in Figure 11 shows that activity C may not begin until two other activities, A and B, are completed and that A and B are otherwise independent of each other.

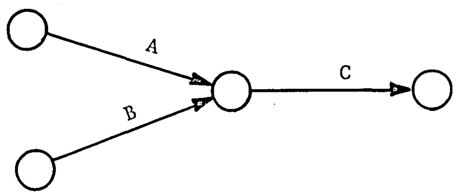


Figure 11. Three-Activity Project Segment

Figure 12 illustrates a project segment consisting of four activities: A, B, C and D. The initiation of B and D are contingent upon the completion of A can C, respectively. However, no relationship exists between A and C. The method of diagramming chosen depends upon the prerequisites of A and C.

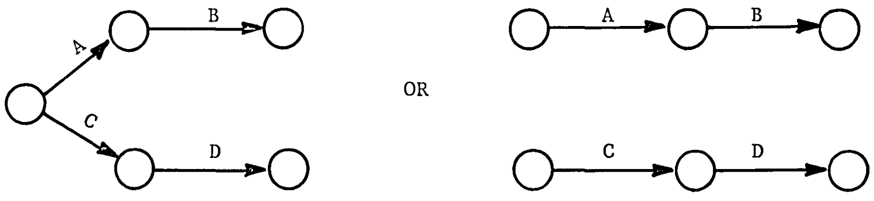


Figure 12. Four-Activity Project Segment

Another type of four-activity project network is shown in Figure 13. Here D may not begin until A is completed, even though they are not related by an activity. This precedential relationship is illustrated by a dummy activity or broken-line arrow. No expected time or duration is associated with dummy arrows used in this manner. They are used only to show precedential relationships.

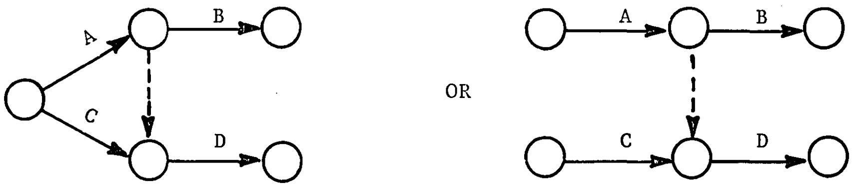


Figure 13. Four-Activity Project Segment with Dummy Activity

Actual projects do not consist of activities that are readily labeled A, B, C, D, etc. Diagrams become more meaningful if activities are labeled by their function or description. However, this method of identification becomes unwieldy in discussions and in a computer environment. The numerical method for activity and event identification, which is essential for computerized network analysis, provides a convenient shorthand for referencing activities.

Figure 14 illustrates event number usage.

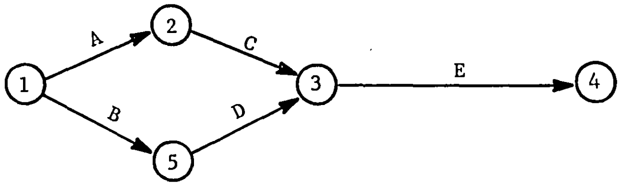


Figure 14. Network Including Event Numbers

Note that event ① represents the project start and event ④ represents project completion. Activity C may be described in terms of its predecessor event and successor event--activity (2, 3) or merely (2, 3). This uniquely identifies the activity, because no other activity lies between events 2 and 3.

A common network design problem is illustrated in Figure 15. Two activities, B and C, have the same prerequisite, completion of activity A. A fourth activity, D is dependent upon the completion of both B and C. In this case, activity B or C cannot be uniquely identified by predecessor-successor event number (2, 3). Both B and C are bracketed by the same events in the figure.

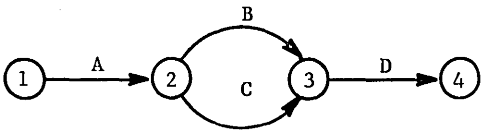


Figure 15. Illustration of Network Design Problem

This bracketing can be avoided by redrawing the diagram with a dummy arrow (necessitating another event) as shown in Figure 16.

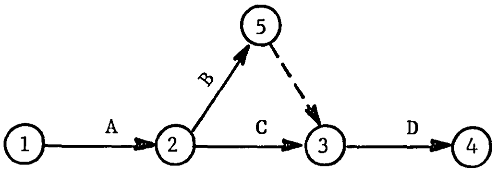


Figure 16. Solution of Network Design Problem

Now activities B and C may be uniquely identified by (2, 5) and (2, 3) respectively.

A simple practical project further illustrates the fundamentals of arrow diagramming.

An electronic equipment manufacturer must establish a broad flow plan to determine plant layout. A study shows that there are four pertinent activities:

1. Building the equipment.
2. Calibrating the equipment.
3. Building a shipping crate.
4. Boxing, packing and shipping the equipment.

The generation of an arrow diagram is partly a trial-and-error process. For each activity, three questions may be asked:

1. Which activities may be done concurrently with this one?
2. Which activities must be completed before this one is begun?
3. Which activities cannot be started until this activity is completed?

Figure 17 shows the manufacturer's resultant network model.

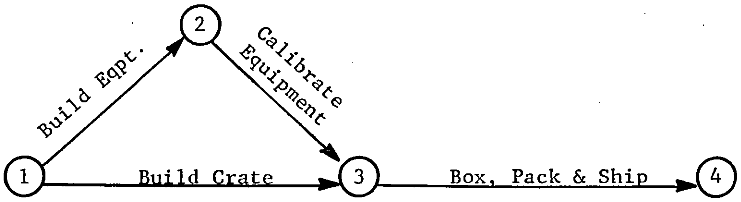
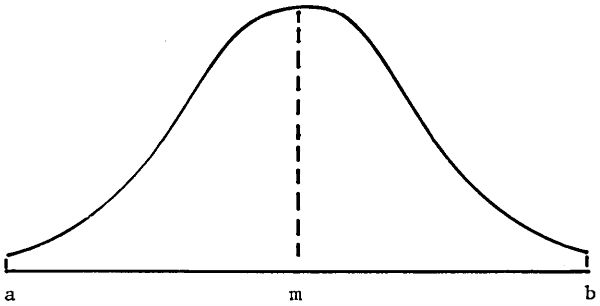


Figure 17. Event Network for Practical Problem

The above discussion shows that drawing the network model constitutes the important planning phase of the project. The user then assigns expected times or durations for each activity of the project. After this, he is ready to fill out his data cards for computer entry.

APPENDIX C
TIME ESTIMATES

GE-PERT/600 time estimates are assumed to follow a BETA distribution.



a = Most optimistic time - An estimate of the time in which an activity can be completed if everything goes well.

m = Most likely time - An estimate of the time in which an activity is most likely to be completed.

b = Most pessimistic time - An estimate of the time in which an activity can be completed under the most adverse conditions.

The expected time is calculated as: $t_e = \frac{a + 4m + b}{6}$

APPENDIX D
DECK SETUP

The GE-PERT/600 deck sequence is as follows:

1. System control cards (beginning):

   a. $ IDENT   with user's identification as required by his installation
   b. $ COMMENT

2. 600 PERT binary deck

3. $ EXECUTE

4. File control cards (See <u>GE-625/635 General File and Record Control</u>, CPB- 1003C)

5. Input data (see Figure 1).

6. System control cards (ending):

   a. $ ENDJOB
   b. ***EOF

Figure 18 is an example of an actual GE-600 PERT deck.

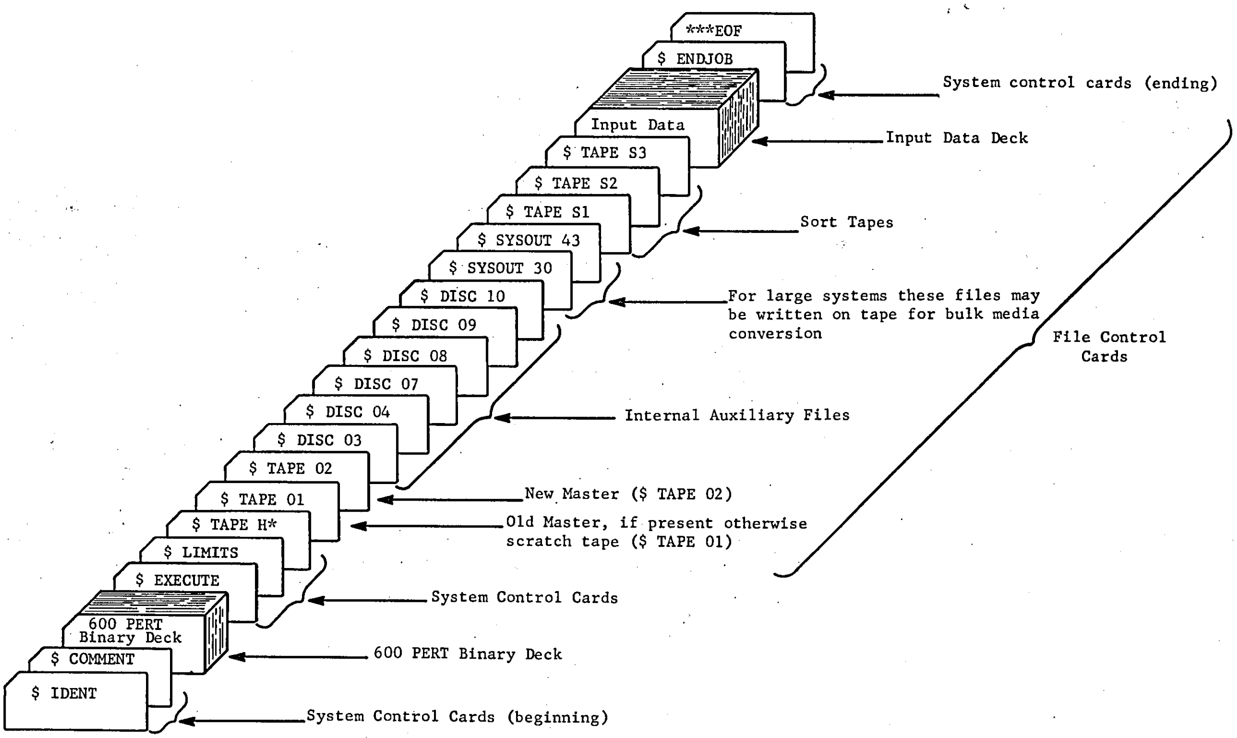
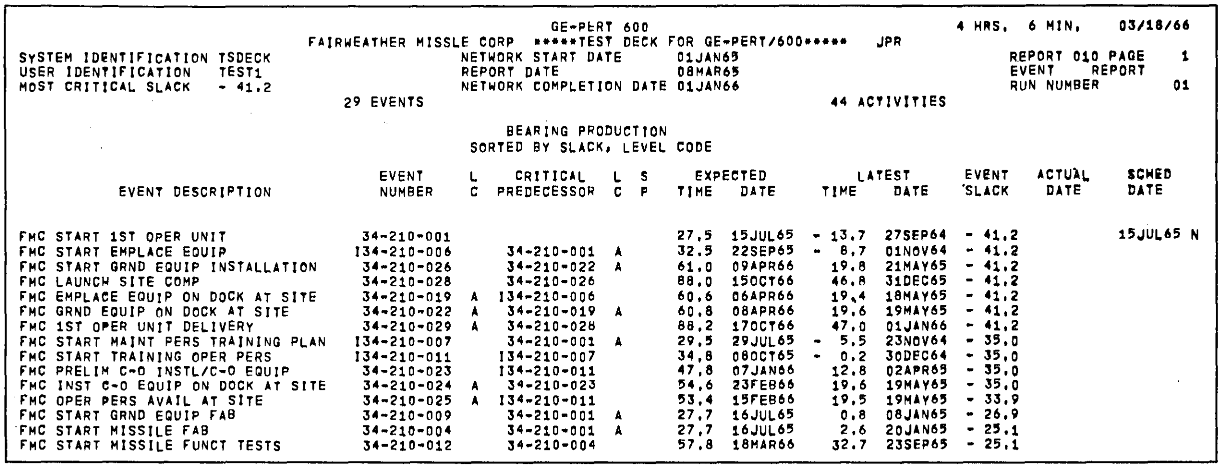


Figure 18. GE-PERT/600 Deck Sequence

APPENDIX D1
SAMPLE OUTPUT REPORTS

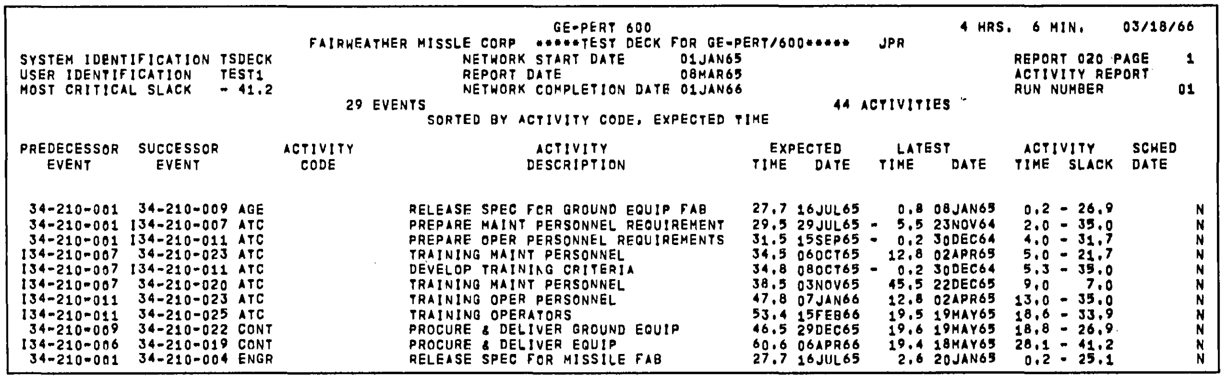
Figure 18a is a sample printout of the event report.



```
                                                           GE-PERT 600                                 4 HRS,  6 MIN,      03/18/66
                                FAIRWEATHER MISSLE CORP  *****TEST DECK FOR GE-PERT/600*****    JPR
SYSTEM IDENTIFICATION TSDECK                     NETWORK START DATE     01JAN65                              REPORT 010 PAGE    1
USER IDENTIFICATION   TEST1                      REPORT DATE            08MAR65                              EVENT    REPORT
MOST CRITICAL SLACK   - 41.2                     NETWORK COMPLETION DATE 01JAN66                             RUN NUMBER        01
                                    29 EVENTS                                   44 ACTIVITIES

                                                      BEARING PRODUCTION
                                                  SORTED BY SLACK, LEVEL CODE

                                        EVENT     L    CRITICAL   L S     EXPECTED          LATEST      EVENT   ACTUAL    SCHED
           EVENT DESCRIPTION            NUMBER    C  PREDECESSOR  C P   TIME   DATE     TIME    DATE    'SLACK   DATE     DATE


FMC START 1ST OPER UNIT               34-210-001                        27,5  15JUL65  - 13.7  27SEP64  - 41.2           15JUL65 N
FMC START EMPLACE EQUIP              I34-210-006      34-210-001  A     32.5  22SEP65  -  8,7  01NOV64  - 41.2
FMC START GRND EQUIP INSTALLATION     34-210-026      34-210-022  A     61,0  09APR66    19.8  21MAY65  - 41,2
FMC LAUNCH SITE COMP                  34-210-028      34-210-026        88,0  15OCT66    46,8  31DEC65  - 41,2
FMC EMPLACE EQUIP ON DOCK AT SITE     34-210-019  A  I34-210-006        60,6  06APR66    19,4  18MAY65  - 41,2
FMC GRND EQUIP ON DOCK AT SITE        34-210-022  A   34-210-019  A     60,8  08APR66    19,6  19MAY65  - 41,2
FMC 1ST OPER UNIT DELIVERY            34-210-029  A   34-210-028        88,2  17OCT66    47,0  01JAN66  - 41,2
FMC START MAINT PERS TRAINING PLAN   I34-210-007      34-210-001  A     29,5  29JUL65  -  5,5  23NOV64  - 35,0
FMC START TRAINING OPER PERS         I34-210-011     I34-210-007        34,8  08OCT65  -  0.2  30DEC64  - 35,0
FMC PRELIM C-O INSTL/C-O EQUIP        34-210-023     I34-210-011        47,8  07JAN66    12.8  02APR65  - 35,0
FMC INST C-O EQUIP ON DOCK AT SITE    34-210-024  A   34-210-023        54,6  23FEB66    19,6  19MAY65  - 35,0
FMC OPER PERS AVAIL AT SITE           34-210-025  A  I34-210-011        53,4  15FEB66    19,5  19MAY65  - 33,9
FMC START GRND EQUIP FAB              34-210-009      34-210-001  A     27,7  16JUL65     0,8  08JAN65  - 26,9
FMC START MISSILE FAB                 34-210-004      34-210-001  A     27,7  16JUL65     2,6  20JAN65  - 25,1
FMC START MISSILE FUNCT TESTS         34-210-012      34-210-004        57,8  18MAR66    32.7  23SEP65  - 25,1
```

Figure 18a. Event report.

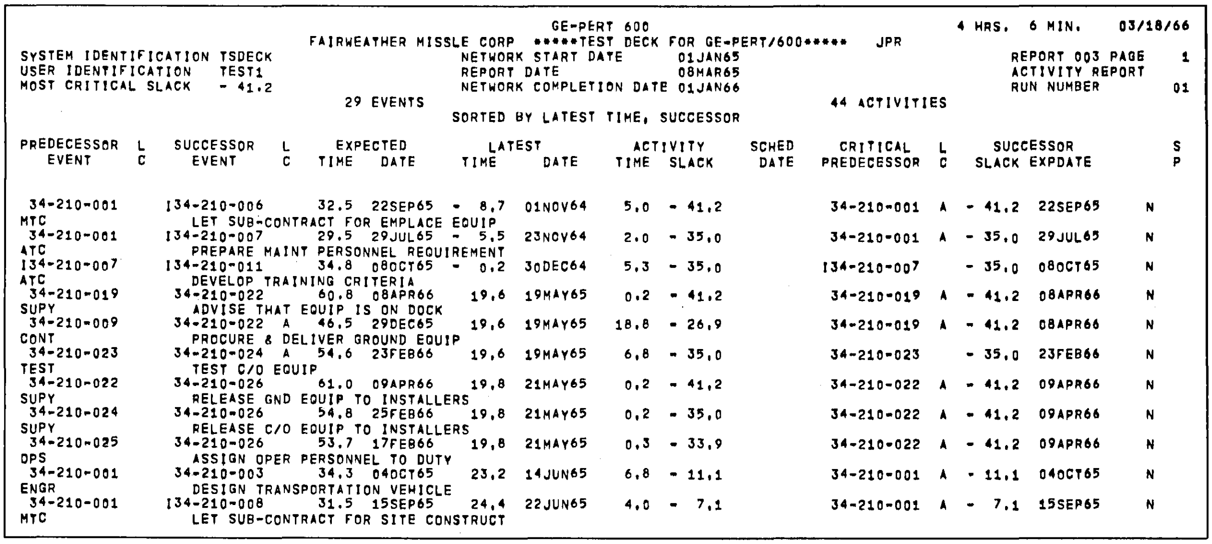
Figure 18b is a sample printout of the short form activity report with one line per activity.



```
                                                           GE-PERT 600                                   4 HRS.  6 MIN.    03/18/66
                                FAIRWEATHER MISSLE CORP  *****TEST DECK FOR GE-PERT/600*****   JPR
SYSTEM IDENTIFICATION TSDECK                     NETWORK START DATE      01JAN65                              REPORT 020 PAGE     1
USER IDENTIFICATION   TEST1                      REPORT DATE             08MAR65                              ACTIVITY REPORT
MOST CRITICAL SLACK   - 41.2                     NETWORK COMPLETION DATE 01JAN66                              RUN NUMBER         01
                                    29 EVENTS                                 44 ACTIVITIES
                                             SORTED BY ACTIVITY CODE, EXPECTED TIME

PREDECESSOR  SUCCESSOR       ACTIVITY                    ACTIVITY                  EXPECTED      LATEST        ACTIVITY    SCHED
   EVENT       EVENT           CODE                     DESCRIPTION              TIME    DATE   TIME    DATE  TIME   SLACK  DATE


 34-210-001  34-210-009 AGE                RELEASE SPEC FCR GROUND EQUIP FAB     27.7 16JUL65     0.8 08JAN65  0.2 - 26.9          N
 34-210-001 I34-210-007 ATC                PREPARE MAINT PERSONNEL REQUIREMENT   29.5 29JUL65 -   5.5 23NOV64  2.0 - 35.0          N
 34-210-001 I34-210-011 ATC                PREPARE OPER PERSONNEL REQUIREMENTS   31.5 15SEP65 -   0.2 30DEC64  4.0 - 31.7          N
I34-210-007  34-210-023 ATC                TRAINING MAINT PERSONNEL              34.5 06OCT65    12.8 02APR65  5.0 - 21.7          N
I34-210-007 I34-210-011 ATC                DEVELOP TRAINIKG CRITERIA             34.8 08OCT65 -   0.2 30DEC64  5.3 - 35.0          N
I34-210-007  34-210-020 ATC                TRAINING MAINT PERSONNEL              38.5 03NOV65    45.5 22DEC65  9.0    7.0          N
I34-210-011  34-210-023 ATC                TRAINING OPER PERSONNEL               47.8 07JAN66    12.8 02APR65 13.0 - 35.0          N
I34-210-011  34-210-025 ATC                TRAINING OPERATORS                    53.4 15FEB66    19.5 19MAY65 18.6 - 33.9          N
 34-210-009  34-210-022 CONT               PROCURE & DELIVER GROUND EQUIP        46.5 29DEC65    19.6 19MAY65 18.8 - 26.9          N
I34-210-006  34-210-019 CONT               PROCURE & DELIVER EQUIP               60.6 06APR66    19.4 18MAY65 28.1 - 41.2          N
 34-210-001  34-210-004 ENGR               RELEASE SPEC FOR MISSILE FAB          27.7 16JUL65     2.6 20JAN65  0.2 - 25.1          N
```

Figure 18b. One-line activity report.

Figure 18c is a sample printout of the long form activity report with two lines per activity. The column headings refer to the first line. The second line contains the activity code followed by the activity description.



```
                                                           GE-PERT 600                                  4 HRS.  6 MIN.    03/18/66
                                FAIRWEATHER MISSLE CORP  *****TEST DECK FOR GE-PERT/600*****    JPR
SYSTEM IDENTIFICATION TSDECK                     NETWORK START DATE      01JAN65                              REPORT 003 PAGE    1
USER IDENTIFICATION   TEST1                      REPORT DATE             08MAR65                              ACTIVITY REPORT
MOST CRITICAL SLACK   - 41.2                     NETWORK COMPLETION DATE 01JAN66                              RUN NUMBER        01
                                    29 EVENTS                                             44 ACTIVITIES
                                                SORTED BY LATEST TIME, SUCCESSOR

PREDECESSOR  L   SUCCESSOR   L     EXPECTED       LATEST        ACTIVITY      SCHED     CRITICAL   L     SUCCESSOR          S
   EVENT     C     EVENT     C   TIME  DATE    TIME     DATE    TIME  SLACK   DATE    PREDECESSOR  C  SLACK EXPDATE         P


 34-210-001     I34-210-006      32.5 22SEP65 -  8,7  01NOV64    5,0 - 41,2             34-210-001 A  - 41,2 22SEP65     N
MTC                LET SUB-CONTRACT FOR EMPLACE EQUIP
 34-210-001     I34-210-007      29.5 29JUL65 -  5,5  23NOV64    2.0 - 35,0             34-210-001 A  - 35,0 29JUL65     N
ATC                PREPARE MAINT PERSONNEL REQUIREMENT
I34-210-007     I34-210-011      34.8 08OCT65 -  0,2  30DEC64    5,3 - 35,0            I34-210-007    - 35,0 08OCT65     N
ATC                DEVELOP TRAINING CRITERIA
 34-210-019      34-210-022      60.8 08APR66   19,6  19MAY65    0.2 - 41,2             34-210-019 A  - 41,2 08APR66     N
SUPY               ADVISE THAT EQUIP IS ON DOCK
 34-210-009      34-210-022  A   46,5 29DEC65   19,6  19MAY65   18,8 - 26,9             34-210-019 A  - 41,2 08APR66     N
CONT               PROCURE & DELIVER GROUND EQUIP
 34-210-023      34-210-024  A   54,6 23FEB66   19,6  19MAY65    6,8 - 35,0             34-210-023    - 35,0 23FEB66     N
TEST               TEST C/O EQUIP
 34-210-022      34-210-026      61.0 09APR66   19,8  21MAY65    0,2 - 41,2             34-210-022 A  - 41,2 09APR66     N
SUPY               RELEASE GND EQUIP TO INSTALLERS
 34-210-024      34-210-026      54,8 25FEB66   19,8  21MAY65    0,2 - 35,0             34-210-022 A  - 41,2 09APR66     N
SUPY               RELEASE C/O EQUIP TO INSTALLERS
 34-210-025      34-210-026      53,7 17FEB66   19,8  21MAY65    0,3 - 33,9             34-210-022 A  - 41,2 09APR66     N
OPS                ASSIGN OPER PERSONNEL TO DUTY
 34-210-001      34-210-003      34,3 04OCT65   23,2  14JUN65    6,8 - 11,1             34-210-001 A  - 11,1 04OCT65     N
ENGR               DESIGN TRANSPORTATION VEHICLE
 34-210-001     I34-210-008      31.5 15SEP65   24,4  22JUN65    4,0 -  7,1             34-210-001 A  -  7,1 15SEP65     N
MTC                LET SUB-CONTRACT FOR SITE CONSTRUCT
```

Figure 18c. Two-line activity report.

APPENDIX E
NETWORK SUMMARIZATION

The network summarization section reduces the number of network activities by retaining events of particular interest to the user and (using these events) constructing a network consistent with the logic of the original network. The degree to which the network is summarized or reduced depends upon the summary option indicated by the user on initial card II, column 30, as explained on page 10.

For a minimum level summary the program selects start and end events in the area where work is being done as those of particular interest.

If the user denotes a summary level (A to Z) the program includes all events of that level and all events of higher levels. For example, a level C summary includes events of levels A, B, and C, as well as start and end events of the network and events which indicate the work in progress.

The program is not intended to be a management reporting tool, but is specifically designed to reduce a network, so that it may be combined with several other networks for a computer run. For this reason, output consists of a deck of punched cards in PERT format.

The basis for the summarization routine is a table of activities arranged by the program in topological sequence. This arrangement assures that only one pass need be made through the table to complete the selection of events, computation of summary activity expected times and actual dates for those activities which are completed.

The results of network summarization can best be explained through the use of a sample problem. The sample network in Figure 19 has been numbered in topological sequence (that is, the successor event number is larger than the predecessor event number for each activity), to facilitate the explanation.

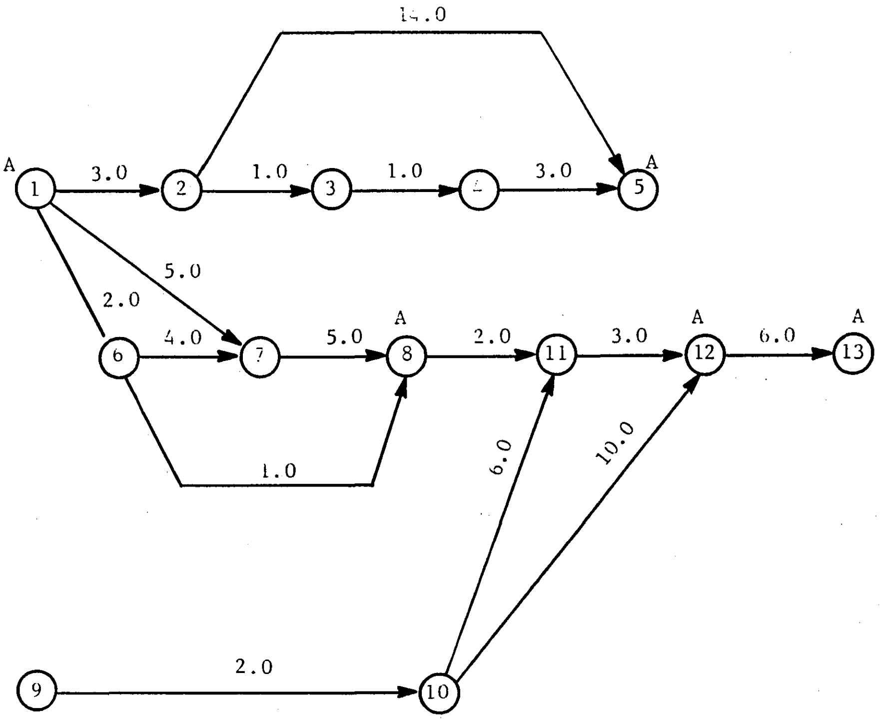


Figure 19. Sample Network for Summarization

The expected times are indicated for each activity; and events 1, 5, 8 and 12 are labeled level A.

Before any work begins on the project, a minimum level summary yields the network shown in Figure 20.

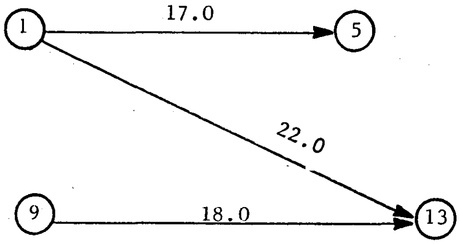


Figure 20. Minimum Level Summary (Before Work Begins)

A level A summary would yield the network shown in Figure 21.

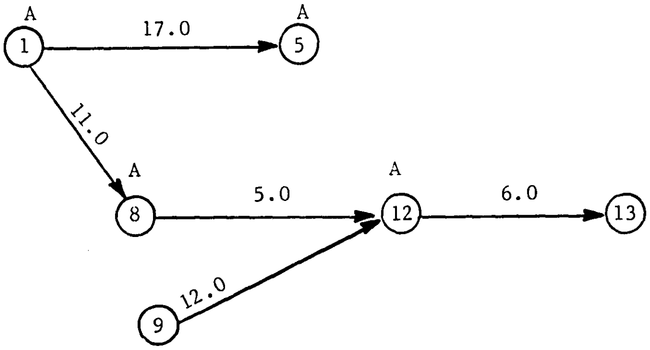


Figure 21. Level A Summary (Before Work Begins)

Note that in the minimum level summary, event level codes are not considered, and since no work is in progress, the summary retains only the start and end events. The level A summary includes events 8 and 12, which greatly enhance the usefulness of the new network.

After the project begins, the picture changes considerably. Suppose, for example, that on the original network some activities are completed after several weeks of work. This case is illustrated in Figure 22, which is a modification of the original example; here completed activities are denoted by two diagonal marks (//).

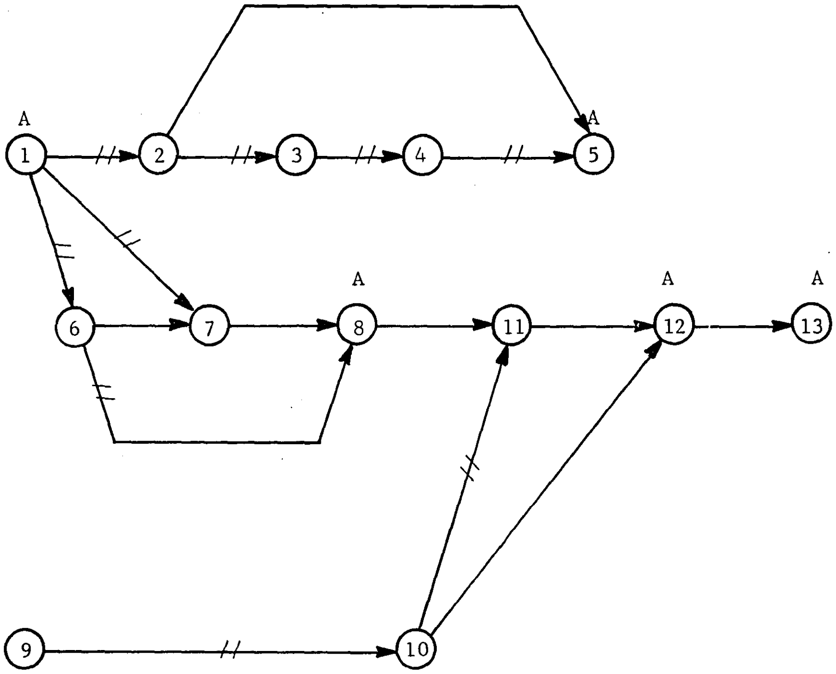


Figure 22. Sample Network After Work Begins

The minimum level summary shown in Figure 23 changes considerably. In fact, because of the limited size of the example and the amount of work actually in progress, only one event, (event 3) is dropped from the original.

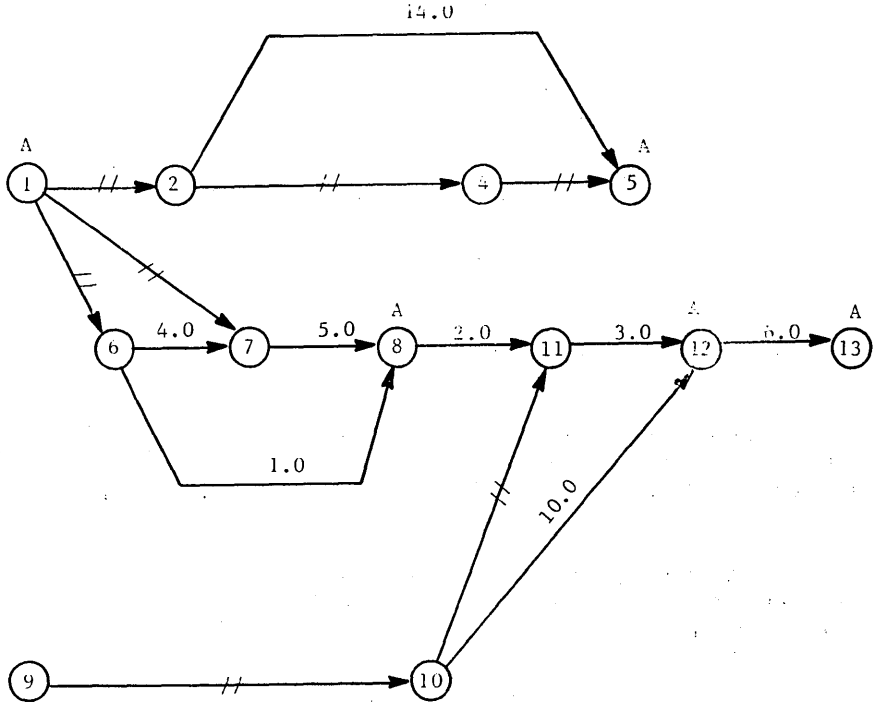


Figure 23. Minimum Level Summary (After Work Begins)

Also observe that in this case the level A summary is identical to the minimum level summary, since all level A events are included in this summary.

Work in progress is clearly shown by the following activities:

Predecessor Event	Successor Event
2	5
6	7
6	8
10	12
11	12

Observe that activity 7-8 and activity 11-12 are still restrained by incomplete activities. Also note that the inclusion of event 4 preserves the unique numbering of the incomplete activity 2-5 and yet shows clearly that one path of the network between events 2 and 3 is finished.

On networks of several thousand activities, the Network Summarization Section can greatly simplify project evaluation. By assigning event level codes with the true purpose of the program in mind, the user can pinpoint trouble areas to the level of accomplishment that best suits his needs.

INDEX

The key-word index lists as entries each keyword subject arranged alphabetically by significant words in the titles of subject matter, program control words, language words, and the titles of both figures and tables.

To locate a subject, think of significant words that might describe the subject, then look in the index for the word being sought. When a title containing the word is found to be of interest, the full abstract can be found on the page number given to the right of the line. Titles are truncated to the left of the significant word; and those words truncated appear to the right of the title line, beginning with an asterisk.

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