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Focus on Supercomputers: Chemical Engineering & Materials Science

Editor's Note: The following material is excerpted with permission from a longer article, "Bubbles, drops and a whole lot more," that appeared in CRAY CHANNELS, *volume 6, number 3.*

Scientists in the fields of chemical engineering and materials science study chemical and physical phenomena at both the micro- and macroscopic levels. Their knowledge and discoveries are then used to create new commercial products and to develop new manufacturing processes.

Researchers in the Chemical Engineering and Materials Science Department at the University use UCC's CRAY extensively in their work. The heaviest users are a group of researchers who study the properties and behavior of fluids in areas such as fluid dynamics, fluid microstructure, and microfluid mechanics. In their work, they attempt to understand the principles that govern fluids at solid surfaces and fluid interfaces, as well as flow and diffusion in viscous fluids.

Simulating fluid behavior via computer now plays a role equal in importance to theory development and laboratory experiments. Practical applications of this work will improve the accuracy of petroleum reservoir simulations and increase the efficiency of coating flow processes. (Coating flows are used in the manufacture of adhesive tapes, photographic film, and magnetic recording media.)

Dr. H. Ted Davis, head of the department, offers some insight into the relationship between the department's two disciplines. He explains that chemical engineers are interested in chemical processes such as catalysis, reactions and purifications, and production of coatings. They study how to control these processes and how to apply them to the creation of finished products.

Materials scientists, on the other hand, are interested in creating novel materials and they study the composition and the electronic and mechanical properties of various substances.

Davis concludes, "The person studying the process of, say, coating a substrate with a plastic film, is better served if he understands the science of the material being deposited. The person attempting to invent novel materials is well served if he understands the processes by which materials are created. As you can imagine, there's a lot of overlap between the two disciplines. Large-scale scientific computation is rapidly increasing our understanding of the science of materials as well as the elements of process technology."

Specialized analytical approach

Dr. Davis and Dr. L. E. "Skip" Scriven direct much of the department's fluids research. Davis, Scriven, and their colleagues have developed their own approach using the CRAY to solve problems in fluid behavior.

Their method is an adaptation of finite element analysis that can be divided into several steps. For many purposes it involves subdomaining, which divides a complex system into manageable parts. This process includes "adaptive subdomaining," which appropriately sizes the parts for the given problem.

"You don't know what size you want your subdomains to be until you have the problem solved, so the subdomains themselves become unknowns," explains Scriven. "In the jargon most people use, they say they need to calculate a mesh or a grid to solve the problem. We're incorporating the calculation of the grid needed to solve the problem into the problem itself, so we get it all done at once. This is particularly advantageous when we deal with liquid surfaces and other 'free boundary' problems."

Finite element basis functions and isoparametric mapping follow subdomaining. The latter process maps irregular curved shapes onto a grid of squares through the use of variable scaling.

"This is what the Flemish cartographer Gerhardus Mercator was trying to do," says Scriven. "He tried to put the Earth on a flat surface. But it got horribly distorted because he was trying to do it all with the same scale. We use different scalings for different parts, so the overall map varies in scale from place to place. Before the advent of computer-aided mathematics, this wasn't practicable for real systems."

Mapping is followed by Newton iteration and vectorized calculations for the coefficients of the basis functions.

"This is the 'Minnesota brand' of analysis," says Scriven. "I don't know of anyone else who's doing all of these things in fluids research."

Bubbles and drops

Fluids research at the University grew out of initial studies in bubble and drop dynamics. Common bubbles and drops include soap bubbles and raindrops. The chemical and physical laws that govern their behavior apply to a wide range of disciplines including nuclear physics and astrophysics. Discovering the principles that govern bubble and drop dynamics aids researchers in many fields.

Surface tension is one of the most significant of the forces that govern drop dynamics. It determines the shapes of fluid drops and is a major factor in determining how readily two fluids will mix.

Surface tension stems from the expression of intermolecular forces within the zone that separates the inside and outside of a drop. It arises because the net attractive forces among molecules parallel to the plane of a drop's surface are always greater than the net attractive forces perpendicular to that plane.

Surface tension that arises from the intermolecular attraction among water molecules, for example, prevents raindrops from dispersing into mist as they fall through the atmosphere. It also relates to water's ability to penetrate some fabrics but not others.

Surface tension magnitude varies proportionately with the gradient in density of molecules between the interior of a drop and the fluid outside it. The molecular theories that enable scientists to understand the mechanisms of surface tensions and interfacial phenomena were too complicated to solve before the advent of large computers like the CRAY. Now, with computer-aided finite element analysis, the nonlinear equations of the molecular theory of surfaces routinely yield the molecular insights necessary to understand the principles that govern surface tension behavior.

The principles that govern drop dynamics are also applied in astrophysics, since stars share some of the properties of fluid drops. While they do not exhibit surface tension because their matter trails off gradually into space, they can be accurately modeled as self-gravitating drops.

"A star does not have an appreciable surface tension analog, but it has gravity," says Scriven. "Electrostatic attraction and gravity are governed by the same inverse square law, so computing predicted behavior for the two phenomena is virtually the same."

Treating stars as rotating, self-gravitating fluid drops has led to a theory to explain the formation of binary stars. A binary star is a system of two stars that revolve around each other due to their mutual gravity. Under certain conditions, a rotating drop will distort into a two-lobed "dumbbell" shape, then split into two separate drops. The principles that govern this behavior in raindrops and spray drops might also govern the formation of binary stars from single stars.

• • •

Knowledge of the physics and chemistry of surface tension, along with other properties of fluids, can be applied to improving a variety of industrial processes. University researchers are currently exploring ways to improve the efficiency of petroleum reservoir simulations and fluid coating techniques. These applications have become increasingly practicable with progress made possible by the CRAY supercomputer.

Petroleum recovery

Oil companies and consumers stand to gain considerably from a better understanding of drop dynamics. Knowledge about surface tension, for example, can be used to predict the behavior of fluids trapped in underground rock, a situation oil companies deal with every day. Surface tension and miscibility dictate the flow rates of such fluids. Computer simulations that take these factors into account are used to assess the probable effectiveness of petroleum recovery operations.

Several major oil companies use CRAY computers in different ways to simulate the gross flow of oil and water underground. The chemical engineering researchers at the University use our CRAY to simulate oil-water interfaces and flow and dispersion rates inside porous microstructures. They hope to develop general theories to explain the dispersion and flow rates of fluids through media of varying permeability. Oil companies may then incorporate such theories into their reservoir simulation programs.

Reservoir simulations can be very cost-effective despite various difficulties. With potentially billions of dollars at stake in an enhanced recovery operation, a single correct decision based on computer simulation could pay for a CRAY many times over.

Coating flows

Another area of fluids research at the University that has drawn heavily on CRAY computing power is the prediction of coating flow configuration. Photographers, musicians, and anyone who has ever wrapped a birthday gift have benefited from the study of coating flows. Photographic film, audio and video tapes, and the many varieties of tape adhesives all consist of a solid substrate that is coated with a thin liquid film during the manufacturing process. You need a working knowledge of fluid dynamics to construct and operate equipment used in such coating processes. University researchers have successfully applied their brand of finite element analysis to fluid dynamics problems in thin film coating.

Typically, the goal of a thin film coating process is to create a liquid layer uniform in thickness and composition at the fastest possible rate with the least waste. Technological progress in this area means coating thinner, more uniform films of high solids content at higher speeds. But, until recently, accurate theoretical models have lagged behind trial-and-error and intuition as tools for change.

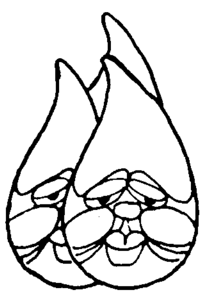
Now some accurate models have been developed. Scriven and various collaborators have developed theories to precisely describe and predict the complicated shapes of flow fields found in real situations in unsuccessful as well as successful coating operations.

The benefits of basic research

Academic researchers are unique in their ability to investigate phenomena without keeping an eye on potential profits. Their bottom line is to advance our understanding of the physical universe. Nonetheless, such understanding can pave the way to improve many commercial and industrial processes.

Better understanding of fluid behavior in permeable media has direct applications for improving the accuracy of petroleum reservoir simulations, an important tool for making multi-billion dollar decisions. Accurate simulations will increase the cost-effectiveness of petroleum recovery operations and, in turn, benefit everyone who uses gasoline, oil, plastics, and other petroleum products.

Improving the efficiency of thin film liquid-coating operations promises to benefit the industries that use these processes and their customers.



The University of Minnesota is one of only four universities in the United States to own a supercomputer. Our supercomputing ability allows researchers to test theories faster and more economically than they could with laboratory experiments alone. The CRAY fills a useful niche, in this case, by making feasible the complex computations needed to accurately simulate the varied behavior and properties of fluids in chemical engineering and materials science research.

CRAY News

CRAY COS/CFT UPGRADE TO VERSION 1.13

We will upgrade our CRAY-1 to COS 1.13 and CFT 1.1, bugfix 2, on January 6. We anticipate a smooth transition with little user impact.

WRITEUP(CRAYCHG) on the CA front-end describes the significant features added in the 1.13 release and the compatibility issues between 1.13 COS and 1.12 COS and between 1.13 CFT and 1.11 CFT. (CFT version 1.12 was skipped to bring the current CFT revision level into agreement with the current COS revision level.)

The major compatibility issues between COS+FT 1.13 and the previous version are:

- 1.13 CFT performs LOC as an inline function rather than calling a library version of this function. If a user wishes to call an external function named LOC, it must be declared in an EXTERNAL statement.

- Only 120 distinct common blocks within a single program unit are allowed by 1.13 CFT. The new calling sequence version of 1.11 CFT allowed up to 123.

- 1.11 and 1.13 CFT use different methods of handling constants passed as arguments to subroutines. 1.11 CFT placed these constants at a temporary location and passed the temporary address to the subroutine. 1.13 CFT passes the address of the constant in the calling program's constant block. Consequently, if the subroutine call contains a constant and the corresponding argument is modified by the subroutine, the constant will be modified in the calling program as well. Subsequent references to the constant within the calling program may then produce erroneous results. When calling subroutines which may modify arguments, care should be taken to avoid using constants in the calling statement for these arguments.

- The default value of MAXBLOCK (the maximum block length for which CFT attempts optimization) has been slightly reduced in 1.13. This change was made to avoid table overflow problems caused by additional table entries made by the new instruction scheduler. Some large jobs may still result in table overflow; in these cases, this value may be further reduced by using the MAXBLOCK parameter on the CFT control statement.

- Several routines were moved from one library in 1.12 to another library in 1.13. Consequently, relocatable binaries should not be loaded with a mixture of 1.12 and 1.13 libraries. This could result in unsatisfied external references and/or duplicate entries.

- Routines ICAMAX, ISAMAX, ISMAX, ISAMIN, and ISMIN in $SCILIB are no longer restricted to a nonnegative increment in the 1.13 release. Programs which call these routines using negative increments will generate a run-time abort if loaded with earlier versions of $SCILIB.

- Use of the heap manager with LDR and SEGLDR precludes use of the table manager.

- User source codes that assembled or compiled using the 1.12 product set or 1.11 CFT will continue to assemble or compile when using the 1.13 product set or CFT.

- Absolute binaries generated using the 1.11 CFT and the 1.12 product set on the 1.12 COS operating system continue to run under the 1.13 COS operating system.

PERMANENT DATASET STORAGE CHARGES

Charges for the storage of permanent datasets on CRAY mass storage went into effect on December 1. They are based on the number of kilo-block days you use. We define one kilo-block day as the use of one kilo block of CRAY disk space for one day's time.

We charge $16.80 per kilo-block day (KBD) for backed-up permanent datasets, and $3.36 per KBD for permanent datasets that are not backed up. These charges are internal, academic rates. External, nonacademic rates are 50 percent higher.

For additional information on these charges, see the article on "Permanent Datasets on CRAY Mass Storage" in the November UCC *Newsletter*.

We have installed three new COS (CRAY Operating System) commands to help you maintain your permanent datasets on the CRAY. These commands are:

- PDCOST, which provides cost information for permanent dataset storage;
- PURGE, which helps delete multiple editions; and
- PURGALL, which will help delete all editions of a dataset.

The PURGE and PURGALL commands simplify the process of deleting files; these new commands replace the ACCESS, DELETE, and RELEASE sequence now required to delete datasets.

These commands are described in more detail in WRITEUP(CRAY=xxx), where **xxx** is the appropriate COS command.

Math and Statistics Packages

SPSS ON THE CRAY

We recently finished converting the IBM SPSS package version 9.0 to our CRAY-1 computer. It has successfully run over 100 test problems supplied by SPSS, Inc. Preliminary timings indicate that CRAY SPSS runs about five times faster than SPSS on our CYBER 845 (CA) and costs about half as much for medium to large problems. The one-million-word memory available on the CRAY also allows you to run much larger problems than you can run on the CYBER.

CRAY SPSS is much closer to the IBM SPSS documented in the McGraw-Hill manuals than CYBER SPSS, although it does not include additional CYBER SPSS procedures such as CTAB, NONLINEAR, etc.

WRITEUP(CRAY=SPSS) documents CRAY SPSS. This 50-page writeup describes how to use the package, gives examples, and includes information about the few differences between CRAY and IBM SPSS (mostly due to variations between the machines and their operating systems).

Exhibits 1 and 2 show a simple CRAY SPSS SUBMIT job and its output.

If you have any problems with CRAY SPSS, call our statistical consultant at 376-1761 between 1 and 2 p.m., Monday through Friday. (*Michael J. Frisch*)

SPSS AND LISREL

On Thursday, January 3, 1985, the FUTURE version of SPSS (9.0) will become current on our CYBER systems and the current version (8.3) will become past. Also on January 3, LISREL VI will become current on the CYBER CA and LISREL IV will become past.

```
/JOB
/NOSEQ
MYJOB,STMCR.
USER,0,0.
JOB.
/ACCOUNT
* EXAMPLE. SIMPLE CRAY SPSS EXAMPLE
SPSS.
/EOR
RUN NAME          CONDESCRIPTIVE TRIAL
DATA LIST         FIXED/ 1 SCORE 1-3, AGE 5-6
N OF CASES        10
VALUE LABELS      SCORE (1) 0-25 (2) 26-50 (3) 51-75 (4) 76-100/
                  AGE (1) 18-35 (2) 36-70 (3) 70-99/
CONDESCRIPTIVE    ALL
STATISTICS        ALL
READ INPUT DATA
096 24
080 78
073 27
035 19
056 70
055 32
100 90
099 67
065 29
042 42
FINISH
```

Exhibit 1. A simple CRAY SPSS SUBMIT job.

```
SPSS BATCH SYSTEM 09/07/84 PAGE 1
SPSS FOR CRAY/COS, RELEASE 9.0, JUL. 1984
DEFAULT SPACE ALLOCATION..   ALLOWSFOR..      73  TRANSFORMATIONS
WORKSPACE      17500 WORDS                   294  RECODE VALUES + LAG VARIABLES
TRANSPACE       2500 WORDS                  1176  IF/COMPUTE OPERATIONS
1  RUN NAME           CONDESCRIPTIVE TRIAL
2  DATA LIST          FIXED/ 1 SCORE 1-3, AGE 5-6
THE DATA LIST PROVIDES FOR 2 VARIABLES AND 1 RECORDS ('CARDS') PER CASE. A MAXIMUM OF 6 COLUMNS
ARE USED ON A RECORD.
LIST OF THE CONSTRUCTED FORMAT STATEMENT..
(F3.0,1X,F2.0)
3  N OF CASES         10
4  VALUE LABELS       SCORE (1) 0-25 (2) 26-50 (3) 51-75 (4) 76-100/
5                     AGE (1) 18-35 (2) 36-70 (3) 70-99/
6  CONDESCRIPTIVE     ALL
***** GIVEN WORKSPACE ALLOWS FOR 1944 VARIABLES FOR CONDESCRIPTIVE PROBLEM *****
7 STATISTICS ALL
8 READ INPUT DATA
CONDESCRIPTIVE TRIAL                                                        09/07/84      PAGE  2
FILE NONAME (CREATION DATE = 09/07/84)
VARIABLE SCORE
MEAN                  70.100     STD ERROR          7.439       STD DEV              23.525
VARIANCE             553.433     KURTOSIS          -1.354       SKEWNESS             -0.027
RANGE                 65.000     MINIMUM           35.000       MAXIMUM             100.000
SUM                  701.000
VALID OBSERVATIONS -  10                                       MISSING OBSERVATIONS -0
---------------------------------------------------------------------------------------------------
VARIABLE AGE
MEAN                  47.800     STD ERROR          8.178       STD DEV              25.862
VARIANCE             668.844     KURTOSIS          -1.526       SKEWNESS              0.510
RANGE                 71.000     MINIMUM           19.000       MAXIMUM              90.000
SUM                  478.000
VALID OBSERVATIONS -  10                                       MISSING OBSERVATIONS -0
CONDESCRIPTIVE TRIAL                                                        09/07/84      PAGE  3
CPU TIME REQUIRED.. 0.00 SECONDS
9 FINISH
NORMAL END OF JOB.
9 CONTROL CARDS WERE PROCESSED.
0 ERRORS WERE DETECTED.
```

Exhibit 2. The output from the sample job in Exhibit 1.

Software on Campus

UCC NOTE: On large-scale systems, it makes good economic sense to share high-quality software. If the software is of use to a large portion of our user community, we may obtain a license or otherwise support it. Thus, from time to time, we publish information that allows you to judge for yourselves the usefulness of a system or package. Such publication does not imply our endorsement of the product. If you wish to use it, you do so at your own risk. We will not consider credit for error and will not provide consulting.

ECONOMETRIC SOFTWARE

The State of Minnesota currently leases the SORITEC computer program from The Sorites Group, Inc. It can be run as an interactive or batch program on the CYBER 845 (CA) system. SORITEC's capabilities include:

- many econometric techniques
- databanking
- report writing
- simultaneous equation solving
- user-defined procedures
- many types of mathematical data transformation.

You can obtain SORITEC manuals directly from the vendor at:

The Sorites Group, Inc.
P.O. Box 2939
Springfield, VA 22152
(703) 569-1400

The cost is about $27.

An interactive NOS procedure is available to run SORITEC jobs; you access it by typing:

X,A,PROCFIL/UN=ZZZ6564
-S (or: -S?)

More information is available by typing:

X,A,SORHELP/UN=ZZZ6564
LIST,F=SORHELP

SORITEC requires at least 124000B central memory to operate. Attempts to run it with less field length will result in the incomprehensible memory manager error:

MAXFL LT HHA+100, CCM CANNOT FUNCTION

If you have questions about SORITEC or how to access it, call Joe Gervais, 297-3621, weekdays from 3 to 4 p.m.

The vendor's lease permits only noncommercial users to access the program; commercial users must make separate arrangements with the vendor. All Minnesota state agency and University users may access the program.

This program will be available until at least June 1985, and possibly longer. We will accumulate user-access counts and these will have some impact on a decision about its availability after June 1985. *(Joe Gervais)*

Programming Languages

THE CRAY'S C COMPILER

C, a general-purpose programming language, was developed at Bell Labs in 1972. A C compiler is now available at UCC; it runs on the CRAY-1 under the CRAY Operating System (COS).

C is a medium-level programming language that supports the use of data structures, character strings, and structured control flow. And, like assembly language, C provides the ability to take advantage of the hardware.

C allows this in part through the support of dozens of operators that let you manipulate bytes, addresses, and words efficiently. Pointers to machine addresses also encourage efficient coding. These pointers reference specific data types and you can manipulate them arithmetically. For example, if you increment the pointer to byte number one with the >> operator, the new pointer points to byte number two.

Data type variety is another feature of C. Predefined data types are byte, integer (long and short, signed and unsigned), and floating point (single and double precision).

Historically, C has been associated with the UNIX operating system. UNIX was originally written in PDP-11 assembly code. But with the addition of new functions and utilities, it became increasingly difficult to move UNIX onto new hardware. To make it more portable without sacrificing its efficiency, UNIX was rewritten in C. The built-in features of other languages (input and output, string handling) were replaced with function calls to a standard library suited to the hardware and facilities of the host machine. To move UNIX to a new machine involved writing a C compiler for the host machine and providing the proper support routines in a library.

Our C compiler consists of two passes: a preprocessing phase and a main compiler phase. The preprocessor provides for language extension. It serves as a macroprocessor that performs simple substitutions and it provides for the inclusion of source code on external files. Kernigham and Ritchie's *The C Programming Language* describes the input to the preprocessor.

The "CC" procedure invokes the C compiler on the CRAY. "CC" combines the ACCESSes to the necessary files, the preprocessing step, the main compiler pass, and the assembly step. For more information about "CC," see WRITEUP(CRAY=CC) on the CYBERs.

Although Cray Research does not formally support the compiler, they are interested in any bugs you encounter. (The compiler has undergone a standard set of tests put out by Bell Labs.) Direct your questions or problems to the HELP-line, 376-5592, or to Jane Gehan, 376-5262. *(Jane Gehan)*

REFERENCES

Stephen Johnson, "The C Language and Models for Systems Programming." *Byte*, August 1983.

James Joyce, "A C Language Primer, Part 1: Constructs and Conventions (or Finnegan's Wake)." *Byte*, August 1983.

Kernighan and Ritchie, *The C Programming Language*. Prentice-Hall.

Richard Lee, *The Exportable CRAY-1 A Compiler*. Bell Labs.

Bruce Roberts, "The C Language." *Byte*, August 1983.

Microcosm

NEW VERSION OF COM

Version 4.0 of COM for IBM, Zenith, and Xerox microcomputers is now available. This new version includes several new features: more flexible configuration, improved recording, and micro to micro file transfer.

COM is a communications program that allows your micro to talk to the University's mainframe computers. You can use COM to turn your microcomputer into an intelligent terminal. It will also allow you to communicate with other mainframe computers, microcomputers, or peripheral devices attached to your microcomputer.

If your micro has two serial ports, the new version of COM can use either one. This is convenient when you have connected a printer to your computer's main serial port. COM can be configured to use the other serial port.

You can configure COM for computers other than UCC mainframes. Different computers use different values for the communications parameters: parity, word size, and stop bits. You now have control over these communications parameters. By adjusting the values for parity, word size, and the number of stop bits, COM can be configured to communicate with almost any other computer, not just the University's mainframes.

COM supports automated file transfer to and from the University Computer Center's CYBER and VAX computers. This eases the sometimes complex task of transferring information between microcomputer and mainframe. COM can also be adapted so this automated file transfer can be done with almost any computer.

In the past, the easiest way to transfer a file from one microcomputer to another was to first send the file to a mainframe computer, then get the file from the mainframe with the other micro. The new version of COM allows you to transfer the files directly from one microcomputer to the other. The microcomputers can be connected with a modem, or they can be connected directly with a cable. If the micros are connected directly by cable, COM allows you to do this file transfer at high speed (up to 9600 baud), which dramatically cuts the transfer time.

COM can now record a session or file directly to disk without size limitations. Previous versions of COM recorded information to memory only. This meant that the amount of information you could save was limited. COM now stores the recorded information directly to a file on your disk. Now the amount of information you can record is limited only by the amount of free space on your disk.

COM has been enhanced to communicate at baud rates above 1200 baud. Characters are written to the screen faster than in previous versions of COM. COM now supports the XON/XOFF method of software handshaking to prevent loss of characters at high baud rates.

Version 4.0 of COM is available for the IBM-PC, XT, and AT (PC-DOS 1.1, 2.0, 2.1, and 3.0), Zenith Z-100 (both CP/M and Z-DOS), Xerox 820 (model I and II, CP/M), and the Heath/Zenith 89 and 90 (CP/M). The IBM-PC version of COM can also be used with a number of IBM-compatible microcomputers including the Zenith Z-150 and Z-160.

The new and improved version of COM, version 4.0, is available in the Williamson Book Center at the electronics desk for $50. Like all software produced by the Microcomputer Systems Group, free software updates for one year from date of purchase are available in 125 Shepherd Laboratories from 9:30 a.m. to noon and 1:30 to 4 p.m. If you purchased COM for one of the microcomputers listed above within the last year, bring in your original diskette and receipt for the free update.

Call the Microcomputer HELP-line, 376-4276, for further information.

(*David Larsen*)

A NEWSLETTER OF OUR OWN

In November 1984, the University Computer Center's Microcomputer Systems Group began to publish its own newsletter. The *Microcomputer Newsletter* appears about once a month as a supplement to the regular UCC *Newsletter*; it concentrates on issues of interest to microcomputer users in the University community.

For more information, or to be placed on the mailing list, write to:

UCC Microcomputer Systems Group
227 Experimental Engineering
208 Union Street SE
Minneapolis, MN 55455

or call the Microcomputer HELP-line, 376-4276, from 9:30 a.m. to noon and from 1:30 to 4 p.m., Monday through Friday.

Graphics

DICOMED D47 SERVICE

UCC provides slide and Polaroid film recording services on a Dicomed D47 film recorder. The prices for this service will change on January 1, 1985. We are increasing the D47 prices and discouraging use of this service for three reasons.

First, the Dicomed D47 is getting older, making it more susceptible to failure and more expensive to repair. For the past year we feared a catastrophic failure (e.g., a display tube burnout) that might be irreparable and immediately end our slide service. We would much rather phase the D47 service out slowly so you can make alternative plans for your graphics needs. We are investigating whether we can produce magnetic tapes that can then be processed into slides elsewhere. If this can be done inexpensively, we will continue the service.

The second reason for our rate change is that the D47 recording service began years ago when we provided an experimental image processing service. Both that image processing service and the D47 recording service failed to generate enough income to cover their costs and we made up the difference from other revenues. The image processing service was discontinued last year. Today supercomputers, microcomputers, and departmental computers provide convenient and cost-effective computing in their respective spheres. We must be certain that any service we offer pays for itself; if it does not, we will eliminate it.

The third reason is that most D47 slide use is related to the TELL-A-GRAF and DISSPLA packages on the VAX/VMS system. This system is not one of our priority services. We intend the VAX graphics services to be used indirectly by those who use our central computer services. But general VAX computing service is not part of our future plans. And finally, the costs of these VAX services are not covered by our charges. In fact, our vendor payment for TELL-A-GRAF and DISSPLA software exceeded our total revenue for D47 services in the 1983-1984 fiscal year.

We will increase our D47 prices and may eliminate the service because we must focus on those computing services that are properly part of our mission. Currently available microcomputer software and hardware can provide better and more cost-effective graphics services than many of our facilities. We will continue to provide and expand the graphics services most useful to users of our large-scale and supercomputer services. We will report on these plans in future *Newsletter* articles.

In summary, we will increase the prices for UCC D47 slide services effective January 1, in an attempt to recover the costs for providing this service. We are in the process of deciding whether to continue this service; our decision will be announced in the March 1985 *Newsletter*. Exhibit 1 contains the new price list. (*K.C. Matthews*)

35 mm color slides	$15.00/slide
70 mm color slides	$25.00/slide
Polaroid color	$25.00/print
4x5 color prints	$30.00/print
35 mm b&w slides	$12.50/slide
70 mm b&w slides	$22.50/slide
Polaroid b&w	$22.50/print
4x5 b&w prints	$27.50/print

Exhibit 1. Dicomed D47 service price list.

ISSCO USERS GROUP

The Minnesota ISSCO Users Group will hold its next meeting on Tuesday, December 11, at General Mills. For more information about this meeting, call Colleen Thompkins at NSP, 330-5836. TELL-A-GRAF and DISSPLA, two graphics packages available at UCC, are ISSCO products.

The Classifieds

Wanted

Used Zenith Z-100 microcomputer. Price must be reasonable. Payment by journal voucher preferred. 373-3137.

All Systems Bulletins

HOLIDAY HOURS

Operating hours during the upcoming holidays will be as follows:

	CHRISTMAS Down		Up	
CRAY-1	3:00 p.m.	Mon 12/24	7:00 a.m.	Wed 12/26
CYBER CA	3:00 p.m.	Mon 12/24	7:00 a.m.	Wed 12/26
CYBER ME	3:00 p.m.	Mon 12/24	7:45 a.m.	Wed 12/26
CYBER MD	3:00 p.m.	Mon 12/24	8:00 a.m.	Wed 12/26
VAX 11/780	3:00 p.m.	Mon 12/24	7:00 a.m.	Wed 12/26
Experimental Engineering Station	Midnight	Sun 12/23	8:00 a.m.	Wed 12/26

	NEW YEAR'S Down		Up	
CRAY-1	5:30 p.m.	Mon 12/31	7:00 a.m.	Wed 1/2
CYBER CA	5:30 p.m.	Mon 12/31	7:00 a.m.	Wed 1/2
CYBER ME	5:30 p.m.	Mon 12/31	7:45 a.m.	Wed 1/2
CYBER MD	5:30 p.m.	Mon 12/31	8:00 a.m.	Wed 1/2
VAX 11/780	5:30 p.m.	Mon 12/31	7:00 a.m.	Wed 1/2
Experimental Engineering Station	Midnight	Sun 12/30	8:00 a.m.	Wed 1/2

PHONE NUMBERS

Access:
- CYBER(CA)—10, 30 cps 376-5730
- —120 cps 376-5706
- MERITSS(ME)—10, 30 cps 376-7730
- —120 cps 376-7120
- VAX/VMS(VA)—(autobaud) 376-9770

Budgets 373-2521
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- HELP-line 376-5592
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- Statistics Packages 376-1761
  1-2 p.m., Monday-Friday
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  9:30 a.m.-noon and 1:30-4 p.m., Monday-Friday
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  1-4 p.m., Monday-Friday

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Tape Librarian: see Lauderdale Services
Text Processing Services 376-2943
User Accounts 373-4548

OPERATING HOURS

	CYBER (CA)	Low rate	CRAY (CR)	MERITSS (ME)	VAX (VA)
M-F	7 a.m. - 4 a.m.	8 p.m. - 4 a.m.	7 a.m. - midnight	7:45 a.m. - 3:30 a.m.	8 a.m. - 6 a.m.
Sat	4 a.m. - 5:15 p.m.	4 a.m. - 5:15 p.m.	7 a.m. - 5 p.m.	7:45 a.m. - 3:30 a.m.	24 hours
Sun	4 p.m. - 1 a.m.	4 p.m. - 1 a.m.	4 p.m. - midnight	4 p.m. - 3:30 a.m.	24 hours

PUBLIC LABS—TWIN CITIES CAMPUS

Location	Batch	Interactive	Micro
East Bank			
Arch 148		X	X
CentH		X	
ComH		X	
DiehlH 270, 207		X	
EltH 121, 125		X	
EltH N640	X		
Exp Eng 130		*	
FolH 14, 14a	X	X*	X
LindH 26	X	X	
MechE 308		X	
Physics 69		*	
SanfH		X	
TerrH		X	
VincH 4		X	
WaLib B9		X	
West Bank			
BlegH 25		*	
BlegH 90	X		
BlegH 140		X	
MdbH		X	
OMWL 2		X	
SocSci 167			X
St. Paul			
BaH		X	
ClaOff 125	X	X	

* Research cluster; access to CYBER CA and VAX/VMS
X in interactive column indicates access to MERITSS

Contents

Michael M. Skow, Acting Director

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