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INTERACTIVE GRAPHIC VERSION OF S/360 CONTINUOUS SYSTEM MODELING PROGRAM USER'S AND SYSTEM MANUAL

by

A. ENDRIZZI

1972

Joint Nuclear Research Centre
Ispra Establishment - Italy
Scientific Data Processing Centre - CETIS

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ABSTRACT

CSMP is a program for the simulation of continuous systems. It provides an application-oriented input language that accepts problems expressed in the form of a system of ordinary differential, algebraic and logical equations. Data input and output are facilitated by means of application-oriented control statements.

This interactive-graphic version of CSMP provides a flexible man-machine interface. The user communicates with his problem by means of an IBM 2250 display unit. The program gives the user the possibility of introducing and/or modifying the equations describing the model from the keyboard. It displays the diagnostics produced during the CSMP translation and Fortran G compilation phases, and the user may change his input statements accordingly. While the system is integrating the equations, some variables, selected by the operator, are scaled and plotted on the screen. At any instant, the operator may stop the integration processus and, by light pen detection on a menu, select among following operations: select variables for x-y plotting, change scaling factors, display list of results, change the values of parameters, stop the run or resume integration at the point it was interrupted. When a end-of-run condition is reached, the results and the data for generating the x-y plotting may be stored on a secondary storage for later analysis. New run operation starts by keying new, or modifying old CSMP data statements. This permits the introduction of new values for the initial conditions, for the parameters and also allows the integration method, the integration step, the end of run conditions etc. to be changed. To use this program, the user should be well acquainted with S/360 CSMP, but no further background is required.

KEYWORDS

PROGRAMMING
DIFFERENTIAL EQUATIONS
MAN
IBM 360
GRAPHS
IMAGE TUBES

Introduction *)

In the field of the simulation of continuous dynamic systems S/360 CSMP is a well established tool for investigating phenomena that are the usual concern of engineers and scientists.

S/360 CSMP is intended to satisfy the need for a problem-oriented program designed to prepare problems for solution on large-scale digital machines. It provides a basic set of functional blocks with which the components of a continuous system may be represented, and it accepts application oriented statements for defining the connections between these functional blocks. S/360 CSMP also accepts Fortran statements, thereby allowing the user to handle probelms of considerable complexity. Input and output are facilitated by means of user-oriented control statements. A fixed format is provided for printing selected variables in tabular form.

CSMP has been designed for batch-mode operation, which introduces some difficulties in the communications between the user and his problem. This interactive-graphic version of S/360 CSMP provides the features for a flexible man-machine interface. Convenient means are available for manipulating the equations describing the model and the integrating processus, by operation at a IBM 2250 display unit, attached to a S/360 configuration.

Automatic scaling and plotting of the selected variables is also done by the program providing an overall view of the behaviour of the simulated system. At any instant of the calculation, the operator may require detailed information about his problem and modify data in accordance to his decisions. These facilities make the program a flexible tool for investigating phenomena in an interactive way.

The grammar controlling the S/360 CSMP has not been modified, so that the programmer should not find any difficulty in using this interactive graphic version.

The description of the I.G. CSMP has been divided into four sections. The first section is intended to be the user's manual and describes the operations to be done by the programmer for controlling his model. The user should read

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carefully this section and then he may start running his problems.

The second section describes the procedure to be followed for displaying on the screen the results of a normal S/360 CSMP batch run.

The third section provides a detailed description of the subroutines contained in the I.G. CSMP and is dedicated to those programmers who intend to introduce some modifications into the program. The final section gives the system information for having the interactive-graphic version of CSMP running on a IBM S/360 configuration.

User's manual

To use this program the user should be well acquainted with S/360 CSMP but no further background is required. Particular application may require also Fortran programming.

The programmer describes his model onto cards using the CSMP language. The deck of cards looks like the following:

```
CSMP     statements
END
data deck
END
data deck
....
STOP
FORTRAN statements (if any)
ENDJOB
```

Note: some END cards may be substituted by CONTINUE cards.

The user punches his model and puts it in the back of the prescribed S/360 JCL cards and then he runs the job as a normal batch job.

This report contains a "Interactive-graphic CSMP user's chart" that represents the flow of the program and all console operations which are at disposal for controlling it. Reading this chart should be straightforward as program flow is quite simple and the options at disposal are self-explanatory.

The following remarks should be kept in mind while running this program:

- The I.G. CSMP runs trough its path automatically. It requires operator's intervention only if needed;
- all options at disposal are displayed on the screen between slashes (like this: /END/). Decision is taken by light pen detect on the selected option;
- numeric values are updated into the selected fields by keyboard typing: the cursor will appear underneath the character to be typed in. Numbers may be written in any of the I, F, E Fortran formats for example the

number 15 may be typed as:

15 +15 15. 15.00 15.E0 1.5E+1 150E-01

with any number of leading and tailing blanks. Keyboard operation must be followed by the depression of the ALT-END keys. That indicates to the program that updating is terminated. At this point the cursor is removed from the field and the new value is assumed for the selected variable.

- Consultation of the I.G. CSMP user's chart is recommended.

The information above allow the reader to run his problem using the I.G. CSMP. If he is particularly interested in the details of the program, or if there is any unresolved doubt, he may read the following description.

The I.G. CSMP program starts calling the CSMP translator that converts the CSMP model into a Fortran subroutine.
Fortran G is called next, to compile the output of the CSMP translator and all user's subroutines.
Finally the Linkage Editor is called to generate an executable program.

Messages appear on the screen signaling the execution of the three phases above.

If any error is encountered during these phases, control is given to the operator. He may look for the diagnostics produced by page up-page down operation at the displayed output, and he may update the input deck from the keyboard.

If no error is detected, I.G. CSMP enters the user's model execution.
If displays the first CSMP data deck contained in the input stream. The last card of the data deck (END or CONTINUE card) will appear as the last of 40 displayed lines, some of which may be blank. Through keyboard operation the user may update the displayed cards or insert new lines using the blank ones, and then he may copy the displayed lines into a selected data deck. By these operations he updates, copies, generates up to 20 data decks numbered from 1 to 20.
Next phase consists in selecting the data deck to be executed. At this point the routine is called, that interprets the CSMP data cards and if no error is encountered a new step of the program is entered, otherwise control is given to the operator for looking to the diagnostics and for

redifining the data.

The first time the integration processus is attached, the list of the PREPARE variables will appear on the screen. The operator must select among them the variable to be plotted against the x-axis, and one or more (up to 5) variables to be plotted against the y-axis. These variables will be represented on the screen during the calculation.
Next operation is to define the lower and upper bounds of the selected variables. Those values are used by the program for linear scaling of the curves.
At this point the program calculates the initial conditions and plots them against the x-y axis.
By light pen detect on the option /OPERATE/, the integration processus is started. During integration the selected lines are generated on the screen. The operator has only the /HOLD/ option at disposal, by which he can stop the calculation and do some graphic operations.

- change the y-axis
- make curves disappear
- make them visible again
- require the coordinates of displayed or blanked points
- cancel them

The user may also require detailed informations about the evolution of his model by selecting /MENU/ which gives him the possibility to:

- change the variables to be plotted in the x-y directions
- modify lower and upper bounds for better scaling of curves
- display the output of CSMP (PRINT variables)
- display the minimum and maximum values of the RANGEd variables
- display the current values of the variables and parameters of the problem and modify them if necessary
- stop the execution of this run
- resume integration at the point it was interrupted by /HOLD/ detect

While integrating, if an end of run condition is reached (see FINISH or FINTIM), the /HOLD/ option disappears and the options described above appear. The user leaves this set of operation by detect on /END OF RUN/.

If a multivalue parameter is specified or a RERUN case is on, next case is initialized automatically and, through /OPERATE/ option integrated. If that is not the case, the operator is asked whether the program should keep the CSMP output and/or the drawings on disk, for later display and comparison with other cases. Default options are: to print out the data set containing the CSMP output and to rewind the data set containing the drawings.

At this point the user decides to:

- execute a new run and goes back to the definition and selection of data
- display previously stored drawings
- end the execution of the problem

By selecting the last possibility he comes to the end of the job unless he wants to modify the CSMP and Fortran statements describing the model and start the analysis of a new model. So far the description of the I.G. CSMP main flow. Details are represented on the user's chart.

Displaying the results of a S/360 CSMP batch run

The user may not be interested in the interactive facilities of the I.G. CSMP but he may use the IBM 2250 for plotting the results of S/360 CSMP runs. The PREPARE option of S/360 CSMP generates a data set which may later be used for plotting as a separate OS/360 job.
The I.G. CSMP contains a subroutine that reads the data set number 15 generated at the end of a run and plots selected variables on the screen (see the user's chart and follow the flow starting at /DISPLAY STORED DRAWINGS/). This facility can be used in a program written by the user, which should contain the statements:

CALL GRAFI(10)	for initializing the IBM 2250
CALL GPREP	for selection and representation of the stored variables

Description of the I.G. CSMP subroutines

The IBM 2250 has been programmed using the GRAFI package in conjunction with the GSP of IBM. The GRAFI package is a set of subroutines for generating graphic forms and for communicating with the 2250 in a handy way. The user will recognize the calling sequences of the GRAFI and GSP subroutines throughout the listing of the program.

Control from OS/360 is received by the I.G. CSMP control routine DEJCSMP2 that in turn links to each of the 8 phases described below:

1 - Phase 1 GC0111 reads the user's model structure and data statements from SYSIN and copies them onto disk FT01F001 by calling subroutine GC080. In the meantime a I.G. CSMP header label will appear on the screen. At the end of this phase the IBM 2250 is switchted off by the program.
2 - Phase 2 is the S/360 CSMP translation phase.
3 - GTRAN activates the 2250 and sends a message to the user signaling the end of the previous phase. If any errors have been encountered during the execution of the previous phase, the operator has the possibility to display the data set 06 which contains the output of the translator (subroutine GLIST), or to correct the input statements (up to 179 cards are admitted by the subroutine GUPDAT).

4 - Fortran G compilation

5 - GCOMP is analogous to phase 3. Subroutine GL120, analogous to GLIST, lists data set 12 that contains the output of the Fortran. The input cards reside on file 07.

6 - Linkage Editor

7 - GLE is analogous to phase 3. Subroutine GL121, analogous to GLIST, lists data set 17 that contains the output of the linkage editor.

8 - I.G. CSMP execution phase.

This phase is in overlay structure. Control is given to the subroutine MAINEX which after necessary initialization calls in turn the following routines:GWRDAT reads data set 05 that contains CSMP data cards and generates data set 16. It will contain 20 data decks separated by a special record. Some data decks may be empty i.e. contain but the END card.

GRDDAT displays and updates the data decks contained onto file 16. Each data deck is supposed to be composed by less then 40 cards, the last of which should be the END or CONTINUE card that will be displayed at the bottom of the screen. The other cards will appear starting from the top. Blank lines are inserted in between and may be filled up using the JUMP key. Subroutine FINDPA is used to find the selected data deck onto file 16. Whenever the COPY option is selected, data set 05 is used to store temporarily the content of file 16 along with the data cards appearing on the screen. Thereafter 05 is rewound and moved to 16. By touching the EXEC option the selected deck is copied from 16 to data set 05 as required by the data translation routine of the CSMP (INTRAN). The variable ERDT is the indicator of the errors in the data statements. It is set by INTRAN and STATUS subroutines.

The variable IPREP contained into DEJCSMP2 is set to zero initially, as there is no run stored onto the PREPARE data set 15.

GPREP reads data set 15 using FINDPR for counting the number of runs stored and displays it to the operator and waits for the selection of a case number.GPREP1 is called next. If it is requested, label and data contained in the common PREP1, filled up by the routine FINDPR, are written onto file 17 and then displayed on the screen. Through the DISPLAY option, a routine is executed, analogous to SELVAR, for selecting variables names.

GDISP scales and plots the selected variables and allows the described graphic operations.
SIMOUT is called during the execution of the integration routine. This subroutine is used to output necessary information for PRINT, PREPARE and PRTPLT requests. Those parts of SIMOUT which are controlled by the PREPARE option, have been extended to permit the creation of the image on the screen.
Variable SELVA is set to "false" the first time the problem is executed. This causes subroutine SELVAR to be called: it displays all PREPARE variables and waits for x-y axis selection. Output parameters IX, IY are the indexes of the selected variables and IYY is the number of the variables to be plotted against the y axis.
SELRAN is called next for introducing the values of the lower and upper bounds. The names of the variables and the corresponding bounds appear in the common CDES1.
STBND is an entry point of the subroutine RETBND which is used for storage and retrieval of the defined bounds onto data set 19. Storing those values has the advantage that it is not necessary to redefine them each time successive cases are executed.
The variable NOPRIM in SIMOUT equals "false" if the image is to be generated. Rerun cases or multivalue parameter are explicitly declared on the screen. While integrating,a test is done to determine if the /HOLD/ option has been detected. The variable STEP1 controls the calculation until the next OUTDEL time interval is reached. Whenever the couple of options /MENU/ and /RESUME OPERATION/ is selected, the image is regenerated reading data set 13 that contains the tables of the PREPARE variables. R218, R222, R183, R306, SELRA are the variables for controlling the flow of the execution inside SIMOUT in accordance to the operator's actions. When an end of run condition is reached the variables PRE and LIST are set by default or by user's instructions. They control the printing of the results and the movement of data from data set 13 to data set 15 on which PREPARE variables will finally reside.

System informations

The I.G. CSMP requires an IBM 2250 display unit attached to a S/360 configuration. During execution about 180 K of core memory are needed. The processus of incorporating the IG CSMP into a S/360 installation is relatively straightforward. First make sure that the S/360 CSMP resides on your system and then follow the instructions below.

The I.G. CSMP is distributed on a tape containing seven partitioned data sets:

File	DSName	Members
		SAMPLES
1	GRAFI.DECKS	LKEDDECK
2	GRAFI.SOURCE	All GRAFI subroutines
3	GRAFI.OBJMOD	All GRAFI subroutines modules
		TRANMOD1
4	CSMP.SYMBM1	CTLCDS1
		EXECMOD1
5	CSMP.SOURCE1	All I.G. CSMP subroutines
6	CSMP.OBJMOD1	All I.G. CSMP subroutines modules
7	CSMP.DECKS1	LKED1
		LKED2
		JCLCARD1
		JCLPREP

Data sets 1,2 and 3 refer to the package GRAFI that must be generated on your configuration. Following are control cards for loading the GRAFI partitioned data sets onto a DASD.

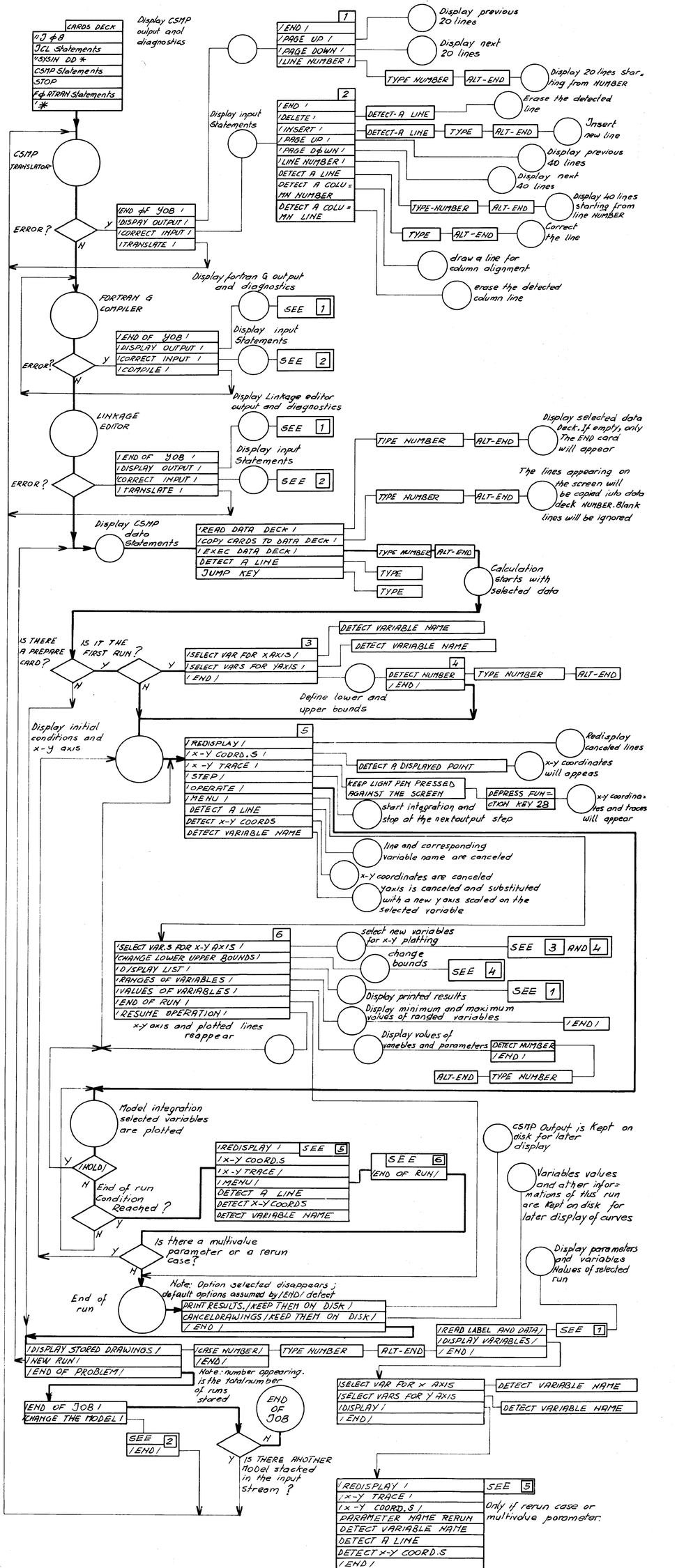
```
//LOADGRA EXEC PGM = IEHMOVE
//SYSPRINT DD SYSOUT = A
//TAPE DD UNIT=TP, VOL = SER = GRAFI, LABEL = (1,NL),
//     DISP = (COLD,FASS), DCB = (DEN=2, DSORG = PO, RECFM = FB, BLKSIZE = 800,
//     LRECL=80)
//DISK DD UNIT = 2314, VOL = SER = VOLGRAFI, DISP = (OLD, KEEP)
//SYSUT1 DD UNIT = 2314  VOL=SER = VOLGRAFI, DISP = OLD
//SYSIN DD *
   COPY   TO=2314=VOLGRAFI,FROM=TP=(GRAFI,1),FROM DD=TAPE,PDS=GRAFI.DECKS
   COPY   TO=2314=VOLGRAFI,FROM=TP=(GRAFI,2),FROM DD=TAPE,PDS=GRAFI.SOURCE
   COPY   TO=2314=VOLGRAFI,FROM=TP=(GRAFI,3),FROM DD=TAPE,PDS=GRAFI.OBJMOD

//PUNCH EXEC PGM = IEBPTCH
//SYSPRINT DD SYSOUT = A
//SYSUT1 DD UNIT = 2314, VOL=SER=VOLGRAFI,DISP = (OLD,KEEP),
//          DSN = GRAFI.DLCKS
//SYSUT2 DD SYSOUT = B
//SYSIN DD *
  PUNCH     TYPORG=PO,MAXNAME = 2
            MEMBER NAME = SAMPLES
            MEMBER NAME = LKEDDECK
```

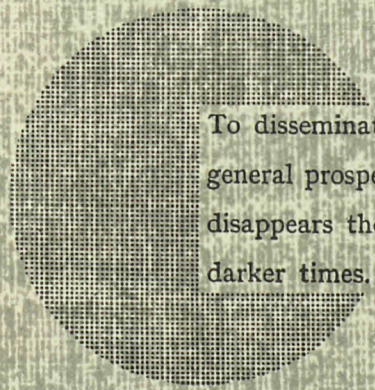
Mount the distribution tape on a nine track tape drive and run the two steps above. This will punch the LKEDDECK that consists of the JCL and control cards for generating the private library SYS1.LIBGRAFI. Run this third step and then run the sample problem number 3 to test the package.

At this point the I.G. CSMP can be generated.

```
//LOADCSMP  EXEC  PGM = IEHMOVE
//SYSPRINT  DD SYSOUT = A
//TAPE DD UNIT = TP, VOL = SER = GRAFI, LABEL = (4, NL),
//        DISP = (OLD, PASS), DCB = (DEN=2, DSORG=PO,RECFM=FB,
//        BLKSIZE=800, LRECL = 80)
//DISK DD UNIT = 2314, VOL=SER=VOLGRAFI, DISP = (OLD,KEEP)
//SYSUT1 DD UNIT = 2314, VOL=SER=VOLGRAFI, DISP = OLD
//SYSIN DD *
```

Graphic interactive CSMP user's chart





To disseminate knowledge is to disseminate prosperity — I mean general prosperity and not individual riches — and with prosperity disappears the greater part of the evil which is our heritage from darker times.

Alfred Nobel

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