CACHE NEWS

News About Computers In Chemical Engineering Education

No. 12

March, 1981



WHAT IS CACHE?

CACHE is a non-profit organization whose purpose is to promote cooperation among universities, industry, and government in the development and distribution of computer-related and/or technology-based edcuational aids for the chemical engineering profession.

CREATION OF THE CACHE CORPORATION

During the 1960's the rapid growth of computer technology challenged educators to develop new methods of meshing the computer with the teaching of chemical engineering. In spite of many significant contributions to program development, the transferability of computer codes, even those written in FORTRAN, was minimal. Because of the disorganized state of university-developed codes for chemical engineering, 14 chemical engineering educators met in 1969 to form the CACHE (Computer Aids for Chemical Engineering) Committee. Initially the CACHE Committee was sponsored by the Commission on Education of the National Academy of Engineering and funded by the National Science Foundation. In 1975, after several successful projects had been completed, CACHE was incorporated as a not-for-profit corporation in Massachusetts to serve as the administrative umbrella for the consortium activities.

CACHE ACTIVITIES

All CACHE projects are staffed by volunteers including both educators and industrial members and coordinated by the Board of Trustees through various Task Forces. CACHE actively solicits the participation of interested individuals in the work of its on-going projects. Information on CACHE activities is regularly disseminated through the CACHE Newsletters. Individual inquiries should be addressed to

> CACHE Corporation 3062 MEB Salt Lake City, Utah 84112 (801) 581-6916

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CACHE NEWS

The CACHE News is published one or two times a year to report news of CACHE activities and other noteworthy developments of interest to chemical engineering educators. Persons who wish to be placed on the mailing list should notify CACHE at the above address. This issue was edited by J. D. Seader with assistance from Thomas F. Edgar.

CACHE REPRESENTATIVES LUNCHEON IN CHICAGO

The annual CACHE Representatives luncheon was held during the 73rd Annual Meeting of the AIChE at the Falmer House Hotel in Chicago on Hednesday, November 19, 1980. The luncheon was co-sponsored by Control Data Corporation (CDC) and was attended by 49 professors representing 42 schools. The program included short presentations by Professor Michael Cutlip of the University of Connecticut and Charles Eckert of the University of Illinois on the PLATO system for computeraided instruction, Professor David M. Himmelblau on the CHEMI continuation project, and Professor H. Scott Fogler on Personal Computing. Prior to and following the luncheon, two PLATO terminals, arranged through CDC, were available at AIChE meeting headquarters for demonstrations by Professor Cutlip, Eckert, and Mordechai Shacham of Ben Gurion University.

NEW MEMBERS OF CACHE

During 1980, four new members of CACHE were elected: John C. Hale, Bruce A. Finlayson, Manfred Morari, and Peter R. Rony.

John Hale is Consulting Manager, On-Line Systems, Engineering Services Division, Engineering Department, of DuPont at Wilmington, Delaware. All 18 years of his industrial employment have been with DuPont, mainly in connection with plant operations and support. John states that his main interest is in activities that translate into useful results at the plant level. He views computers as a tool to more directly and fully apply chemical engineering technology. He uses computers for modeling, analysis, simulation, and mainly control. At DuPont, he is responsible for process computer consultation on a corporate basis and for coordination with vendors and industrial departments to provide new and expanded capabilities for process computers. John has an ScD in Chemical Engineering from the University of Virginia.

Bruce Finlayson is Professor of Chemical Engineering and Applied Mathematics at the University of Washington, where he has authored numerous papers on methods of weighted residuals and other topics. He is the author of two books, <u>The Method of Weighted Residuals and Varia-</u> <u>tional Principles by Academic Press in 1972, and</u> <u>Nonlinear Analysis in Chemical Engineering by McGraw-Hill in 1980. In 1979, he presented the Second Annual Tutorial Lecture in Chemical Engineering at the ASEE meeting in Baton Rouge. He has developed a number of computer programs for chemical reactor design, including REACOL, REACFD, and ETAPHI. Bruce has a Ph.D. from the University of Minnesota.</u>

Manfred Morari is Assistant Professor of Chemical Engineering at the University of Wisconsin, where he has authored a number of papers in the areas of process synthesis, design, and control. In 1980, he received the Donald P. Eckman Award of the American Automatic Control Council for outstanding contributions to the field of automatic control from one under 30 years of age. Manfred was born in Austria, graduated from the Swiss Federal Institute of Technology, and received his PhD from the University of Minnesota.

Peter Rony is Professor of Chemical Engineering at the Virginia Polytechnic Institute and State University. Prior to joining that institution, he was employed by Monsanto and EXXON. He has authored papers in the areas of separation operations, catalysis, and microcomputers. Most recently, he has authored nine books on TL integrated circuits and on programming and interfacing of microprocessors. In addition, since 1974, he has written or edited monthly columns on computer and microcomputer interfacing in American Laboratory and Computer Design and has presented many short courses on various aspects of microcomputers. Peter has a PhD from the University of California at Berkeley. With financial support from DuPont and Simulation Sciences, Inc., CACHE has leased, from the British Institution of Chemical Engineers, through the efforts of Rudy L. Motard of Washington University, a version of the PPDS physical property retrieval and estimation program. The service is now installed on a DEC System 20 computer at Carnegie-Mellon University and can be accessed via the TELENET communication network, which provides local dial-up service in most cities.

The commercial version of PPDS provides retrieval of the following 17 constant and 15 variable properties, in a variety of units, including S.I. and British, for several hundred compounds:

Constant Properties	Variable Properties
Molecular Weight Critical Temperature Critical Pressure Critical Volume	Vapor Heat Capacity Vapor Viscosity Vapor Thermal Conductivity Liquid Heat Capacity
Melting Point	Liquid Viscosity
Normal Boiling Point	Liquid Thermal Conductivity
Parachor	Vapor Density
Heat of Formation of Vapor	Vapor Enthalpy
Heat of Formation of Liquid	Liquid Density
Flash Point	Liquid Expansion Coefficient
Lower Flammability Limit	Liquid Enthalpy
Upper Flammability Limit	Latent Heat of Vaporization
Autoignition Temperature	Liquid Surface Tension
Solubility Parameter	Vapor Pressure
Acentric Factor	Total Heat of Formation
Acentric Factor of Homomorph	i i i i i i i i i i i i i i i i i i i
Dipole Moment	

The CACHE version of PPDS, when accessed from a terminal, can retrieve values of the above properties or support a FORTRAN-callable interface for user-written application programs for the following 50 compounds and/or mixtures thereof: Light Gases

		ouner	anu
Hydrocarb	ons	Organic O Compounds	ther Inorganic Compounds
Methane Ethane Propane Isobutane n-Butane Isopentane n-Pentane n-Heptane 2,2,4-Trimethyl- pentane n-Octane n-Dodecane Acetylene	Ethylene Propene Isobutene I-Butene Cyclopentane Methylcyclo- pentane Benzene Toluene O-Xylene Ethylbenzene Styrene Naphthalene	Methanol Ethanol Isobutyl alcohol Acetic Acid Acetaldehyde Ethyl acetate Ethylene glyco Ethylene oxide Vinyl chloride Chloromethane Chloroform Chlorocthane Acetic Anhydri	H ₂ N ₂ CO CO ₂ HC1 C1 ₂ H ₂ S 1 NH ₃ H ₂ O e

Input to PPDS is interactive, wherein the user enters replies to questions from PPDS. For example, certain properties of a water-acetic acid mixture are requested in the following dialog: **ORUN PPDS** PHYSICAL PROPERTY DATA SERVICE VERSION NUMBER: 4.03 TYPE THE STREAM TITLE. (10A4) EXAMPLE 2. NUMBER OF COMPONENTS IN THE STREAM? (I) 2 TYPE QUANTITY UNITS CODE: 1=LB,2=LBMOLE,3=KG,4=KGMOL,5=MOLE FRAC. 5 FOR EACH COMPONENT TYPE THE CODE NUMBER AND QUANTITY PRESENT. 2(I,F) 26.0.6 36,0.4 TYPE THE NUMBERS OF CONSTANT AND VARIABLE PROPERTIES REQUIRED. (21) 6,6 TYPE THE CODE NUMBERS OF THE CONSTANT PROPERTIES REQUIRED. 6(1) 1,2,3,4,14,15 TYPE THE CODE NUMBERS OF THE VARIABLE PROPERTIES REQUIRED. 6(I) 5,7,9,10,12,13 TYPE THE TEMPERATURE INPUT UNITS: 1=DEG C; 2=DEG K; 3=DEG F. (I) 1 TYPE PRESSURE INPUT UNITS: 1=ATMS; 2=N/M2, 3=PSIA; 4=BAR ABS; 5=MMHG. (I) 1 TYPE NUMBER OF (T,P) POINTS, OR O TO STEP THROUGH A RANGE OF VALUES. (I) 4 TYPE THE 4 SETS OF VALUES IN DEG C AND ATMS (F) 25.,1.0 25.,2.0 50.,1.0 50.,2.0 TYPE OUTPUT UNITS CODE: 1=ENGINEERING, 2=S.I., 3=BRITISH.

Output from PPDS consists of:

3

- 1. Tabulated, selected constant properties of pure compounds or mixtures.
- Tabulated, selected variable properties of pure compounds or mixtures at specified intervals of T and P.
- 3. Warning messages for less reliable estimates.
- 4. Array values for user-written programs through FORTRAN interface.

The following is the output from PPDS that results from the previous example of input:

COMPONENTS:

26 WATER

36 ACETIC ACID

COMPOSITION: EXAMPLE 2. COMPONENT WATER ACETIC ACID	WT. 10.809 24.021	WT.PERCENT 31.033 68.967	WT.MOL 0.600 0.400	MOL.PERC. 60.000 40.000
MIXTURE:	34.830		1.000	

STREAM CONSTANTS: EXAMPLE 2.

COMPONENT 1 MOLECULAR WEIGHT 2 CRITICAL TEMPERATURE 3 CRITICAL PRESSURE 4 CRITICAL VOLUME 14 SOLUBILITY PARAMETER 15 ACENTRIC FACTOR	DEG F PSIA CU.FT/LBMO RT(CAL/CC)	26 18.015 705.560 3250.63 0.8907 23.400 0.3480	36 60.053 610.340 836.170 2.749 8.880 0.4543	
STREAM VARIABLES, EXAMP	LE 2		LIST 1	
TEMPERATURE REDUCED TEMPERATURE PRESSURE REDUCED PRESSURE MOLECULAR WEIGHT	DEG F PSIA O	77.000 0.4761 14.695 0.6432E-02 34.830	77.000 0.4761 29.391 0.01286 34.830	122.000 0.5161 14.695 0.6432E -02 34.830
5 LIQUID HEAT CAPACITY 7 LIQUID DENSITY 9 LIQUID ENTHALPY 10 LIQUID LATENT HEAT 12 LIQ. VAPOUR PRESSURE 13 LIQUID VISCOSITY	BTU/LB F LB/CU.FT BTU/LBMOLE BTU/LBMOLE PSIA LB/H FT	0.6396 64.129 997.738 10790.2* 0.3952 2.371	0.6396 64.129 997.738 10790.2* 0.3952 2.371	0.6519 62.791 2009.05 9995.94* 1.507 1.528

THE SYMBOL * INDICATES THAT A WARNING MESSAGE IS ASSOCIATED WITH THE DATA POINT. TYPE 1 TO LIST WARNING MESSAGES; O TO ERASE THEM.

In order to use CACHE-PPDS, contact:

Professor R. L. Motard Department of Chemical Engineering Washington University St. Louis, Missouri 63130

He will send a contract and additional information. Upon receipt of the signed contract, a purchase order is sent to CACHE to cover an initiation fee of \$100 for CACHE-sponsoring departments or \$200 non-sponsoring departments.

This should be sent to: CACHE 3062 MEB Salt Lake City, Utah 84112

The approximate total cost to access CACHE-PPDS by TELENET is \$5.00 per connect hour, payable to Carnegie-Mellon University. Professor Motard is currently completing a user's manual for CACHE-PPDS.

NEW AICHEMI MODULAR INSTRUCTION SERIES

In the CACHE Newsletter No. 11, mention was made that the first phase of the CACHE CHEMI (Chemical Engineering Modular Instruction) Project, under the direction of Professor Ernest J. Henley of the University of Houston, and William A. Heenan of Texas A and I University, was successfully completed with the transmission of 230 modules to the Division of Continuing Education of AIChE for publication and dissemination under the direction of Harold I. Abramson. The modules are being published in the following six series of major areas with from four to six volumes per series:

Series	Subject	Series Editor			
A	Process Control	T. F. Edgar, University of Texas at Austin			
В	Stagewise and Mass Transfer Operations	E. J. Henley, University of Houston J. M. Calo, Princeton University			
С	Transport	R. J. Gordon, University of Florida			
D	Thermodynamics	B. M. Goodwin, Northeastern University			
Е	Kinetics	H. S. Fogler, University of Michigan B. L. Crynes, Oklahoma State University			
F	Material and Energy Balances	D. M. Himmelblau, University of Texas at Austin			

During 1981, AIChE plans to issue the first volume in each of the six series. In January, 1981, all chemical engineering departments received complimentary copies of the 83-page Volume 1, Series A, entitled "Analysis of Dynamic Systems," which contains eight modules written by Glenn Atwood of the University of Akron, H. E. Nuttall of the University of New Mexico, Gerald Mueller of the University of Waterloo, V. E. Sater of Arizona State University, P. R. Krishnaswamy of Indian Institute of Technology, and W. C. Clements, Jr., of University of Alabama. Each module begins with lists of objectives and prerequisite skills and includes study problems with solutions.

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The modules were designed to be used for outside study, special projects, entire university courses, review courses, correspondence courses, continuing education courses, or to provide new and timely material that can supplement other courses. A tentative outline listing titles and authors of all modules appears in the volume distributed to all chemical engineering departments. Future volumes will be available from AIChE, 345 East 47 Street, New York, NY 10017, by single volume or by subscription.

NSF MAKES GRANT TO CACHE FOR MICROCOMPUTER PROJECT

On June 23, 1980, NSF awarded a two-year grant to CACHE to develop a microcomputer network and courseware for teaching chemical engineering design. The Principal Investigators are Professor Brice Carnahan, 1980 recipient of the annual award of the CAST Division of AIChE, and Professor H. Scott Fogler, both of the University of Michigan. With a staff of consultants, program authors, and editors, they plan to develop a series of interactive programs for use from floppy disks or tape cassettes on microcomputers such as the Apple, TRS-80, and Pet. A solicitation for program authors is planned in the near future.

PROGRAMS FOR HAND-HELD PROGRAMMABLE CALCULATORS

The CACHE Task Force on Microcomputers and Hand-Held Calculators is collecting Chemical Engineering programs written for hand-held programmable calculators to be published in booklet form. The proposed booklet will present unpublished programs of interest to Chemical Engineers and Chemical Engineering Educators. Abstracts of published programs, with references, will also be given. Material will be organized by subject and cross-referenced. If you have programs you would like to submit, please contact the Task Force subcommittee on hand-held programmable calculators.

F. William Kroesser, Task Force Subcommittee Chairman Engineering and Science Division West Virginia College of Graduate Studies Institute, WV 25112 Phone (304) 768-9711, ext 453

CHEMI CONTINUATION (PHASE II) PROJECT

Since October 1979, the second phase of the CHEMI project, funded by NSF, has been underway with D. M. Himmelblau of the University of Texas at Austin as the Principal Investigator. A steering committe including the following was established in November, 1979:

Brice Carnahan, University of Michigan Dean E. Griffith, Director of Continuing Education at Oklahoma State University

Lee Harrisberger, University of Alabama

Vladimir Slamecka, School of Information and Computer Science, Georgia Institute of Technology

Robert Tinker, Technology Education Research Center, Cambridge, Massachusetts.

Activities underway to achieve the project objectives are:

 Preparation of new and revised modules to fill gaps in the previous CHEMI compilation.

2. Preparation of 80 advanced-level modules and modules suitable for plant engineers.

3. Arrangement for testing of the modules in companies and in three or four universities.

4. Preparation of a usage inducement system entered onto a micro-computer system together with an information system.

5. Assessment of the technological impact and impact on curriculum.

Under Item 1, 30 process control and 27 material and energy balance modules have been revised. A total of 87 new modules are being written in the original six areas and 30 new modules are planned for the Design area.

Thus far, two series of advanced modules have been commissioned, one on "Wastewater Treatment" to W. Eckenfelder, Jr., of Vanderbilt University, and the other on "Filtration" to Frank M. Tiller at the University of Houston.

Modules in five of the seven areas are currently being tested by F. G. King of Howard, N. F. Marsolan of Louisiana Tech., M. L. Brisk of Sydney, P. J. Sukanek of Clarkson, D. D. Bruns of Tennessee, H. H. Luttrell of McNeese, M. A. Serageldin of Michigan Tech., E. D. Sloan of Colorado School of Mines, and R. D. Noble of Wyoming. The tests are devised to determine student attitudes toward modular instruction, student evaluations of individual modules, and degree of mastery of subject matter covered by an individual module. Modules will also be tested by individual companies later in the project.

Brief abstracts on 500 application elements are being prepared for entry into an information system together with associated entries for a glossary, notation list, reference list, and index. The information system will also include module pre-tests and post-tests and graphics of the interrelationships among components and modules.

This data base, to be accessed from a computer, will help a user decide which modules are suitable for study or be given an external reference in the event that no module exists. Professor Himmelblau expects the online information system to be used primarily for searching, diagnostics, testing, and reference. Users will probably not be eager to read through individual modules online because: 1) They will feel rushed, since the computer is waiting for a response, 2) Reading text on a terminal screen can become tiring. Once the user has found the material of interest, provision will be made to have a high-quality hard copy available. A user can easily return to the online system for further searching, diagnostics, or testing. Upon entering the system, a user should be able to: 1) see an outline of all the subjects covered by the modules or a subset of the modules (subject area); 2) see graphs of modules and their interconnections; 3) see abstracts of subject areas and modules; 4) work through diagnostic routines designed to help choose a sequence of modules to read; 5) see a record of his own progress through the system; 6) enter a keyword or symbol and see a definition, a list of modules which cover the subject, a list of more specific terms on the subject, a list of broader terms, a list of related terms, bibliographic citations (including abstracts) of works dealing with the subject, a narrative overview of the subject if it is general (abstract of a subject area in the system), and a list of computer programs treating the subject; 7) enter an author's name and see a list of modules dealing with his subject area(s).

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The UNIX operating system with a PDP 11/23 minicomputer is being used to develop the information system. UNIX allows entry and retrieval of 1) alpha numeric characters, 2) graphics, 3) equations and special symbols, and 4) declarations. Departments of Chemical Engineering may not necessarily have output devices of high resolution; and, consequently transferrable codes are being produced that can reproduce the modules with low-level resolution as well as high-level resolution, such as Tektronix terminal. The project team is focusing attention on how to minimize the machine dependence of the components of computer programs so that they can transfer tapes or disks to other sites with a minimum of difficulty. FORTRAN is the language used because it is the only widely available language that can be compiled both on large, small, and micro-computers in Departments of Chemical Engineering.

A session entitled "The CHEMI Project-Update and Preliminary Results" was held at the 1980 ASEE Meeting in Amherst, Maine, on June 25, 1980, with presentations by Professors J. M. Calo of Princeton University, T. F. Edgar of University of Texas at Austin, B. M. Goodwin of Northeastern University, B. L. Crynes of Oklahoma State University, E. J. Henley of University of Houston, P. C. Wankat of Purdue University, and Hal Abramson of AIChE.

Further details on the CHEMI Continuation project are available from: Professor David M. Himmelblau, Dept of Chemical Engineering, University of Texas, Austin, Texas 78712.

CACHE PLANS INDUSTRIAL RECRUITERS BOOKLET

In order to improve the interface between education and industry, CACHE is preparing a guidebook for industrial recruiters to help them locate graduating students who are computer oriented and would like to work in this type of environment in industry. The book will contain one page for each of 75 participating schools. Included will be a short listing by title of computing-andcontrol-related courses, and the names of faculty members who can help direct recruiters to interested students. The booklet was suggested by Dr. Edward M. Rosen of the Monsanto Company.

FLOWTRAN NEWS

Six years ago, Monsanto Company first made FLOWTRAN available through CACHE via the United Computing System (UCS) network for educational use. Since then 54 schools in the United States and Canada have used FLOWTRAN. During the 1979-80 academic year, FLOWTRAN was used by 29 schools with total UCS charges of \$32,858.

CACHE has produced three books to assist educators in teaching FLOWTRAN. The first, "FLOWTRAN Simulation -An Introduction," is in its second edition. The second, "CACHE Use of FLOWTRAN on UCS," is currently being revised by L. T. Biegler and Professor R. R. Hughes of the University of Wisconsin. The third, "Exercises in Process Simulation Using FLOWTRAN," by J. Peter Clark, has just been revised by T. P. Koehler under the direction of Professor Jude T. Sommerfeld at Georgia Tech. An order form for these books is included at the end of this newsletter.

FLOWTRAN has had a significant impact on chemical engineering education at a large number of schools. It has helped revive an interest in process design and modeling. Anyone interested in using FLOWTRAN can contact: Professor J. D. Seader, MEB 3062, University of Utah, Salt Lake City, Utah 84112 (801) 581-6916. Questions regarding communication with the UCS network can be directed to the UCS representative for FLOWTRAN,

> Ms. Carolyn Kuehl United Computing Systems, Inc. Suite 170 10 30 Woodcrest Terrace Drive St. Louis, M0 63141 (314) 434–6633

CACHE TASK FORCES

Most of the work done by CACHE is through the efforts of its task forces. Current task forces and chairmen are as follows. Those wishing to work on task forces are encouraged to contact the designated chairman.

Task Force	Chairman
Data Management	Professor R. L. Motard Washington University
CHEMI Continuation	Professor D. M. Himmelblau University of Texas, Austin
Graphics	Professor G. V. Reklaitis Purdue University
Large-Scale Systems	Professor J. D. Seader University of Utah
Personal Computing	Professor H. S. Fogler University of Michigan
Real-Time	Professor J. W. White University of Arizona

CHANGE TO CACHE BYLAWS

At the November, 1980, CACHE Trustees Meeting, an important change was made to the CACHE Bylaws that makes those other than educators eligible to become Trustees of CACHE. The revised section of the Bylaws now reads:

Section 2.1

a. Classes of Membership. There shall be one class of membership in the corporation, which class shall be known as Trustees. The membership of the corporation shall consist of no more than 26 Trustees, who shall serve designated terms of office. Any educator, <u>industrial or government employee</u>, or consultant shall be eligible to become a Trustee of this corporation. No <u>more than 21 of the Trustees shall be educators of academic rank, and no more than 5 Trustees shall be fulltime employees in industry or government or consulting. Trustees shall be entitled to all rights and privileges</u>

Section 2.8 Quorum (change to first sentence only)

At all meetings of the Trustees, <u>nine</u> Trustees, present in person or represented by proxy, shall constitute a quorum.

CACHE COMPUTER PROGRAMS FOR CHEMICAL ENGINEERING STILL AVAILABLE

In 1972, CACHE published seven volumes of "Computer Programs for Chemical Engineering." The volumes covered the following areas: Stoichiometry, Kinetics, Control, Transport, Thermodynamics, Design, and Stagewise Computations. Each volume contained descriptions and listings of from 11 to 24 tested FORTRAN programs prepared by eminent chemical engineering educators. The programs have proven useful for homework problems, classroom demonstrations, design laboratories, and process simulation. The seven volumes are still available individually at prices ranging from \$12.95 to \$14.95, and as a complete set at \$89.95. Complete information on the volumes is available from the current publisher:

Sterling Swift Publishing Company P. O. Box 188 Manchaca, TX 78652

CACHE REAL-TIME COMPUTING MONOGRAPHS IN DEMAND

In 1977, the CACHE Real-Time Computing Task Force, under the direction of Professor Duncan Mellichamp, prepared eight monographs on the following topics in Real-Time Computing:

MONOGRAPH	Ι	-	"An	Introduction to Real-Time Computing'
			0.	Digital Computing and Real-Time
				Digital Computing (Mellichamp)
			1.	The Structure of Real-Time Systems
				(Mellichamp)

 An Overview of Real-Time Programming (Mellichamp)

MONOGRAPH	II	-	 PROCESSES, MEASUREMENTS, AND SIGNAL PROCESSING 3. Processes and Representative Applications (Edgar) 4. Measurements, Transmission, and Signal Processing (Wright)
MONOGRAPH	III	-	<pre>INTRODUCTION TO DIGITAL ARITHMETIC AND HARDWARE 5. Representation of Information in a Digital Computer (Fisher and Seborg) 6a. Digital (Binary) Logic and Hard- ware (Engelberg and Howard)</pre>
MONOGRAPH	IV	-	 REAL-TIME DIGITAL SYSTEMS ARCHITECTURE 6b. Digital Computer Architecture (Engelberg and Howard) 7. Peripheral Devices and Data Communications (Rudd) 8. Digital Computer/Process Interfacing (Hughes)
MONOGRAPH	V	-	 REAL-TIME SYSTEMS SOFTWARE 9. Assembly Language Programming (Fisher) 10. Utility or Systems Software (White) 11. Multitask Programming and Real-Time Operating Systems (Wright)
MONOGRAPH	VI	-	REAL-TIME APPLICATIONS SOFTWARE 12. Real-Time BASIC (Mellichamp) 13. Real-Time FORTRAN (White) 14. Control-Oriented Languages (Smith)
MONOGRAPH	VII	-	MANAGEMENT OF REAL-TIME COMPUTING FACILITIES 15. System Justification, Selection, and Installation (Smith) 16. System Operations Management and Program Documentation (McCarthy and Weaver)
MONOGRAPH	VIII	-	PROCESS ANALYSIS, DATA ACQUISITION, AND CONTROL ALGORITHMS A. Process Analysis and Description (Edgar)

B. Digital Computer Control and Signa¹ Processing Algorithms (Edgar and Wright)

These monographs are intended for use in lab courses, in self-study, and by real-time users at all levels because they contain many detailed examples. The monographs have been in heavy demand, particularly due to the trend towards use of real-time computing in the undergraduate laboratory. The monographs are being used as texts in a number of universities and are available as single volumes at \$3.75 and as complete sets at \$28.00 from

> Professor Brice Carnahan CACHE Publications Committee Chemical Engineering Department University of Michigan Ann Arbor, MI 48109

An order form appears on the last page of this newsletter.

CACHE GRAPHICS SOFTWARE EXCHANGE PROJECT

Costs of graphics terminals and associated printers and plotters have been greatly reduced in recent years. For example, a Lear-Siegler ADM-3A "Dumb" Terminal retailing for \$895 can be retrofitted for about \$1000 with a graphics board by Digital Engineering, Inc. that is completely compatible with Tektronix Plot 10 software. The resulting graphics terminal, for less than \$2000, has full vector drawing and point-plotting capabilities on a 512 x 250 grid. Because of rapidly growing interest in graphics, the Computer Graphics Task Force of CACHE is initiating a pilot program, in which several graphics software programs for interactive graphics will be exchanged and tested by members of the Task Force. The purpose of this effort is to test the portability of available graphics software packages prior to more general distribution of the programs to the chemical engineering community. Professors F. Kayihan (Oregon State University) and G. V. Reklaitis (Purdue) will coordinate this activity.

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Programs that have been identified as candidates for the software exchange project are listed below:

1.	F. Kayihan Oregon State	"Interactive Computer Graphics for Flowsheet Drafting and Simulation"
2.	T. F. Edgar U. Texas	"Interactive Controller Tuning by Frequency Response"
3.	D. M. Himmelblau U. Texas	"Simulation of Combined Models for Transport and Reaction"
4.	Y. Arkun RPI	"Computer-Aided Operability Analy- sis of Chemical Processes via Inter- active Graphics"
5.	J. M. Calo Princeton	"Design of Distillation Columns Using Interactive Graphics"
6.	K. A. Bishop U. Kansas	"Generalized Routine for Inter- active Processing"
7.	G. Stephanopolous U. Minnesota	"Generalized Controller Design Package"
8.	B. Carnahan U. Michigan	"Graphical Process Simulation System"
9.	K. R. Jolls	"Computer-Generated Phase Diagrams"
10.	G. Reklaitis Purdue U.	"Automated Flow Sheeting and Equip- ment Layout"

11. S. Jaffe "Graphics Use with APL"
Mobil Oil

The procedures envisioned, once the programs are tested, are as follows:

- Potential contributors will provide a two-page description of their software covering what it is, what it does, hardware limitations, support software requirements, and CP resource requirements.
- These two-page descriptions could be distributed to the CACHE departmental representatives to locate parties interested in putting one or more programs up on their systems to test and to evaluate them.
- Those programs that appear worthwhile could be publicized in a CACHE program availability list.
- The authors of the above programs would be asked to provide satisfactory program documentation. The document would include the program listing and examples.
- 5) The programs would be distributed by the authors themselves. The requestor would send a tape to the author and would pay mailing charges (or any other charges required by authors).
- CACHE could provide a framework for graphics program user groups as follow-up.

Any chemical engineers interested in participating in this activity or providing additional software are asked to contact either Professor Reklaitis at Purdue or T. F. Edgar at the University of Texas. Current members of the CACHE Computer Graphics Task Force are: <u>Chairman</u>: Gintaras V. Reklaitis Department of Chemical Engineering Purdue University West Lafayette, IN 47907

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