CACHE NEWS

News About Computers In Chemical Engineering Education.

No. 17

September 1983
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 educational 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 teaching the students and of giving them meaningful experience. 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 1971, 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 activities 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 ongoing projects. Information on CACHE activities is regularly disseminated through CACHE News, which is published twice each year. Individual inquiries should be addressed to:

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CACHE NEWS
The CACHE News is published twice 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. Contributions from CACHE Representatives are welcome. This issue was edited by J. D. Seader with contributions from a number of CACHE members and representative.
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At the June 28-29, 1983 meeting of the CACHE trustees, John Hais of duPont was re-elected as an industrial trustee. and Jeffrey A. Strollo and H. Dennis Sprigg were elected as industrial trustees.

Dr. Strollo is currently Research Associate at the ECO Research Laboratories of Eastman Kodak Company in Kingsport, Tennessee, and a Director of the CAST Division of AIChE. He received a PhD at the University of Wisconsin, following which he spent two years with the U.S. Army Chemical Corps. In 1972, he joined Eastman Kodak Company at Easton Kodak. As an Undergraduate Student at the University of Utah, he received the A. C. Marshall Award of AIChE for the student contest problem. He is the co-author of the introductory text, Process Synthesis, and is author of a number of articles and papers in the areas of heat integration, separation sequencing, and overall process synthesis. He developed the ATNPS process synthesis system. Besides synthesis, his interests include computer-aided design, non-numerical programming, data structures, artificial intelligence, and technology assessment.

Dr. Sprigg is currently Associate Director of Chemical Engineering Technology and Distribution Technology and Services Within Central Engineering for Union Carbide and is an active member of the CAST Division of AIChE. He received a PhD at the University of Virginia, following which he was a professor at West Virginia University and the University of Wyoming. Before obtaining his PhD, he worked for Allied Chemical. Prior to his present assignment with Union Carbide, he was Manager of Applied Math and Computing and of Process Design Data and Thermodynamics for Union Carbide. He has managed Union Carbide's process simulator 1975.

Zenith Z100 series
IBM, PC, IBM XT, or IBM "Personal" OFF Rainbow or OFF Professional
Data General Desktop Generation
Apple Corporation Model X
So far, Zenith, IBM, and DEC are represented. If your university has just made a decision to require all freshmen to purchase any of the other brands, please let Peter know immediately.

IAN DOIG'S PROCESS TROUBLESHOOTING EXERCISES COMPLETED

Process Diagnostic Exercise
An Interactive Educational Computer-Based Troubleshooting Exercise
by
Professor Ian D. Doig
School of Chemical Engineering & Industrial Chemistry
The University of New South Wales
P.O. Box 1 Kembsaington
New South Wales Australia 2033
(Pune 653-0351)

(Article written by David M. Hummelblau)

CACHE has cooperated with Professor Doig in making his troubleshooting and diagnostic code available to chemical engineers. His program is the first to make substantial use of computer-student interaction in process fault diagnosis. Most attempts to engage in the improvement of skills in troubleshooting have let students work on their own to determine the causes of the fault(s) in the process or work via groups, but the students obtain information from the instructor by asking questions about past experiences, the results of their calculations, the results of experiments, etc. Also, usually the troubleshooting cases that are examined refer to simple pieces of equipment or small collections of equipment. Often the emphasis is placed on students to work on developing a suitable strategy for solving the problem, and little effort goes into an actual solution of the problem that is realistic.

What Professor Doig has accomplished is to set up a large data base of information that represents a flow sheet for a chemical plant based on plant calculations so that the plant does not have to be simulated to produce measurements. Data are made on demand for measurements at a large number of locations in the plant for streams such as cooling water, steam, chilled water, and other utilities. In addition, measurements can be solicited as requested by the user on all of the details of valves, pumps, blowers, and so forth, as well as physical data for all components of all streams.

Upon logging onto the computer, the student is presented with a corresponding set of current routine measurements, which differ significantly in some ways from the normally expected values. Consequently, a fault exists. The student calls for additional samplings and measurements until his hypothesis concerning the causes of the fault have
been accepted or rejected. Over 100 possible faults exist in the system, and the instructor, by introducing code numbers, can select one of these.

For each ad-hoc sampling and measurement ordered by the student, he or she is charged an imaginary expense. The goal is to locate and identify the fault with a minimum cost. Other features of the system that provide realistic representation of a plant include a randomly generated Gaussian distributed error that is contained in all the measured values reported.

An instructor can use the computer program to develop student troubleshooting skills, including 1) realization that summing is in error, 2) definition of the problem, 3) collection of data, 4) reaching conclusions about the data, 5) re-evaluation of the problem, 6) cycling of the analysis until the final diagnosis is complete.

Two different plants exist to be drawn on for teaching purposes:

1. A Synthet plant including a detailed section for acid absorption
2. A distillation plant

Malfunctions that can be introduced include leaks, impurities, off-specification compositions, restrictions on proper flow rates, and excessive use of utilities.

Professor Dwig recommends (Chemical Engineering Education, Summer 1980, p. 130) that no more than 10 students be allocated per instructor if the whole class works on a common problem. He also suggests that real plant experience helps provide the proper type of responses to student questions.

Figures 1 and 2 show the flow sheets of the distillation plant and the equipment involved. All the other information needed is on the computer tape provided by CACHE. In addition to each plant database, there is a manual for students for each plant that can be printed out by a student on a line printer or displayed on a dumb terminal. Now for A WORD OF WARNING: The instructor's manual is also located on the tape. If the program is installed on your computer, either remove the file containing the instructor's manual or prevent student access to the file. All the fault codes and other key details are in the instructor's manual and must not be made available to students.

Figure 1. FLOWSHEET FOR DISTILLATION PLANT

Figure 2. SCHEMATIC DIAGRAMS

CACHE has exerted considerable effort to make the computer code portable. The code has run on 1) CDC Cyber 170/, 2) CDC 6600, 3) IBM 340/340, 4) VAX 11/780, and 5) DEC SX computers. If you obtain the code, list it and review the comment statements which explain the changes needed to make the code compatible with one of the above computers. Coding of the program is in standard FORTRAN IV (1966), but some special features of your FORTRAN compiler may cause errors to be omitted in coding. CACHE does not support the program. Consequently, you must direct your questions about compilation errors to your computer center analysts and questions arising from manuals or operation of the code to Professor Dwig directly. CACHE would appreciate comments about education benefits and experiences using the code. If you are interested in obtaining the program on a tape, contact:

Professor D. M. Hummelblau
Dept. of Chemical Engineering
The University of Texas
Austin, TX 78712
(512) 471-7445

FOCAPD-83 CONFERENCE

A total of 162 chemical engineers and other engineers and scientists attended the second conference on Fundamentals of Computer-Aided Process Design (FOCAPD-83) held June 19-24, 1983, at the Snowmass resort near Aspen, Colorado. The attendees represented 12 countries, with 84 from industry and 78 from academic institutions. The conference was sponsored by the CASI (Computing and Systems Technology) Division of AICHE, the National Science Foundation, and CACHE, with the latter being responsible for all arrangements. Professor Arthur W. Westerberg of Carnegie-Mellon University and Dr. Henry H. Chinn of Monsanto Company served as conference chairman and co-chairman, respectively.

Nine concurrent sessions were held during a five-day period. The focus of the meeting was on the presentation of both industrial and academic viewpoints on computer-aided design, with about 90 minutes of each session devoted to discussion of issues raised by the speakers.

A limited number of copies of the proceedings of the conference will be published by CACHE late this year.
Session V: "Nonsequential Modular Flowsheeting"
Chairman: Rodolpho I. Meo
Washington University
Speaker: John D. Perkins
Imperial College, London
"Equation-Oriented Flowsheeting"
Speaker: Lorenz T. Bigler
Carnegie-Mellon University
"Simultaneous Modular Simulation and Optimization"

Session VI: "Design and Scheduling of Batch Chemical Plants"
Chairman: Richard S. H. Mah
Northwestern University
Speaker: C. V. Roklalid
Purdue University
"Intermediate Storage in Non-Continuous Processes"
Speaker: Harold N. Gabow
University of Colorado
"On the Design and Analysis of Efficient Algorithms for Deterministic Scheduling"

Session VII: "Complex Single Unit Design"
Chairman: Babu Joseph, Washington University, and Bruce A. Finlayson, University of Washington
Speaker: Warren E. Stewart
University of Wisconsin
"Collocation Methods in Distillation"
Speaker: H. H. Klein
BJF Scientific Research & Development
"Modeling Fluidized-Bed Chemical Reactors"

Session VIII: Contributed Papers
Chairman: Cameron M. Crowe
McMaster University

"Scheduling of Multipurpose Batch Plants with Product Precedence Constraints" by I. Suhami, Exxon, and R. S. H. Mah, Northwestern University
"The Prediction of Properties and Its Influence in the Design and Modeling of Superfractionators" by M. K. Hernandez, H. Gani (Speaker), J. R. Segura, and E. A. Briegleb, Universidad Nacional del Sur, Argentina
"Reduced Contour Solutions to Multilayer, Multi-Component Separations Problems by a Hybrid Fixed-Point Algorithm" by K. R. Westman and A. Lucia (Speaker), Clarkson College of Technology, and S. Marzallin, Imperial College
"Solution of Systems of Complex Interlinked Distillation Columns by Differential Homotopy-Continuation Methodologies" by T. A. Wayburn and J. D. Seider (Speaker), University of Utah
"Strategies for Simultaneous Modular Flowsheeting and Optimization" by M. A. Stadtherr (Speaker) and M.-S. Chen, University of Illinois - Urbana
"Recent Developments in Solution Techniques for Systems of Nonlinear Equations" by M. Shacham, Ben-Gurion University of the Negev

Session IX: "Operability in Design"
Chairman: George Stephanopoulos
National Technical University, Athens
As part of a continuing program of support to education, Monnaanto Company announced on August 19, 1982, that load modules for the FLOWTRAN simulation program will be made available on magnetic tape to departments of chemical engineering to install on their own in-house computers. From departments will be able to run FLOWTRAN on their own computer or at no charge other than that of their own computer center. CACHE is currently supervising the preparation of load modules for a wide variety of mainframe-type digital computers and the distribution of the modules on magnetic tape to those departments that order them. Instructional books on FLOWTRAN are already available through CACHE.

FLOWTRAN tapes are now available for the following computers:

1. UNIVAC computers running under the UNIX (Michigan Terminal System) operating system with a FORTRAN Level G or H compiler (4-track, 6250 BPI tape).

2. UNIVAC 1100 series computers running under the EXEC 1100 (UNIX/UCB) operating system with the FORTRAN 77-G (10/8) compiler (9-track, 1600 BPI tape).

3. IBM and IBM-compatible mainframe computers such as the 370, 380, and 43XX with the VS FORTRAN compiler (Program 07440-03) running under the VM/CMS operating system (3-track, 1600 BPI tape).

4. IBM and IBM-compatible mainframe computers such as the 370, 380, and XL7 with the FORTRAN II - extended compiler Program 7424-04 plus the library, running under the 37 IBM operating system (9-track, 3000 BPI tape).

5. DEC VMX mainframe computer running with the FORTRAN-10, version 7 compiler (9-track, 1600 BPI tape).

It is also anticipated that a FLOWTRAN tape for the following computer will be available by the end of 1983:

6. DEC VAX 11-7XX series of super minicomputers running with the VMS operating system.

Plans are also being made now to obtain, if possible, tapes for the DEC 10, CDC, and Prime machines. Each tape contains either load and/or relocatable code, text problems and solutions, and installation instructions. The FLOWTRAN program may be used for educational purposes, but not for consulting. FLOWTRAN is already installed at:

- The University of Akron (Glenn Atwood)
- The University of Michigan (Bruce Carnahan)
- The University of Pennsylvania (Warren Seider)
- Rice University (Derek Dyer and Kyriacou Zygourakis)
- The University of Utah (J. O. Seader)
- Worcester Poly (W. L. Kranich)

If you would like to obtain a FLOWTRAN tape for your computer and have not already expressed that desire in a signed agreement that must be approved by Monnaanto. The cost of the tape is $250. However, the charge is $175.

Programs for Hand-Held Programmable Calculators

The CACHE booklet entitled "Hand-Held Programmable Calculators: A Review of Available Programs for Chemical Education," by Professor F. William Kresser of West Virginia College of Graduate Studies, is still available. In this 26-page booklet, approximately 100 programs are listed under the following subjects:

- Thermodynamics
  - Thermodynamic Properties
  - Equations of State
  - Equilibria

- Transport Phenomena
  - Viscosity
  - Interchange Equation
  - Conduction
  - Convection
  - Pipe Flow
  - Radiation
  - Mass Transfer and Masse Flow
  - Diffusivity

- Unit Operations
  - Distillation
  - Absorption
  - Humidification and Cooling

- Process Design and Control
  - Heat Valve Size
  - Fluidized Beds
  - Compressors

Given for each program listed are 1) a description, including restrictions; 2) a literature reference to the program listing, and 3) a summary of input and output data. Sources of the programs are the NAEC/97 Users' Libraries, the 1158/99 Program Exchange Club and specialty booklets, and articles in Chemical Engineering, Chemical Engineering Progress, Hydrocarbon Processing, and the Oil and Gas Journal.

An order form for Professor Kresser's booklet is included at the end of this issue of CACHE News.

Computer-Based Instruction Via PLATO: More Options at Lower Cost

by Mordechai Shecham and
Michael A. Chilton

Some chemical engineering materials have been created for the worldwide PLATO educational computer system of the Control Data Corporation. Access to these educational materials is with a CDC PLATO terminal connected to a mainframe computer which is dedicated to the PLATO system. Previous newsletters
have discussed these materials. (See CAMEL News No. 15, p. 13 and No. 16, p. 7.) Direct connection to the PLATO mainframe is made at universities such as Illinois and Delaware where dedicated computers are available. However, most typical PLATO users must use telephone communications to access PLATO from CDC computers in distant locations.

This situation has recently changed because Control Data has introduced the following new options in its educational computer system:

1. Installation of PLATO in existing or new computers
2. A multi-use microcomputer to run PLATO
3. Access to PLATO via personal computers

These options open up many new possibilities in the creation of educational materials on PLATO because the expenses associated with the computer-based instruction can be reduced significantly.

Installation of PLATO in existing or new computers

Universities that have or will purchase one of the CYBER 170 Series 800 computers from CDC can have the option of running PLATO. The system can be installed in the computer with a relatively small investment, and it will execute in parallel with other applications. No longer does the entire machine need to be dedicated to PLATO. The PLATO terminals can be connected directly, or telephone communications can be made from other locations. Some terminals that provide computer-based instruction to students can be used to author and program new materials. An example of a new installation of PLATO in an existing computer is found at the University of Massachusetts at Amherst.

A multi-use microcomputer for PLATO

The CD 110 is actually a microcomputer system which has a minimal configuration consisting of a Control Data 721-30 Viking terminal and a flexible disk drive. The Viking terminal containing a Zen processor has a self-contained and tiltable display, a 12-inch viewing screen, a detached keyboard, vector graphics within a 512 x 512 dot array, a 16 x 16 touchpanel with 256 locations on the screen, and a 64K RAM for loading and operating memory. The disk drive of the CD 110 has a 280 microprocessor and 64K RAM. It uses a soft sector, 8-inch flexible disk with maximum capacity of 1.2 million characters.

The major benefit of the CD 110 is that it can execute in a stand-alone mode thereby eliminating communication costs as well as mainframe operating expenses. The CD 110 can be used for the delivery of lessons which are stored on the diskettes. Unfortunately, most of the mainframe PLATO materials require some conversion to run on the microcomputer. New materials can be programmed on that they run on both mainframe and micro PLATO, but connection of author terminals to the mainframe is required. It is also significant that CDC now offers a software package so that lessons for the CD 110 can be authored without a connection to any mainframe. This application requires two disk drives.

The CD 110 has additional flexibility in that it can operate as a microprocessor with a CP/M operating system. This application gives 55K of memory to the user. Also the CD 110 can be used to communicate with other mainframe computers by emulating both dumb and intelligent terminals. Since it can also act as a terminal to a mainframe PLATO computer, it has wide versatility for educational utilization.

At this time, materials for the micro PLATO mode have been created by Control Data with the help of several universities for basic courses which are typically found in a lower division engineering curriculum. Courses available on disk include FORTRAN 77, chemistry, and physics. A number of universities will be evaluating this mode of computer-based instruction during this upcoming academic year. Chemical engineering materials are being converted, and details will be made available in this Newsletter.

Access to PLATO via personal computers

CDC has announced that personal computer users such as the IBM can access a PLATO Microlink which permits telephone access to selected lessons and courses (also games and electronic communications). Some of the standard PLATO features, such as the touch-sensitive screen, will not be available. A one-time charge of $50 will cover an access disk. After a registration fee of $10, the use charges are to be $5/hr.

Future Prospects for Computer-Based Instruction

There seems to be intense activity at the present time which is resulting in increased capabilities at reduced cost. An encouraging trend is developing regarding the portability of educational materials. What we see at present is just the beginning. It is hoped that this Newsletter can keep you informed of current developments. Should you like to participate in the CAMEL Task Force in Computer Based Instruction, please contact either:

Dr. Michael B. Callip Dr. Stanley I. Sandler
Dept of Chemical Engrg Dept of Chemical Engrg
Univ of Connecticut Univ of Delaware
Storrs, CT 06268 Newark, DE 19711
(203) 486-4019 (302) 739-2945

MEETINGS AND CONFERENCES

October 30 - November 4, 1983
AFCEA Diamond Jubilee Meeting, Washington, DC
Sessions on:
Innovations in Applied Math
Computer-Aided Process Analysis and Synthesis
Computer-Assisted Engineering
Directions in Process Control
Computers and the Control of Biophysical Processes
Evaluated Thermo Properties for Process Design
December 6-8, 1983
Software Maintenance Workshop, Monterey, California
Sponsored by Illinois Institute of Technology; Contact Professor Norman Schneider, Chairman, Dept. of Aeronautical Sciences, Naval Postgraduate School, Monterey, CA 93940 (656-7719 or 656-7111)
December 12-14, 1983
Winter Simulation Conference, Arlington, Virginia
Sponsored by SES; Contact Bruce Schneier, School of Industrial Engineering, Purdue University, West Lafayette, IN 47907 (317) 494-5422
February 2-4, 1984
SCS Multiconference: Modeling and Simulation on Microcomputers, Simulation in Health Care Delivery Systems, Simulation in Strongly Typed Languages—ADA, PASCAL, SIMULA, Aerospace Simulation. Sponsored by SCS; Contact Charles A. Pratt, SCS, P.O. Box 2228, Labella, CA 92030 (619) 494-1888

February 26 - March 3, 1984
First International Symposium on Modeling and Control in Mineral Processing and Process Metallurgy, Los Angeles, CA. Co-sponsored by SME/IMS of AIME; Contact J. A. Herbst, Dept. of Metallurgy, University of Utah, 412 Browning Bldg, Salt Lake City, UT 84112 (801) 581-6386

May 20-24, 1984
AIOE Annual Meeting, Anaheim, CA
Sessions on:
- Process Modeling with Computers
- Process Data Reconciliation and Rectification
- Human Factors in Computer Control
- Software for Advanced Computer Control
- Software for Control of System Design
- Process Towards Process Engineering Workstations
- Microcomputers (5 sessions)

June 12-16, 1984
SIAM Conference on Numerical Optimization, Boulder, CO. Sponsored by SIAM; Contact W. H. Marr, SIAM, Suite 1405, 117 South 17th Street, Philadelphia, PA 19103 (215) 564-7979

June 19-21, 1984
Fifth IMACS International Conference on Computer Methods for Partial Differential Equations, Bethlehem, PA; Contact William E. Schiesser, Dept. of Chemical Engineering, Whitaker Lab B3, Lehigh University, Bethlehem, PA 18015 (215) 861-4264

Sessions on:
- Methods, Applications, Programming, and Hardware
- Numerical Analysis
- Computational Fluid Dynamics
- Numerical Linear Algebra
- Computational Methods for Partial Differential Equations

June 20-22, 1984

July 8-14, 1984
Gatlinburg IX, Householder-Gatlinburg Meeting on Numerical Algebra, Waterloo, Ontario, Canada. Contact J. A. George, Computer Science Dept., University of Waterloo, Waterloo, Ontario N2L 3G1, Canada. (519) 885-1211, Ext. 3473

July 24-27, 1984
International Congress on Computational and Applied Mathematics, Luven, Belgium. Contact Professor F. Bruckel, University of Antwerp, (KUCA), Faculteit Toegepaste, Economische Wetenschappen, Middelheimlaan 1, B-202, Antwerp, Belgium. Sessions on:
- Analysis of computational techniques for solving real scientific problems

September 2-6, 1984
IFIP Conference on System Modeling and Optimization, Budapest, Hungary. Contact IFIP Secretariat, I rue du Marche, CH-1202 Geneva, Switzerland
March 31 - April 12, 1985

July 29 - August 2, 1985
World Conference on Computers in Education, Norfolk, VA. Sponsor: IDP/IC-3 and AIP²S; Contact John Mcgregor, Computer Science Dept., Christopher Newport College, Newport News, VA 23606

STATUS OF CHEMI PROJECT

by

David M. Himmelblau

Advances in computer science and telecommunication systems technology throughout the 1970's have contributed to the development of new techniques and systems for the education of scientists and engineers. The CHEMI project represents such an effort in the field of chemical engineering.

The first phase of the project, begun in 1975 via a grant from the National Science Foundation, resulted in the production of more than 300 single-topic, stand-alone instructional modules spanning the key subject areas in the undergraduate chemical engineering curriculum. Each module is approximately 20 pages and covers a subject content roughly equivalent to one contact hour of lecture. These modules were originally written for off-line study and are being published by the AIEE as the Modular Instruction Series.

The second phase of the CHEMI project has developed an on-line information system that will access over 500 abstracts of key topics taken from chemical engineering encyclopedias, handbooks, and journals, plus (eventually) all instructional modules covering the following subjects: Material and Energy Balances, Thermodynamics, Transport Phenomena, Stagnation and Mass Transfer Processes, Process Control, Kinetics, and Design. The CHEMI system has been designed to serve as a model for other disciplines that might benefit from an on-line, modularized data base.

One of the major goals of Phase II of the CHEMI project was to develop a computer-aided instruction package that would contain, in addition to the information system, modules designed to be used in interactive learning and testing. Because of the limitations of time and funds, the number of modules that have been entered into the data base of the system has been limited to approximately 100; and the interactive testing feature of the system has been omitted. The unexpected high cost of designing and coding the required software for the CHEMI information system prevented designing an interactive computer-aided instruction program as elaborate as, for example, the PLA10 system. The
CHEMI on-line system focuses on information retrieval, primarily for searching, diagnostics, and reference. The system allows on-line access to the modules and abstracts through a keyword search of the index and sequence selection. A module, part of a course, or any screen of information can be printed off-line. The shortest path through a sequence of modules for a curriculum can also be obtained.

Figure 1 is an example screen from the on-line information system that shows the basic functions.

**ANYTIME:**
- Help
- Keywords
- Mod/As
- Pages
- Print
- Login
- Menu
- Display this page

**ADDITIONAL:**
- Choices can be entered at any stage in your session with CHEMI.
- To start, enter a letter to indicate your choice.

---

**Figure 1. A Screen from the Information System showing the main functions of the system**

The information system has been written in the "C" programming language and runs on the UNIX operating system, version 7, on a DEC PDP-11/23 minicomputer. The choice of "C" as the language makes the source code highly portable between computers because "C" is a young language whose conventions have been standardized. The language is highly structured, which is desirable for good programming, and it is modular. The machine and operating-system routines are isolated, allowing a program to be easily expanded. As UNIX becomes more widely accepted as an operating system, the "C" language is gaining in popularity, especially on minicomputers.

In designing and implementing the on-line CHEMI system, we have gained a thorough understanding of the problems that can evolve through lack of prior knowledge of computer systems and programming costs. The hardware that was purchased for the project includes a PDP 11/23 minicomputer with 256 kilobytes of random-access memory (see Figure 2). Although there were relatively few problems with the computer, we did make the mistake of setting up a service contract for the computer with a company located nearly 90 miles from our site in Austin. As we did not have a tape drive on our hardware system, we had no way of transferring data from the PDP 11 disks to tape, much of the time was lost in arranging for service.

In the planning stage of the project, it was thought that there would be two versions of the CHEMI system made available:

Version 1 (for output on dumb terminals and line printers) would have the following characteristics:

- allow retrieval on standard ASCII terminals
- ASCII characters only
- spelled-out Greek letters, functions, and operations (Figure 3)
- simple figures only (Figures 4 and 5)
- would require an accessory package of printed material containing complex figures, study questions and answers, and computer programs

---

**Figure 2. UNIX PDP 11/23 Minicomputer Configuration**

![Image of PDP 11/23 minicomputer configuration]

**Figure 3a. Example of an Equation - Original Format**

\[ a + b = c \]  

where \( a \) is the input and \( b \) is the output. This equation is frequently referred to as a mechanical energy balance.

**Figure 3b. Example of an Equation - On-Line Format**

\[ a + b = c \]  

where \( a \) is the input and \( b \) is the output. This equation is frequently referred to as a mechanical energy balance.
Figure 1. A Typical Hydrometer.

Figure 2. Example of a Three-Dimensional Drawing

Table 1. Average Costs per CHEMI Module

<table>
<thead>
<tr>
<th>Module Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>- Figure/mms</td>
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<td>8.57</td>
</tr>
<tr>
<td>- Formatting</td>
<td>19.40</td>
</tr>
<tr>
<td></td>
<td>$256.70</td>
</tr>
</tbody>
</table>

The costs listed in this table do not include computer services of approximately 9 minutes per module for TM charges (CPU time and input/output charges) on the DEC SYSTEM 20, and approximately 8 hours per module for real-time charges on the NCR-IBM 1130. The DEC 20 charges $200/hr TM time, and the NCR charges $3/hr real time.

We have not produced Version 2 of the CHEMI system although we have employed the DEC GIGI system's
graphics editor to enter some figures in the Materials and Energy Balance modules (see figures 6 and 7). We have found it costly to enter data using the graphics editor, and the software for some functions that we need is not yet available.

Figure 6a. Original Drawing (Module MEB 5)

Figure 6b. GIGI On-Line Drawing (Module MEB 5)

Cross Section A A

fixed end

pressure inlet

Figure 7a. Original Drawing (Module MEB 5)

Figure 7b. GIGI On-Line Drawing (Module MEB 5)

During the preliminary planning of the project, in the late 1970's, the decision was made to design the CHEM system so as to avoid hardware dependency in order that it would be highly portable. It was thought that the computers and terminals would not be standardized among the many colleges and universities using computer-based educational materials thus preventing the widespread use of any information system that was dependent on hardware. Furthermore, software rapidly becomes obsolete. There was agreement that there would be a number of standards ACII terminals available to college and university students for a good many years to come and that their cost would remain relatively low.

Since the start of the CHEM project, developments in electronics and computer science have refined the capabilities of graphics programs, and at the same time the costs of equipment have been reduced. The cost of graphics terminals and printers may reach a level compatible with most school budgets. Nevertheless, there is still no standardization in graphics protocols; hence no portability. If this issue is ever resolved, the CHEM system's database of modules can be altered to accommodate the specifications. The system's flexibility allows it to adapt easily in response to rapid technological change.

Trends in today's society toward decentralization are evidenced by the increased use of microcomputers. The development of decentralized systems and services brings the capabilities of on-line processing well within the budget range of colleges and universities, as well as individuals. The electronic dissemination of educational materials developed by the CHEM project can make available to students and practicing engineers, information on-line that is necessary for them to keep pace with the major trends that are shaping our society.
STATUS OF MICROCACHE PROJECT

by Brice Carnahan

The final report on the MicroCACHE Project was submitted by Professors Brice Carnahan and H. Scott Fowler to the NSF in April, 1983. The report is in one main document plus five system documents:
1) User’s Manual; 2) Module Preparation Guide; 3) Overview of System Architecture; 4) Graphics Package; and 5) Instructor’s Manual. Altogether, 12 modules were prepared, with five being tested by students at the University of Michigan. A new version of the supervisory system has been implemented, and all 12 modules are now being converted over to this new system. This will be followed by student testing at several different schools.

For the NSF-funded project, an Apple-II Plus microcomputer equipped as follows was chosen as the development machine for the MicroCACHE system:
- 64K Apple-II Plus
- 16K RAM extension board
- 7 Disk drives
- 1 Microsoft Z-80 software
- 1 Monochrome monitor

The principal reasons for choosing the Apple were its record for reliability, widespread availability, and the substantial amount of existing hardware and software available for it. It was clear from the beginning that 64K main memory might be restrictive from the standpoint of software organization and that the processing speed might be slower than desirable for computationally intensive engineering problems; however, at the time, 64K was the largest available memory in any of the popular microcomputers, and the Z-80 processor speed was comparable to that for processors used in the other most widely used microcomputer. Currently, the system is being converted in the IBM/PC.

The purposes of this project, under the direction of Professors Brice Carnahan and H. Scott Fowler, were to:
1. Develop prototype microcomputer-based software for delivering educational materials and programs (modules) for chemical engineers and engineering students, and
2. Prepare several educational modules to test the system.

Mr. Mark Malotz functioned as the principal project systems analyst and programmer, and many graduate and undergraduate students at the University of Michigan were involved.

Most of the goals of the first phase were met. The highly modular and reasonably transportable MicroCACHE supervisory system was designed, written, debugged, and tested using the Apple-II microcomputer as the development hardware. Several major system utility programs that allow module authors to prepare educational modules and incorporate them into the MicroCACHE framework were written, thoroughly debugged, and tested. Prototype educational modules were written and debugged. Some were tested with students at the University of Michigan and seemed to be well received by them, testing continues at Michigan and will be extended to other Chemical Engineering departments in the near future.

More information can be obtained by writing to
Professor Brice Carnahan
Dept of Chemical Engineering
University of Michigan
Dow Bldg, North Campus
Ann Arbor, MI 48109

FORTRAN TEACHING CODE NEEDED

WANTED: A FORTRAN code that teaches FORTRAN using the computer only. If you have such a code that you can share with another university, write
Professor David M. Hammeblau
Dept of Chemical Engineering
University of Texas
Austin, TX 78712

SYSOPT

SYSOPT is a software package for the solution and/or demonstration of (mainly) unconstrained optimization programs on an Apple-II plus microcomputer. One routine for constrained optimization is included. SYSOPT is built up from different, separate modules. Following the selection made by the user, the necessary routines are loaded from floppy disk into the memory of the micro.

The library offers the following optimization algorithms:

* unconstrained optimization:
  a. non-dimensional search
     - Fibonacci
     - Davison, Swann & Campey
     - Fletcher (inexact line search)
  b. n-dimensional optimization
     - Rosenbrock & Palmer
     - Powell
     - Fletcher & Reeves
     - Davidson, Fletcher & Powell (DFP)
     - Complementary DFP Algorithms (BFGS)

* constrained optimization

Information on SYSOPT

* The program is interactive and completely menu driven.

* The problem formulation consists of the definition of the objective function and of the inequality and inequality constraints. Eventually the gradient of the objective function should also be stated. The objective function \( f(x) \) can be given by an analytical expression or by a
recursive relation. The function values may also be the result of a computer program. It is also possible to introduce the function values directly.

* SYSPIT will propose a standard procedure which can be accepted or rejected. If the proposed procedure is rejected, the user will be able to put together another procedure selected through a series of menus. When all selections are made, the user can have the chosen procedure registered as the future standard.

* For an algorithm, based on derivative values, one can choose to use either numerically or analytically derived gradients.

* For each algorithm default, options are provided for the stopping criteria. These options can eventually be changed by the user. The same is true for all heuristic parameters that need to be introduced.

* For Fletcher-Reeves, DF, and RFGS, the possibility exists of restarting the algorithm after each n+1 iteration.

Constrained Optimization

* The only technique made available here is the penalty function technique. It reduces the constrained problem to an unconstrained one. For inequality constraints, the interior approach is used and for equality constraints, the exterior approach.

* If the starting point, provided by the user, is not feasible for the inequality constraints, then the code will generate a feasible point through a Phase-1 procedure.

* The user can influence the sequence of unconstrained problems to be solved by selecting the penalty coefficient and the reduction factor for this coefficient in subsequent problems.

Manual

A typewritten manual is provided, together with a manual written on a file for the APPLE Writer and residing on the same disk as the SYSPIT program.

The code is available at a price of $150.

Please contact:

Professor M. Rijckaert
Instituut voor Systeem-Ingenieurtechniek
de Croyaan 2
B-3030 Heverlee
Louvain, Belgium

NEW NUMERICAL METHODS SOFTWARE

by Bill Schiesser

The following new items of software may be of interest to those involved in the application of numerical methods:

1. ODEPACK (Alan C. Hindmarsh) - Systematized collection of NDF solvers for application of initial-value ODE solvers to PDE's via the numerical method of lines. Contact:

National Energy Software Center
Argonne National Laboratory
Y-700 Case Avenue
Argonne, IL 60439

2. PIUCON (Werner C. Reinholdt and John V. BukaśkuiL) - Package of procedures for solving systems of nonlinear equations by differential homotopy continuation, Algorithm 596. Contact:

Algorithms Distribution Service
ISL Libraries, 6th Floor NDC Bldg
7500 Bellaire Blvd
Houston, TX 77036

3. BFS/7, version 1, release 1 (William F. Schiesser) - Library of transportable subroutines of initial-value ODEs and PDEs. This new release has features that include:

- A variable-grid spatial differentiation routine for one-dimensional PDEs based on five-point Lagrange interpolation polynomials. The approximation of the spatial derivatives can be centered for parabolic PDEs and noncentered (five-point biased upwind) for hyperbolic (convective) PDEs, with the grid points located by the user to accommodate rapidly changing solutions in space.

- Two variable-grid spatial differentiation routines for one-dimensional PDEs based on cubic splines with numerically approximated third derivatives as end conditions. The grid points can be located by the user to accommodate rapidly changing solutions in space. The usual requirements of finite element and weighted residual approximations do not apply to these routines, e.g., compatibility of initial and boundary conditions, boundary conditions of a prescribed form requiring the temporal derivatives of the boundary condition functions, inextricable linkage of the spatial and temporal integrations.

- Two routines based on five-point Lagrange interpolation polynomials for two and three-dimensional PDEs. The user may select centered and noncentered approximations in each of the spatial directions in these routines, in combination with the earlier one-dimensional routines, can accommodate convective-diffusion (hyperbolic-parabolic) PDEs in one-, two-, and three-dimensional regions. In principle, these routines can be used in any orthogonal coordinate system, e.g., Cartesian, cylindrical, spherical coordinates.

- Two utilities for mapping the Jacobian matrix of an ODE system and computing its temporal eigenvalues. Since PDEs are integrated in ODS/2 by the numerical method of lines, the approximating ODEs can also be analyzed by these routines. The map of the ODE Jacobian matrix gives a direct indication of the problem structure which is invaluable in the selection of the temporal integrator. The temporal eigenvalues directly indicate whether the ODE system is: 1) computationally stable, 2) sufficiently stiff to require an implicit integrator, and 3) correctly programmed with respect to the problem time scale.
The DSS/2 FORTRAN IV source code on 9-track tape is available to academic institutions for $250 and to industry for $1000. Contact:

Dr. William L. Schianoor
Dept of Chemical Engineering
Lehigh University
Whitaker Lab No. 5
Bethlehem, PA 18015

PERSONAL COMPUTER USERS SURVEY

by
Bruce Finlayson

The last issue of CACHE News included a form to determine the extent to which microcomputers were being used at universities and interest of those responding. A total of 54 responses gave the following results:

<table>
<thead>
<tr>
<th>Microcomputer</th>
<th>No. of Schools</th>
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<tbody>
<tr>
<td>Apple</td>
<td>20</td>
</tr>
<tr>
<td>IBM</td>
<td>16</td>
</tr>
<tr>
<td>Commodore</td>
<td>15</td>
</tr>
<tr>
<td>HP</td>
<td>10</td>
</tr>
<tr>
<td>Radio Shack</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interests</th>
<th>No. of Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design &amp; Simulation</td>
<td>16</td>
</tr>
<tr>
<td>Control</td>
<td>14</td>
</tr>
<tr>
<td>Computer-Aided</td>
<td>14</td>
</tr>
<tr>
<td>Instruction</td>
<td>13</td>
</tr>
<tr>
<td>Data Acquisition</td>
<td>12</td>
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<tr>
<td>Physical Properties</td>
<td>11</td>
</tr>
<tr>
<td>QC Education</td>
<td>8</td>
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<tr>
<td>Distillation</td>
<td>7</td>
</tr>
<tr>
<td>Numerical Utilities</td>
<td>4</td>
</tr>
</tbody>
</table>

Each school responding has received a list of universities having the same type of microcomputer and a list of persons having the same interest. The program dBASEII was used to produce the lists.

CACHE MICROCOMPUTER TASK FORCE SURVEY

on

MICROCOMPUTERS AND PERSONAL COMPUTERS IN AMERICAN AND CANADIAN DEPARTMENTS OF CHEMICAL ENGINEERING

by
Peter R. Rony and Joe D. Wright

Late in November, 1982, the newly formed CACHE Microcomputer Task Force sent a CACHE questionnaire to about 150 departments of chemical engineering in the United States and Canada. The reason for distributing the questionnaire was stated as follows:

"The CACHE Microcomputer Task Force is being replaced by the CACHE Microcomputer Task Force, which better reflects the real-time computing activities that are currently going on in chemical engineering departments in the United States, Canada, and Mexico. Since this is a new task force, it is appropriate to develop a questionnaire that probes current work, by chemical engineering faculty, with microcomputers or personal computers in laboratory applications such as real-time control, data logging, system timing, etc.; the availability of information on such work, including reports, articles, and theses; what can be done to improve the perception of university administrators of the value of such work; suggested activities for the CACHE Microcomputer Task Force; and local interest in "CACHE consultants."

Most of the 46 responses to the questionnaire were received during the period January through April, 1983, with a few being received before and after this period.

A 40-page report is being sent to all CACHE member institutions as well as to those individuals who participated in the survey.

In view of the recent excitement that has been created among colleges of engineering as a direct consequence of the pioneering due in 1983 to purchase specific models of personal computers (Zenith 2100 at Clarkson and a special Apple computer at Drexel), some of the results of the survey--notably the responses in Items 16 and 17--are probably already obsolete.

The survey should therefore be viewed as a snapshot in time; namely, perceptions during the 1982-83 academic year. The authors believe that in a few years we shall look back on these results and conclude that they reflected the "calm before the storm," the storm being an avalanche of personal computers being placed in the hands of engineering undergraduate students, graduate students, and faculty; and the calm being a conservative view of the future by chemical engineering educators.

The central focus of the report is Appendix B, which provides verbatim the 46 responses to the 17 items in the questionnaire. Some of the individual comments are quite interesting. Rather than summarize the results of the survey, the brief commentary contained in the report provides conclusions and recommendations for action by the CACHE Corporation and the CACHE Microcomputer Task Force. Specific topics in the commentary include:

The Microcomputer Smorgasbord
Information Dissemination is an Important Opportunity for CACHE
Procedure for Submitting Microcomputer Information Items to CACHE News
Chemical Engineering Faculty Tend to Prefer Packaged Laboratory Systems
The "CACHE Consultants" Idea Should Be Tested
Sample "CACHE Consultant" Resume
The CACHE Microcomputer Task Force

We would like to thank those faculty members who graciously provided their time to answer our questionnaire in detail. Your names will be added to the mailing list of the CACHE Microcomputer Task Force.
The CACHE Microcomputer Task Force is developing a mailing list of faculty members who are interested in microcomputers and wish to receive announcements of task force activities. Faculty representatives who have been named as university contacts since the September 1982 issue of CACHE NEWS are listed below. For your department is not represented or you wish to serve as our contact, please send your name and phone number on your department letterhead to

Dr. Peter Rony
Dept. of Chemical Engineering
Virginia Polytechnic Institute & State Univ
Blacksburg, VA 24061

Richard G. Akins, Kansas State Univ
Paul R. Amorose, Technical Univ. of Nova Scotia
Donald K. Anderson, Michigan State Univ
Yaman Arkan, Kenesiaor Polytech Institute
Glenn A. Atwood, Univ of Akron
Philip M. Becker, Christian Brothers College
Robert F. Benenati, Polytech Inst of New York
Ali Omer, Illinois Inst of Technology
A. Constantines, Rutgers Univ
Arminda Contrin, Louisiana State Univ
Cameron M. Trow, McMaster Univ
Sebastiao F. de Azavedo, Univ do Porto
Ray DeSousa, Texas Tech Univ
Prasad Dharjaj, Univ. of Delaware
Philip S. Dickson, Colorado School of Mines
Peter Douglas, Queen's Univ
Thomas F. Edgar, Univ of Texas
Robert V. Edwards, Case Western Reserve Univ
M. N. Esmai, Univ of Saskatchewan
Jack Famulare, Manhattan College
I. T. Fan, Kansas State Univ
Clifford E. George, Mississippi State Univ
Richard F. Golbert, Univ of Nebraska
Thomas M. Godbold, Vanderbilt Univ
Rakesh Goyal, Univ of Cincinnati
David J. Groeco, Univ of Pennsylvania
Brid L. Halpern, Yale Univ
Daran Hancock, New Jersey Inst of Tech
Michael E. Honeycutt, Jr., Rensselaer Polytechnic Inst
John Hoydewiller, Syracuse Univ
Gerald D. Holder, Univ of Pittsburgh
Alan P. Jackson, Univ of California, Davis
Carl P. Jeffrey, Univ of Nevada, N. Reno
Balu Joseph, Washington Univ
Deniz Karahan, Univ of New Brunswick
Joseph C. Katz, Johns Hopkins Univ
Kent S. Knapp, Ohio State Univ
R. Krishnam, Pratt Institute
C. William Lee, Univ of Dayton
Young H. Lee, Drexel Univ
Ludwig Luft, LaFayette Univ
Robert M. Main, Univ de Concepcion
Stephen S. Melheuser, Clemson Univ
J. Claude Merriam, Loyola Univ
H. E. Nuttall, Univ of New Mexico
James O. Olschow, Univ of Iowa
Jean Parot, Ecole Polytech, Quebec
Michel Perrier, Ecole Polytech, Quebec
Leonard K. Peters, Univ of Kentucky

Jonathan Phillips, Pennsylvania State Univ
George W. Precker, Univ of Missouri-Columbia
N. L. Rieker, Univ of Washington
F. Joseph Schrock, Georgia Inst of Technology
J. D. Riedler, Univ of Utah
Oliver C. Sittow, Univ of Missouri - Rolla
Tadeusz K. Slawek, Youngstown State Univ
Philip Smith, Brigham Young Univ
Lui C. Tsao, Univ of Nebraska-Lincoln
Charles M. Hatcher, Univ of Arkansas
John Tierney, Univ of Pittsburgh
Van Voorhees, K. A., Jr., Tufts Univ
John W. Walding, Univ of Lowell
Ralph White, Texas A & M

FOURTH AND FINAL CACHE SHORT COURSE ON MICROCOMPUTER INTERFACING/PROGRAMMING

Should there be sufficient interest, the fourth and final CACHE short course on microcomputer interfacing/programming will be hosted by the Dept of Chemical Engineering, Virginia Polytechnic Institute & State University during the winter quarter, 1984. Possible dates for the course are either January 13, January 15-20, January 30-February 3, February 5-10, or February 14-17. Several faculty members are planning to attend the course but we do not have a sufficient number yet to have firm plans to offer the course. If you are interested--and this is your last chance--send your name and any comments that you have to

Dr. Peter R. Rony
Dept. of Chemical Engineering
Virginia Polytechnic Institute & State Univ
Blacksburg, VA 24061

Short course fees--which we estimate to be no more than $65, a figure that includes all course texts--will be very low since participants do not have to share the travel and lodging costs of the lecturer. Additional laboratory and test material is currently being written for the FOX trainer--and available in January or February 1984--will cover a range of topics from digital electronics to microcomputer programming/interfacing in a novel way that emphasizes the similarities and tradeoffs between hardware and software. No prior experience in digital electronics or microcomputers is required.

See the April 1983 CACHE NEWS for additional information on the CACHE short courses.
LIST OF INDUSTRIAL CONTRIBUTORS TO CACHE

The following companies have contributed financial support to specific CACHE activities during 1981-83:

Chiyoda Chemical Engineering and Construction Company
Digital Equipment Company (DEC)
DuPont Committee on Educational Aid
LXON Research & Engineering Company
The Haltron SD Group, Inc.
Monsanto Fund, Monsanto Company
Olin Chemicals Corporation
Process Simulation Intl
Shell Companies Foundation
Tennessee Eastman Co.
Weyerhaeuser Company

LIST OF CHEMICAL ENGINEERING DEPARTMENTS SUPPORTING CACHE

CACHE recently concluded a solicitation of universities for funds to carry out on-going CACHE activities and to provide seed money for new projects. Departments providing support for the 1982-84 period, as well as the 1981-83 period, are as follows:

1982-1984

University of Arizona
Auburn University
University of California, Berkeley
University of California, Davis
University of California, Santa Barbara
Clemson University
Colorado School of Mines
University of Colorado
University of Connecticut
Cornell University
Georgia Institute of Technology
University of Houston
Howard University
Illinois Institute of Technology
Iowa State University
University of Iowa
Johns Hopkins University
Kansas State University
University of Kentucky
Lafayette College
Lehigh University
Louisiana State University
University of Maryland
University of Michigan
Michigan Technological University
University of Minnesota
Mississippi State University
University of Nevada, Reno
New Jersey Institute of Technology
City College of New York
University of North Dakota
Northeastern University
Northwestern University
Ohio State University
University of Pittsburgh
Princeton University
Purdue University
Rensselaer Polytechnic Institute
Rose Hulman Institute of Technology

University of Sidney
South Dakota School of Mines
University of South Florida
University of Southwestern Louisiana
Virginia Polytechnic Institute and State University
Washington University
West Virginia College of Graduate Studies
West Virginia Institute of Technology
West Virginia University
Widener University
University of Wyoming
University of Waterloo

1981-1983

University of Alabama
Brigham Young University
Bucknell University
California State Poly Univ, Pomona
University of California, Davis
University of California, Santa Barbara
California Institute of Technology
Carnegie-Mellon University
Case Western Reserve University
University of Cincinnati
Clarkson College of Technology
Cleveland State University
University of Dayton
University of Delaware
University of Florida
Kansas State University
Lamar University
Michigan State University
University of Nebraska
Polytechnic Institute of New York (Annklyn)
Ohio University
University of Oklahoma
Oklahoma State University
Oregon State University
University of Pennsylvania
Pennsylvania State University
University of Rhode Island
University of Rochester
Stevens Institute of Technology
University of Tennessee
University of Texas
Texas A & M University
Texas A&M University
University of Toledo
University of Tulane
University of Utah
University of Virginia
University of Washington
Wayne State University
University of Wisconsin, Madison
Worcester Polytechnic Institute
Yale University
Youngstown State University
University of Alberta
University of Calgary
University of New Hampshire
Nova Scotia Technical College
Universidad de las Américas
Universidad de Concepcion
Eidgenössische Technische Hochschule (E.T.H.)
Universidad Nacional del Sur
The work done by CACHE is through the efforts of its task forces. Current task forces and their chairman are as follows. Please note the newly formed task force on process design case studies. Those wishing to work on task forces are encouraged to contact the designated chairman.

**Task Forces**

- **CACHE Conferences:**
  - Professor Richard S. Mah
    - Northwestern University
  - Data Management:
    - Professor K. L. Motard
      - Washington University
  - CHEM Continuation:
    - Professor D. M. Himmelblau
      - University of Texas, Austin

- **Graphics:**
  - Professor G. V. Rekaitis
    - Purdue University

- **Large-Scale Systems:**
  - Professor J. D. Scudder
    - University of Utah

- **Personal Computing:**
  - Professor H. S. Fogler
    - University of Michigan

- **Microcomputers:**
  - Professor P. R. Rony
    - Virginia Polytechnic Institute and State University

- **Process Design Case Studies:**
  - Professor M. Morari
    - California Institute of Technology

- **Computer-Based Instruction:**
  - Professor M. Cutlip
    - University of Connecticut

**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 stage-wise computations. Each volume contains 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

Manchester, TX 78652

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**AICHE Modular Instruction Series Available**

AICHE is publishing one volume per year of each of the AICHE Modular Instruction Series listed below. The series were prepared by CACHE under the direction of Professor Ernest J. Henley of the University of Houston and William A. Henuak of Texas A & I University.

**Series**

- **A. Process Control:** T. F. Edgar, Editor
- **B. Stagnwise and Mass Transfer Operations:** E. J. Henley, Editor
- **C. Transport:** R. J. Gordon, Editor
- **D. Thermodynamics:** B. M. Goodman, Editor
- **E. Kinetics:** H. S. Fogler and B. L. Cuykendell, Editors
- **F. Material and Energy Balances:** R. M. Himmelblau, Editor

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. The volumes are available from:

**Publications Department, AICHE**

345 East 47 Street

New York, NY 10017

by single volume or by subscription.
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 I. AN INTRODUCTION TO REAL-TIME COMPUTING**
1. Digital Computing and Real-Time Computing (Mellichamp)
2. The Structure of Real-Time Systems (Mellichamp)
3. An Overview of Real-Time Programming (Mellichamp)

**MONOGRAPH II. PROCESSING, MEASUREMENTS, AND SIGNAL PROCESSING**
4. Processes and Representative Applications (Edgar)
5. Measurements, Transmission, and Signal Processing (Wright)

**MONOGRAPH III. INTRODUCTION TO DIGITAL ARITHMETIC AND HARDWARE**
6. Representation of Information in a Digital Computer (Fisher and Sebora)
7. Digital (Binary) Logic and Hardware (Engelberg and Hiewarn)

**MONOGRAPH IV. REAL-TIME DIGITAL SYSTEMS ARCHITECTURE**
8. Digital Computer Architecture (Engelberg and Howard)
9. Peripheral Devices and Data Communications (Rudd)
10. Digital Computer/Process Interfacing (Hughes)

**MONOGRAPH V. REAL-TIME SYSTEMS SOFTWARE**
11. Assembly Language Programming (Fisher)
12. Utility or Systems Software (White)

**MONOGRAPH VI. REAL-TIME APPLICATIONS SOFTWARE**
14. Real-Time BASIC (Mellichamp)
15. Real-Time FORTRAN (White)
16. Control Oriented Languages (Smith)

**MONOGRAPH VII. MANAGEMENT OF REAL-TIME COMPUTING FACILITIES**
17. System Justification, Selection, and Installation (Smith)
18. System Operations Management and Program Documentation (McCarthy and Weaver)

**MONOGRAPH VIII. PROCESS ANALYSIS, DATA ACQUISITION, AND CONTROL ACQUISITION, AND ALGORITHMS**
19. Process Analysis and Description (Edgar)
20. Digital Computer Control and Signal 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. Complete sets are now being closed out at $15.00, plus postage and handling from

Professor Bruce Carnahan
CACHE Publications Committee
Chemical Engineering Department
Dow Wing, North Campus
University of Michigan
Ann Arbor, MI 48109

An order form appears at the end of this Newsletter.
TO: Bruce Czernecki, Chairman
CACHE Publications Committee
Chemical Engineering Department
University of Michigan
Ann Arbor, MI 48109

Please send me the following monographs at $3.75 per volume or $15.00 per complete set:

<table>
<thead>
<tr>
<th>Monograph</th>
<th>No. Copies</th>
<th>Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. An Introduction to Real-Time Computing</td>
<td></td>
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<tr>
<td>II. &quot;Processing, Measurements &amp; Signal Processing&quot;</td>
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<td>III. &quot;Introduction to Digital Arithmetic and Hardware&quot;</td>
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<tr>
<td>IV. &quot;Real-Time Digital Systems Architecture&quot;</td>
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