Engineering News

VOLUME 3/ NUMBER 8 SEPT. 1976 JOYCE LEKAS, EDITOR X6601 RHYS SCHROCK, ASSOCIATE EDITOR X6071 DS 50/462

HIGH LEVEL LANGUAGE FOR MICROPROCESSORS

by Norm Kerth & Bill Randle

A growing controversy exists among microprocessor software engineers over the use of high level languages. Intel's PL/M has been available for three years, and other manufacturers are developing or have developed languages of their own. Tektronix's TESLA is also maturing rapidly. However, criticisms of these languages "takes up too much memory" or "too slow execution time" are often heard.

Programming in a high level language (HLL) has several advantages over programming in assembly language (ASM) during the implementation, debugging, and documentation of software.

Implementation

Studies [1,2,3] show that a programmer produces the same number of source language statements per time unit regardless of which level of language is used. For a given program, an HLL uses less statements than an ASM. The result is a time reduction of 60-80%, depending on the size and complexity of the program.

Debugging

A frequent error in writing assembly language programs is the misuse of the machine registers. This does not happen in an HLL program because the compiler has control over the registers. In general, fewer errors are made and thus less debugging is needed using an HLL.

Errors that do crop up in an HLL program are usually easily diagnosed logic errors. The same logic errors in an ASM program tend to be obscured by the multiplicity of instructions as well as by the fact that the programmer's attention is divided between the machine status and the program itself.

Less elaborate debugging tools are required for a high level language. This is because HLL debugging primarily involves focusing attention on program steps rather than looking inside registers. An adequate debug box might consist of an address word recognizer, memory interrogation, and single step features with address and data bus displays. →

Documentation

An HLL tends to document itself, since the language reads more like English or mathematics, e.g., X=1, as opposed to LDI 1, STA X. Also labels are more understandable since more characters are permitted (32 using PL/M, as compared to 5 characters allowed by most assemblers.) For example, ALLOCATE$DATA$BUS is more readily understandable than ADBUS.

A source listing using a block-structured HLL like PL/M or TESLA with indentation reads like an outline, with major ideas at left and sub-ideas indented at the right. Thus particular sections can be found very quickly and can be followed easily.

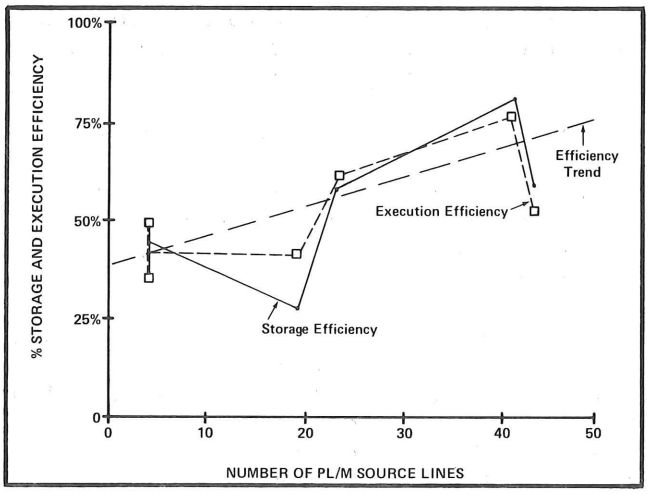
Efficiency?

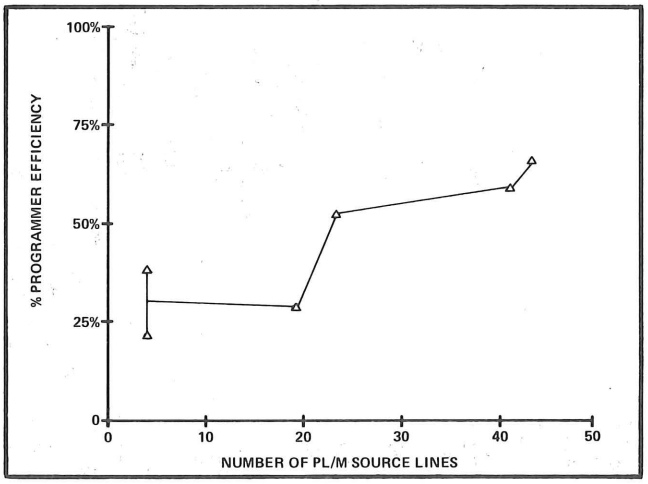
The trade-off in using an HLL is that it requires more storage space (memory) and execution time. The present compilers for microprocessor HLLs are not as efficient as coding by hand. This inefficiency causes extraneous machine code to be generated, which takes up more memory. More instructions also take longer to execute.

Execution time is not always critical, however. And even where the HLL program is too slow for the application, research[5] has shown that hand coding a relatively small portion of the program (only the most time-consuming sections) will usually solve the problem. And the availability of increasingly larger, cheaper ROMs should soon make the problem of increased storage less significant.

A Comparison of Efficiency (PL/M vs. ASM)

A comparison of the efficiency of an HLL and assembly language was made using a set of floating-point math routines originally written in PL/M and rewritten in assembly language in order to decrease execution time. For this group of not necessarily typical routines, comparisons were made of storage space, execution time, and program length (number of lines).





Figures 1 and 2 summarize the results. It can be seen that efficiency of PL/M over assembly languages apparently tends to increase as program size increases.

$$\%\ \text{Storage Efficiency} = \frac{\text{ASM storage (Bytes)}}{\text{PL/M storage (Bytes)}} \quad 100\%$$

$$\%\ \text{Execution Efficiency} = \frac{\text{ASM total memory fetches}}{\text{PL/M total memory fetches}} \quad 100\%$$

$$\%\ \text{Programmer Efficiency} = \frac{\text{ASM source code lines}}{\text{PL/M source code lines}} \quad 100\%$$

Three factors might contribute to this. First, as the program gets larger, the assembly language programmer becomes less able to visualize the entire program at once and therefore writes less efficient code. Second, the overhead in calling a procedure is significant in short procedures, but is a small percentage of long programs. Third, the efficiency of the compiler depends on the type of instruction compiled. A short program of inefficient HLL instructions will compile into less efficient machine code than a larger program with perhaps a mixture of efficient and inefficient HLL instructions.

Most of the inefficiency in the math routines is probably due to the nature of the algorithms. They involve a lot of bit manipulation, which is hard to do elegantly in PL/M. Higher efficiency would probably have resulted if a different class of routines, such as I/O or control, had been tested.

If the execution time of a critical loop is a concern, the assembly language output from the compiler can be hand optimized, then run through an assembler to generate the machine code. In this study, the loop in the largest routine (a DIVIDE) was hand optimized. A 26% reduction in execution time was achieved, with corresponding 15% decrease in storage requirements. →

(A similar comparison of PL/M vs. ASM reported by Microcomputer Technique, Inc. in "New Logic Notebook" tends to support these findings.)

Conclusions

To improve the efficiency of HLL programming for microprocessors, an optimizing compiler is needed. Several HLLs, e.g., FORTRAN and ALGOL, currently have optimizing compilers for large computers that can generate machine code to execute faster and take less memory than the equivalent hand coded program. TESLA and a new version of the PL/M compiler are almost here and will include improved optimization routines. This should considerably expand the use of high level languages in microprocessors.

Some years ago, high level languages were popular only on large machines, while mini-computer users scoffed at the idea of using a high level language. Now most minis are programmed in HLL. History repeats itself as high level language creeps into the micros.

References

1. Corbato, F.J., "Sensitive Issues in the Design of Multi-use Systems", Lecture at the opening of the Honeywell EDP Technology Center, (1968).
2. Taliaffero, W.M., "Modularity the Key to Systems Growth Potential," **Software**, 1, (1971), pp. 245-57.
3. Brooks, F.P., Jr., The Mythical Man Month, Addison-Wesley, Reading, Mass. (1975) Ch. 8, pp. 87-94.
4. Ogdin, J., "PL/M vs. Assembly Language—Part 2", **New Logic Notebook**, v. 1, no. 4, (Dec. 1974).
5. Corbato, F.J., J.H. Saltzer, and C.T. Clingen, "Multics—The First Seven Years", AFIPS PROC SJCC, 40 (1972), pp. 571-582.

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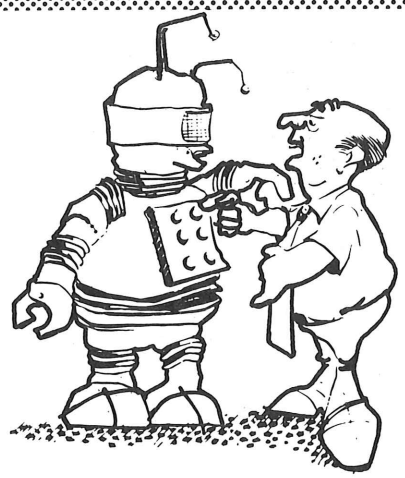
TALKING TO MACHINES

Speech Recognition



Long a popular feature of science fiction, the ability to talk to machines and have the machine respond, either by action or word, has recently received a lot of attention by industry and researchers. Advances in digital speech processing, minicomputers and microprocessors have certainly contributed to this increasing interest, but a separate major influence has been a $15 million five-year speech-understanding project begun in 1971 by ARPA (Advanced Research Projects Agency). These ARPA funds have been distributed to speech-recognition research projects at a number of universities and laboratories, the specific end goal being the development of a machine that can understand a 1000-word vocabulary of continuous speech, limited to a small number of speakers. In addition to the ARPA program, there are major efforts with similar goals underway by companies such as IBM and Xerox.

These goals are still a long way from the HAL computer in the movie **2001**. HAL, if you'll remember, understood not only every word spoken by the space explorers, but was receptive to emotional stresses and a little too perceptive when it came to hidden meanings and reading between the lines. Actually, the development of a machine understanding unlimited vocabulary connected speech by any speaker may not happen this century, if ever.

"What speech recognition systems are possible in the next few years?" one might ask. No existing machine could understand and answer that question, but there are some limited capability voice recognition machines on the market which have already found applications in industry. The literature commonly refers to three modes of **voice input** to machines:

1. **Isolated word recognition** systems are available commercially for $10,000 and up, but their cost is expected to drop an order of magnitude in the next few years. These systems are usually trained to recognize one voice. Vocabulary is limited and must be fed to the machine one word at a time by the person who will use it. →

Then input is compared against the stored vocabulary, and the machine acts accordingly. The actual meaning of the words is not considered by the machine – only how it has been trained to respond to a particular speech pattern. So it is possible to train the machine to go when you say "Stop" or to shut off when you say "Hiya Fella." **Isolated word recognition** systems are used in "hands-free" situations such as mail or package sorting where the operator is handling packages of different sizes and can call out digits and letters. Systems have also been designed for use by severely disabled persons and the blind. One comapny has designed a **word recognition** system which does not have to be trained by each user by use of a technique called "Greek chorus." The machine is trained by feeding it each word as spoken by 50 or 100 people. All the voices are combined to model each word, and the machine continually updates each word as it is used. In this way, the machine becomes more familiar with each speaker the more it is used.

2. **Speaker verification** systems identify the speaker and determine if he is really who he says he is. **Speaker verification** is also used with **word recognition** systems to identify a speaker and reference subsequent discussion to that speaker's pre-stored vocabulary. Applications include identification for security systems or banking transactions. The following fictional scene of a banking transaction includes both the **word recognition** and **speaker recognition** modes of voice input, as well as **voice generation** (or voice response) by machine. (See Engineering News, March 1976, p. 11 for a description of a voice-generation machine which is presently on the market.)

Computer: Please enter your account number.
Customer: OU812 (The computer finds this number, verifies the speaker's voice pattern, then finds that user's file and pre-stored vocabulary.)
Computer: Would you like to make a withdrawal or a deposit?
Customer: Withdrawal.
Computer: What is the amount that you wish to withdraw? (The computer includes a verification of the last spoken message with this question.)
Customer: Fifty dollars.
Computer: Will two twenties and a ten be adequate denominations for your fifty dollar withdrawal. (Again, verification of previous message.)
Customer: Yes.
Computer: Thank you and don't spend it all in one place. (The money comes out a slot.)

3. **Continuous speech recognition** is much more difficult to achieve. For one thing, in speech it is often hard for a machine to distinguish or separate words. This problem is usually compensated for in human speech by contextual clues. As an example, the phrase "Hand some ice in" was spoken to four subjects who were given no contextual clues. The four results were:

han some I sen
hand some ice in
hansomism
handsome icing

It can be seen that even a machine which exactly duplicates the human ear could have difficulty with connected speech. Future speech recognition systems will have to imitate the way humans subconsciously use knowledge of the language, environment, and context to fully understand speech. These sources of knowledge (KS) include phonetics, variable pronunciation, stress and intonations, the sound patterns of words, syntax, word meanings, and context of the specific conversation.

A machine that anyone could speak naturally into and receive immediate typed copy doesn't seem likely in the near future. But industry is beginning to realize the tremendous possible benefits of speech recognition technology. In the next few years there will be an increasing number of systems in industry using designated speaker, limited vocabulary, voice recognition systems. There will also be corresponding increase in research into the more difficult concept of user-independent, total speech recognition systems.

Rhys Schrock

For more information on Speech Recognition, see:

1. IEEE Special Issue on Man-Machine Communications by Voice, Proceedings of the IEEE, April 1976.
2. DATAMATION Magazine, August 1976, p. 65.
3. COMPUTER Magazine, May 1976, p. 40.
4. Don Terwilliger, ext. 6610.
5. Robert Chew, ext. 7020.

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IN PRINT

Stu Rasmussen, TV Product Marketing, authored an article which appeared in the July/August issue of VIDEO SYSTEMS magazine entitled 'Video Frequency Response - So What?' He describes how to check frequency response specs on a video system by combining ". . . . visual response checks done with a test pattern, and the electrical response measurements made by using a waveform monitor and test signal generator . . . ."

CATHODOCHROMICS

Dorothy Geroche

Cathodochromic storage tubes would be useful for document retrieval (their gray scale capabilities are suitable for photographs and x-rays), signature verification, computer terminals, chartroom displays, etc. Dr. Todd has also been working on photoluminescent cathodochromic displays and developing a cathodochromic tube with a flood gun readout.

On August 16 in the Technical Center Auditorium, Dr. Lee T. Todd, Jr. of the University of Kentucky gave a talk on cathodochromic materials and devices. Dr. Todd was invited to speak by the Display Research group.

Cathodochromics are materials which change color when excited by an electron beam. The coloration is reversible either by bleaching with light or by heating. The materials, which include sodalite, alkali-halides, calcium-titanate and others, are reflective rather than light-emitting, although they may luminesce under certain conditions. Cathodochromic dark trace storage tubes have been developed, and interest in them is increasing because of their simplicity and high resolution capability.

The major advantages of cathodochromics are:

1. High resolution (the limitation is essentially the spot size of the writing beam).
2. High contrast (10:1 contrast ratios are easily obtainable and contrast does not degrade under bright lighting).
3. Long storage time (essentially infinite).
4. Good gray scale capabilities (up to 30 levels possible).

The main problem with cathodochromic storage tubes has been the difficulty of building economically feasible erasable displays. Dr. Todd has been working on improving erasure in devices using sodalite.

Although sodalite can be erased under certain conditions either by light or by heat, most of the interest has centered on heat erasure. It became feasible to use the material in storage tubes when it was discovered that an oxidation process would render sodalite easily erasable by the heat of an electron beam. This discovery by Dr. Todd, who was then doing graduate work at MIT, caused him to expand his interest from materials to device development. Several different approaches have been taken to the cathodochromic storage tube structure by RCA and others interested in it. These have included a dual-gun model and one which uses a white-on-black display. The tube developed by Dr. Todd and his colleagues at MIT uses a single gun.

The white-on-black display was one attempt to solve a problem inherent in electron beam erase. Owing to the Gaussian distribution of energy in the beam, the cooler edges of the erase beam are simultaneously writing while the middle of the beam is erasing. This leaves streaks in the erased display. The white-on-black display camouflaged the streaks, but the screen took several minutes to erase.

The MIT storage tube handles this problem by overlapping the beam positions of successive scans. If the second scan occurs before the area heated by the first scan has a chance to cool down, the combined energy in the overlap area will erase the streaks. The thermionic time constant of the screen (the time it takes the screen to cool down) can be adjusted by varying the screen thickness.

The characters on this type of display are darkened by scanning more than once. They must be rescanned rather than continuously bombarded to prevent heat from building up and erasing the character. The cathodochromic storage tube developed at MIT uses a circular lamp behind the screen to enhance the contrast by integrating the reflectiveness of the material through the screen thickness. individual dots have a 15 us writing time and a 40 us erase time using a 20kV acceleration potential on the MIT storage tube.

USES OF CATHODOCHROMIC STORAGE TUBES

The material can be used for small screen direct viewing tubes.

The erasure time for larger screen direct viewing tubes (one minute to erase an 8½" by 11" screen using a 10W electron gun) would be objectionable in many cases. However, Dr. Todd has been working on a storage tube which projects a small cathodochromic display onto a large viewing screen (6 ft. by 4 ft.) with good, high resolution results.

Hydrogen Sulfide Testing

HYDROGEN SULFIDE TESTING (Understanding Its Purpose)

In the past the necessity and validity of the H_2S Tests at Tek have frequently been challenged. Some reasons for this are lack of understanding of the purpose of the tests, lack of documentation of the test procedures, and misinterpretation of test results.

Earlier this year, **Bob Aguirre, Bill French and Elmar Wefers,** all of Switch and Relay Engineering; **Wally Doeling and Doug Reed,** Electrochem Engineering; **Bruce Goodwin,** Component Evaluation; and **Jim Simley,** Environmental Test Lab questioned the test in an attempt to understand it, and they documented the test procedure. In a moment, the results of that trial.

The purpose of the H_2S Test is to show the quality (good or bad) of the protective coating or plating which is sometimes placed over copper and some copper alloys. Copper (copper conductors on EC boards), or copper alloy parts (contact made from phosphor bronze or beryllium copper), are usually plated with tin, nickel, or gold or combinations thereof. The quality of the plating in this case refers to the porosity of the plating and the inclusion of copper particles in the plating. The gold plus nickel plating over the copper is one of the most critical. One of the prime chemical properties of gold is its inertness to oxidation and chemical attack. If low contact resistance is required of a gold plated part over a long time, porosity in the gold plating will allow corrosion of the base metal (copper) and increase the contact resistance.

Hydrogen sulfide gas provides a corrosive atmosphere for showing the porosity of protective plating within a relatively short time. The test is **not** some kind of corrosive lift testing nor does it attempt to simulate specific environments.

Why Hydrogen Sulfide?

Other gasses such as sulfur dioxide or oxidants of sodium can be used instead of hydrogen sulfide and will yield similar results. The advantages of H_2S are that it is relatively inexpensive and the methods of H_2S gas generation are simple:

1. A solution of equal parts of saturated sulfurated potash and water is prepared.
2. The solution is left to stabilize for 72 hours.
3. As the solution breaks down H_2S is released.
4. The gas concentration is regulated by the surface area of the solution which is exposed to air.

Generation techniques for sulfur dioxide are more complicated and according to Chet Schin, Corporate Chemist, and Jerry Turnbaugh, Safety Services Manager, using gas purchased in cylinders is potentially less safe than the do-it-yourself method described above.

It took quite some time to come up with a level of gas concentration controllable within tolerances that would yield useful results. Most references consulted mention a H_2S gas concentration between 0.2 and 10 parts per million. However, these references usually list the H_2S as a part of a gas mixture which tries to simulate certain environmental conditions.

After some experimentation a level of 4 ppm $^{+4ppm}_{-3ppm}$ was chosen. At first glance this appears to be a loose tolerance, but the gas concentration drops drastically as soon as parts are placed in the chamber. The parts appear to either adsorb ate certain environmental conditions.

After some experimentation a level of 4 ppm $^{+4ppm}_{-3ppm}$ was chosen. At first glance this appears to be a loose tolerance, but the gas concentration drops drastically as soon as parts are placed in the chamber. The parts appear to either adsorb or absorb some of the H_2S gas. Depending on the material and surface area of the parts, the H_2S concentration level may drop from 4ppm to 1ppm. The concentration is monitored with a Bendix gas analyzer. Exposure to hydrogen sulfide alone does not provide an adequate corrosive environment. Humidity is required also, both before and after.

From all this information the following test sequence evolved. The test specimen is submitted to:

1. Twenty-four hours of 90-98% relative humidity per MIL STD 202E, METHOD 106D, less steps 7a and 7b.
2. Twenty-four hours exposure to a H_2S concentration of 4 ppm at 70% +10% relative humidity, 20° to 25°C.
3. Eight days of 90-98% relative humidity per MIL STD 202E, METHOD 106D, less steps 7a and 7b.

Interpretation of test results is still not entirely settled. Obviously if the test specimen turns a rich black color the protective plating must be like a sieve (no good). If it stays a shiny uniform gold or silver color the protective coating is dense (or may have an additional film of oil over the plating!) and supposedly good. But what about the borderline cases?

A frequent misinterpretation goes like this: A gold plated EC board undergoes the H_2S test. The conductor runs are →

.040 inches. After the test the board shows badly corroded conductors. The conclusion is "lousy gold plating!"

Very little can actually be concluded about the plating quality from such a test. The edges of conductor runs have approximately 2.5 mils of exposed copper. The copper will readily corrode and chances are good that the corrosion will creep over the "protective" gold plating. If anything can be concluded from this it is that it is not good design practice to use narrow runs with exposed copper edges. Use immersion tin.

To put things in the right perspective it should be pointed out that Tek follows generally the environmental test procedures as outlined in MIL T-28800B, which specify humidity testing. The H_2S Test is a voluntary in-house comparative test procedure which is very useful, but not official. Properly used Hydrogen Sulfide testing could be a convincing control test for periodic checking of the quality of our production plating of gold/nickel over copper.

If you have any questions, suggestions or other input, contact any of the persons mentioned above.

Elmar Wefers
ext. 5814

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TECHNICAL STANDARDS

DOD (Department of Defense) has adopted a new identification system for "hard metric" or "hard converted" items, and other distinctly metric documents, as opposed to documents for "soft converted" items. The new system replaces the symbol "MIL" with "DOD" in new and revised specifications and standards as described above. For example: MIL-B-24507 (Batteries) is now DOD-B-24507A.

These new standards will have an Improvement Request form as their back cover. Anyone using a DOD standard and wishing to make inquiry or comment is encouraged to do so. The IR forms may be duplicated.

CRT TECHNOLOGY

Kevin Considine, Display Research, has been invited to present an overview of CRT technology at the 1976 Biennial Display Conference at the Statler Hilton Hotel in New York City. Kevin's paper will start the Electrophoretics session at 9:00 a.m., Thursday, October 14. He will examine the primary reasons for the cathode ray tube's continuing dominance in the display field, and review recent developments in CRT technology, including storage, projection CRTs, flat CRTs, electron emmitters, and color CRTs. Kevin will also compare CRTs with new display technologies.

SPS Tek BASIC

Signal Processing Systems (SPS) Tek BASIC will be taught this term by Gary Fouts, SPS Engineering through the Tektronix Education Program. Classes are on Tuesday from 4-6 in Conference room A in building 55. The first session is scheduled for September 28. Anyone interested in this new signal processing software package (and has access to a PDP-11 computer) is encouraged to sign up through TEP.

A LOOK AT METRICS

The following information is from a metric survey which was conducted by the Standards Engineers Society (Minnesota Section) early in 1976.

Four hundered and twenty-eight questionnaires were sent to American industries to determine the extent of metric usage. Of the 125 replies, 54 were from electronic industries and 47 from mechanical industries. Twenty-two of the electronic industries (including TEK) were manufacturers of electronic equipment.

Since we fit into this category, this summary is confined to these 22 respondents. Fourteen reported they used dual dimensioning (but only six had conducted formal in-house metric training). Nine companies have used metric fasteners and components, twelve have metric committees, nine have a plan for conversion to metric and three of these have already begun to convert. Five companies have designed and manufactured new products in metric.

Most of these companies have not yet established time-dated plans for conversion prior to 1980. The survey reveals an awareness of, and some progression into metrics, but conversion to metric usage appears to be an evolutionary process. I believe that we can expect the metric conversion movement to accelerate.

—Chuck Sullivan, Technical Standards

IN PRINT

John E. Reichen, Cost Analyst, wrote an article which appeared in the May/June issue of PERFORMANCE, official magazine of the Society of American Value Engineers. The article, entitled "Design to Cost," describes the Design to Cost (DCT) technique which is used in Value Engineering to set cost goals and parameters early in product design.

Scientific Computer Center

ISIS NOW HAS GRAPHICS

ISIS (Interactive Statistics Instructional System) has recently been modified to plot on TEK terminals. Figures 1-2 show some examples of ISIS graphics output. An instruction manual for ISIS can be obtained by typing (after loggin on) WRITEUP,ISIS. The latest information on the program can be obtained by typing HELP,ISIS. If there are any questions or problems call Kurt Krueger, ext. 5976.

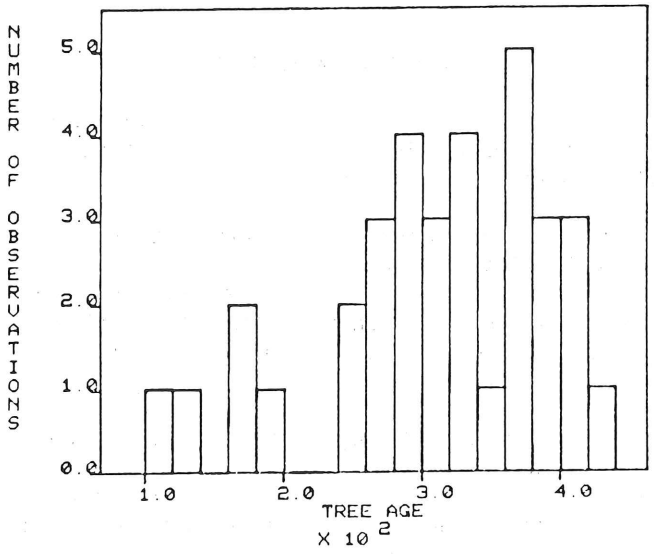


Fig. 1. Histogram generated by Unides.

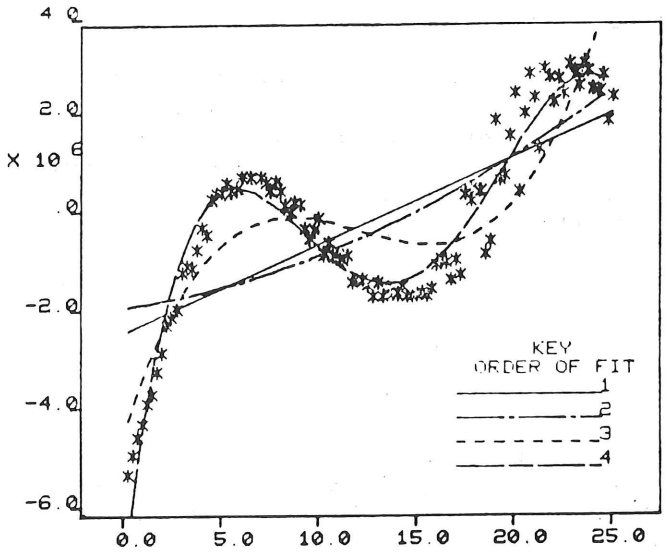


Fig. 2. Polynomial F17 by program POLREG. The data is from a sixth order curve with some random error in X.

NEW SCIENTIFIC SOFTWARE – IMSL

The Scientific Computer Center has recently acquired the IMSL library of mathematical and statistical subroutines for use with FORTRAN. These routines form an up-to-date and fully supported software library. This library is intended to replace the SSP library currently in use.

The IMSL library has several advantages over SSP. Foremost is that IMSL is supported, whereas SSP is not. IMSL has more routines in more areas than SSP and uses more up-to-date numerical methods.

More information can be obtained by typing HELP,IMSL after logging on the CDC. Any questions or comments can be directed to Kurt Krueger, ext. 5976.

MICROPROCESSOR USER'S GROUP MEETING

The monthly MUG meeting was held on Wednesday, August 25. Mark Tratner, Terminal Programming, presented his preliminary benchmarks of the Zilog Z-80 microprocessor. His findings indicate that the Z-80 is probably the fastest general purpose, single chip, 8 bit processor available. Further data should be forthcoming at the next MUG meeting. Support for the Z-80 will be provided by the Microprocessor Support Group. A Z-80 class assembler is nearing completion, as is a preliminary MPU (MicroProcessor Unit) board to plug into existing in-house debugging systems. Associated debug firmware is currently being generated.

Don Dunstan, Scientific Computer Center, announced that TESLA, Tek's new high level programming language, is now being released for the Motorola 6800 microprocessor, and is approximately 75 percent ready to run on the CYBER 73. Users are being solicited, and can reach Don at extension 5616. Two TESLA classes will be offered through TEP this fall. See the TEP Fall Catalogue for schedules.

Inquiries regarding the Microprocessor User's Group should be directed to Bill Lowery, ext. 5865.

STATISTICAL CIRCUIT DESIGN SEMINAR: A REPORT

On August 16, there was an SCD seminar presented by John Golembeski of the Bell Laboratories. (See Engineering News, Aug. 13 issue.) Discussions with engineering groups on SCD applications at Tektronix were held subsequent to the seminar. A sampling of the responses of groups and →

individuals and additional discussions led to the following conclusions:

1) The seminar was well received.
2) The need for an SCD capability at Tek ranged from very strong to very weak depending on the group or individual speaking.
3) The general concensus on implementing an SCD capability at Tek was neutral to negative primarily because of the resources required to develop and maintain such a facility.

Several suggestions were made by Tektronix staff with respect to more critical CAD support of their efforts. Present modeling capabilities (primarily the Gummel-Poon model in SPICE 2) do not adequately characterize "real world" phenomena. Our present transistor library data base is misleading and inadequate. The availability of a statistical data base for discrete devices would be a valuable tool. The need for adequate logic design and analysis aids was a major concern.

With these inputs, it is apparent that a full-scale effort on an SCD facility is not warranted. There is still some communication required with the Bell Laboratories on SCD, but for the present, our efforts will be low level.

I would like to thank all the individuals and groups who helped me with the seminar and discussions. The cooperation I received was significant.

Ron Bohlman

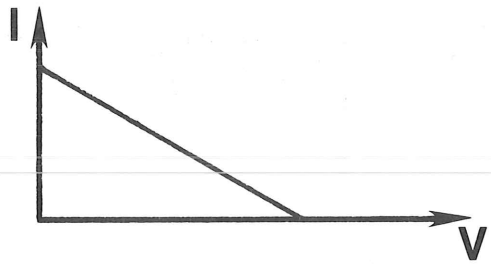
COMPUTER NETWORKING

Computer Networking is the subject of a book of selected reprints published by the IEEE and recently acquired by the Tektronix Library. In this volume computer networking is considered to be an interconnection of computer systems and/or terminals together with communication facilities. The 46 papers included in this volume cover network technology, design considerations, networking examples, network management, and future developments.

Load Line Plotting with the DPO

Are you designing power converters or other circuits which involve medium to high power switching of reactive or inductive loads? Are you interested in measuring the switching transistor's load line characteristics to see if you're avoiding secondary breakdown and other sinful operating areas? Hoo-boy, have I got something for you!

What you want is the familiar I-V graph like the one shown below with a sample resistive load line.



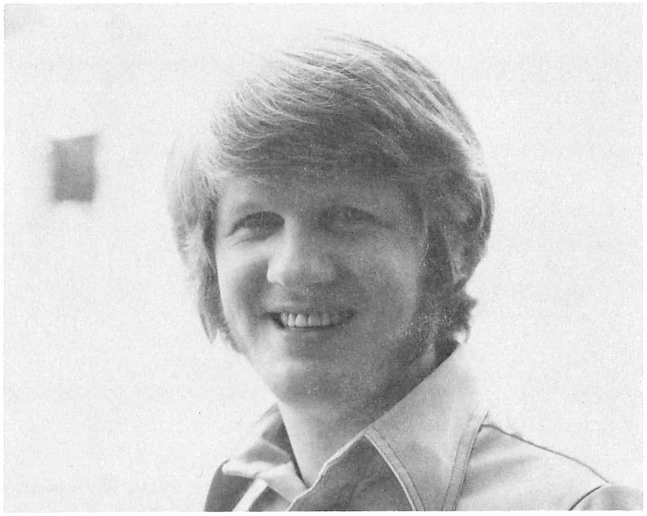
You can make this a real time measurement by using the X-Y mode of your scope. But even the speedy 485 will significantly taint results obtained at switching speeds above 200 ns due to phase error.

An alternative is the DPO system, which can digitize the voltage and current waveforms without the involvement of the scope's slow horizontal system. A minicomputer then plots the points in the familiar X-Y format on a terminal. The plot is updated several times a minute, so the system is interactive. The versatility of the computer makes additional information displays such as instantaneous power plots possible.

Kit Bradley, x6211, has an operating software package and Bruce Campbell, x6740, has some hardware experience. Give us a call if you're interested.

—Bruce Campbell

TEK EDITORS



Dr. Jack Grimes, IDS, was appointed Technical Editor for COMPUTER magazine. He is responsible for establishing and overviewing the technical content of the magazine. Jack has been with Tektronix since 1971, in which time he has published numerous journal articles, conference papers, and IDG Technical Reports.

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Cliff Schrock, FDI Marketing, has become Technical Editor of CABLEVISION magazine. He will also edit the new quarterly, CABLEVISION'S TECH REVIEW. Cliff began working at Tek in 1973 and has written a number of papers on Cable TV equipment and Spectrum Analyzer Test procedures.

. . . *Call for papers* . . .

★ A symposium on Minicomputers and Large-Scale Computations will be held May 29—June 2, 1977, in Montreal, Canada.

SPONSOR: American Chemical Society Division of Computers in Chemistry

TOPICS: Original contributions not previously published are invited from chemists and nonchemist.

ABSTRACTS: Submit abstracts by December 1, 1976, to:
Prof. Peter Lykos
Illinois Institute of Technology
Chicago, Illinois 60616

Phone: (312) 567-3430

★ **The International Federation for Information Processing Congress 77** will be held August 8—12, 1977, in Toronto, Canada. The theme of the conference will be "The Maturing Profession - Perspectives and prospects."

TOPICS: All papers should be related to the design or use of computer systems, but may include theoretical advances, new techniques, or practical experiences.

ABSTRACTS: Papers must be typed clearly, double spaced, and on one side of each page. Four copies of each paper are due by November 15, 1976.

OTHER: A pamphlet entitled "Instructions and Aids for IFIP 77 Authors" is available from:
Program Committee for IFIP Congress 77
IFIP Foundation
Paulus Potterstraat 40
Amsterdam 1007, Netherlands

★ **The Fifth Annual ACM Computer Science Conference** will be held January 31—February 2, 1977, in Atlanta, Georgia.

TOPICS: Papers are invited which describe current research in computer science.

ABSTRACTS: Submit abstracts by November 15, 1976, to:
Prof. Vladimir Slamecka, Director
School of Information and Computer Science
Georgia Institute of Technology
Atlanta, Georgia 30332

OTHER: An SIGCSE technical symposium on computer science and education will be held on February 2—3, 1977, in conjunction with the conference. Submit symposium papers by November 15, 1976, to John Goda, Symposium Chairman, at the above address.

Maureen Key 60-553