PHILCO

A SUBSIDIARY OF Ford Motor Company

COMPUTER DIVISION

ELECTRONIC DATA PROCESSING SYSTEMS

PHILCO 2000

Critical Path Scheduling System

CPS

TM-26

PHILCO 2000
CRITICAL PATH SCHEDULING SYSTEM
CPS

November 1962

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TM-26

PREFACE

The CPS program discussed in this manual is the Philco 2000 version of an original critical path program prepared by the Operations Research Staff of the Finance Department of the Ford Motor Company.

The chapters of the manual contain all the information necessary for preparing data to be analyzed by CPS. Appendices A and B contain information for computer operators and for the systems personnel, respectively.

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CHAPTER 1

INTRODUCTION

WHAT IS CPS

The Philco 2000 Critical Path Scheduling System, CPS, is a programming system designed to aid management in planning and evaluating project schedules. By means of the CPS program, the best feasible combination of time and cost estimates for a project can be speedily determined.

CPS does not require any programming experience on the part of the user. The user merely supplies the data and specifies the output desired.

CPS helps management to:

- Develop a clear picture of the scope of the project, and the relationships between the individual jobs or activities that make up the project
- Develop detailed project time and cost tables
- Determine which jobs or activities, of the many which comprise the project, are *critical* in their effect upon total project time
- Develop alternate schedules based on new estimates of critical activities
- Evaluate and forecast outcome of alternate schedules
- Determine how to best schedule all jobs in the project in order to meet the target date at minimum cost
- Check progress against current plans and objectives

UNDERLYING MATHEMATICAL PRINCIPLE

To produce a schedule with the least cost for a given project duration, the CPS program employs a rigorous mathematical algorithm. This algorithm is based on a solution to a parametric linear programming problem, in which the parameter is project duration and appears in the requirement vector.

The algorithm employed uses a network flow theory solution to the problem proposed by D. R. Fulkerson in the article "A Network Flow Computation for Project Cost Curves," *Management Science,* Vol. 7, No. 2, January 1961.*

Using a notation similar to Fulkerson's, the program is constructed with activity (i, j) having four non-negative integers associated with it: Crash time $a(i, j)$, normal time $b(i, j)$, normal cost $k(i, j)$, and cost slope $c(i, j)$, with

$$a(i, j) \leq b(i, j).$$

Then, the cost of performing activity (i, j) in $\tau(i, j)$ units of time is

$$k(i, j) + c(i, j)\tau(i, j)$$

with

$$a(i, j) \leq \tau(i, j) \leq b(i, j). \tag{1}$$

Now, given a total time λ in which to complete a project, the duration $\tau(i, j)$ is sought for each activity which will satisfy (1) and minimize

$$\sum_{i,j} [\, k(i, j) + c(i, j)\tau(i, j)\,]$$

or, equivalently, minimize

$$\sum_{i,j} c(i, j)\tau(i, j) \tag{2}$$

If $\tau(i)$ is taken as the time of occurrence of event i, the program seeks to minimize (2) subject to

$$\tau(i, j) + \tau(i) - \tau(j) \leq 0, \quad \text{for all } (i, j) \tag{3}$$

$$-\tau(1) + \tau(n) \leq \lambda \tag{4}$$

$$\tau(i, j) \leq b(i, j) \qquad \text{for all } (i, j) \tag{5}$$

$$-\tau(i, j) \leq -a(i, j) \qquad \text{for all } (i, j) \tag{6}$$

The inequalities have obvious meaning. Inequality (3) states that events i and j must be separated by at least $\tau(i, j)$ units of time; inequality (4) states that the total project duration (with starting event 1 and terminal event n) should not exceed λ. Expressions (5) and (6) are restatements of (1).

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* See also "Critical Path Method for Planning and Scheduling — Mathematical Basis," *Journal of the Operations Research Society of America,* Vol. 9, No. 3, May-June 1961.

A fundamental assumption is that cost increases as time decreases. This may be due to overtime payments, or additional factors employed to complete a job in less time.

The process of determining optimum (minimum cost) schedules for decreasing project durations terminates when a specified project duration is reached, or if no further reduction in project duration can be accomplished. The optimum schedules determined are printed in tabular form in the output.

APPLICATIONS OF CPS

The many diverse kinds of projects which lend themselves to analysis by CPS include the following, to name a few:

- Research and development projects
- Construction projects
- Programs which include the planning and introduction of new products
- Manufacturing and assembly projects
- Major re-tooling projects
- Maintenance projects
- Production and process control projects

In these and other areas, the CPS technique is a valuable aid to management in making decisions that are both timely and sound.

STANDARD CPS TERMS

The following is an explanation of standard CPS terms which are used throughout the manual.

ACTIVITY - A job or operation to be accomplished in the project. It is represented by an arrow in the graphical network or arrow diagram (see page 6), and may have associated with it a cost estimate and two time estimates (Normal and Crash, see below).

Associated with each activity is a predecessor and a successor event (see Event, below).

ARROW DIAGRAM - A graphical representation of the entire project showing the interrelationships between all required activities.

COST SLOPE - The additional cost associated with a unit reduction in time below normal time.

CRASH TIME - The minimum estimated time to complete an activity.

CRITICAL PATH - The particular sequence of activities which requires the greatest expenditure of time to accomplish. A delay along the critical path increases the duration of the entire project.

DUMMY ACTIVITY - A timeless, costless imaginary activity that is included in the arrow diagram only to show the proper sequence and functional relationship between other activities.

EARLIEST FINISH TIME - The earliest possible time an activity can be completed without affecting the project duration.

EARLIEST START TIME - The earliest possible time an activity can be started without affecting the project duration.

EVENT - A stage reached in the project which indicates the beginning or end of an activity.

EXTRA COST - The additional cost incurred in completing an activity in less than normal time (see below).

FLOAT - The difference between the maximum time available for completing an activity and the time required to complete that activity. There are three kinds of float — Free Float, Independent Float and Total Float.

- *Free Float* is the slippage or slack time available at one activity if all activities in the project are started as early as possible.

- *Independent Float* is the slack time available at one activity if all preceding activities start as late as possible, and all succeeding activities as early as possible.

- *Total Float* is the difference between the earliest and latest start times of an activity.

LATEST FINISH TIME - The latest possible time for completing an activity without affecting the project duration.

LATEST START TIME - The latest possible time for starting an activity without affecting the project duration.

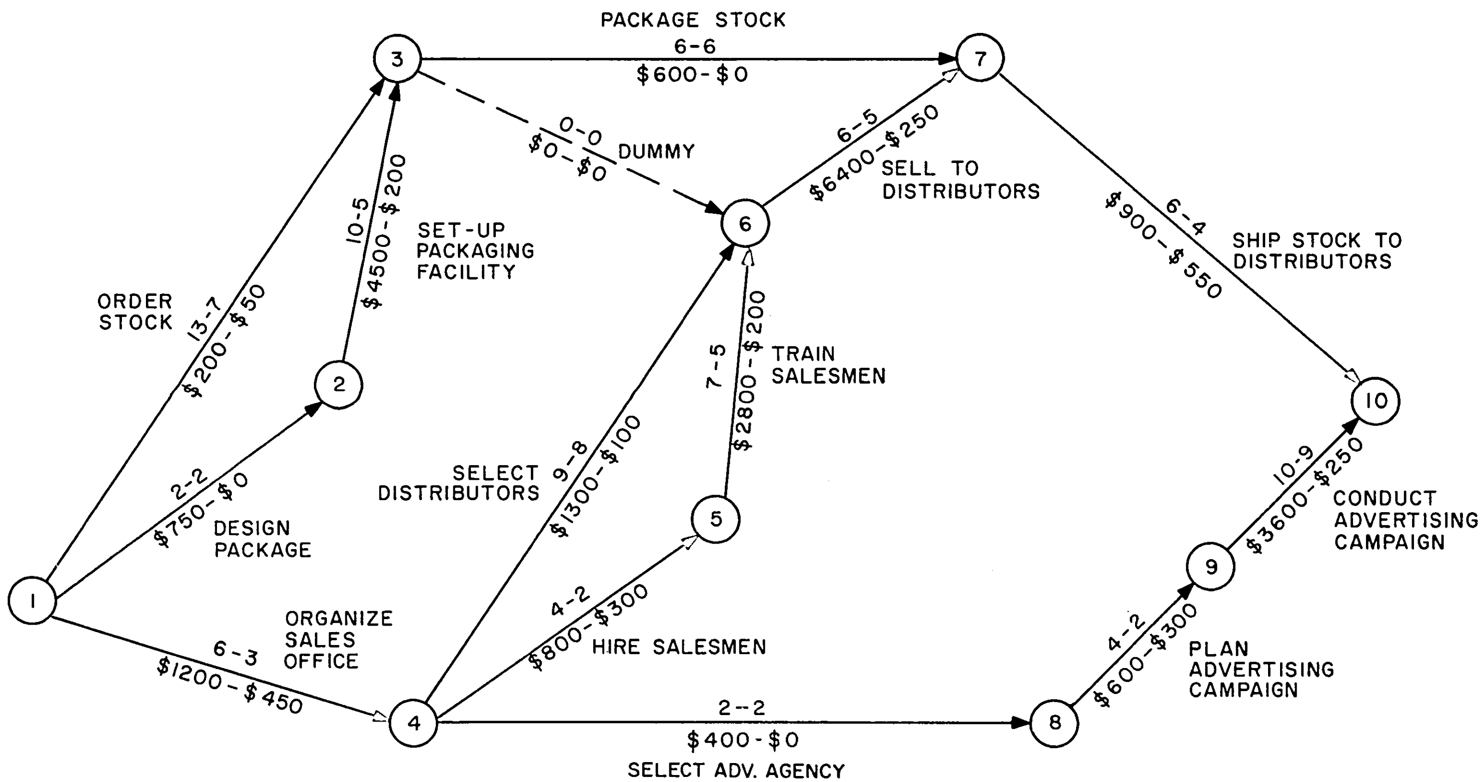
NETWORK - An arrow diagram graphically depicting the entire project.

NORMAL COST - The estimated cost of an activity performed under "normal" conditions.

NORMAL TIME - The estimated duration of an activity performed under "normal" conditions.

PROJECT DURATION - The amount of time specified for the completion of the project.

TOTAL COST - The cost incurred in completing the project in the time specified as project duration.



LEGEND:

Figures above line are normal and crash time estimates
Figures below line are normal cost and cost slope estimates
——— Critical activities

FIGURE 1- MARKETING A NEW PRODUCT

CHAPTER 2

BASIC CONCEPTS OF CPS

ARROW DIAGRAMS

After all phases of the project are defined as to the various activities to be completed, the time and cost estimates for each activity, and the relationship between activities, a network or arrow diagram is constructed to represent the project.

The arrow diagram presents a clear picture of the scope of the project thereby permitting easier over-all evaluation.

The model serves to make evident such questions as:

- What activities will be affected by a delay at some point, and by how much?
- How much additional time or cost should be allowed in order to counteract the delay?
- The order in which the operations are to be performed, and when should individual activities be completed?

Figure 1 on page 6 is an arrow diagram of a simplified project to market a new product.

Each arrow in the figure represents an activity, and each sequentially numbered circle or node represents an event. Each activity is labeled, and is identified by the events that immediately precede and follow it. For example, the activity "Train Salesmen" may be identified as activity (5,6).

Note also the sequence of the activities: Activity "Hire Salesmen" is completed before activity "Train Salesmen" starts, while activities "Order Stock" and "Design Package" may be performed concurrently.

The length of the arrows has no significance. As is customary, dummy activities are indicated by a broken arrow. The dummy activity (3,6) merely indicates that activity (6,7) cannot start before event 3 has been reached.

The arrow diagram is completed with the inclusion of the time and cost estimates for each activity. The estimates supplied are normal time, normal cost, crash time, and the slope of the activity time-cost curve.

A curve of this type is shown in Figure 2, below.

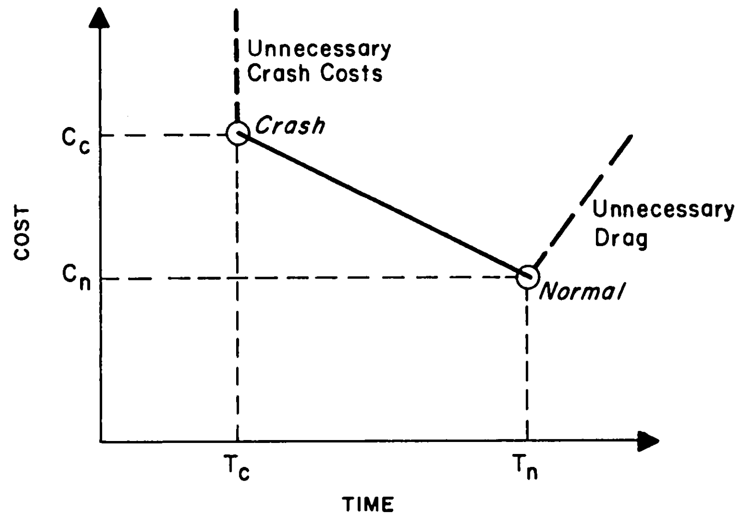


FIGURE 2- TYPICAL ACTIVITY TIME-COST CURVE

The Activity Time-Cost curve is a straight line function showing the cost associated with each activity duration, and the relative increase in cost for unit decrease in time.

Allocating funds in excess of the crash cost C_c would be unnecessary, since this would not reduce the activity completion time beyond the crash time T_c. Likewise, allowance of greater than normal time to complete the activity would result in unnecessary drag.

THE CRITICAL PATH

The longest time path through the network controls the schedule for the entire project and is referred to as the CRITICAL PATH. *A delay in an activity along the critical path increases the total project duration.*

Critical activities are those along the critical path. Associated with each is a total float of zero. It is to the critical activities that attention should be first focused when attempting to prevent potential delays from becoming a costly reality.

There may be one or more critical paths in a network.

PROJECT COST CURVES

Of the several schedules which may be selected to complete the project in a specified time, CPS produces the schedule with the minimum cost. The piece-wise linear curve in Figure 3 graphically represents these minimum cost schedules; other points (⊗) in the figure denote alternative, but more costly, schedules for a given project duration.

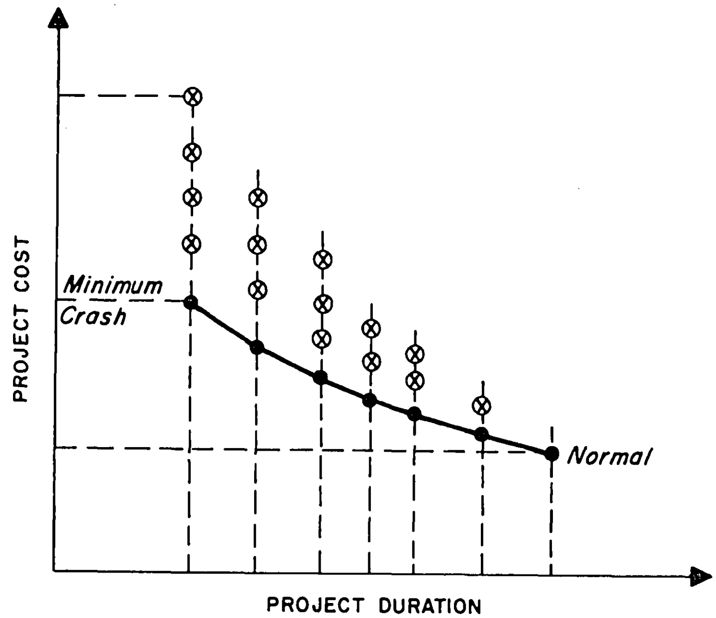


FIGURE 3 - MINIMUM DIRECT COST CURVE

The point labeled "*Normal*" represents a schedule where all activity durations and costs are normal, while the point "*Minimum Crash*" represents the optimum (minimum cost) schedule for the shortest possible project duration.

By adding the direct costs to the company's indirect costs, such as overhead, the user can construct a total project cost curve (see Figure 4) which would indicate an optimum duration for the project.

DEVELOPING ALTERNATE SCHEDULES

The CPS program develops numerous schedules of decreasing project durations until a specified duration is reached, or until no further reduction in project duration can be made.

In developing an alternate schedule, the CPS program reduces the duration of one or more critical activities in such a way as to cause a *minimum* increase in cost.

If there is more than one critical path, an activity from each of the critical paths must be reduced to decrease the total project time.

Reduction of an activity's duration may result in other activities turning critical and the emergence of new critical paths.

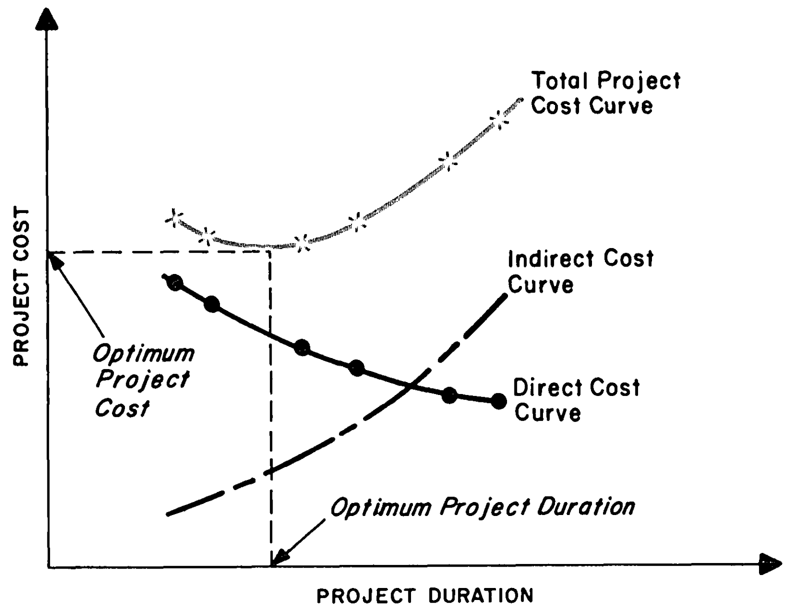


FIGURE 4- TYPICAL TOTAL PROJECT COST CURVE

The second schedule presented on page 16 represents a two-day decrease in project duration from the first schedule presented on that page. To achieve this, the duration of the critical activity "Train Salesmen" has been reduced to the crash time with an increase in cost of $400.00.

If none of the schedules developed is of the optimum project duration determined by the total project cost curve, linear interpolation can be performed among the activities of the neighboring schedules to achieve the desired optimum schedule.

CHAPTER 3

INPUT FORMAT

INPUT DECK

Following the arrow diagram definition of the project, the required input information is written on the CPS data form, then punched on cards. Figure 5 shows the arrangement of the data for the project in Figure 1 on the standard CPS data form. Figure 6 shows the appearance of this data on cards.

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CRITICAL PATH SCHEDULE DATA FORM

Date 8/15/62 Page 1 of 1

Prepared by R. HULSE

I	J	JOB CODE	ACTIVITY DESCRIPTION	NORMAL TIME	NORMAL COST	CRASH TIME	COST SLOPE	
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
N	OV	1	1962 NEW PRØDUCT	LAUN	CH		PLAN	NING
1	2		DESIGN PACKAGE	2	750	2	0	
1	3		ØRDER STØCK	13	200	7	50	
1	4		ØRG. SALES ØFF.	6	1200	3	450	
2	3		SET UP PKG. FAC.	10	4500	5	200	
3	6		DUMMY	0	0	0	0	
3	7		PKG. STØCK	6	600	6	0	
4	5		HIRE SALESMEN	4	800	2	300	
4	6		SEL. DISTRIBUTØRS	9	1300	8	100	
4	8		SEL. ADV. AGENCY	2	400	2	0	
5	6		TRAIN SALESMEN	7	2800	5	200	
6	7		SELL TØ DISTRS.	6	6400	5	250	
7	10		SHIP TØ DISTRS.	6	900	4	550	
8	9		PLAN ADV. CAMP.	4	600	2	300	
9	10		CØNDUCT ADV. CAMP.	10	3600	9	250	
			END PRØJ	2				
END	DATA							

TF-30

FIGURE 5 - STANDARD CPS DATA FORM

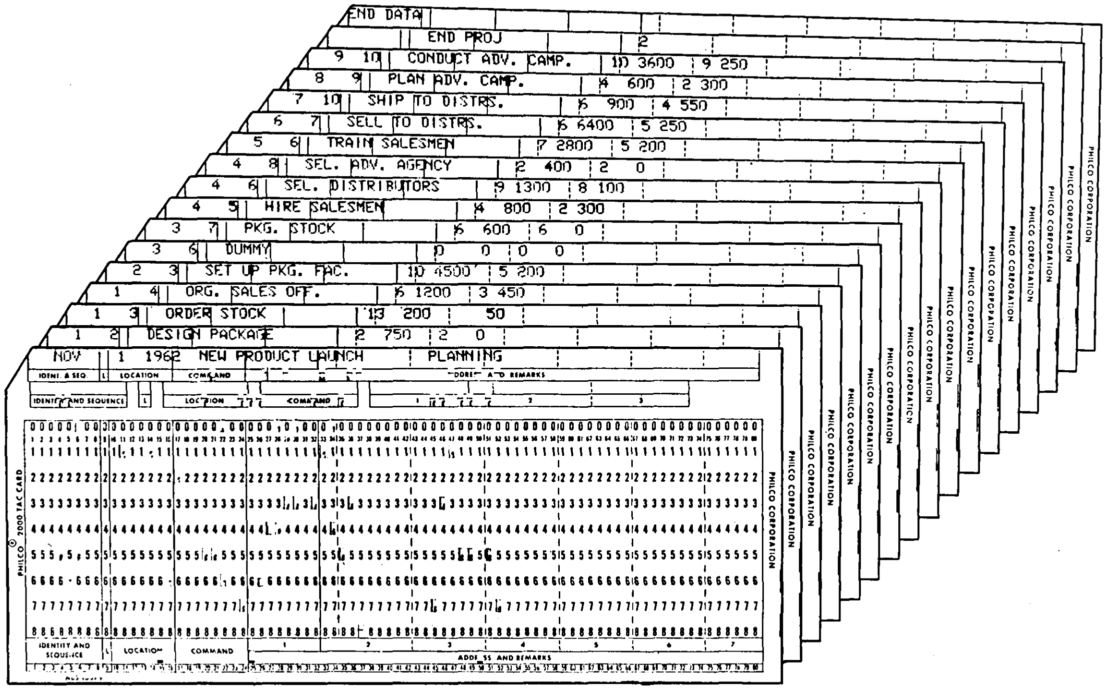

FIGURE 6- SAMPLE CPS INPUT DECK

The input deck submitted for a CPS run must contain the following cards:

- Project Identification Card
- Activity Cards
- End-of-Project Card
- End-of-Data Card

An input deck may comprise one or more project decks. Each of the project decks contains its own set of project identification card, activity cards, and end-of-project card. The end-of-data card is the last card in an input deck.

The following rules govern the format and the order of these cards.

PROJECT IDENTIFICATION CARD

The Project Identification Card is the first card of a project deck, and it specifies the name of the project. The format of this card is:

COLUMNS	CONTENTS
4-7	Month
10-11	Day
14-17	Year
20-43	A name by which the project is identified.
45-68	A descriptor identifying a particular phase of the project.

The contents of the above columns, which may be any combination of alphanumeric characters, including blanks, are included in the printed output. Columns not mentioned above are ignored.

ACTIVITY CARDS

Each activity description is punched on a single card. Time and cost estimates (the units of which must be uniform throughout the project) and other information associated with the activity are punched right justified in their respective columns, as indicated below:

COLUMNS	CONTENTS
1-4	An unsigned integer identifying the event which initiates the activity. (This event is labeled I in the printed output.)
5-8	An unsigned integer identifying the event which terminates the activity. (This event is labeled J in the printed output.)
9-11	Job Code. Any combination of alphanumeric characters is acceptable.
12-31	Alphanumeric activity description. (Need not be right justified.)
32-35	An unsigned integer representing the normal time estimate.
36-40	An unsigned integer representing the normal cost estimate.
41-44	An unsigned integer representing the crash time estimate. This estimate must not exceed that specified for the normal time in columns 32-35.
45-48	An unsigned integer representing the cost slope for the activity.

Columns not mentioned above are ignored.

The activity cards must be in sequence when submitted. The activities are grouped sequentially, first according to a common predecessor event I, then within each group according to successor event J. If a card is out of sequence, an appropriate error indication is made on the printed output identifying the card (see page 17); no schedules are developed.

The value of J should always exceed the value of I.

The maximum number of activities and events permitted is a function of the computer memory size and the size of the operating system used, and is established by the installation. (See page 21).

END-OF-PROJECT CARD

The End-of-Project Card is used to indicate the end of a particular project deck. This card immediately follows the last activity card of the project. The format of this card is:

COLUMNS	CONTENTS
12-19	The characters ENDΔPROJ (Δ denotes a space.)
35	The decimal digits 0, 1, 2, or 3, representing one of the four output options. (See Chapter 4, page 15).
41-44	The desired project duration, right justified. Provided no input or other errors are encountered, the CPS run terminates when this project duration is reached or when no further reduction in project duration is possible. If these columns are blank, CPS terminates when no further reduction in project duration is possible.

Columns not mentioned above are ignored.

END-OF-DATA CARD

The End-of-Data Card is the last card in an input deck. It follows the last end-of-project card in the deck. Columns 1-8 of this card contain the characters ENDΔDATA. The rest of the card is ignored.

CHAPTER 4
OUTPUT FORMAT

OUTPUT OPTIONS

The CPS program provides the user with four output options. The desired option is punched in column 35 of the End-of-Project Card, and is interpreted as follows:

OPTION	INTERPRETATION
0 or blank	Print the NORMAL TIME/COST SCHEDULE only.
1	Print the MINIMUM DIRECT COST CURVE and the MINIMUM CRASH COST SCHEDULE.
2	Print the NORMAL TIME/COST SCHEDULE, the MINIMUM DIRECT COST CRUVE, and the MINIMUM CRASH COST SCHEDULE.
3	Print all schedules.

PRINTED OUTPUT

The following are examples of the Philco 2000 CPS output.

SCHEDULES REPRESENTING THE MINIMUM DIRECT COST CURVE

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NOV 1 1962                                                              PAGE 1

                         PHILCO 2000 CRITICAL PATH SCHEDULING

                           PROJECT:  NEW PRODUCT LAUNCH
                           PHASE:    PLANNING

                           MINIMUM DIRECT COST CURVE

                                      PROJECT          TOTAL
                                      DURATION         COST

                  NORMAL                 29            24050.
                  PT.  1                 27            24450.
                  PT.  2                 26            24700.
                  PT.  3                 25            25100.
                  PT.  4                 24            25600.
                  PT.  5                 22            26700.
                  PT.  6                 20            28100.
```

NORMAL TIME/COST SCHEDULE

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PHILCO 2000 CRITICAL PATH SCHEDULING

PROJECT: NEW PRODUCT LAUNCH

PHASE : PLANNING

PROJECT DURATION 29

I	J	JOB CODE	ACTIVITY	NORMAL TIME	NORMAL COST	EARLIEST START	EARLIEST FINISH	LATEST START	LATEST FINISH	FLOAT TOTAL	FLOAT FREE	FLOAT INDEP
1	2		DESIGN PACKAGE	2	750.	0	2	5	7	5	0	0
1	3		ORDER STOCK	13	200.	0	13	4	17	4	0	0
1	4		ORG. SALES OFF.	6	1200.	0	6	0	6	0	0	0
2	3		SET UP PKG. FAC.	10	4500.	2	12	7	17	5	1	0
3	6		DUMMY	0	0.	13	13	17	17	4	4	0
3	7		PKG. STOCK	6	600.	13	19	17	23	4	4	0
4	5		HIRE SALESMEN	4	800.	6	10	6	10	0	0	0
4	6		SEL. DISTRIBUTORS	9	1300.	6	15	8	17	2	2	2
4	8		SEL. ADV. AGENCY	2	400.	6	8	13	15	7	0	0
5	6		TRAIN SALESMEN	7	2800.	10	17	10	17	0	0	0
6	7		SELL TO DISTRS.	6	6400.	17	23	17	23	0	0	0
7	10		SHIP TO DISTRS.	6	900.	23	29	23	29	0	0	0
8	9		PLAN ADV. CAMP.	4	600.	8	12	15	19	7	0	0
9	10		CONDUCT ADV. CAMP.	10	3600.	12	22	19	29	7	7	0

TOTAL COST $ 24050.

AN INTERMEDIATE TIME/COST SCHEDULE

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PHILCO 2000 CRITICAL PATH SCHEDULING

PROJECT: NEW PRODUCT LAUNCH

PHASE : PLANNING

PROJECT DURATION 27

I	J	JOB CODE	ACTIVITY	TIME NORMAL	TIME CRASH	ACTUAL DURATION	COST NORMAL	COST EXTRA	EARLIEST START	LATEST START	FLOAT TOTAL	FLOAT FREE	FLOAT INDEP
1	2		DESIGN PACKAGE	2	2	2	750.	0.	0	3	3	0	0
1	3		ORDER STOCK	13	7	13	200.	0.	0	2	2	0	0
1	4		ORG. SALES OFF.	6	3	6	1200.	0.	0	0	0	0	0
2	3		SET UP PKG. FAC.	10	5	10	4500.	0.	2	5	3	1	0
3	6		DUMMY	0	0	0	0.	0.	13	15	2	2	0
3	7		PKG. STOCK	6	6	6	600.	0.	13	15	2	2	0
4	5		HIRE SALESMEN	4	2	4	800.	0.	6	6	0	0	0
4	6		SEL. DISTRIBUTORS	9	8	9	1300.	0.	6	6	0	0	0
4	8		SEL. ADV. AGENCY	2	2	2	400.	0.	6	11	5	0	0
5	6		TRAIN SALESMEN	7	5	5	2800.	400.	10	10	0	0	0
6	7		SELL TO DISTRS.	6	5	6	6400.	0.	15	15	0	0	0
7	10		SHIP TO DISTRS.	6	4	6	900.	0.	21	21	0	0	0
8	9		PLAN ADV. CAMP.	4	2	4	600.	0.	8	13	5	0	0
9	10		CONDUCT ADV. CAMP.	10	9	10	3600.	0.	12	17	5	5	0

TOTAL COST $ 24450.

MINIMUM CRASH COST SCHEDULE

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PHILCO 2000 CRITICAL PATH SCHEDULING

PROJECT: NEW PRODUCT LAUNCH

PHASE : PLANNING

PROJECT DURATION 20

I	J	JOB CODE	ACTIVITY	TIME NORMAL	TIME CRASH	ACTUAL DURATION	COST NORMAL	COST EXTRA	EARLIEST START	LATEST START	FLOAT TOTAL	FLOAT FREE	FLOAT INDEP
1	2		DESIGN PACKAGE	2	2	2	750.	0.	0	0	0	0	0
1	3		ORDER STOCK	13	7	10	200.	150.	0	0	0	0	0
1	4		ORG. SALES OFF.	6	3	3	1200.	1350.	0	0	0	0	0
2	3		SET UP PKG. FAC.	10	5	8	4500.	400.	2	2	0	0	0
3	6		DUMMY	0	0	0	0.	0.	11	11	11	1	1
3	7		PKG. STOCK	6	6	6	600.	0.	11	10	0	0	0
4	5		HIRE SALESMEN	4	2	3	800.	300.	3	3	0	0	0
4	6		SEL. DISTRIBUTORS	9	8	8	1300.	100.	3	3	0	0	0
4	8		SEL. ADV. AGENCY	2	2	2	400.	0.	3	4	1	0	0
5	6		TRAIN SALESMEN	7	5	5	2800.	400.	6	6	0	0	0
6	7		SELL TO DISTRS.	6	5	5	6400.	250.	11	11	0	0	0
7	10		SHIP TO DISTRS.	6	4	4	900.	1100.	16	16	0	0	0
8	9		PLAN ADV. CAMP.	4	2	4	600.	0.	5	6	1	0	0
9	10		CONDUCT ADV. CAMP.	10	9	10	3600.	0.	9	10	1	1	0

TOTAL COST $ 28100.

CHAPTER 5

INPUT ERROR INDICATIONS

ERROR PRINT-OUTS

The CPS program checks the activity cards for proper sequencing, and to determine whether there is a predecessor event (I) and a successor event (J) associated with each activity.

If a check reveals an activity with no predecessor or successor event, or reveals a sequencing error, an appropriate error indication is made in the printed output. Checking continues until a project identification card or the end-of-data card is reached. Information on the cards is not processed.

The following is an explanation of the possible error indications.

ERROR INDICATION	EXPLANATION
SEQUENCE ERROR: i, j	Activity i,j is out of sequence.
OPEN END ACTIVITY: i, j	An open end condition exists: (1) If event i (not the first event) was not previously an event j. (2) If event j (not the last event) is not subsequently an event i. A sequence error can create an open end condition.
NO OPTION SPECIFIED	This indication occurs if an option other than 0, 1, 2, 3 or a blank is specified on the End-of-Project card. The program prints the characters NO OPTION SPECIFIED, and continues processing as if the zero option were specified.

APPENDIX A

TAPE ERROR HALTS, TYPE-OUTS AND RECOVERY

XORD TYPE-OUTS

CPS is an ALTAC language program which uses the subroutine XORD to execute its magnetic tape orders. If a tape error occurs which XORD cannot correct, an appropriate type-out is made by XORD indicating the error condition.

The following is a list of possible console type-outs, the error conditions causing the type-outs, and suggested recovery actions.

TYPE-OUT	MEANING	SUGGESTED RECOVERY ACTION
TAPE *t* IN LOCAL	Unit *t* is in local. Computer halts with M/11111 displayed in the Program Register.	Place unit in REMOTE and press ADVANCE to continue.
TAPE *t* WR RING	Unit *t* is missing a write ring. Computer halts with M/11111 displayed in the Program Register.	Insert ring. Press ADVANCE to continue.
TAPE *t* ROCKED 5	A parity or sprocket error was detected on tape *t*. The subroutine XORD tried to correct the condition five times and failed. (To correct a read error, XORD issued a reverse space order and a reread. A write error is corrected by an erase-resume operation.) Computer halts with M/11111 displayed in the Program Register.	Press ADVANCE to attempt to correct the block in error five more times. This type-out continues until the error correction procedure is successful or the tape is changed.
TAPE *t* FAULTY	A tape error other than a parity or sprocket error was detected on tape *t*. Computer halts with M/11111 displayed in the Program Register.	Change tape and restart job.

In the above cases, *t* may be any integer 0-15 as selected by the particular installation. (See CPS TAPES, Appendix B.)

APPENDIX B

CPS PROGRAM REQUIREMENTS

The following information is intended primarily for systems personnel at the various Philco 2000 installations.

ESTABLISHING THE MAXIMUM NUMBER OF ACTIVITIES AND EVENTS

The maximum number of activities and events permitted for a project is a function of the computer memory size and the size of the operating system used. These maximum values may be determined by means of the inequality

$$7A+4E \leq M-S$$

where

A = maximum number of activities permitted,

E = number assigned to the last event of the project,

M = computer memory size, and

S = size of the operating system used *plus* the size of the CPS program (4250 locations).

If the maximum values of A and E, determined by the above method, do not agree with those specified on the cards:

- DIMENSION K(5,A),KEY(2,E),LABEL(2,E),NFUNCT(2,A)
- MAXACTS = A
- MAXEVNT = E

the three cards should be replaced.

CPS TAPES

CPS program tapes are assigned by the installation. The symbols IT and NOUT refer to the CPS scratch tape and the printer output tape respectively, and may be assigned (at compilation time) any numerical value ≤ 15. If the tapes specified by the cards

- IT= 3
- NOUT = 5

do not agree with those established by the installation, the cards should be replaced.

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Printed in U.S.A.