AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

TECHNICAL COMPUTATIONAL NEWSLETTER

Sigmund J. Lawrence, Editor — Mid-Year, 1977

MCC NOTES

Vernon J. Sterba - chairman

Warren D. Seider - vice chairman

Robert J. Lackmeyer - secretary/treasurer

Robert E. Harris - membership chairman

As of March, there were 81 members on the committee. The proposed name as a division is "Computer and Systems Technology Division". 975 persons responded to the direct AIChE member contact questionnaire. Of these, 470 indicated they would both support and join the CAST division, and 274 indicated they may join. An additional 280 individuals responded favorable to the "Join a Division" flyer. Although formal approval of the division by Council is expected this year, no officer elections are planned for 1977. Albin Johnson reported that the Canadian Society of Ch. E's is interested in a cooperative relationship with the new division.

MCC decided that a session in Area 1d consisting of a panel discussion and/or technical papers dealing with the subject of "productivity in computer programming projects" should be included in the 1978 or 1979 meeting program if scheduling permits.

GAZING AT THE CRYSTAL BALL - DELPHI

Round 3 of "Computing in the 1980's" will take place in Denver during late August, as part of the Pacific Area Chemical Engineering Conference. A summary of the results of the responses received from the first two rounds will be presented, and these will be analyzed and discussed by a panel of experts at the meeting. Discussions among the panelists and interaction with the audience will be encouraged. The panelists include several world renowned experts and will discuss various aspects of computing hardware, software and applications, including communications and networks. Mike Tayyabkhan will moderate. Ted Peterson will present the results of the responses. The panelists are:

D. F. Costello, U. of Nebr., Lincoln, NB
J. D. Couger, U. of Colo., Colorado Springs, CO
P. A. Cunningham, Input, Menlo Park, CA
M. L. Deutsch, Mobil Oil Corp., New York, NY
H. S. Dordick, U. of So. Calif., Los Angeles, CA
D. Gillette, Bell Telephone Labs, Homedale, NJ
J. E. Heaton, Logicon, Inc., Merrifield, VA
G. M. Hopper, U.S. Navy, Washington, DC
J. E. Lane, Tenneco, Inc., Houston, TX
T. I. Peterson, IBM Corp., Armonk, NY
A. J. Perlis, Yale U., New Haven, CT
T. N. Pyke, Natl. Bur. of Stds., Washington, DC
W. D. Seider, U. of Penn., Philadelphia, PA
C. L. Smith, Louisiana State U., Baton Rouge, LA
T. M. Stout, Profimatics, Inc., Los Angeles, CA
M. T. Tayyabkhan, Mobil Res. & Dev. Corp., Princeton, NJ

ALGORITHMS AND PROGRAMS

This is a feature of Computers and Chemical Engineering, a new journal published by Pergamon Press. In it, descriptions of programs of interest to chemical engineers will be presented together with listings of the programs when they consist of fewer than 60-100 lines of code. For longer ones, a punched card copy of the program and photocopies of the documentation will be available from AIChE Headquarters in New York City at prices near cost to members and at higher prices to non-members.

The first issue of the journal was published in March with the second one scheduled to appear in June. Program descriptions are scheduled to appear for the first time in the September issue and regularly after that. A program for the optimization of non-linear functions subject to equality constraints has been accepted and is now being revised to conform with the standard format of the feature. Another program for the solution of two-point boundary value problems is being revised by the author.

Members of the Machine Computation Committee have volunteered to participate in the two-tier review system. The first round is a review of the program description itself - this is essentially the same as the normal review of a paper submitted for publication. The second round consists of evaluating the program by running it from the available documentation, preferably on two computers which are different from those used by the developer. There are at least 6 and as many as 22 referees/evaluators for each of the 14 topical areas: plant design, equipment design, simulation of equipment performance, simulation of other systems (supply and distribution, for example), process control - design and simulation, data acquisition, mathematical methods, statistical methods, cost estimation, economic analysis, management information systems, data base management, symbolic manipulation of equations, and graphics. In addition, reviewers are available to handle programs in a dozen or more areas.

If you are interested in these program descriptions, you might consider doing one or more of the following:

1. See to it that you or your library receives Computers and Chemical Engineering.

2. Consider submitting a general-purpose, state-of-the-art, computer program, and.

3. Offer your services as a referee/evaluator in one or more of the above topical areas, or another of special interest to you.

For more information or a copy of Guidelines to Authors, Guidelines to Referees, or Guidelines to Evaluators, write to:

Charles H. Ware, Jr.
Commercialization Insights
33 Sandi Drive
Poughkeepsie, NY 12603

COMPUTER AIDED INDUSTRIAL PROCESS MODELING

The chemical engineering department at MIT is running a survey to identify available software for chemical process flowsheet analysis as part of a project on Computer-Aided Industrial Process Modeling. Programs of interest include simulation, design, equipment sizing, cost estimation, economic evaluation, synthesis and optimization, as well as service routines for physical property calculations, data regression and equation solving. A report assessing the state of the art will be prepared to be published in Chemical Engineering. Jeffrey N. Peterson and Chau Chyun Chen are doing the work.

PROGRAMMING PRACTICES

If you write or supervise others who write computer programs, you will find this article to be very interesting:

"Programming Style: Examples and Counter-examples" by B. W. Kernighan and P. J. Plauger (ACM Computing Surveys, V6 N4, Dec. 74). The author discusses some common sins, such as being too clever--as in this example:

```
      DO 20 I = 1,N
      DO 20 J = 1,N

   20 A(I,J) = (I/J)*(J/I)
```

There are more straight-forward (albeit less compact) ways of doing what this code does--and the author proceeds to discuss this along with numerous other examples. - by V.J. Sterba

PROJECT ASPEN AT MIT

A major research project has been started at the Massachusetts Institute of Technology Energy Laboratory to develop an advanced process simulation system. The project, budgeted at $3,285,000 by ERDA for a period of three years, is being directed by Professor Lawrence B. Evans at MIT and Professor Warren D. Seider at the University of Pennsylvania. Dr. Paul W. Gallier has recently been named project manager on a full time, on-loan basis from Monsanto Co.

The software system, to meet the needs in the 1980's has been tentatively named ASPEN (Advanced System for Process Engineering). It is intended to play an important role in the development of new fossil energy processes and in the modification of conventional processes for greater energy conservation. For a system such as a coal gasification plant, it would perform the steady state material and energy balances, size the equipment and carry out an economic evaluation.

The goal of this project is to develop a "third generation" system that would build

upon the present technology and be available to the entire profession.

Dr. Chris Knudsen, Assistant Director of Fossil Energy Review and Analysis at ERDA, explained that the system would provide his organization with a rapid, efficient, and consistent means of performing its process evaluation functions. He said, "With the large government expenditures for fossil energy process development, it is important to identify problems as soon as possible, before beginning costly construction of pilot and demonstration plants."

The system will be designed to meet the specialized requirements of fossil energy conversion processes. It will contain data bases for the physical properties of coal, be compatible with reactor models currently available or being constructed, and contain routines for modeling solids-handling operations and waste-product recovery systems. The program will provide both detailed heat and material balances and detailed economic projections for process plant construction and operation over its entire economic life.

Dr. Bernard Baratz, Project Manager at ERDA, said, "We want the input information supplied to the system to be the same as would be supplied to a group of competent engineers involved in process evaluation. The results computed by the system should include all the information normally used to assess economic viability, including costs of products, capital and operating costs, and return on investment."

Industry will be actively involved in the project. Representatives of industry will serve on an advisory committee with experts from government and universities. The advisory committee will guide development of the system and ensure that it will meet the needs of the ultimate users. Senior staff members will be recruited on loan from industry to work on the project. Where possible, the best existing industrial software will be obtained and incorporated in the system. Funds have been budgeted for acquisition and modification of proprietary software.

Although the project is centered at M.I.T. and managed by the Energy Laboratory, Prof. Evans emphasized that, "The work is intended as a cooperative effort involving the entire profession. We will need the help of many people, if the project is to be successful and the system is to receive wide acceptance."

For more information or details contact Prof. L. B. Evans or P. W. Gallier, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139.

CACHE

CACHE is in its ninth year of existence. New projects include:

1. The large scale systems task force is searching for more computer programs such as heat exchanger design and process synthesis packages.

2. In the area of process synthesis, an attempt is aimed toward implementation of separation synthesis programs for students who are designing trains.

3. Richard Mah is preparing a seminar on Computer Graphics.

4. Bob Weaver is directing an effort to include Resource Management within undergraduate curricula.

CACHE is actively soliciting industrial participation. Interested industrial representatives are encouraged to contact the secretary of CACHE, Dr. Rodolphe L. Motard, Dept. of Chem. Eng'g., Univ. of Houston, Houston, Texas 77004.

EDITORIAL - THE ULTIMATE SAMPLED DATA SYSTEM OR, AS ABOVE, SO BELOW

Somewhere, I read that the number of particles in the universe has been estimated at 10^{72}. Cosmic rays vibrate at the highest known frequencies, approximately 10^{15} Hertz. In data sampling, 10 samples per second or 10 samples per cycle have been considered satisfactory. The product: $10^{72} \times 10^{15} \times 10 = 10^{88}$ should give an adequate sampling rate. However, the Central Processor operates at even higher frequencies; let's say 10^{100} for a GOD round number!

CONTACTS

For copies of the newsletter: Herb Owens, Assistant Secretary AIChE, 345 E. 47th St., New York, NY 10017.

To contact the editor: Sigmund J. Lawrence, 10 Yorkshire Drive, East Windsor, NJ 08520; office phone 215-864-3861.

GAS PROCESSORS ASSOCIATION - TECHNICAL DATA

The Gas Processors Association (GPA) has for many years provided the gas processing industry many valuable process design tools. Among these are:

1. The Engineering Data Book (first published in 1935). This book is periodically updated and provides the design engineer with a comprehensive design manual with contents ranging the gamut from compressor and heat exchanger design data and methods to detailed physical/thermal and phase equilibria data and procedures.

2. Process Design Computer Programs. These embody recently developed correlations whose accuracies and utility for practical engineering design purposes have been assessed by both academic and industrial workers.

3. The sponsorship of research projects in the areas of phase equilibria and enthalpy. The research work has been conducted at both universities and industrial laboratories and has encompassed both theoretical and experimental investigations.

Although the goals of GPA research are geared to providing data and thermodynamic methods for use by the gas processing industries, the basic data obtained and correlations developed have applications in many other process design areas as well.

Future items in the Newsletter concerning GPA-Technical Data will relate current research projects. - by Steve Newman

AMERICAN PETROLEUM INSTITUTE - TECHNICAL DATA

Since the publication of the first edition in 1966, the API Technical Data Book has become a standard reference source of correlations and basic design data for the petroleum industry. Its contents reflect a continuing contribution of almost twenty years effort on the part of both industrial sponsors, who include all the major petroleum organizations and engineering contractors, and academia. The latter, notably Penn State University, have evaluated proposed correlations for accuracy and suitability as process design tools and have undertaken experimental research programs when suitable data for correlation evaluation were lacking in the existing literature.

In addition to contributing funds through API membership, the petroleum industry provides additional support through maintenance of an advisory staff, The Subcommittee on Technical Data, who meets twice a year with the Penn State Data Book staff and other investigators working under API sponsorship. Besides directing the Data Book effort, the Subcommittee also provides guidance to API Research Project 44, located at the Thermodynamics Research Center at Texas A&M University. A product of Project 44 has been the publication of data sheets containing carefully selected tabular properties of pure hydrocarbons; much of this data has been source material for the API Data Book project.

Future items in the Newsletter concerning API-Technical Data will provide descriptions of the Data Book and will describe current technical data research and evaluation projects. - by Steve Newman

AIChE AREA 1d - PROPOSED SESSIONS

Atlanta Meeting, February/March 1978

1. Nonlinear Programming Methods: Theory Meets Practice
   David Himmelblau

2. Treating Uncertainty in Design and Operation
   Woo Young Lee, Richard Hughes

3. Data Base Management
   Ted Leininger

Philadelphia Meeting, June 1978

1. Process Synthesis
   Geo. Stephanopoulos, J.D. Seader

2. Applied Mathematics
   Warren Stewart

Miami Meeting, November 1978

1. Computers in Design and Control
   Warren Seider, Larry McCune*

2. Impact of New Developments in Computer Hardware
   R.S.H. Mah, Dweight Prater

3. Free Forum on Computing Technology
   Irv Rinard, Bob Stanfield*

* Not yet formally asked to participate as indicated.

LIAISON REPRESENTATIVES WITH ORGANIZATIONS EXTERNAL TO AIChE

Organization	Representative
ACM - General	G. D. Byrne
- SIGMAP	R. R. Hughes
ACS	N Rawson
ASCE - Subcommittee on Prof. Society Software	B. Gottfried
ANSI - FORTRAN	B. Gottfried
GPA,API - Technical Data	S. A. Newman
ASTM	T. Williams
CACHE	W. D. Seider
Canadian Computer Group	A. I. Johnson
CODATA	R. L. Motard
EDUCOM	R. R. Hughes
IEEE	A. R. Glueck
IFIP - General	A. I. Johnson
- W.G.5.2. on CAD	E. M. Rosen
Operations Research Society of America	M. Tayyabkhan
SIAM	G. D. Byrne
SHARE	T. Leininger
GROUP 21	G. Fisher

BOOKSHELF

The following book descriptions were obtained from the SIGMINI newsletter of January 1977.

From Osborne & Associates come two titles of interest:

Introduction to Microcomputers, vol. I & II.

Volume I - Basic Concepts, from elementary logic and simple binary arithmetic through concepts which are shared by all microcomputers. The logic devices that constitute a microcomputer system; communicating with external logic via interrupts, direct memory access, and serial or parallel I/O; microprogramming and macroprogramming; assemblers and assembler directives; linking and relocation are covered. Volume I is equivalent to Chapters 1 through 6 of An Introduction to Microcomputers, first edition, but with extensive new sections on chip slice products and serial I/O. Order publication number 2001. Price:$7.50

Volume II - Some Real Products, covers real microcomputers, in considerable detail. It describes products that are only now appearing on the market. These include:

- The 8259 Priority Interrupt Control Unit from Intel.
- The 8253 Programmable Counter Timer from Intel.
- The 8257 Direct Memory Access control device from Intel.
- The 6028 Priority Interrupt Controller from Motorola.
- The 6875 USART from Motorola.
- The M6700 single chip microcomputer from Motorola.
- The 10800 family of chip slice logic from Motorola.
- The single chip F-8 from Fairchild.
- The EA9002 microprocessor from Electronic Arrays.

Publication number 3001 Price: $12.50

Introduction to Microcomputers and Microprocessors
by Arpad Barna and Dan Porat. 1976, 112 pages.

This book gives descriptions of the structure of microcomputers, input and output, process and control units, memory, programming languages and techniques, logic circuits, and arithmetic operations.

There are also explanations of number systems, coding, flow charts, access and retrieval, hardware sharing, and much more, including assemblers, loaders, and subroutine linkages. Numerous examples simplify use of this information in actual practice. Price: $10.50

Order from:

John Wiley & Sons, Inc.
P.O. Box 063
Somerset, N.J. 08873

Effective Use and Application of Minicomputers
by Raymond P. Wenig.

This 335 page technical guidebook contains tables for comparing peripherals, languages, and operating systems. The following is a partial list of the chapter headings:

- What is or isn't a minicomputer!
- Minicomputer peripherals
- Minicomputer applications
- Evaluating, selecting and configuring systems
- Developing and testing application software
- Minicomputer installation, operations and systems enhancement
- Multiple minicomputer systems and distributed computing.

Price: $29.95

Order from:

International Management Services, Inc.
70 Boston Post Road - Route No. 20
Wayland, Mass. 01778

Trends and Applications 1976: Micro and Mini Systems, IEEE. May 27, 1976, 142 pages.

Two parallel sessions - applications and systems, and language and miscellaneous - are featured. Papers present new research results and practical applications.
Non-members - $8.00 Members - $6.00

Minicomputers and Microprocessors, IEEE.
271 pages

Review of recent developments in both minicomputer and microprocessor technology. Each chapter begins with a short section which introduces the topics to be discussed and also highlights the significant points found in the chapter. Topic headings include technological advances, microprogramming, minicomputer architectures, microprocessors, mini and micro computer system development, and interfacing and peripherals.
Non-members - $12.00 Members - $9.00

Designing with Microprocessors, IEEE.
150 pages.

This unique tutorial, given by Professor Tilak Agerwala of the University of Texas, Gerald Masson of Johns Hopkins, and Roger Westgate of Johns Hopkins at COMPCON Fall 76, deals with the principles and practice of microprocessor design. Covers such topics as chip architecture, microprocessor selection criteria, software aids, development systems, microprocessor applications, networks, bussing strategies, and distributed intelligence.
Non-members - $10.00 Member - $7.50

Order from:

IEEE Computer Society
5855 Naples Plaza, Suite 301
Long Beach, CA 90803

NEWS FLASH!!! ENTER "CAST"

Bob Morris, chairman of our division formation committee, made a comprehensive presentation to Council in New York City on Sunday June 5, on behalf of the formation of a Computing & Systems Technology Division in place of the Machine Computation Committee.

Following from these discussions, Council considers that we have met all the necessary requirements for an Institute Division, subject to final confirmation at the Denver meeting in August.

-by Al Caselli

ACTION: Become a charter member!
Come aboard!
Contact our secretary,
Bob Lackmeyer
SOHIO
Midland Bldg- 215 CB
Cleveland, Ohio 44115
216-575-5002

BITS & PIECES (BYTES & PICOS)

MIT is offering a summer non-credit course in New Developments in Modeling, Simulation, and Optimization of Chemical Processes. July 18-27. Warren Seider of the MCC is one of the contributing lecturers. Larry Evans is in charge.

Confucius say: Time flies like an arrow; fruit flies like a banana.

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Veni, vidi, et illegitimi me presserunt.

Two sessions on advances in ChE computing will be held at the AIChE meeting in New York City, Nov. 13-17, 1977. Rudy Motard will chair, and Irven Rinard will cochair the sessions.

Enough for man, to work, to hope, to love.

A FLOWTRAN workshop will be held July 13-16 at the University of Wisconsin, Madison. The purpose is to provide hands-on experience in the usage of FLOWTRAN. Contact Hal Abramson at AIChE headquarters.

Łata na łacie, a dziura zawsze.

A Computer Simulation Conference will be held July 18-20 at the Hyatt Regency O'Hare, Chicago. Contact Dr. R. M. Howe, Aerospace Eng'g. Dept., U of Michigan, 305 Aerospace Eng'g. Bldg., North Campus, Ann Arbor, Mich. 48104.

TO THE ORACLE

1. Do you know of any physical property estimation systems superior to the APPES (AIChE Physical Property Estimation System) that are commercially available?

2. Whom may I contact for information relative to this or other commercially available systems?

3. If you have such information, please contact the editor, at 10 Yorkshire Drive, East Windsor, NJ 08520.

ACRONYMS DEMYSTIFIED

AACE: American Association of Cost Engineers
ACM: Association for Computing Machinery

ASCE: American Society of Civil Engineers

ANSI: American National Standards Institute

API: American Petroleum Institute

ASPEN: Advanced System for Process Engineering
ASEE: American Society for Engineering Education
CACHE: Computer Aids for Chemical Engineering Education

CODATA: Committee on Data for Science and Technology

COMP: Computers in Chemistry (ACS)

EDUCOM: Inter-University Communications Council

GPA: Gas Processors Association

IFIP: International Federation of Information Processing

MCC: Machine Computations Committee

NRCC: National Resource for Computation in Chemistry

ORSA: Operations Research Society of America

SIAM: Society of Industrial and Applied Math

SIGMAP: ACM Special Interest Group on Mathematical Processing

SIGMINI: ACM Special Interest Group on Minicomputers

FORTRAN CHANGES

Fortran, the Esperanto of engineering computing, is about to change dramatically. The X3J3 Committee of the American National Standards Institute (ANSI) has been working for over five years on a replacement for Fortran IV. In an even greater departure from the past, the CODASYL Fortran Data Base Committee is devising a data base language capability for the new Fortran. Both efforts are nearing fruition.

The ANSI Committee has among its 27 corporate members the big five of large computers, four leading mini manufacturers, several branches of the Federal Government, and industrial firms like Foxboro, Aerojet, GE, and Bell Labs. It has recently completed work on the final round of public comment on the proposed standards for the full language and a proper subset. Nearly 2500 comments were received and gone over in detail by this hard-working organization.

The changes to Fortran while numerous and mindboggling are for the most part enhancements. Compatibility with Fortran IV and portability between machines were given highest priority among the criteria used in developing the standard. Despite this orientation, there are 23 recognized conflicts with Fortran IV. The major changes are in three areas: control statements, I/O statements and the introduction of the character data type.

The new control statements involve the concept of an IF level with IF blocks delineated by IF THEN, ELSE IF, ELSE and END IF statements. This will be a big help in writing structured programs.

The whole area of I/O statements has been worked over with the introduction of the logical record and file. An OPEN statement provides the means of defining a file while CLOSE disposes of it. An INQUIRE statement provides information about the properties of a file or its connection to a peripheral unit. These statements function through a control information list of specifiers which look, act and are as extensive as JCL parameters. Most I/O statements can be used with either direct access or sequential files.

The character data type joins the five others, integer, real etc. with its own definition of constant, variable, array, expression, relational expression and assignment statement. To manipulate this data the concatenation and substring operators are available as well as several intrinsic functions.

In all, ten new statements have been added to the Fortran IV language making a total of 56 statements in FORTRAN 77. Others, particularly, the I/O statements have changed. By the time this is published the X3J3 Committee will have approved the final editing of the documents describing FORTRAN 77 and forwarded it to a superior committee for final approval. Several of the manufacturers who are represented on the committee have jumped the gun in that the latest version of their Fortran compilers incorporate many elements of FORTRAN 77. Univac has announced that their Fortran (ASCII) compiler will be a superset of FORTRAN 77 and in full compliance. DEC Fortran 4+ already has many of the I/O enhancements. Burroughs has leaked the news that they are developing a new large scientific computer with FORTRAN 77 as its primary language.

The development of a data base facility for Fortran recognizes the ever increasing importance of the data base concept to all computing and the need to have a Fortran program communicate with data bases. The CODASYL Fortran Data Base Committee has followed the pattern used in the development of the original Cobol oriented CODASYL data base facility. They have created seven new Fortran statements which are used to define a logical view of the data accessible to a program unit - in the jargon a "sub-schema". The data is viewed as a network of sets consisting of records, with the sets themselves part of a realm. Full provision for privacy and data base integrity are incorporated. Because this method of defining a sub-schema is compatible with the original Cobol one, programs in either language can use the same data bases.

The data manipulation language (DML) adds fifteen more statements to FORTRAN 77. It provides for program access to a sub-schema through an INVOKE or READY statement. Then it is possible to FIND a specific record, GET the record moved into Fortran variables or do both operations with a FETCH. The Fortran program can also STORE, MODIFY or ERASE data. When the sub-schema is not exactly what is desired, an ORDER statement can temporarily or permanently change the logical order. Furthermore records can be put into or removed from a set with CONNECT or DISCONNECT. A user exit may be used to call a subroutine to do things not within the scope of the DML.

Like the ANSI X3J3 Committee, the CODASYL FORTRAN Data Base Committee has a broad membership base in computer manufacturers, the federal government and industry. The notable omission is IBM which does not support the CODASYL Data Base effort. This committee is also nearing final approval of their proposal. When the proposed changes are implemented, Fortran will have taken long strides toward meeting the criticism that it has become an isolated and archaic language. - by Ted Leininger

DATA ACQUISITION, CONTROL AND SIMULATION (DACS) CENTRE AT THE UNIVERSITY OF ALBERTA

There is an increasing interest in computer control techniques for industrial applications because of tighter performance specifications, larger more integrated systems, energy conservation and environmental considerations. Fortunately, this increased interest in process control has been paralleled - and in many cases preceded - by the development of improved techniques plus the computing hardware necessary to use them. For example, large interactive, computer-based systems make it relatively easy to design and simulate multivariable process control systems, and real-time process computers, and/or microprocessors, provide a convenient means of implementing modern control systems in industrial plants. However, there is still a shortage of people with "hands-on" experience with DACS systems and of well-documented, experimental applications. These shortages led to a continuing program of education and research in the Department of Chemical Engineering at the University of Alberta that began over ten years ago and is continuing on an ever increasing basis.

The Data Acquisition, Control and Simulation (DACS) Centre was established within the Department of Chemical Engineering at the University of Alberta in 1967. The primary purpose of the Centre is to facilitate and extend the research interests of the Department and to assist university programs at the undergraduate, graduate and continuing education levels. An active program of university - industrial cooperation at all levels is also pursued. (1)

The Centre operates an IBM 1800 process control computer system with 48K core, 3 disk storage units, card-reader-punch, line printer, digital plotter, 15 remote terminals, display oscilloscopes, and over 500 process input/output points for direct connection to research equipment and control systems. The computer operates under the IBM/MPX system which permits time-sharing between real-time applications such as direct-digital-control and gas chromatograph monitoring, and off-line applications such as data processing and program development. The DACS Centre staff consists of four full-time staff people.

A DEC 680 communications system (based on a PDP-8I computer) handles telecommunications plus the servicing of teletype units located in individual research and student lab areas. A PDP-1103 microprocessor and an EAI hybrid computer system are also available for special projects.

In very general terms the usage of the present system may be divided into three areas: teaching, service, and research. Teaching applications are typified by "open-shop" undergraduate and graduate student use of the system in the two "Real-Time Computer Applications" courses that have been offered since 1968, and by laboratory and problem assignments in a larger number of other departmental courses. Typical service functions include general purpose data acquisition and data processing programs; automation of laboratory instruments such as gas chromatographs and mass spectrometers; plus a number of interactive computer programs that assist with the design and/or implementation of student and research projects. (3)

A number of research projects have been undertaken which would have been impossible without these facilities. Most of these have been concerned with the development of multivariable computer control techniques and their evaluation on the computer controlled pilot plant units. (2)

The best indication of the widespread usage of the current system is found in the statistics summarizing actual usage of the system over the past three years. The 'keyboard queue' statistics indicate that an average of about 1500 requests per month are made to execute existing programs which have been developed and stored on the system. The statistics on "batch process jobs" indicate that approximately 2000 programs are run on the system every month to assist with the development of new applications and/or processing of results related to teaching and/or research projects. The monthly average of 5642 GC runs in 1976 is an indication of the utilization of this system for "lab automation". In 1975 and 1976 there was an average of over 40 direct digital control (DDC) loops operating everyday and the Process Operator's Console was used an average of over 250 times per day to display or change information related to teaching and research applications.

Plans are now underway to replace the present facilities with a distributed computing system consisting of a large central computer plus a number of subsystems (usually containing microprocessors), all interconnected into a network which uses standardized hardware interfaces (e.g., IEEE 488-1975) plus a common communications and systems-control protocol. This "real-time" network will also be connected to the University's Amdahl 470 V/6 computer (cf. IBM 370-168). This new system will permit expansion of present teaching and service functions and permit extension of research projects into the area of distributed systems which is receiving an increasing amount of industrial interest. By D. G. Fisher

(1) "Data Acquisition Control and Simulation Centre", a booklet available from the Department of Chemical Engineering, University of Alberta, Edmonton, Canada. T6G 2G6.

(2) FISHER, D. G. and SEBORG, D. E., Multivariable Computer Control - a case study, American Elsevier (1976).

(3) FISHER, D. G., "Real-time Computing in the University", Chem. Eng. Education, pp. 24-30, winter issue (1971).

A NEW PROGRAMMING METHODOLOGY

Ronald L. Klaus, Software Consultant
607 S. 48th St., Philadelphia, Pa. 19143

In recent years there has been a great deal of discussion about a new programming methodology which claims to offer great increases in programmer productivity and program reliability. A very readable overview of this technology appears in the December 1973 issue of Datamation, beginning with an article by Daniel McCracken[1]. He claims that this methodology is "a major intellectual invention, one that will come to be ranked with the subroutine concept or even the stored program concept".

There are three aspects to this new methodology. First is structured programming. This is a method of coding which restricts the logical constructs allowed in a program so as to make coding more uniform, easier to read, more reliable and easier to maintain and extend. It could be said that structured programming is a programming discipline which causes the production of "better" computer programs.

The second innovation is called top-down programming. This is a method of design and implementation of programs in a systematic manner in such a way as to minimize re-coding and debugging and so as to facilitate checking. It might be said that top-down programming is a strategy for the implementation of computer programs which drastically reduces the implementation effort. The third innovation is called chief programmer teams. This is a method of organizing people and tasks in a computer programming effort so as to maximize the production of computer code and minimize the incidence of errors.

There are a number of important historical milestones which led to the emergence of this new methodology. First was a paper by Bohm and Jacobini[2] in 1966. This theoretical paper showed that it is possible to write any program with only the three following programming constructs: a sequence of instructions, an if-then-else construct, and some looping mechanism, such as the DO-WHILE or DO-UNTIL. The important point is that the GO-TO statement is not a necessary programming construct. This was followed by a paper by Harlan Mills[3] in which he proved that if a program used only the three constructs mentioned above and if it had only one entry and one exit point, it was theoretically possible to prove the program to be correct. Automatic program-proving is an important area of research whose motivation is to provide methods of proving that computer programs are correct. The thrust of Mills paper was that programs with only one entry and exit point are the easiest to prove correct.

Widespread discussion of these issues was touched off by a widely-cited letter by Prof. E. W. Dijkstra[4] which appeared in the Communications of the ACM in 1968. He claimed that (a) the quality of a program is inversely proportional to the number of GO-TO statements, and (b) that, therefore, the GO-TO should be eliminated from programs except for branching on detection of errors. This assertion touched off a great deal of controversy and discussion which goes on until this day.

The practical significance of the newly-emerging technology was dramatically thrust upon the computer programming community by the New York Times data base project reported by Baker and Mills[5][6]. The three aspects of this new methodology were used to develop an 83,000 instruction package with extremely complex logic. The claims made for this project are indeed phenomenal when compared to today's state of the art. Programmer productivity was measured at 10,000 statements per man-year which is a five-fold increase over what is typical. The entire system integration took one week. Five weeks of N.Y. Times acceptance testing resulted in the discovery of only 21 errors and in its first year of use, only 25 additional errors were detected. These results stirred up a great deal of interest and have resulted in a large number of additional experiments with this methodology.

When one carefully examines the three aspects to this new methodology, it becomes clear why it is so powerful and why such improvements in productivity and reliability are probably to be expected. The net effect of this methodology is to move programming much closer to being a science than an art. In much the same way that the disciplines of mathematics or physics

or chemistry provide a systematic framework for the precise solutions of physical problems, the programming disciplines provide such a framework for the solution of programming problems. This does not mean that programming will cease to be creative any more than a chemist can cease to be creative even though chemistry has evolved into a highly developed science. However, programmers will now have available to them a powerful discipline within which to solve their problems.

Even a small amount of experience with structured programming makes it clear that the need to adhere to the discipline involved forces the production of clearer (and therefore usually better) programs. Unfortunately, the Fortran language is not directly suited to structured programming. However, some proposals have been made which enable "structured programming thinking" to be used in a Fortran environment[7]. Moreover, the Fortran ANSI standards committee is now considering the release of a new standard which would include the necessary constructs so as to permit structured programming in Fortran. One hopes that these standards will include the present ANSI standard Fortran as a sub-set so that existing programs will not need to be modified in order to run with the new compilers which will undoubtedly be developed if a new standard is adopted.

In the mean time there are a number of program products which provide extensions of Fortran so that structured programming methodology may be directly used. One such is a system called Logically Structured Fortran, available on the United Computing Systems network[8]. Another system, called FLECS[9] is a standalone system, available quite inexpensively for installation on one's own computer. These systems include Fortran but provide several additional statements which include all the necessary structured programming constructs. They are both quite convenient to use. These are only two of the more easily available systems. They are essentially translaters, which scan a program for all the non-Fortran statements and translate them into equivalent Fortran statements. Errors in the non-Fortran statements will be flagged by a message. The resulting machine-generated program is then compiled by a traditional compiler.

Other languages such as PL/1 and Algol may be directly used within the discipline of structured programming. However, even these are not perfect because they do not include certain constructs which would be very helpful. It is no doubt to be expected that as structured programming becomes a more established discipline that programming languages will evolve to become increasingly convenient vehicles for its use.

Top-down programming is a strategy and therefore is not language-dependent. It is a strategy which is best used, however, in conjunction with structured programming. In essence it dictates that programs be designed, coded and tested beginning at the highest level and proceding down toward lower levels. Successful case studies have almost always dealt with non-numerical applications. The author's own experience indicates that there may be two situations in which a strictly top-down approach should be modified. First of all, in some highly numerical applications, it appears best to implement and test the lowest-level numerical code first. Also, where certain low-level code is very critical and highly innovative, we have found that it is sometimes best to implement this first.

Chief programmer teams appear to be an excellent way to organize people and tasks in all but the smallest programming shops. They permit the most qualified programmers to do the highest-level and most critical parts of the programming task, while relieving them from much of the tedious detail. They also provide for a natural flow of communication between members of the team and provide for back-up in case a programmer is moved to another project and for a method of easy integration of new programmers into a project.

It is likely that these developments, once perfected, will strongly influence the way programming is done in the next decade. There still appear to be some problems to be resolved, most particularly the addition of convenient features to current languages. However, this will undoubtedly take place shortly. This methodology, once established, will undoubtedly speed up the emergence of programming as a recognized discipline with well-trained programmers who will do a better job in the writing of computer programs.

This new methodology is among the topics discussed in greater detail in a short course given by the author and sponsored by the A.I.Ch.E.(10).

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8. For further information contact: United Computing Systems, Inc., Marketing Services, 2525 Washington, Kansas City, Mo. 64108

9. For further information contact: Mr. Terry Beyer, Computing Center, University of Oregon, Eugene, Ore. 97403

10. For further information contact: Mr. Harold Abramson, Continuing Education Dept., AIChE, 345 E. 47th St., New York, N.Y. 10017. Course Title: Cost-Effective Management and Documentation of Computer Programming Efforts

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BOOK REVIEW: The Mythical Man Month--Essays on Software Engineering
by Frederick P. Brooks, Jr., Published by Addison-Wesley

Many texts have been written about the various aspects of software development. Early works centered around programming techniques (reliable, efficient methods of writing code). More recent works have addressed the overall methodology of systems development (top-down design or structured programming). When a software engineering effort became large, requiring the services of several engineers or programmers, more than coding techniques and structured programming was required. No texts have been available to help solve the problems associated with large systems development. What was required was a manager experienced in the development of such systems. Brooks is such a man. His essays draw on his own experiences as project manager for the IBM System/360 and for OS/360, its operating system. Brooks believes that large systems development projects suffer management problems different from smaller ones due to division of labor. The book consists of 15 essays each dealing with an aspect of systems management. The first essay, appropriately titled "The Tar Pit", describes how a large project can get into trouble. Essays 2-7 are the heart of the book containing Brooks' main observations and philosophy. The remaining essays deal with other aspects of software development.

I believe that Brooks has condensed and refined what we call "experience" and put it into a clear, concise form. I have learned many of the lessons that Brooks relates and have also benefitted from his experience on projects I have managed subsequent to reading his book. In addition to learning from Brooks' experiences the reader will also be delighted by his style of writing. The book is both informative and a joy to read. by - Pete Hanik

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