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SPLA CONTROL NUMBER: 189

This form should be completed and submitted with the program package to the SHARE Program Library Agency at the address shown above. Standards and instructions for submitting programs are in the "SHARE Reference Manual".

- (1) Program Number (to be filled in by SPLA)..... 360D-23.0.001
- (2) System Type (machine)..... 360/370
- (3) Search Key..... Plant Layout, Facilities Design
Materials Handling System Design
- (4) Programming Systems/Languages..... Fortran IV
- (5) Author's Name and Address..... J. A. Tompkins
Box 5511, North Carolina State
Univ., Raleigh, North Carolina 27906
- (6) Direct Technical Inquiries to Name & Address
(if different than Author) _____

- (7) Title of Program..... COFAD: Computerized Facilities Design

- (8) Submitter's Installation Membership Code..... NCS
- (9) Submitter's Own Program Identification and Suffix(Optional)..COFAD II
- (10) Primary Subject Code..... 230
- (11) Minimum System Requirements..... OS/Fortran IV
- (12) New or Revision Code (if revision, show prior Program Number in Item 1) N
- (13) Year Completed..... 1976
- (14) Date of Submittal..... 4/15/76
- (15) Documentation (number of original pages submitted)..... 8
- (16) Abstract (should contain sufficient information for a reader to determine the value of the program). Listed on the reverse side of this form are subjects which may serve as a guide for a descriptive abstract.

SHARE PROGRAM LIBRARY SUBMITTAL FORM

Subject Guide:

- a. Purpose
- b. Programming Language used
- c. Version and modification level or release number
- d. Field of application
- e. Type of routine (main program, subroutine, etc.)
- f. Specific description of machine requirements

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ABSTRACT

COFAD II (Computerized Facilities Design) is a computer program designed to determine suboptimal layout and handling systems for physical facilities. The program is governed by a set of heuristic rules which iteratively selects a layout and then a handling system so as to approach the minimal materials handling system cost. COFAD II improves layouts in a manner similar to CRAFT but then differs significantly in that realistic materials handling equipment costs are included so as to allow the joint determination of the layout and handling system. Input into COFAD II includes the flow data within the facility, the costs of alternative materials handling equipment types and an initial layout. COFAD II differs from the original COFAD in flexibility, ease of altering the model for various problems and output format. COFAD II is written in Fortran IV and contains approximately 3300 cards. Storage of 500k is required to implement COFAD II.

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(Please attach additional pages if necessary).....Total pages attached 0

Permission to Publish

"I hereby give the SHARE Program Library Agency permission to reprint, reproduce, and distribute this program."

- (17) Signature of Submitter and Date J. A. Tompkins (James A. Tompkins) 9/15/76
- (18) Signature of Installation Addressee W. Hamilton (WAS)

COFAD USER'S GUIDE

COFAD, an acronym representing Computerized Facilities Design, is a facilities design improvement routine which jointly selects a plant layout and a materials handling system which will approach the minimal materials handling system cost. The plant layout selection routine within COFAD closely parallels the computerized plant layout technique CRAFT. Detailed information on COFAD may be obtained from either of the references stated at the end of this guide.

This guide is divided into three sections. The first section describes the input format, the second section lists the input for an example problem, and the last section lists and interprets COFAD'S diagnostics.

Section 1: Input Format

| Number of Cards | Column | Variable | Description |
|--------------------|--------|----------|--|
| 1 | 1-5 | PCUT | Percent of the total number of equipment assignments and the total materials handling system cost which is allowed to be changed without terminating the problem. Format (F5.3). |
| | 6-10 | SCALE | Distance in feet between entries in the initial layout. Format (F5.3) |
| | 11-13 | N | Total number of moves to be considered. Not to exceed 200. Format-I3. |
| | 14-15 | NDEPT | Number of departments. Not to exceed 40. Format-I2 |
| | 16-17 | M | Number of alternative materials handling equipment types. Not to exceed 6. Format-I2. |
| | 18-19 | IM | Number of equipment types which are to have From-To Charts inputted. From-To Charts need not be inputted for fixed path materials handling equipment. Format-I2. |
| | 20-21 | IEQUIP | Materials handling equipment alternative to originally handle all moves. Format-I2. |
| | 22-23 | IROW | Number of rows in the scaled layout. Not to exceed 30. Format-I2. |
| | 24-25 | ICOL | Number of columns in the scaled layout. Not to exceed 30. Format-I2. |

| Number of Cards | Column | Variable | Description |
|--|--------|-------------------------------|--|
| | 26-27 | IFIX | Number of departments to be fixed. Format-I2. |
| | 28-29 | IRUN | Number of variations to be made to the From-To Chart to evaluate the sensitivity of the solution. Not to exceed 6. Format-I2. |
| | 30-31 | IDFIX(1) | Department number of the first department to be fixed. Format-I2. |
| | 32-33 | IDFIX(2) | Department number of the second department to be fixed. Format-I2. |
| | 34-80 | . : | Same as the above. Two columns for each additional department to be fixed. Format (23 I2). |
| The product of the number of departments, Columns 14-15, Card 1 and the number of equipment types to have From-To Charts inputted, Columns 18-19, Card 1. | 1-80 | FRTO (IM, NDEPT, NDEPT) | Weekly From-To Charts for each mobile materials handling equipment type. The first From-To Chart will correspond to the first mobile equipment alternative, the second to the second, etc. Punch a row of each From-To Chart on each card. Format (40F2.0). |
| If the number of moves being considered, Columns 11-13, Card 1, is between 1 and 80, 6 cards will be required, if between 81-160 moves are being considered, 12 cards will be required and if between 161-200 moves are being con- sidered, 18 cards will be required. | 1-80 | IMMOV (M, N) | Which equipment alternatives are feasible to consider for which moves. Each card, two card, or three card series (depending if 1-80, 81-160, or 160-200 moves, respec- tively, are being considered) contains a value greater than 2 if that equipment type is not feasible for the new move rep- resented by the column number plus 80 or column number plus 160 respectively. Format (80I1) |

| Number of Cards | Column | Variable | Description |
|---|--------|----------------------|---|
| 1 | 1-6 | IDT(M) | Indicator describing if a materials handling equipment alternative is to be evaluated based on straight line or rectilinear distances. If an equipment type is to be evaluated on straight line flow, a value greater than 1 should be entered in the column corresponding to the alternative number. Format (6I1) |
| 1, if between 1 and 80 moves are being considered, columns 11-13, Card 1; 2, if between 81 and 160 moves are being considered and 3 if between 161 and 200 moves are being considered | 1-80 | IMHF(N) | Fixing a materials handling equipment type to perform a specific move. If an equipment type is to be assigned to a specific move, a value representing the alternative number should be entered in the column corresponding to the move number, where the second card considers moves 81-160 and the third card considers moves 161-200. Format (80I1). |
| The number of materials handling equipment types which are to have From-To Charts inputted. Columns 18-19, Card 1. | 1-30 | PCH (IM, IRUN) | Percent change in the From-To Chart for each materials handling equipment type for the evaluation of solution sensitivity. Format (6F5.3). The first card represents the percent change for the consecutive changes in the From-To Chart for the first alternative materials handling equipment type. The second card represents the percent change for the consecutive changes in the From-To Chart for the second alternative materials handling equipment type, etc... |
| The number of alternative materials handling equipment types, Columns 16-17, Card 1 | 1-24 | CCUL (1,M,M) | Annual cost of changing unit load between two alternative materials handling equipment types. Format (6F4.0). The first card represents the annual costs to change unit loads between the first materials handling equipment alternative; and, in the second field, the second alternative; in the third field, the third alternative, etc. The second card represents the annual costs to change unit loads between the second materials handling equipment alternative, and in the first field, the first alternative, in the third field, the third alternative, etc.. Such a card will exist for each materials handling equipment alternative. |

| Number of Cards | Column | Variable | Description |
|--------------------|--------|------------------------|--|
| 2 | 1-5 | CNV(I) | The non-variable cost for each equipment type. CNV(1), CNV(2), CNV(3), and CNV(4) represent the non-variable costs for mobile equipments alternatives 1, 2, 3, and 4. Format (F5.0) |
| | 6-9 | CVME(I) | The hourly rate of operating mobile equipment alternative I. Format (F4.2) |
| | 10-14 | STUP(I) | The time (hours) for mobile equipment alternative I to pick up, unload, accelerate, and decelerate. (Format (F5.4) |
| | 15-19 | VEL(I) | The velocity (hours/foot) of traveling at a continuous velocity with mobile equipment alternative I. Format (F5.4) |
| | 20-24 | TTC(I) | The time (hours) to reduce speed, turn a corner and regain constant velocity for mobile equipment alternative I. Format (F5.4) |
| | 25-27 | EFF(I) | The historical effectiveness of mobile equipment alternative I. Format (F3.2) |
| | 1-5 | CNV(I) | The non-variable cost for each equipment type. CNV(5) and CNV(6) represent the non-variable costs for fixed path equipment alternatives 1 and 2. Format (F5.0) |
| | 6-9 | CVFE(I) | The variable cost (dollars/foot) of fixed path equipment alternative I. Format (F5.2) |
| | 1-60 | ISP (IROW, ICOL) | Initial Layout. Punch each row of the initial layout on a separate card. Punch 01 for A, 02 for B, 03 for C...26 for Z, 27 for AA, 28 for BB...39 for MM and 40 for NN. Format(30I2) There should be as many fields punched on each card as the number of columns in the scaled layout, columns 24-25 of Card 1. If the building is not a square or rectangle, dummy departments should be added and held constant to complete a square or rectangle. Do not have over 75 squares devoted to one department and input departments so that at most there is a protrusion from a basic square or rectangle in only one direction. |
| | | | |

The number of
rows in the
scaled layout.
Columns 22-23,
Card 1.

Column 1

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0044142408060000

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020202020203030303030505050505050505

0202020202030303030303030303030303030303030303
020202020203030303030305050505050505050505

0202020202030303030303030303030303
0303030303040404060606060606060505

02020202020404040608080808080808080909
04040404040404040606060606060606060606

04040404040404040404080808080808080808
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04040404040404040808080808080606060606060606

0404040404040408080808080808080808

Section 3: COFAD Diagnostics

1. CDIST PARAMETER NEGATIVE OR GREATER THAN NDEPT OR NOT 41-44 -

Department to be exchanged is negative or zero or greater than NDEPT or not one of the dummy departments - 41, 42, or 44.

2. DIST NEGATIVE OR GREATER THAN 60 -

Calculated distance between department centers is negative or greater than 60 square side units.

3. ICEN NEGATIVE OR GREATER THAN IDEPT OR NOT 41-44 -

Department number calculating center for is negative, greater than NDEPT or not one of the dummy departments - 41, 42, Or 44.

4. INVALID ROWCEN OR COLCEN COMPUTED -

Calculated row or column center 0 or greater than 30 square side units.

5. INITIAL CELL ZERO OR GREATER THAN NDEPT -

Initial layout department number(s) have a value 0 or NDEPT

6. TOO MANY OR NO CELLS IN A DEPARTMENT -

Either number of cells in initial layout for a required department 75 or no initial layout is provided.

7. INITIAL DEPARTMENT INVALID -

Squares counted versus calculated squares in department unequal when determining shape of department.

8. FIXED DEPT ZERO OR GREATER THAN NDEPT -

Fixed department number in card 1 0 or number NDEPT.

9. COST OR VOLUME DATA INVALID -

Interdepartmental flow or cost per unit distance data 0.

10. ICOST OR JCOST NEGATIVE OR GREATER THAN NDEPT -

When computing transportation costs between departments I and all other departments J, a department number is 0 or NDEPT.

11. EXCH PARAMETER NEGATIVE OR GREATER THAN NDEPT -

One or both of two departments to be exchanged have department numbers 0 or NDEPT.

12. PICK UP GOOF -

When unrotating cells of "old" larger department, failed to find all squares.

13. EXCT PARAMETER NEGATIVE OR GREATER THAN NDEPT

Department to be exchanged during the exchange of Department A and Department C across Department B has department number 0 or NDEPT.

14. PERIM GOOF -

Failed to find all cells for a department when measuring the common border between departments.

15. JVALID NEGATIVE OR GREATER THAN NDEPT OR NOT 41-44 -

Department number 0 or NDEPT or not dummy department 41, 42, or 44.

16. ERROR IN INPUT FRTO FOR EQUIPMENT TYPE -- MOVE NUMBER ---

An inconsistency exists for the mobile equipment type noted as a move is indicated for the first mobile equipment type and not for this one.

17. ERROR IN NUMBER OF MOVES

The number of moves for the first mobile equipment types is different than the number of moves indicated on the first input card.

18. ILLEGAL CONTROL CARD PARAMETER -

One of the following has occurred:

Number of departments 0
Number of departments 40
Number of rows 0
Number of rows 30
Number of columns 0
Number of columns 30

REFERENCES

1. Tompkins, J. A. and Reed, R., Jr. "COFAD-A New Approach to Computerized Layout," Modern Materials Handling, April 1975, pp. 40-43.
2. Tompkins, J. A. and Moore, J. M., Computer Aided Facilities Design: A User's Guide, Facilities Planning and Design Division, American Institute of Industrial Engineers, 25 Technology Park, Norcross, Georgia, 1976, Chapter 4.

MAGNETIC TAPE KEY

The tape volume contains two files and three tape marks (TM) as shown below. The DCB information is the same for all files:

DCB=(RECFM=FB,LRECL=80,BLKSIZE=1600)

File 1: COFAD source program
EBCDIC
3196 card images
160 blocks
TM

File 2: Sample input data
EBCDIC
45 card images
3 blocks
TM
TM